DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

THIRTY-SIXTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1915

WASHINGTON
GOVERNMENT PRINTING OFFICE
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THIRTY-SIXTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1914–15 comprised items amounting to $1,620,520. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES.

A LARGER PUBLIC SERVICE.

In the last decade the United States Geological Survey has largely increased its return to the public, both in amount and in variety of service rendered. The statement was made in this report a year ago that never before had the general public been in closer touch with this Survey or made larger use of the results of its scientific investigations. The recognition by citizens generally that the Geological Survey is a bureau of information as well as a field service has gradually placed upon it a large burden of work as well as of responsibility. The amount of correspondence involved in performing this public duty may be indicated by the fact that approximately 50,000 letters of inquiry were handled in the different scientific branches of the Survey last year. The scope of these inquiries is not less noteworthy, for they range from requests for information concerning the geology of every part of the United States or the water supply, both underground and surface, of as widely separated regions as Alaska and Florida, or for engineering data on areas in every State in the Union, to inquiries regarding the natural resources of foreign countries, especially those of Central and South America.

The changes in the world's trade in metals and other mineral products during the last year brought to the Geological Survey a new opportunity for special service. The inquiries concerning possible sources of this or that mineral product began early in August, and the Secretary of the Interior gave to the public an interview outlining the expected developments in the mineral industry. His

statement was followed by special press bulletins issued by the Survey on the more important subjects. In September, however, the demand for authoritative information had become so lively that a bulletin—"Our mineral reserves" (Bulletin 599)—was quickly prepared and issued without delay. In this publication the whole subject of the country's ability to meet the emergency demands for minerals was summarized and the Survey offered to serve as an agent in bringing consumer and producer into touch with each other. This new function of acting as "central" to the mineral industry proved popular, a large volume of special correspondence developed, and a gratifying use was made of the Geological Survey's list of mineral producers and of the specific information in the possession of the Federal geologists regarding practically every type of mineral deposit in the country. It is believed that this correspondence has been of material advantage to consumers and producers alike—the users of mineral products who were formerly dependent upon foreign sources of supply and the mine operators who have learned of new markets for their output.

The preparation of this special information to meet a new public demand, together with the continued task of replying to requests for specific information, has resulted in placing fresh emphasis on this phase of the work of the Geological Survey. The rendering of such service is in itself instructive to those charged with the duty, and the Survey staff has acquired a keener realization of the need not only of giving the facts to the public, but also of making those facts intelligible and useful to the citizen who lacks professional training in geology or engineering. Two obligations are thus laid upon the Government scientist—first, that of making his investigations more and more exact in method and more definite in result; second, that of transmitting the product of his investigations in a form to meet the needs of not only his professional associates but of the general public. Most scientists in the public service should aspire to the translation of their own reports into the language of the people.

The Survey as the center of public information concerning the geology of the United States bears an educational obligation to the public. It has so far, in part, neglected its opportunity as well as its duty as an investigative branch of the Government to furnish popular information of an instructive type regarding this most enlightening science. In recognition of this educational responsibility and of the importance of making its work more generally intelligible and useful to the private citizen who has not been geologically educated, several members of the Survey have of late given more attention both to the simplification of the language of the professional publications and to the preparation of reports that are popularly descriptive and instruc-

tive, yet also exact and efficient as vehicles for professional discussion or for the announcement of geologic discoveries.

Conforming to this growing conviction, the Survey has printed on the backs of several of its topographic maps nontechnical descriptions of the physical features of the area mapped and of their origin. The evident appreciation by the general public of such explanations of the geologic features as shown by the increased demand for the maps has encouraged the extension of the practice. Accordingly, after the publication of such matter for the map of the Crater Lake National Park, Oregon, the Bright Angel area, in the Grand Canyon of Arizona, has similarly been described, and descriptions for other areas, including the Delaware Water Gap, in Pennsylvania and New Jersey, are now being prepared. This work is a by-product of the geologic mapping and therefore involves comparatively little expense, but it adds greatly to the general interest and educational value of the topographic maps.

Survey geologists have prepared guides covering the points of scenic or unusual geologic interest in the Glacier National Park and in the Mount Rainier National Park, which were published as small brochures for distribution from the office of the Secretary of the Interior, and now the compilation of more elaborate and comprehensive accounts of the geography and the origin of the principal geologic features in several of the national parks has been undertaken for publication as bulletins of the Survey. "The Glacier National Park, a popular guide to its geology and scenery," by M. R. Campbell, has been issued within the year as Bulletin 600. An illustrated guide containing descriptions, with maps, of the geology and of the origin of the striking physical features in the Yosemite Valley of California, with a study of the glaciation, is now being prepared in popular language by F. E. Matthes and F. C. Calkins and will probably be published at an early date as a bulletin. The Mesa Verde National Forest is to be similarly described and illustrated by A. J. Collier, the preparation of whose matter has, however, been necessarily interrupted by work in land classification.

A more ambitious project was undertaken this year. Mindful of the great numbers of educated and intelligent tourists, both American and foreign, who were likely to visit the Pacific coast during the exposition year, and painfully aware of the lack of satisfactory guidebook descriptions, with adequate and accurate maps, covering the physical features of the regions traversed by the greater number of the exposition visitors, the Survey determined to give the public the benefit of a portion of the wealth of geographic and geologic information in its possession, through the publication of guidebooks to the geography, geology, mineral wealth and other natural resources, industries, and history of the regions bordering several of the trans-

continental routes. The small amount of money that could be devoted to this project without sacrifice to the public welfare in other lines of Survey work of more importance though of less popular interest made it practicable this year to undertake the preparation of only four such guides, as follows:

The Northern Pacific Route, from St. Paul to Seattle, with a side trip to the Yellowstone National Park (Bulletin 611).

The Overland Route, from Omaha to San Francisco, with a side trip to the Yellowstone National Park (Bulletin 612).

The Santa Fe Route, from Kansas City to Los Angeles, with a side trip to the Grand Canyon of the Colorado (Bulletin 613).

The Shasta Route and Coast Line, from Seattle and Los Angeles to San Francisco (Bulletin 614).

The first of these books, that describing the Overland Route, was issued in June, and the others followed in July, August, and September. These books inform the traveler concerning the great West, its features and its resources, as well as unfold to him in attractive form its fascinating geology. The method adopted is to entertain the traveler by making more interesting what he sees from the car window, to guide his eyes toward the more important or essential things within his field of vision, and then to have much that he sees explained by what is unseen in the swift passage of the train. The magnificent illustrations of the great principles of earth evolution seen along the route are used to teach some of the principles of geology; and fragments of the story of the past are narrated to enable him to interpret the present. As stated in the preface of these volumes—

The plan of the series is to present authoritative information that may enable the reader to realize adequately the scenic and material resources of the region he is traversing, to comprehend correctly the basis of its development, and above all to appreciate keenly the real value of the country he looks out upon, not as so many square miles of territory represented on the map in a railroad folder by meaningless spaces, but rather as land—real estate, if you please—varying widely in present appearance because differing largely in its history and characterized by even greater variation in values because possessing diversified natural resources. One region may be such as to afford a livelihood for only a pastoral people; another may present opportunity for intensive agriculture; still another may contain hidden stores of mineral wealth that may attract large industrial development; and taken together these varied resources afford the promise of long-continued prosperity for this or that State.

Items of interest in civic development or references to significant epochs in the record of discovery and settlement may be interspersed with explanations of mountain and valley or statements of geologic history. In a broad way, the story of the West is a unit, and every chapter should be told in order to meet fully the needs of the tourist who aims to understand all that he sees. To such a traveler-reader this series of guidebooks is addressed.

Somewhat related to the more distinctly educational reports already described are two bulletins—"The data of geochemistry" (Bulletin 491), by F. W. Clarke, and "Useful minerals of the United

States" (Bulletin 585), compiled by Samuel Sanford and R. W. Stone. A third edition of the former (Bulletin 616) and a revision of the latter, much enlarged by F. C. Schrader, with a glossary showing the composition and character of each mineral (Bulletin 624), are now in course of publication. The editions of these handbooks of general information on broad subjects are rapidly exhausted.

The special efforts of the last year to reach the public with these more popular publications are intended as the beginning of a movement to popularize further the results of scientific investigations. Both the opportunity and the duty of the United States Geological Survey to furnish scientific information in popular form are appreciated.

DEMAND FOR GEOLOGIC WORK.

Especially noteworthy among the features of the year's work is the great increase in the demands made on the Federal geologists for specific investigations of an economic nature. The requests have touched all lines in the geologic province, but most of them ask for the examination of reported discoveries of potash or nitrate salts; for the study of the ore deposits in metal-mining districts, newly discovered or old; or for the investigation of the geologic structure in many regions, with a view to the discovery of areas that may be regarded as structurally favorable for the occurrence of oil or gas pools.

The calls from many States for examinations as to the possibilities of finding oil in untested regions have been nearly as numerous as all others combined, applications for classification of public lands excepted. In this field of applied geology especially the Geological Survey is coming more and more to be regarded as the consulting geologist for the public. Many of the great oil companies, recognizing the paramount value of a knowledge of the geologic structure in the guidance of oil exploration and development, have secured the exclusive services of geologists trained in oil geology. These strong corporations, most of which have lured away from the Survey a number of its best men, are able to organize geologic corps for themselves and to examine geologically great areas of unleased and untested lands in order more certainly to select the sections in which, other things being equal, the prospects for pools are most favorable and the hazards of dry holes the least. But these corporations rarely publish the original information gained by their geologists, and, whether or not the company is able to obtain all the lands it desires, the public is seldom much the wiser for these investigations at private expense.

The appeals to the Survey come mainly from citizens and landowners singly and in groups, from chambers of commerce, and from delegations and communities. The Geological Survey is, by its

organic act, forbidden to make and therefore does not make examinations of private lands primarily in behalf of their owners, whether the owners are individuals or corporations. Its examinations are regional in extent, without regard to ownership, and when confined to small areas they are conducted without reference to property lines and with regard only to the geologic problems in hand and to the interests of the community and the Nation in the development of the mineral resources in the vicinity or district. In strict conformity with this principle, the results of all examinations and investigations are withheld until they are printed, either as press notices or as more formal reports, and in these forms they are simultaneously given out to all who ask for them.

Both through its own resources and through the cooperation of State surveys, the Federal Survey greatly extended its examination of oil structure during the year, and the results will be found in its current economic bulletins and in State reports. Yet in this field, as well as in others, the increase in extent and efficiency of the work made possible by the larger funds provided by Congress for this year has been insufficient to warrant attention to any except the most urgent calls on this national bureau for information regarding the geology of the country and for guidance in the discovery and development of its mineral resources. The increase both in the number and in the range of these calls is, in effect, proof of the public's growing appreciation of the value of the Survey work.

A CONTRIBUTION TO PUBLIC HEALTH.

The geologic resource of greatest value to the health of communities is a supply of pure drinking water. It is generally recognized that a number of diseases, prominent among which are typhoid fever and amœbic dysentery—a disease more common in tropical climates but found also in the United States—are contracted through contaminated water or contaminated food. Therefore a supply of pure water will eliminate one of the sources of such infection.

It is highly desirable to obtain supplies of domestic water from sources other than the shallow wells, some of them open, that are found near many houses. The water obtained from deep wells has percolated through sands and other material for so great a distance that its impurities have been removed by filtration, and it possesses a sanitary value that can not well be overestimated, for such water is free from the bacteria causing typhoid fever and the protozoa causing amœbic dysentery, and its use obviates the necessity for shallow wells that may serve as a breeding place for Anopheles, the mosquito to which malarial infection is due.

The United States Geological Survey for a number of years has been prosecuting, largely in cooperation with the State surveys, a

systematic study of the ground-water resources of all the Coastal Plain States. Reports have been issued, either by the Federal Survey or by cooperating State geological surveys, for Virginia, North Carolina, Georgia, Florida, Alabama, Mississippi, eastern Tennessee, Kentucky and southern Illinois, southeastern Missouri, southeastern Arkansas and Louisiana, northeastern Texas, the Black and Grand Prairie areas of Texas, and the area underlain by Tertiary formations in Texas south of the latitude of Jefferson and east of Brazos River. The manuscripts of papers on the ground-water resources of Delaware and Maryland, on the ground waters of northeastern Arkansas, and on the ground waters of Lasalle and McMullen counties, Tex., have been completed and will be published during the next fiscal year. Additional studies of the ground waters of Mississippi are in progress and it is hoped that within the next year the manuscript will be transmitted for publication. Comprehensive studies of the ground-water resources of the Coastal Plain of Texas west of Brazos River are approaching completion, and the manuscript of a report will be submitted for publication within a year.

With good health recognized as one of the great national assets, the extent of this study of underground-water resources furnishes a measure of its value to the public. Reports have been published covering 376,000 square miles in the Atlantic and Gulf States, reports on 27,000 square miles are completed though not yet published, field work has been completed on 50,000 square miles, and work is contemplated to cover 16,000 square miles. These areas of nearly half a million square miles include the parts of the United States in which impure water supplies involve the greatest danger. The value of such surveys in conserving public health has already been demonstrated, for it has been noted that wherever an adequate supply of deep-well water has been obtained, typhoid fever, amœbic dysentery, and malaria have abated.

The methods used by geologists in working out the distribution of ground waters are complex, but it is noteworthy that among the more significant criteria used are the fossil remains occurring in the different beds. Each one of the geologic horizons usually has its distinctive fossils, and by an accurate knowledge of these vestiges of organisms the geologist is aided in recognizing particular geologic formations. In this way he may be able to determine by means of the samples taken from the bore the depth to a certain water horizon.

That paleontology, so generally regarded as a purely scientific study, has a great value in the investigation of economic resources may not be generally recognized. In order, however, to understand the conditions controlling the occurrence of any one of three of the most important mineral resources—ground waters, coal, and oil and gas—an accurate knowledge of the succession of the different

rock sheets and their geologic structure is essential, and the determination of that order of succession depends upon the study of fossil remains included in these rocks. The value of the work of the paleontologists who have studied the geologic formations in the Coastal Plain area is therefore inestimable. Among the men who have aided in the paleontologic characterization of horizons and thereby assisted in the development of the ground water and oil and gas resources of the Coastal Plain, W. H. Dall, G. D. Harris, and R. T. Hill should be specially mentioned. The excellent work of these scientists has been continued either by themselves or by others who have entered the same fields, and it is hoped that within a few years there may be available biologic characterizations of all the Tertiary and Cretaceous formations of the Coastal Plain. Additional accurate information will assist in the further development of many of the natural resources of the Coastal Plain region.

It is unfortunate that the paleontologists are subjected to increasing overwork, and it is to be regretted that on account of inadequate funds the distinguished Survey specialists engaged in these important studies, which are particularly in demand by the cooperating State surveys, can not be provided with assistance.

It should be added that the science of paleontology has a large educational value, and its popular interest is well illustrated in the western guidebooks, just published. As with geology in general, so in paleontology, the Survey is the central public source of information.

CHANGES IN PERSONNEL.

The death of Henry Gannett, on November 5, 1914, terminated a long and important service. Mr. Gannett was connected with the Survey, with a few interruptions, since 1882 and accomplished much in establishing the methods and fixing the standards of the topographic work in the early days of the organization. He held the title of chief geographer (or chief topographer) in the years 1882 to 1896. His Government work outside of the Survey, chiefly work on the census of the United States, Cuba, Porto Rico, and the Philippines, and his services as chairman of the United States Geographic Board and as geographer of the National Conservation Commission, covered a wide field of geographic investigations and showed large grasp of new problems. He was also president of the National Geographic Society.

Among the important resignations or transfers from the Survey within the fiscal year were those of David T. Day and E. W. Parker. These two men are to be credited with the development of the division of mineral resources, a service that is unique among the statistical organizations of the world. Dr. Day, after a service of nearly 30 years, was transferred August 31, 1914, to the Bureau of Mines,

where, as consulting chemist, he will continue his investigation of the special problems connected with the technology of petroleum, devoting part of his time to this Government work. Mr. Parker, who served in various positions in the Survey since 1891 and who has been in charge of the collection of statistics of the mineral resources of the United States since 1908, resigned June 30, 1915, to accept an important position with the anthracite-coal interests. Mr. Parker's resignation necessitated several changes in the division of mineral resources—the appointment of Hiram D. McCaskey as geologist in charge, of E. F. Burchard as geologist in charge of the section of nonmetallic resources, and of C. E. Lesher, associate geologist, to take charge of the statistics of coal. The number of men designated to take up the work relinquished by Mr. Parker is perhaps the strongest indication of the amount and importance of that work, which he so long successfully carried on.

Mr. E. C. Barnard, geographer, resigned May 2, 1915, after a service of more than 30 years, to accept the position of expert commissioner on the part of the United States in the International Boundary Commissions (Canada). Since 1910 Mr. Barnard's connection with the Geological Survey has been only nominal, by reason of his detail to the State Department in connection with the surveys of the international boundary.

Other changes in the organization were the appointment, in January, of Philip S. Smith as administrative geologist and, in the absence of the Director, Acting Director, and the appointment, in February, of Guy E. Mitchell as chief of the executive division. Mr. Mitchell was succeeded by T. P. O'Hara as private secretary to the Director.

EXHIBIT AT PANAMA-PACIFIC EXPOSITION.

With a small allotment from the congressional appropriation for the Government exhibit at the Panama-Pacific Exposition, San Francisco, the Survey has made a creditable and instructive exhibit, including scenarios showing many of the kinds of work done by the Survey in exploring and investigating the resources of the country; an exhibit of the per capita production of minerals of the United States; an exhibit of the use of many of the minerals in the rough and in the manufactured form; and specimens, maps, pictures, and instruments illustrative of various subjects studied or used by the Survey. Ralph W. Stone, geologist, was detailed to have charge of the exhibit and to give illustrated lectures daily describing the work of the Survey. The Survey has been awarded one grand prize, three medals of honor, three gold medals, two silver medals, and one bronze medal. Silver medals for collaboration were also awarded to the following Survey members: George H. Ashley, A. H. Brooks, J. C. Hoyt, S. J. Kübel, R. B. Marshall, and Edward W. Parker.

SCOPE OF THE WORK.

In the following pages of this administrative report the activities of each branch of the Survey are set forth in detail; the following paragraph is a brief summary of the whole. Geologic investigations were made in 47 States and Alaska; topographic surveys were made in 30 States, Alaska and Hawaii, and stream measurements were made in 41 States and Hawaii. The total area covered by the geologists in reconnaissance and detailed surveys was more than 76,000 square miles and the area topographically mapped by the topographers was more than 35,000 square miles. The land-classification work of the Geological Survey last year resulted in the classification of about 36,000 square miles in the public-land States. In the collection of statistics of mineral production the Geological Survey cooperated with the State geologists of 16 States and carried on correspondence with 90,000 producers.

WORK OF THE YEAR.

PUBLICATIONS.

The work of the Geological Survey is reflected chiefly in the publication and distribution of its printed reports and maps. The publications of the year consisted of 1 annual report, 1 monograph, 5 professional papers, 10 separate chapters from 2 professional papers, 35 bulletins, 30 separate chapters from 5 bulletins, 33 water-supply papers, 18 separate chapters from 4 water-supply papers, 1 annual report on mineral resources for 1913 (published also in 62 advance chapters, 15 delivered in 1913–14 and 47 in 1914–15), 5 advance chapters from the annual report on mineral resources for 1914, 3 geologic folios, 2 lists of publications, 1 list of topographic maps and folios, pamphlets entitled "Topographic instructions of the United States Geological Survey, 1915," and "Service bulletin, 1914," leaflets entitled "Nature and uses of topographic maps," "The production of copper in 1914," and "The production of spelter in 1914," 3 circulars concerning geologic folios, 22 index-map circulars, 55 press bulletins, and 10 monthly lists of new publications. The total number of pages in these publications was 23,574, a notable increase from the preceding year and a larger number than in any other year of the Survey's history. The publications of the year 1913–14 comprised 16,631 pages.

Brief notes on the publications of the year are given below.

THIRTY-FIFTH ANNUAL REPORT OF THE DIRECTOR of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1914. 1914. 163 pages, 2 plates.

A detailed account of the work of the Geological Survey during the fiscal year 1914, with a statement of the total appropriation made by Congress for the Survey

and the allotments for each kind of work. Under the heading "Special features" is a brief discussion of the province of a Federal Survey. The report also includes abstracts of the publications of the year and maps of the United States showing areas covered by topographic and geologic surveys.

MONOGRAPH 53. The Pleistocene of Indiana and Michigan and the history of the Great Lakes, by Frank Leverett and F. B. Taylor. 1915. 529 pages, 32 plates, 15 text figures. Price $1.50.

Describes in detail the glacial features and the great glacial lakes of a district which includes a considerable part of Indiana and all of the southern peninsula of Michigan. The question of a pre-Illinoian drift in southern Indiana is briefly treated, but the Wisconsin drift, the concealed portions of the earlier drift sheets that underlie it, and the somewhat intricate lake history associated with and following the retreat of the ice are the main subjects of discussion. The monograph is profusely illustrated with maps showing the topography and geology of the area discussed, glacial lakes and eskers, ancient lake beaches, morainic systems, profiles of warped water planes, and river distributaries. It is closely related to Monographs 38 and 41, which treat of glacial geology in districts directly adjoining that discussed in the present report.

PROFESSIONAL PAPER 85. Shorter contributions to general geology, 1913. David White, chief geologist. 1914. 99 pages, 14 plates, 7 text figures.

The first volume of a new series to be published annually by the Geological Survey under the title "Shorter contributions to general geology." In advance of the printing of the full volume, separates, each including one or more papers, are issued to the number of 10 or 12 a year as the manuscript and illustrations are ready without waiting until the material for the full volume is in hand or even promised. These separates are paged continuously, so that the volume is simply a consolidation of the separates, without change of pagination. The papers included in these "Shorter contributions to general geology" may relate to any phase of geology, provided it possesses general interest—petrology, paleontology, stratigraphy, glaciology, structural geology, etc. This volume is intended not as a catch-all for current odds and ends, but as a dignified collection of scientific contributions, each suitable in importance of subject, value of results, and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length.

Professional Paper 85 contains the following contributions:

The origin of colemanite deposits, by H. S. Gale.

The mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Interpretation of anomalies of gravity, by G. K. Gilbert.

The Jurassic flora of Cape Lisburne, Alaska, by F. H. Knowlton.

Resins in Paleozoic plants and in coals of high rank, by David White.

PROFESSIONAL PAPER 86. The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pages, 3 plates, 89 text figures.

The finer débris transported by a stream is borne in suspension; the coarser is swept along the channel bed. The suspended load is readily sampled and estimated, and much is known as to its quantity. The bed load is inaccessible, and we are without definite information as to its amount. The primary purpose of the investigation of which Professional Paper 86 is the outcome was to learn the laws which control the movement of the bed load, and especially to determine how the quantity of load is related to the stream's slope and discharge, and to the degree of comminution of the débris. The paper contains the record and discussion of a series of experiments made in a specially equipped laboratory at the University of California, Berkeley, in the years 1907–1909.

PROFESSIONAL PAPER 87. Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright. 1915. 110 pages, 22 plates, 11 text figures.

A detailed description of the geology of Kasaan Peninsula and Copper Mountain, the two most important copper-bearing areas in southeastern Alaska, prefaced by a general account of the geology of the Ketchikan district, within which these areas lie. The mining development is only briefly discussed, because it is not of permanent interest and is fully treated in the Survey's annual bulletins showing the progress of investigations of mineral resources in Alaska. The genesis and occurrence of the copper ores are discussed, and special attention is paid to contact deposits, which are well exemplified in this region. The illustrations include a geologic map of the Ketchikan district, topographic and geologic maps of Copper Mountain and Kasaan Peninsula, plans and sections of mines, and halftone views of rocks and minerals from the areas discussed.

PROFESSIONAL PAPER 88. Lavas of Hawaii and their relations, by Whitman Cross. 1915. 97 pages, 4 plates.

Describes in detail the petrography of the Hawaiian Archipelago, treating each of the larger islands individually. It is an accepted generalization concerning the Hawaiian Islands that they have been built up by a long-continued series of volcanic eruptions beginning at a point far west of the principal islands of to-day. They represent, therefore, the higher summits of a chain of volcanic mountains, mainly submarine, rising from an ocean floor more than 20,000 feet below the surface of the sea and extending for about 1,800 miles in a general north-northwesterly direction. They appear to form a simple petrographic province whose igneous rocks are clearly consanguineous. The paper also discusses the mineral, chemical, and normative composition of the Hawaiian lavas, as well as their distribution and association, and the theoretical bearings of the data presented. A map of the islands, photomicrographs of the rocks, a diagram illustrating variation in normative composition of the lavas, and a table of normative ratios and symbols, accompany the report.

PROFESSIONAL PAPER 90. Shorter contributions to general geology, 1914. David White, chief geologist. 1915. 199 pages, 21 plates, 20 text figures.

A consolidation of 12 short papers which were first issued as parts A to L, inclusive, forming the second annual volume bearing this title. The corresponding volume for 1913 was Professional Paper 85.

Professional Paper 90 contains the following contributions:

Geology of the pitchblende ores of Colorado, by E. S. Bastin.

Erosion and sedimentation in Chesapeake Bay around the mouth of Choptank River, by J. F. Hunter.

Dike rocks of the Apishapa quadrangle, Colorado, by Whitman Cross.

The composition of crinoid skeletons, by F. W. Clarke and W. C. Wheeler.

Contributions to the stratigraphy of southwestern Colorado, by Whitman Cross and E. S. Larsen.

A reconnaissance in the Canyon Range, west-central Utah, by G. F. Loughlin.

The Montana group of northwestern Montana, by Eugene Stebinger.

A deep well at Charleston, S. C., by L. W. Stephenson, with a report on the mineralogy of the water by Chase Palmer.

The stratigraphy of the Montana group, with special reference to the position and age of the Judith River formation in north-central Montana, by C. F. Bowen.

The Cretaceous-Eocene contact in the Atlantic and Gulf Coastal Plain, by L. W. Stephenson.

The history of a portion of Yampa River, Colorado, and its possible bearing on that of Green River, by E. T. Hancock.

The inorganic constituents of echinoderms, by F. W. Clarke and W. C. Wheeler.

PROFESSIONAL PAPER 95–A. Composition of muds from Columbus Marsh, Nevada, by W. B. Hicks. 1915. pp. 1–11, fig. 1.

A part of Professional Paper 95, "Shorter contributions to general geology, 1915." Professional Paper 95–A is a further report on the investigation of the dry lake of Columbus Marsh, situated on or near the line between Esmeralda and Mineral counties, Nev. The investigation of this lake, begun in 1912, had for its economic motive the discovery of potash. Results of the work done in 1912 are given in Bulletin 540–N. Professional Paper 95–A tells of the work done in 1913, which included the drilling of one shallow well and the collection of a set of surface samples of muds from the marsh. After considering all the facts at hand, the author expresses his belief that large amounts of potash have been absorbed from surrounding or percolating solutions and are held in loosely combined form by the muds of Columbus Marsh and perhaps by the muds of the desert basins in general, while the other salts, being less completely absorbed, have been gradually concentrated through evaporation. This theory explains the presence of the natural brines and salt incrustations with low potash content now found in the desert regions of the United States.

PROFESSIONAL PAPER 95–B. Eocene glacial deposits in southwestern Colorado, by W. W. Atwood. 1915. pp. 13–26, Pls. I–IV, figs. 2–11.

Professional Paper 95–B describes briefly the geology of the Montrose quadrangle, near Ridgway, Colo., at the base of the San Juan Mountains. This locality is of especial interest because one series of its exposed rocks includes a section of glacial till that is overlain by formations of Tertiary age. These exposures were found in September, 1913, in the same region where three distinct stages of Pleistocene glaciation among the mountains were demonstrated in 1912. The illustrations include a map of the area discussed, showing distribution of Eocene and Pleistocene glacial deposits, and geologic sections at several localities near Ridgway, Colo.

BULLETIN 541. Contributions to economic geology (short papers and preliminary reports), 1912, Part II, Mineral fuels—M. R. Campbell, geologist in charge. 1914. 532 pages, 29 plates, 17 text figures.

This bulletin includes 26 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations, the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to subjects or general regions, and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the volume follows:

Oil and gas in the northern part of the Cadiz quadrangle, Ohio, by D. D. Condit.

Gas from mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Structure of the Fort Smith-Poteau gas field, Arkansas-Oklahoma, by C. D. Smith.

The Glenn oil and gas pool and vicinity, Oklahoma, by C. D. Smith.

The Douglas oil and gas field, Converse County, Wyo., by V. H. Barnett.

The Shoshone River section, Wyoming, by D. F. Hewett.

Oil and gas near Green River, Grand County, Utah, by C. T. Lupton.

Petroleum near Dayton, N. Mex., by G. B. Richardson.

Reconnaissance of the Barstow-Kramer region, California, by R. W. Pack.

Rhode Island anthracite, by G. H. Ashley.

Coking coal in Powell Mountain, Scott County, Va., by M. R. Campbell.

The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, by Charles Butts.

The coal resources of a part of northeastern Missouri, by F. C. Greene.

The Cannonball River lignite field, Morton, Adams, and Hettinger counties, N. Dak., by E. R. Lloyd.

Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont., by C. M. Bauer.

Geology and coal resources of the area southwest of Custer, Yellowstone, and Bighorn counties, Mont., by G. S. Rogers.

Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen.

The Cleveland coal field, Blaine County, Mont., by C. F. Bowen.

The Big Sandy coal field, Chouteau County, Mont., by C. F. Bowen.

The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho, by E. G. Woodruff.

The Glacier coal field, Whatcom County, Wash., by E. G. Woodruff.

The Eden Ridge coal field, Coos County, Oreg., by C. E. Lesher.

Geology and coal resources of the Sierra Blanca coal field, Lincoln and Otero counties, N. Mex., by C. H. Wegemann.

Coal near Thompson, Grand County, Utah, by F. R. Clark.

Coal near Wales, Sanpete County, Utah, by F. R. Clark.

Analyses of coal samples from various fields in the United States, by M. R. Campbell.

BULLETIN 544. Fauna of the Wewoka formation of Oklahoma, by G. H. Girty. 1915. 353 pages, 35 plates.

Describes the fauna of the Wewoka formation, which is typically exposed in the Coalgate and Wewoka quadrangles, in Atoka, Coal, Hughes, Okfuskee, Okmulgee, Pittsburg, Pontotoc, and Seminole counties, Okla. This formation occupies a part of the Carboniferous area of Oklahoma, which is especially interesting because its rocks were laid down under physical conditions so much at variance with those of the Carboniferous areas farther north and east that both its sediments and its faunas show marked differences from those of the other areas. The fossils of the Wewoka formation are in an excellent state of preservation and offer an opportunity for careful generic and specific studies which may serve as a starting point for work in less satisfactory material. The illustrations show specimens of the fossils described in the report.

BULLETIN 548. Electric activity in ore deposits, by R. C. Wells. 1914. 78 pages, 7 text figures.

A contribution to the study of ore deposits, showing that contact with solutions, as well as some other conditions, may impart electric energy to certain metalliferous minerals, thus transforming them into conductors of electric currents in ore deposits. Under certain conditions the valuable metals may be deposited from solutions by electrolytic action and thereafter be protected from redissolving by contact with any of the more oxidizable ores. Although the results thus far obtained afford no adequate basis for any method of electric prospecting, this bulletin possesses value in the broader investigation of ores, for even feeble currents may exert a directional influence on ore deposition, and chemical conditions, even at a distance, may be a factor in determining mineral association. The illustrations consist of diagrams showing apparatus and methods used in studying currents produced by combinations of solutions and minerals.

BULLETIN 549. The Shinumo quadrangle, Grand Canyon district, Arizona, by L. F. Noble. 1914. 100 pages, 18 plates, 1 text figure.

Ever since Powell's daring boat trip down the Colorado in 1869 geologists have known that the walls of the Grand Canyon display one of the most remarkable and instructive geologic sections in the world. Bulletin 549 treats of the geology of part of this district—the Shinumo quadrangle, covering about 270

square miles in Coconino County, northern Arizona. Although the book contains considerable lithologic and stratigraphic material that will scarcely interest those who are not geologists, the author has very properly remembered that the people as a whole have unusual claims to consideration in any publication dealing with the Grand Canyon, and has skillfully supplied as a setting to his more strictly scientific work much vivid description and lucid explanation, which will help all those who take more than a transient and superficial interest in what they see to understand one of the most impressive and significant of the inanimate works of nature.

The map which accompanies this bulletin represents the first geologic mapping done in the canyon that attains the standard of accuracy and detail set for the Geologic Atlas of the United States.

BULLETIN 550. The ore deposits of northeastern Washington, by Howland Bancroft including a section on the Republic mining district by Waldemar Lindgren and Howland Bancroft. 1914. 215 pages, 19 plates, 26 text figures.

Describes the geology of an area of about 6,000 square miles in Stevens and Ferry counties, northeastern Washington, giving detailed information as to its mining districts and ore deposits—chiefly lead, zinc, and copper. States that the general conditions for mining are particularly favorable and discusses briefly the methods and costs of mining, treatment of the ores, and means of transportation. The illustrations include plans and sketch maps of some of the mines and halftone plates showing geologic conditions.

BULLETIN 559. Results of spirit leveling in Michigan, 1911 and 1913—R. B. Marshall, chief geographer. 1914. 79 pages, 1 plate.

BULLETIN 560. Results of spirit leveling in Minnesota, 1897 to 1914, inclusive, R. B. Marshall, chief geographer. 1915. 190 pages, 1 plate.

BULLETIN 561. Results of spirit leveling in Hawaii, 1910 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 42 pages, 1 plate.

BULLETIN 562. Results of spirit leveling in Virginia, 1900 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 68 pages, 1 plate.

BULLETIN 563. Results of spirit leveling in Maryland, 1896 to 1911, inclusive. R. B. Marshall, chief geographer. 1914. 80 pages, 1 plate.

BULLETIN 566. Results of spirit leveling in Utah, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 77 pages, 1 plate.

BULLETIN 567. Results of spirit leveling in Idaho, 1896 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 130 pages, 1 plate.

BULLETIN 569. Results of spirit leveling in Iowa, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1915. 126 pages, 1 plate.

BULLETIN 570. Results of spirit leveling in Wisconsin, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1914. 86 pages, 1 plate.

BULLETIN 572. Results of spirit leveling in Nebraska, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 57 pages, 1 plate.

Reports on precise and primary leveling in the States mentioned, showing the exact altitude of a great number of places. The work in Michigan, Hawaii, and Maryland, and part of that in Minnesota, Virginia, Iowa, and Nebraska was done in cooperation with the States. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

BULLETIN 574. Mining districts of the Dillon quadrangle, Montana, and adjacent areas, by A. N. Winchell. 1914. 191 pages, 8 plates, 16 text figures.

A sketch of the geology of the Dillon quadrangle, which covers about 3,200 square miles in southwestern Montana, and detailed descriptions of its mining districts. The illustrations consist of geologic sketch maps of many of the districts and halftone plates showing geologic conditions.

BULLETIN 576. Geology of the Hanagita-Bremner region, Alaska, by F. H. Moffit. 1914. 56 pages, 6 plates, 6 text figures.

This bulletin presents information about a region that was very little known prior to 1911. Although the author's survey was of a reconnaissance character it was sufficiently detailed to outline the geography, general geology, and geologic history of the region and to obtain information about the occurrence and distribution of the gold and copper deposits. The Hanagita-Bremner region includes some mineral deposits which, though almost undeveloped, give promise of becoming commercially valuable, now that they have been made comparatively accessible by the railroad recently completed up the Copper River valley. The illustrations include topographic and geologic reconnaissance maps, a map showing the distribution of timber, and diagrams illustrating some of the methods of formation of canyons and other stream channels.

BULLETIN 577. Geology of the phosphate deposits northeast of Georgetown, Idaho, by R. W. Richards and G. R. Mansfield. 1914. 76 pages, 14 plates, 3 text figures.

This report discusses briefly the geography and geology of an area in Bear Lake and Bannock counties, southeastern Idaho, and a part of Georgetown Canyon. Detailed descriptions, by townships, of the phosphate deposits are given, and the book contains geologic maps and sections of many of the phosphate-bearing districts. The type of geologic survey represented in this work is a development of the constantly increasing requirement for detail. The delineation of phosphate outcrops in areas beyond the properties that have been located and the estimation of the depth, tonnage, and quality of the different beds furnish part of the data.

BULLETIN 578. The Iditarod-Ruby region, Alaska, by H. M. Eakin. 1914. 45 pages, 6 plates, 1 text figure.

Describes an area in west-central Alaska between the mining settlements on Iditarod River and those on the Yukon at Ruby, visited by the author in the summer of 1913. This volume is the third report based on work inspired by the discovery of gold in the Innoko district in 1906. The author shows that the bedrock sources of the placer gold in this district include the igneous intrusive rocks and the Cretaceous sediments at or near their contacts with the intrusives; also that the auriferous lodes thus far found are closely associated with dikes and other intrusive rocks. These conditions augur well for the future of the mining industry of the region, for similar conditions exist in other parts of Alaska where gold mining is successfully carried on.

BULLETIN 579. Reconnaissance of oil and gas fields in Wayne and McCreary counties, Ky., by M. J. Munn. 1914. 105 pages, 6 plates, 6 text figures.

Gives a brief description of the stratigraphy and structure of the rocks in Wayne and McCreary counties, Ky., with especial reference to their oil and gas content. The oil and gas fields are treated in detail, and numerous records of wells are given. As to the future of the area, there is every reason to suppose that many other profitable oil pools will be found eventually in districts in and adjacent to Wayne County, and the structural conditions seem to favor the practical application of geology in finding these pools. The illustrations include sketch maps showing the location of oil and gas pools, sections of deep wells, and views of specimens from the Beaver Creek oil "sand."

BULLETIN 580. Contributions to economic geology (short papers and preliminary reports), 1913, Part I, Metals and nonmetals except fuels. F. L. Ransome and H. S. Gale, geologists in charge. 1915. 462 pages, 9 plates, 97 text figures.

This bulletin is made up of 16 brief reports on investigations of mineral deposits except fuels in the United States in 1913. The papers included are of the two classes indicated for Bulletin 541 (p. 19). A list of the papers, arranged according to subjects, is given below:

Gold and silver.

Gold placers on Wind and Bighorn rivers, Wyoming, by F. C. Schrader.
Lode deposits of the Alleghany district, California, by H. G. Ferguson.
The Rochester mining district, Nevada, by F. C. Schrader.

Copper.

Notes on the Unaweep copper district, Colorado, by B. S. Butler.
The Grand Gulch mining region, Mohave County, Ariz., by J. M. Hill.

Lead and zinc.

The Darwin silver-lead mining district, California, by Adolph Knopf.
Some cerusite deposits in Custer County, Colo., by J. F. Hunter.
Ore deposits in the Sawtooth quadrangle, Blaine and Custer counties, Idaho, by J. B. Umpleby.

Rare metals.

Carnotite near Mauch Chunk, Pa., by E. T. Wherry.
The rutile deposits of the eastern United States, by T. L. Watson.

Phosphates.

The phosphate deposits of South Carolina, by G. S. Rogers.
The Elliston phosphate field, Montana, by R. W. Stone and C. A. Bonine.

Salines.

Salines in the Owens, Searles, and Panamint basins, southeastern California, by H. S. Gale.

Miscellaneous.

A new gypsum deposit in Iowa, by G. F. Kay.
Some deposits of mica in the United States, by D. B. Sterrett.
Publications by Survey authors on metals and nonmetals except fuels, compiled by I. P. Evans.

BULLETIN 581. Contributions to economic geology (short papers and preliminary reports), 1913, Part II, Mineral fuels. M. R. Campbell and David White, geologists in charge. 1915. 187 pages, 11 plates, 6 text figures.

This bulletin includes six brief reports of the two classes indicated for Bulletin 541 (p. 19). A list of the papers follows:

Petroleum and natural gas.

Oil shale of northwestern Colorado and northeastern Utah, by E. G. Woodruff and D. T. Day.
Oil and gas in the western part of the Olympic Peninsula, Wash., by C. T. Lupton.
The Moorcroft oil field, Crook County, Wyo., by V. H. Barnett.
Possibilities of oil in the Big Muddy dome, Converse and Natrona counties, Wyo., by V. H. Barnett.
Geology and oil prospects in Waltham, Priest, Bitterwater, and Peachtree valleys, Cal., by R. W. Pack and W. A. English.

Coal.

The Coalville coal field, Utah, by C. H. Wegemann.

BULLETIN 582. Mineral deposits of the Santa Rita and Patagonia mountains, Arizona, by F. C. Schrader, with contributions by J. M. Hill. 1915. 373 pages, 25 plates, 46 text figures.

The purpose of this paper is to furnish a general idea of the character, occurrence, distribution, and development of the mineral resources of a desert area comprising about 1,400 square miles in Pima and Santa Cruz counties, Ariz., 26 miles southeast of Tucson. The physiography, geology, and water supply of the area are briefly discussed, and the mining districts, camps, and properties are considered in detail. The deposits include gold, silver, copper, lead, zinc, tungsten, molybdenum, and building materials. Topographic and geologic maps of the area discussed and of parts of it, maps, plans, and sections of some of the mines and their workings, and halftone plates showing geologic features make up the illustrations.

BULLETIN 583. Colorado ferberite and the wolframite series, by F. L. Hess and W. T. Schaller. 1914. 75 pages, 14 plates, 35 text figures.

This report is made up of two papers, namely, "The mineral relations of ferberite," by Mr. Hess, and "Crystallography of ferberite from Boulder County, Colo.," by Mr. Schaller. Ferberite, as ordinarily defined, is that mineral of the wolframite series which is composed wholly or almost wholly of iron tungstate and which, like other wolframites, crystallizes in the monoclinic system. It is comparatively rare and where found seems to occur in small quantities only. It occurs in largest quantity in the locality described in this report. The illustrations of Bulletin 583 include diagrams and halftone plates representing crystals of ferberite.

BULLETIN 584. Bibliography of North American geology for 1913, with subject index, by J. M. Nickles. 1914. 183 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the continent of North America and adjacent islands, also Panama and the Hawaiian Islands, issued in 1913. The work is indexed and contains lists of chemical analyses reported and minerals, rocks, and formations described.

BULLETIN 586. Slate in the United States, by T. N. Dale and others. 1914. 220 pages, 26 plates, 18 text figures.

This volume is not only a corrected and revised edition of Bulletin 275, "Slate deposits and slate industry of the United States," but also contains the results of all recent discoveries and studies of slate in this country. Its plan is (1) to set forth, in succinct form, the present state of scientific knowledge as to the origin, structure, texture, and chemical and mineral composition of slate; (2) to describe in more or less detail the slates and quarries of each district; and (3) to consider the economic geology of slate, including scientific prospecting for it, methods of testing it, slate machinery, and the uses of slate and slate waste, together with a tabular summary of the slates described. The book is illustrated by numerous maps showing the location of slate deposits and quarry sites in New England, the Middle Atlantic States, and Arkansas, and halftone plates showing some of the quarries.

BULLETIN 588. The constitution of the natural silicates, by F. W. Clarke. 1914. 128 pages.

This bulletin represents the results of a study of the chemical structure of the silicates found in the solid crust of the earth. From the geologist's point of view the silicates are of fundamental importance, for they form at least nine-tenths of the entire known mass of the earth's crust, and a study of their inner constitution may be reasonably expected to shed light upon many serious problems. Every primitive rock or eruptive mass contains an aggregation of silicates, each one capable of undergoing chemical change by which alteration products are formed, so that in time the rock may become transformed into new substances, quite unlike those which originally existed in it. A knowledge of the processes which thus occur, dependent on chemical structure, should be

applicable to the study of the rocks and should ultimately render it possible so to investigate a metamorphosed mass as to clearly indicate its origin.

BULLETIN 589. The calcite marble and dolomite of eastern Vermont, by T. N. Dale. 1914. 67 pages, 2 plates, 11 text figures.

A companion report to Bulletin 521, "The commercial marbles of western Vermont," by the same author. The region discussed in the earlier report includes the most extensive marble industry in the United States, whereas Bulletin 589 relates to a virgin field whose development is still a work of the future. The object of this bulletin is twofold—to locate definitely and describe accurately the marbles and dolomites of eastern Vermont with a view to setting forth their possible economic uses and to discuss whatever features of scientific interest they may present. To this end the deposits are treated in detail by counties and towns. The illustrations include a map of the State and maps of many of the townships, showing the marble and dolomite localities described.

BULLETIN 590. Reconnaissance of the geology and oil prospects of northwestern Oregon, by C. W. Washburne. 1914. 111 pages, 1 plate.

This report is based on a hasty reconnaissance, made during the summer of 1910, of a certain part of the Coast Range of Oregon, where the presence of oil had been suggested by the topographic similarity of the locality to the oil regions of California. It contains a brief description of the geology of the district as a whole and of each county, as well as discussions of the oil and gas indications in each county. The author concludes that there is no good reason for believing that oil will be found in the northern part of the Coast Range of Oregon. A map of northwestern Oregon showing gas and oil prospects accompanies the report.

BULLETIN 592. Mineral resources of Alaska—report on progress of investigations in 1913, by A. H. Brooks and others. 1914. 413+xi pages, 17 plates, 13 text figures.

A collection of 21 papers by 13 authors on the work of the Geological Survey in Alaska during 1913. Papers of a general character are presented first, followed by those treating of special districts, arranged geographically from south to north. The book contains preliminary statements on investigations made during the year and summaries of the conditions of the mining industry, including statistics of mineral production. It is illustrated by maps showing the distribution of mineral resources in the whole Territory and in certain portions of it and by sketch maps showing the location of lode prospects in some of the districts. The titles of the papers are given below:

Administrative report, by A. H. Brooks.

The mineral deposits of Alaska, by A. H. Brooks.

The Alaskan mining industry in 1913, by A. H. Brooks.

Lode mining in the Ketchikan region, by P. S. Smith.

Marble resources of the Juneau, Skagway, and Sitka districts, by E. F. Burchard.

A barite deposit near Wrangell, by E. F. Burchard.

Mineral deposits of the Yakataga district, by A. G. Maddren.

Preliminary report on a water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport.

The Port Wells gold-lode district, by B. L. Johnson.

Mining on Prince William Sound, by B. L. Johnson.

Gold lodes and placers of the Willow Creek district, by S. R. Capps.

Mineral resources of the upper Matanuska and Nelchina valleys, by G. C. Martin and J. B. Mertie, jr.

Preliminary report on the Broad Pass region, by F. H. Moffit.

Mining in the Valdez placer district, by F. H. Moffit.

The Chisana placer district, by A. H. Brooks.

Lode mining near Fairbanks, by Theodore Chapin.
Placer mining in the Yukon-Tanana region, by Theodore Chapin.
Placer mining in the Ruby district, by H. M. Eakin.
Mineral resources of the Yukon-Koyukuk region, by H. M. Eakin.
Placer mining on Seward Peninsula, by Theodore Chapin.
Lode developments on Seward Peninsula, by Theodore Chapin.

BULLETIN 594. Some mining districts in northeastern California and northwestern Nevada, by J. M. Hill. 1915. 200 pages, 19 plates, 4 text figures.

A general outline of the geology of a part of northern California and northwestern Nevada, with a brief statement of the nature and occurrence of the ore deposits as a whole and detailed descriptions of individual mining districts. In these descriptions the following points concerning the districts are considered: Location, accessibility, history, production, climate and vegetation, topography, geology, type and origin of the ore deposits, and origin and character of the veins. Sketch maps of the districts, structure sections of the mountain ranges, and halftone plates showing geologic features make up the illustrations.

BULLETIN 596. Geology and coal resources of North Park, Colo., by A. L. Beekly. 1915. 121 pages, 12 plates, 1 text figure.

Describes the geography, stratigraphy, structure, and economic geology of North Park, a great natural depression in the Rocky Mountains of northern Colorado, sharply defined as a topographic unit by its prominent, almost continuous rim of mountain crests 2,000 to 5,000 feet above the bottom of the basin. On account of its remoteness from frequented routes of travel, very little has been known of the geology of this basin until recent years. As coal is the most valuable known mineral resource of North Park, this report calls special attention to the coal deposits, discussing their occurrence and development and the production and estimated tonnage of the mines. The illustrations consist of a geologic map and sections of North Park, sections of coal beds, and photographic views of geologic features.

BULLETIN 599. Our mineral reserves—how to make America industrially independent, by G. O. Smith. 1914. 48 pages.

The readjustments in the world's commerce necessitated by the European war have already imposed new conditions on the mineral industry as well as on other industries. Second only in importance to the food supply is the supply of mineral products necessary to meet the requirements of twentieth-century civilization. The United States has cause for congratulation in the facts that it is almost independent in the possession of essential mineral resources and that the interference with manufacturing caused by interruption of the importation of many necessary raw materials may be overcome almost wholly by development of neglected resources in our own country. Beginning in August, 1914, there was a lively demand for information regarding possible sources of mineral products, both crude and manufactured. Bulletin 599 was issued for the purpose of furnishing to the public in convenient form a summary of the mineral resources available for utilization under the pressure of present conditions, in the hope of encouraging their development and discouraging the importation of raw material and products which can be supplied at home.

BULLETIN 600. The Glacier National Park: a popular guide to its geology and scenery, by M. R. Campbell. 1914. 54 pages, 13 plates, 13 text figures.

Describes briefly the geology and scenery of the Glacier National Park, which was set apart by act of Congress in 1910 and includes that part of the Front Range of the Rocky Mountains lying just south of the Canadian line in Teton and Flathead counties, Mont. Illustrated by a topographic map of the park, diagrams showing geologic features, and halftone plates depicting some of the wonderful scenery to be found and enjoyed there.

BULLETIN 612. Guidebook of the western United States, Part B, The Overland Route, with a side trip to Yellowstone Park, by W. T. Lee, R. W. Stone, H. S. Gale, and others. 1915. 244 pages, 29 route maps, 50 plates, 20 text figures.

A handbook for the traveler which deals not only with the geology but with the natural resources, history, and development of the country between Omaha and San Francisco. It shows how differences in scenery and climate depend upon past geologic events and dispels the monotony of the Great Plains by taking the traveler back to times when these regions supported a vegetation very different from their present scanty covering and were inhabited by animals of strange forms and huge size. The scenery of the mountains acquires additional interest from the explanation of the earth movements and the resulting rock structure to which fundamentally the mountain forms are due. Even the desert becomes attractive when the traveler is told of its vanished lakes and is shown the old beach lines which their waves cut in the now arid hillsides.

The book is intended to educate by being interesting, to win hearing for the story of geology by telling it in a clear and simple way, with abundant illustration from the car windows not only of the story itself but of its intimate connection with human life.

The text deals with the route consecutively from east to west and is accompanied by a series of conveniently folded maps and by abundant halftone cuts and diagrams. Matter slightly more technical or detailed than is comprised in the body of the text, although not necessarily less interesting on that account, has been printed as footnotes.

BULLETIN 620–A. A gold-platinum-palladium lode in southern Nevada, by Adolph Knopf. 1915. pp. 1–18, Pl. I, fig. 1.

Part of Bulletin 620, "Contributions to economic geology, 1915, Part I." A brief description of the geology of the district surrounding the Boss copper mine, in the Yellow Pine mining district, Clark County, Nev., at which platinum-bearing gold ore was discovered in 1914. The development of the mine and the genesis of the ore are discussed and a review is given of the known lode occurrences of platinum. Great interest attaches to so unusual and remarkable an occurrence of platinum and palladium in a gold-bearing lode. The Boss vein is one of the few primary deposits in which metals of the platinum group occur in more than traces and, with one possible exception (the New Rambler mine in Wyoming), is the only primary deposit of economic importance in which these metals are the constituents of predominant value.

WATER-SUPPLY PAPER 312. Surface water supply of the United States, 1911, Part XII, North Pacific coast drainage basins, prepared under the direction of M. O. Leighton by F. F. Henshaw, G. C. Baldwin, G. C. Stevens, and E. S. Fuller. 1915. 706 pages, 4 plates.

Presents briefly the results of measurements of flow made on streams of the north Pacific coast of the United States during the calendar year 1911. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Accuracy, and Cooperation. The book also contains tables giving gage heights and daily and monthly discharges at each station, lithographed maps showing the mean annual precipitation and run-off in the United States, and halftone plates representing typical gaging stations and current meters.

WATER-SUPPLY PAPER 321. Surface water supply of the United States, 1912, Part I, North Atlantic coast basins, by C. C. Babb, C. C. Covert, and J. G. Mathers. 1914. 240 pages, 3 plates.

WATER-SUPPLY PAPER 325. Surface water supply of the United States, 1912, Part V, Upper Mississippi River and Hudson Bay basins, by A. H. Horton, W. G. Hoyt, and H. J. Jackson. 1914. 193 pages, 2 plates.

WATER-SUPPLY PAPER 326. Surface water supply of the United States, 1912, Part VI, Missouri River basin, by W. A. Lamb, Robert Follansbee, and H. D. Padgett. 1914. 375 pages, 2 plates.

WATER-SUPPLY PAPER 327. Surface water supply of the United States, 1912, Part VII, Lower Mississippi River basin, by Robert Follansbee. 1914. 84 pages, 2 plates.

WATER-SUPPLY PAPER 328. Surface water supply of the United States, 1912, Part VIII, Western Gulf of Mexico basins, by W. W. Follett, Robert Follansbee, and G. A. Gray. 1914. 121 pages, 2 plates.

WATER-SUPPLY PAPER 329. Surface water supply of the United States, 1912, Part IX, Colorado River basin, by Robert Follansbee, E. A. Porter, and H. D. Padgett. 1914. 238 pages, 2 plates.

WATER-SUPPLY PAPER 330. Surface water supply of the United States, 1912, Part X, The Great Basin, by F. F. Henshaw, E. A. Porter, and G. C. Stevens. 1914. 275 pages, 3 plates.

WATER-SUPPLY PAPER 331. Surface water supply of the United States, 1912, Part XI, Pacific coast basins in California, by H. D. McGlashan and G. C. Stevens. 1914. 442 pages, 2 plates.

WATER-SUPPLY PAPER 332–A. Surface water supply of the Pacific drainage basins in Washington and upper Columbia River basin, 1912, by F. F. Henshaw and W. A. Lamb. 1915. 282 pages, 2 plates.

WATER-SUPPLY PAPER 332–C. Surface water supply of lower Columbia River and Rogue, Umpqua, and Siletz rivers, 1912, by F. F. Henshaw and E. S. Fuller. 1914. 226 pages.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1912. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books also contain tables giving gage heights and daily and monthly discharges at each station, and halftone plates representing typical gaging stations and current meters.

WATER-SUPPLY PAPER 335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pages, 6 plates, 17 text figures.

The area discussed in this report embraces 36,317 square miles and includes that part of the Coastal Plain of Texas lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County. The paper includes a brief description of the geology of this area, with special reference to the underground-water horizons, and discussions of the quality of the water and artesian conditions and prospects in each of the several counties, as well as a geologic map of a part of eastern Texas, maps of several of the artesian reservoirs, maps showing the distribution of timber and the mean annual rainfall and run-off, and diagrams and sections showing ground-water conditions.

WATER-SUPPLY PAPER 336. Water resources of Hawaii, 1912, by C. H. Pierce and G. K. Larrison. 1914. 392 pages.

This volume contains results of measurements of the flow of certain streams and ditches in the Territory of Hawaii made during the calendar year 1912.

WATER-SUPPLY PAPER 338. Springs of California, by G. A. Waring. 1915. 410 pages, 13 plates, 4 text figures.

As a basis for the discussion of springs and spring waters of California this paper opens with a brief outline of the physical features of the State, together with a few notes on the character of the rocks and their structure, then proceeds to explain the usual or possible composition and properties of most natural waters as well as the source of their constituent substances, and concludes with dis-

cussions of the springs of California classified under the following groups: Hot, carbonated, sulphur, saline, magnesic, iron, artesian, large cold, and minor perennial springs. Accompanying the discussions of many of the springs are analyses of their waters, and at the end of the book are two tables, one of which gives an alphabetic list, by counties, of the best-known springs of the State, with name of owner, location, temperature, and yield, and the other a list of California spring resorts. The illustrations consist of lithologic and topographic maps of the State, showing locations of springs, and photographs of many of the springs and their environs.

WATER-SUPPLY PAPER 339. Quality of the surface waters of Washington, by Walton Van Winkle. 1914. 105 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Washington, showing the nature and amount of the material they hold in solution. The book contains many analyses.

WATER-SUPPLY PAPER 340–C. Stream-gaging stations and publications relating to water resources, 1885–1913, Part III, Ohio River basin, compiled by B. D. Wood. 1914. pp. i–xxii, 31–42.

WATER-SUPPLY PAPER 340–D. Stream-gaging stations and publications relating to water resources, 1885–1913, Part IV, St. Lawrence River basin, compiled by B. D. Wood. 1914. pp. i–xx, 43–52.

WATER-SUPPLY PAPER 340–E. Stream-gaging stations and publications relating to water resources, 1885–1913, Part V, Hudson Bay and upper Mississippi River drainage basins, compiled by B. D. Wood. 1914. pp. i–xxi, 53–61.

WATER-SUPPLY PAPER 340–F. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VI, Missouri River basin, compiled by B. D. Wood. 1915. pp. i–xxiii, 63–81.

WATER-SUPPLY PAPER 340–G. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VII, Lower Mississippi River basin, compiled by B. D. Wood. 1915. pp. i–xxi, 83–93.

WATER-SUPPLY PAPER 340–H. Stream-gaging stations and publications relating to water resources, 1885–1913, Part VIII, Western Gulf of Mexico drainage basins, compiled by B. D. Wood. 1915. pp. i–xx, 95–104.

WATER-SUPPLY PAPER 340–I. Stream-gaging stations and publications relating to water resources, 1885–1913, Part IX, Colorado River basin, compiled by B. D. Wood. 1915. pp. i–xxiii, 105–116.

WATER-SUPPLY PAPER 340–J. Stream-gaging stations and publications relating to water resources, 1885–1913, Part X, The Great Basin, compiled by B. D. Wood. 1915. pp. i–xxi, 117–129.

WATER-SUPPLY PAPER 340–K. Stream-gaging stations and publications relating to water resources, 1885–1913, Part XI, Pacific coast basins in California, compiled by B. D. Wood. 1915. pp. i–xxiv, 131–146.

Parts of Water-Supply Paper 340, a directory of Survey stream-gaging stations and publications relating to water resources of the United States. Each part contains a list of all gaging stations maintained in the section named in its title and an annotated list of publications issued by the United States Geological Survey relating specifically to that section, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

Water-Supply Paper 340–C pertains to the Ohio River basin, which includes Ohio River with all its tributaries, the most important being Allegheny, Monongahela, Beaver, Muskingum, New (or Kanawha), Scioto, Miami, Kentucky, Wabash, Cumberland, and Tennessee rivers. These streams drain wholly or in part the

States of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Water-Supply Paper 340–D pertains to the United States portion of the St. Lawrence River basin, which includes streams that drain into the Great Lakes and St. Lawrence River from the United States. These streams drain wholly or in part the States of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Vermont, and Wisconsin.

Water-Supply Paper 340–E pertains to the United States portion of the Hudson Bay and upper Mississippi River basins, which include streams (from the United States) whose waters reach Hudson Bay and the Mississippi above its junction with the Ohio (except the Missouri). These streams drain wholly or in part the States of Illinois, Indiana, Iowa, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wisconsin.

Water-Supply Paper 340–F pertains to the Missouri River basin, which includes Missouri River and all its tributaries, the most important being Jefferson, Madison, Gallatin, Prickly Pear, Little Prickly Pear, Dearborn, Sun, Marias, Judith, Musselshell, Milk, Yellowstone, Little Muddy, Little Missouri, Cheyenne, Niobrara, Platte (including North Platte and South Platte), Kansas, Osage, and Gasconade rivers. These streams drain wholly or in part the States of Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Water-Supply Paper 340–G pertains to the lower Mississippi River basin, which includes the main stream and all its tributaries below the mouth of the Ohio, the most important tributaries being Meramec, White, Arkansas, Yazoo, Homochitto, and Red rivers. These streams drain wholly or in part the States of Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas.

Water-Supply Paper 340–H pertains to the western Gulf of Mexico basins, which include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest of these streams are the Rio Grande, Sabine, Trinity, and Brazos rivers, Colorado River of Texas, Guadalupe and Chama rivers, Rio Puerco and Pecos River, in the United States, and Rio Salado and Rio San Juan in Mexico, draining wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and the northern States of Mexico.

Water-Supply Paper 340–I pertains to the Colorado River basin, which includes Green, Grand, Dolores, San Juan, Little Colorado, Virgin, and Gila rivers. These streams drain wholly or in part the States of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Water-Supply Paper 340–J pertains to the Great Basin, which is made up of a number of minor basins whose streams do not discharge into the ocean. The largest of these minor basins are the depressions that hold Great Salt Lake, Sevier Lake, Humboldt Sink, Truckee, Walker, Carson, and Owens rivers, and Honey, Mono, Malheur, Harney, Warner, Abert, Summer, and Silver lakes. The streams of this section drain wholly or in part the States of California, Idaho, Nevada, Oregon, and Utah.

Water-Supply Paper 340–K pertains to the Pacific coast basins in California, which include Tia Juana, Sweetwater, San Diego, Bernardo, San Luis Rey, and Los Angeles rivers, draining areas to the south of San Francisco Bay; and San Joaquin, Sacramento, Russian, Eel, Mad, and Klamath rivers, which flow into the ocean through San Francisco Bay or north of it. With the exception of Klamath River and a few streams in Oregon that flow into Goose Lake, at the head of Pit River, all the streams in this division are entirely in California.

WATER-SUPPLY PAPER 341. Underground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, and a discussion of the quality of the waters, by R. B. Dole. 1915. 539 pages, 21 plates, 4 text figures.

Gives the results of investigations made to determine the composition, structure, and stratigraphic relations of the formations of the Coastal Plain of Georgia and the geologic position, quality, quantity, and economic adaptability of the waters they contain. These topics are discussed first as applicable to the Georgia Coastal Plain as a whole and then as applicable to each county in this geologic province. Mr. Dole, who discusses the quality of the waters, concludes that all the underground waters of this province may be used advantageously for domestic and industrial purposes, although those from the later formations may require a little softening. He thinks also that the surface waters of this section are even better for industrial use than the ground waters, because they are lower in mineral content. The illustrations include a geologic map of the Coastal Plain of Georgia, a map of the underground water resources, a sketch map showing the relation of the drainage to the geologic structure, and halftone plates showing typical formations exposed by railroad cuts.

WATER-SUPPLY PAPER 342. Surface water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport. 1915. 343 pages, 13 plates, 5 text figures.

Describes briefly the general features of the Yukon-Tanana region, such as the geography, geology, climate, and water supply, and gives an account of the stream-measurement work and the establishment of gaging stations, with an explanation of the methods of carrying on the work and collecting the data. Contains tables showing the daily gage height and discharge of the various streams, and maps and other illustrations showing the hydraulic development of the region.

WATER-SUPPLY PAPER 343. Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pages, 19 plates, 51 text figures.

Describes the physiography, drainage, and geology of Tularosa Basin, New Mexico, with special reference to its underground water resources and their availability for use in irrigation. Tularosa Basin, which includes about 6,000 square miles of arable land entirely shut in by mountain ranges so that it has no drainage outlets, is dependent upon its scanty rainfall and underground water for the growing of its crops. The paper outlines the routes of travel through the basin, briefly describing the watering places to be found on these routes, and contains analyses of some of the well, spring, and stream waters in this and adjoining areas. The illustrations include maps of the basin and adjacent country showing groundwater conditions, maps showing settlements, diagrams showing precipitation and its relation to altitude and other features, and sections of wells.

WATER-SUPPLY PAPER 344. Deschutes River, Oregon, and its utilization, by F. F. Henshaw, J. H. Lewis, and E. J. McCaustland. 1914. 200 pages, 28 plates, 8 text figures.

This report describes the general features of the Deschutes River basin and gives in concise form the results of measurements of stream flow for 1912 at each gaging station. It includes sections on the availability of the water supply, the economic distribution of the water, and the developed and undeveloped water sites, as well as a brief discussion of the old and new laws relating to water (which is necessary for a proper understanding of the water-right situation) and the relation of the Federal Government to the development of water power in this basin. Deschutes River is unique among western rivers in that its natural flow is constant and its headwaters afford reservoir sites so large and so well distributed that the total flow of the river may be utilized both for irrigation and for power. The paper is illustrated by a map of the basin showing the position of the gaging

stations, plans and profiles of Deschutes and Metolius rivers, and maps of many of the power sites. The report was prepared in cooperation with the State of Oregon.

WATER-SUPPLY PAPER 345–E. A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce. 1914. pp. 53–65, figs. 1–2.

WATER-SUPPLY PAPER 345–F. The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport. 1914. pp. 67–77, Pls. IV–V, figs. 3–4.

Parts of Water-Supply Paper 345, "Contributions to the hydrology of the United States, 1914."

WATER-SUPPLY PAPER 345–G. The water resources of Butte, Montana, by O. E. Meinzer. 1914. pp. 79–125, Pls. VI–VIII, figs. 5–8.

Part of Water-Supply Paper 345. Gives the results of an investigation of the water resources of the small rock-bound basin in the center of which is situated the city of Butte, Mont. The investigation was made in response to an urgent request from the citizens of Butte for information as to the supply of ground water in the flat and the feasibility of developing it for industrial uses and for irrigation. The author concludes that the bedrock in this area forms a nearly water-tight basin but contains small quantities of water near the surface, where the rock is partly disintegrated, and in joints at greater depths. This bedrock will yield enough water in small quantities for domestic use but not enough for irrigation or industrial use. The deposits of clay, sand, and gravel which partly fill the basin are saturated with water below the water table, so that with proper methods of construction a yield of 100 gallons a minute from a single well can probably be developed in most parts of the flat, but flows of large volume should not be expected. The illustrations include a map of the basin discussed, showing water resources, a map of Silverbow Creek near Butte, and a diagram showing average monthly precipitation at Butte.

WATER-SUPPLY PAPER 345–H. Ground-water resources of the Niles cone and adjacent areas, California, by W. O. Clark. 1915. pp. 127–168, Pls. IX–XVII, figs. 9–24.

Part of Water-Supply Paper 345. Discusses briefly the physiography, drainage, and origin of ground-water supply of an area comprising the so-called Niles cone (the alluvial fan of Alameda Creek) and adjacent tracts in Santa Clara Valley, Cal., just east of the south end of San Francisco Bay, and describes the geologic formations in relation to ground water. This region is one of intensive farming, dependent on irrigation, and for more than 20 years there has been contention between the farmers and certain water companies that take large supplies from the Niles cone and tributary drainage basins to San Francisco and other cities on the bay. In the investigation resulting in this report an attempt was made to determine the source of the ground water, the quantity now being withdrawn, the amount available, and the area dependent on Alameda Creek. The author concludes that the ground-water supply is hardly adequate for the full irrigation of the area and the present-scale diversions by the water companies. The illustrations include maps of the area, well sections, and graphs showing fluctuations of the water table.

WATER-SUPPLY PAPER 345–I. Gazetteer of surface waters of Iowa, by W. G. Hoyt and H. J. Ryan. 1915. pp. 169–221.

Part of Water-Supply Paper 345. Embraces descriptions of all the streams named on the best available maps of Iowa, including the United States Geological Survey's base map of the State, county maps published in the annual report of the Iowa Geological Survey, and the topographic atlas sheets of the United States Geological Survey.

WATER-SUPPLY PAPER 346. Profile surveys in the basin of Clark Fork of Columbia River, Montana-Idaho-Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 6 pages, 3 plates.

Describes briefly the general features of the Clark Fork basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the stream and conditions along the bank between Deer Lodge, Mont., and the international boundary.

WATER-SUPPLY PAPER 347. Profile surveys in Snake River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1914. 12 pages, 3 plates.

Describes briefly the general features of the Snake River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the streams and conditions along the banks of Snake River from Enterprise to Minidoka and of Salmon River from Salmon to its junction with Snake River.

WATER-SUPPLY PAPER 348. Profile surveys in Hood and Sandy River basins, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 2 plates.

Describes briefly the general features of the Hood and Sandy River basins and gives lists of the gaging stations maintained by the Geological Survey on the two main streams and their tributaries. Contains plans and profiles of Hood River and of Sandy and Zigzag rivers and Camp and Still creeks above Marmot, Oreg.

WATER-SUPPLY PAPER 349. Profile surveys in Willamette River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 9 pages, 3 plates.

Describes briefly the general features of the Willamette River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains plans and profiles of Middle Fork of Willamette River and tributaries, Clackamas and Collawash rivers, and North Fork of Santiam River and tributaries.

WATER-SUPPLY PAPER 350. Profile surveys in Bear River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pages, 1 plate.

Describes briefly the general features of the Bear River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries above the mouth of Logan River. Contains a plan and profile of the river from Riverdale to Novena, Idaho.

WATER-SUPPLY PAPER 353. Surface water supply of the United States, 1913, Part III, Ohio River basin, by A. H. Horton, W. E. Hall, and H. J. Jackson. 1915. 264 pages, 5 plates.

WATER-SUPPLY PAPER 354. Surface water supply of the United States, 1913, Part IV, St. Lawrence River basin, by C. C. Covert and W. G. Hoyt. 1915. 136 pages, 2 plates.

WATER-SUPPLY PAPER 356. Surface water supply of the United States, 1913, Part VI, Missouri River basin. N. C. Grover, chief hydraulic engineer. 1915. 291 pages, 2 plates.

WATER-SUPPLY PAPER 357. Surface water supply of the United States, 1913, Part VII, Lower Mississippi River basin, by Robert Follansbee and G. A. Gray. 86 pages, 2 plates.

WATER-SUPPLY PAPER 358. Water resources of the Rio Grande basin, 1888–1913, by Robert Follansbee and H. J. Dean, including Surface water supply of the United States, 1913, Part VIII, Western Gulf of Mexico basins, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 724 pages, 3 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1913 and in the Rio Grande basin during the years 1888 to 1913, inclusive. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations and current meters. Water-Supply Paper 353 gives, in addition, views of two bridges over Miami River at Hamilton, Ohio, taken during the flood of March–April, 1913, and Water-Supply Paper 358 contains a map of the Rio Grande basin showing the location of gaging stations and mean annual precipitation in New Mexico and Texas.

WATER-SUPPLY PAPER 363. Quality of the surface waters of Oregon, by Walton Van Winkle. 1914. 137 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Oregon, showing the nature and amount of the materials they hold in solution. The paper contains many analyses, which show that the river waters of Oregon are low in mineral content and are very good for general industrial use and for irrigation. The report was prepared in cooperation with the State of Oregon.

WATER-SUPPLY PAPER 364. Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pages.

Contains 203 analyses, made in the chemical laboratory of the United States Geological Survey, of waters from rivers, lakes, wells, and springs in the United States as well as some mine waters. Most of these analyses have been published elsewhere, but many of the original documents are out of print and are therefore obtainable with difficulty.

WATER-SUPPLY PAPER 365. Ground water in southeastern Nevada, by Everett Carpenter. 1915. 86 pages, 5 plates, 3 text figures.

Gives an outline of the geography and geology of an arid region comprising about 17,000 square miles in Clark, Lincoln, Nye, and White Pine counties, Nev., and discusses the quality and source of its water supply. The watering places on routes of travel are briefly described and there is a table giving the approximate distances, in miles, between the chief watering places in this section of the State. The illustrations consist of maps of the area discussed, a diagram showing average monthly precipitation at several stations, sections across Spring Mountain, and halftone plates showing types of flowing wells in Las Vegas Valley and other geologic features.

WATER-SUPPLY PAPER 366. Profile surveys of Snoqualmie, Sultan, and Skykomish rivers, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 3 plates.

Describes briefly the general features of the Snohomish River basin and gives a list of the gaging stations maintained by the Geological Survey in the area drained by Snoqualmie, Sultan, and Skykomish rivers. Snohomish River is formed by the union of Skykomish and Snoqualmie rivers in the southwestern part of Snohomish County, Wash., and flows northwestward into Puget Sound. The paper contains plans and profiles showing the fall in the stream and conditions along the banks of Snoqualmie River and certain tributaries above Fall City, Sultan River above Sultan, and Skykomish River and certain tributaries above Gold Bar.

WATER-SUPPLY PAPER 367. Profile surveys of Missouri River from Great Falls to Three Forks, Mont., prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 1 plate.

Describes briefly the general features of the Missouri River basin and gives a list of the gaging stations on the main stream in Montana maintained by the Geological Survey. Contains a plan and profile of the river from Great Falls to Three Forks, Mont.

WATER-SUPPLY PAPER 368. Profile surveys in Wenatchee River basin, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 1 plate.

Describes briefly the general features of the Wenatchee River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains a plan and profile of Wenatchee Lake, Wenatchee River, and certain tributaries.

WATER-SUPPLY PAPER 375–A. Ground water for irrigation in the Sacramento Valley, California, by Kirk Bryan. 1915. pp. 1–49, Pls. I–II, figs. 1–6.

Part of Water-Supply Paper 375, "Contributions to the hydrology of the United States, 1915." Describes briefly the geography and geology of Sacramento Valley. The water-bearing formations and the origin, movements, and development of the ground water are discussed, special attention being given to pumping problems. A relief map of northern California, showing outlines of Sacramento Valley, and an outline map of the valley, showing pumping areas and depth to water, as well as diagrams of the fluctuations of the water table at different points in the valley, make up the illustrations.

WATER-SUPPLY PAPER 375–C. The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport. 1915. pp. 77–84.

Part of Water-Supply Paper 375. Considers stream gaging as a branch of hydraulic engineering and concludes that, while a large amount of research is needed before hydraulics can be considered an exact science, yet the recent developments in stream gaging point to the possibility that this branch may in time reach a state of perfection so commensurate with the requirements imposed upon it that all problems connected therewith may be solved with mathematical exactness. When this ideal condition is attained the developments in the science of hydraulics that may be wrought by means of the current meter and the stop watch should be such as to justify the highest expectation of the most enthusiastic stream gager of to-day.

MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1913. 1914. Part I, Metals, clxxiii+901 pages, 8 text figures; Part II, Nonmetals, vi+1,617 pages, 9 plates, 26 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. Contains four inserts showing (1) mineral products of the United States since 1904, (2) clay products of the United States in 1913, (3) production of coal in the United States since 1807, and (4) production of crude petroleum in the world since 1857. A consolidation of 62 advance chapters, each covering a single mining industry or group of allied industries.

MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1914; parts as follows:

The production of sand-lime brick in 1914, by Jefferson Middleton. 1915. pp. 1–7. Part II: 1.

Potash salts, 1914, by W. C. Phalen. 1915. pp. 9–33, Pl. I. Part II: 2.

The production of fuller's earth in 1914, by Jefferson Middleton. 1915. pp. 35–40. Part II: 3.

The production of phosphate rock in 1914, by W. C. Phalen. 1915. pp. 41–56. Part II: 4.

Fuel briquetting in 1914, by E. W. Parker. 1915. pp. 57–60. Part II: 5.

GEOLOGIC FOLIO 193. San Francisco (Cal.), folio, by A. C. Lawson. 1914. 24 folio pages of text, 10 maps, 5 structure-section sheets, 1 columnar-section sheet, 10 plates, 4 text figures. Price, 75 cents.

Description and maps of the San Francisco district, California, comprising the Tamalpais, San Francisco, Concord, San Mateo, and Haywards quadrangles, in Alameda, Contra Costa, Marin, San Francisco, and San Mateo counties. Large parts of four of these quadrangles cover the waters of the Bay of San Francisco or of the adjacent Pacific Ocean. The matter contained in this folio is to be published also in octavo form, price 75 cents.

GEOLOGIC FOLIO 194. Van Horn (Tex.) folio, by G. B. Richardson. 1914. 9 folio pages of text, 2 maps, 1 structure-section sheet, 9 plates, 6 text figures. Price, 25 cents.

Description and maps of the Van Horn quadrangle, comprising about 1,019 square miles in El Paso and Culberson counties, Tex.

GEOLOGIC FOLIO 195. Belleville-Breese (Ill.) folio, by J. A. Udden and E. W. Shaw. 1915. 13 folio pages of text, 4 maps, 1 columnar-section sheet, 13 text figures. Price, 25 cents.

Description and maps of the Belleville and Breese quadrangles, comprising about 467 square miles in Bond, Clinton, Madison, and St. Clair counties, Ill.

TOPOGRAPHIC MAPS as follows:

Alaska (Territory).[1]
Ames, Iowa.
Avena, Cal.
Axial, Colo.
Baldwin, Ill.
Battle Lake, Minn.
Benson, Ariz.
Boring, Oreg.
Burnham, Cal.
Chester, Ill.-Mo.
Chitina, Alaska.[2]
Churubusco, N. Y.
Cincinnati, Ohio-Ky.[3]
Clintwood, Va.-Ky.
Corning, N. Y.
Coshocton, Ohio.
Crawford, W. Va.
Crow Creek, Idaho-Wyo.
Crystal City, Mo.-Ill.
Cuskers, Mont.
Deerwood, Minn.
Douglas, Ariz.
East Cincinnati, Ohio-Ky.[3]
Elkhorn Weir, Cal.
Fredericktown, Ohio.
Gambier, Ohio.
Gillespie, Ill.
Grand Rapids, Mich.
Hereford, Ariz.
Hindman, Ky.
Hominy, Okla.
Hoquiam, Wash.
Houghton, Mich.
Kern River oil field, Cal. (2 sheets).[4]
Kirkville, Cal.
Lanes Creek, Idaho.
Lathrop, Cal.
Little Muddy, Ky.
Longs Peak, Colo.
Loudonville, Ohio.
Macomb, Ill.
Malaga, Wash.
Manteca, Cal.
Marengo, Ohio.
Massachusetts, Rhode Island, and Connecticut (States).[1]
Meadow Creek, W. Va.
Merritt, Cal.
Mesa, Ariz.
Mesa Verde National Park, Colo.
Milford, Pa.-N. Y.-N. J.
Milton, Vt.
Montana (State).[1]
Monument Butte, Colo.
Morenci, Ariz.-N. Mex.[5]
Mount Baker district, Wash.
Mount Morrison, Cal.-Nev.
Mount Olive, Ill.
Mount Rainier National Park, Wash.
Murphy, Tenn.-N. C.[3]
Nemaha, Nebr.-Mo.
Nowata, Okla.[6]
Number Four, N. Y.
Nyack, Mont.
Oregon (State).[1]
Oregon City, Oreg.
Ottawa, Ill.[6]
Palatka, Fla.
Perham, Minn.
Perrysville, Ohio.
Petaluma, Cal.
Peters, Cal.
Pine, Oreg.-Idaho.
Platte County, Mo.
Port Valdez, Alaska.
Pound, Va.-Ky.

[1] Photolithograph.
[2] Reprint of Plate I, Bulletin 374.
[3] New edition; revised in field.
[4] Formerly Oil Center; revised in field and enlarged.
[5] Formerly Boyles.
[6] Resurveyed and reengraved.

Priest Valley, Cal.
Reading, Pa.[1]
Renault, Ill.-Mo.
Ronda, Cal.
Roxabell, Ohio.
Sago, W. Va.
San Francisco and vicinity, Cal.
San Francisco Bay (sheet J–10 of world map).
Seaford, Del.-Md.
Soda Canyon, Colo.
Spring Creek, Mont.
Sunnyside, Utah.
Swingle, Cal.
Todd Lakes, Mont.
Troy, Ohio.
Tule Valley, Mont.
Underwood, Minn.
Union Island, Cal.
United States (2-sheet base map).[2]
United States (2-sheet contour map).[2]
Vergas, Minn.
Vermont and New Hampshire (States).[3]
Vernalis, Cal.
Vincennes, Ind.-Ill.
Virginia (State).[3]
Walker Creek, Cal.[4]
Washington (State).[3]
West Cincinnati, Ohio-Ky.[5]
Wyoming (State).[3]
Yerington district, Nev.
Yolo, Cal.

GEOLOGIC BRANCH.

SCOPE OF WORK.

The geologic branch is responsible for the geologic work of the Survey. Its original duties, as defined in the act establishing the Survey, were "the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain." These duties were at first construed to apply only to the public-land States. Later, however, in order that all parts of the country might share alike in the benefits of its work, the Survey was specifically authorized "to continue the preparation of a geological map of the United States," the scope of its operations being thus made nation-wide. Since that time (1882) the investigations necessary to the fulfillment of the Survey's obligations to the public have become as varied as the aspects of geology itself.

At present the geologic branch is not only the effective agency of the Survey in the geologic investigations carried on by the Government in all parts of the United States and Alaska but also the great geologic information bureau to which the American public, from Key West to Point Barrow and from San Diego to Eastport, applies for knowledge of every sort concerning the earth's crust and its mineral constituents. To the people of this country and, in a surprising degree, to the citizens of other countries, the Survey is the principal source of geologic information regarding not only the geology of the United States and its possessions but also that of Mexico, Central America, and even South America. Through its correspondence it is asked for data regarding the geology and mineral deposits of all parts of the world. The geologic branch has therefore the double task of geologic surveying, including the investigation, description, and mapping of the geology and mineral deposits of all parts of the country, the classification of the public lands, and the publication of the results of

[1] Resurveyed and reengraved.
[2] Revised map; published in new form.
[3] Photolithograph.
[4] Preliminary edition showing part of quadrangle.
[5] New edition; revised in field.

its work on the one hand, and of furnishing to the public miscellaneous geologic information derived from all sources on the other.

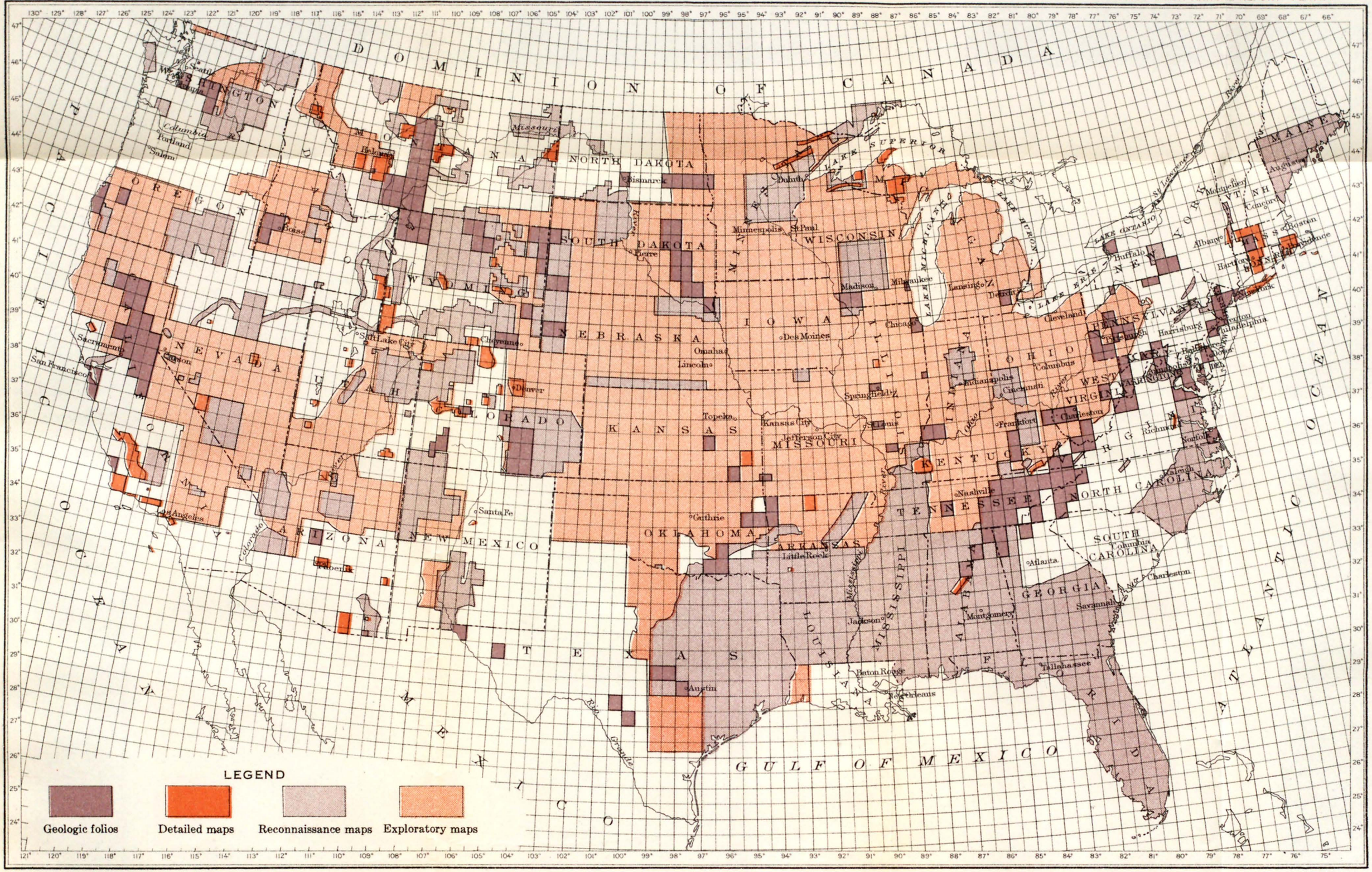
ADMINISTRATION.

For the more efficient and systematic accomplishment of its work, the geologic branch is organized in four divisions—geology, David White, chief geologist, in charge; Alaskan mineral resources, A. H. Brooks in charge; mineral resources, H. D. McCaskey in charge; chemical and physical researches, G. F. Becker in charge. These divisions, though as nearly autonomous as is practicable without loss of efficiency and strength in the organization as a whole, cooperate effectively. Most of the statistical reports of the division of mineral resources are prepared by members of the division of geology who are specialists in the geology of the respective mineral deposits and whose field investigations give opportunities for close observation of the mineral industries. In paleontologic and other laboratory investigations there is free exchange of assistance between the division of Alaskan mineral resources and the division of geology. Field investigations are occasionally made by members of the division of chemistry and physics under the auspices of the division of geology.

The chief geologist plans the geologic investigations to be carried on by the Survey in the United States and has general supervision of the work. He gives special attention to cooperation in geology with the State surveys and devotes such time as is available to him for field work to field inspections and conferences with geologists and chiefs of sections and to the direction and inspection of the work of the section of eastern fuels.

PUBLICATIONS.

The publications of the fiscal year 1915 prepared wholly or partly in the geologic branch embrace 1 monograph, 34 professional papers, bulletins, etc., 92 chapters of reports later published as annual volumes, and 3 geologic folios. Titles and brief abstracts of these publications are given on pages 16–37. Besides the official publications, 56 papers were, with the permission of the Director, published in scientific journals and in the publications of scientific societies. Eight reports, based on work done in cooperation with State geological surveys, have, in accordance with the cooperative agreements, been transmitted to the States for publication. On the other hand, three somewhat extensive geologic reports, prepared by the State organizations under the same agreements, have been submitted for publication by the Federal Survey, and others are in preparation by the States. In the preparation of the reports of mineral production some of the material relating to certain of the industries in the different States is compiled by the State geologists.



MAP OF THE UNITED STATES, SHOWING AREAS COVERED BY GEOLOGIC MAPS PUBLISHED PRIOR TO JULY 1, 1915

Scale 1/14,000,000

100 0 100 200 300 400 500 Miles

SNYDER & BLACK N.Y.

AREA GEOLOGICALLY SURVEYED IN THE UNITED STATES DURING THE YEAR.

On account of the differences in the nature of the work performed, it is difficult to estimate areas covered by all the geologists in square miles of detailed areal, detailed reconnaissance, and reconnaissance mapping. However, calculations, in which examinations for inspection, paleontologic studies, revision, and local investigations have been omitted, furnish the following results for the fiscal year ended June 30, 1915.

Areas covered by geologic surveys, fiscal year 1914–15.

	Square miles.
States east of the one-hundredth meridian:	
Detailed areal	3,346
Detailed reconnaissance	1,830
Reconnaissance	36,650
States west of the one-hundredth meridian:	
Detailed areal	10,411
Detailed reconnaissance	4,705
Reconnaissance	10,705
Total in the United States:	
Detailed areal	13,757
Detailed reconnaissance	6,535
Reconnaissance	47,355

The areas in the United States covered by geologic maps published by the Survey and the general nature of the work in each area are shown on Plate I, which does not, however, indicate areas for which reports, prepared by this Survey, have been submitted for publication to cooperating State organizations or to other bureaus and departments of the Federal Government.

The progress of geologic surveying in Alaska is described in the section on the division of Alaskan mineral resources (pp. 92–99).

DIVISION OF GEOLOGY.

ORGANIZATION.

The scientific force of the division of geology at the beginning of the year consisted of 66 geologists, 33 associate geologists, 26 assistant geologists, 15 junior geologists, and 22 geologic aids. During the year eight members of the scientific staff resigned to take positions in private life at higher salaries, two members were transferred to the land-classification board, and 12 members were appointed. The total number of geologists of various grades on the staff at the end of the year was 164. Of this number, 81 were employed continuously, 35 gave only part of their time to Survey work, and 48 were not employed.

The division of geology is organized in nine sections, as follows:

1. Section of eastern areal geology (east of the one-hundredth meridian).
2. Section of western areal geology (west of the one-hundredth meridian), including the subsection of investigations in petrology.
3. Section of Coastal Plain investigations.
4. Section of glacial geology.
5. Section of paleontology and stratigraphy.
6. Section of metalliferous deposits.
7. Section of nonmetalliferous deposits.
8. Section of eastern mineral fuels (east of the one-hundredth meridian).
9. Section of western mineral fuels (west of the one-hundredth meridian).

The section of geologic-map editing, although a part of the publication branch, comes under the general supervision of the chief geologist.

ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1914–15 were as follows:

Geologic surveys	$400,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemistry and physics)	16,150
	429,850

The allotments of the appropriations were as follows:

Section of eastern areal geology	$24,700
Section of western areal geology	47,700
Section of Coastal Plain investigations	12,400
Section of glacial geology	7,175
Section of paleontology and stratigraphy	23,500
Section of metalliferous deposits	47,855
Section of nonmetalliferous deposits (including potash)	38,750
Section of eastern fuels	31,800
Section of western fuels	57,610
Geologic map editing	7,020
Débris investigation and inspection	4,400
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	95,440
	398,350
Land-classification board	31,500

Of the amounts allotted to this division, approximately $309,900 was expended directly for geologic work, including the search for potash. Of this amount, about $208,540, or 67.3 per cent, was expended west of the one-hundredth meridian and $101,375, or 32.7 per cent, east of the one-hundredth meridian. If, however, the $31,500 for the operations of the land-classification board is included, 70.3 per cent of a total approximating $341,415 was spent for investigations west of the one-hundredth meridian—that is, essentially in the public-land States. The allotment for supervision, etc., is

divisible in very nearly the same proportions between the eastern and western work.

COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

In strictly geologic field investigations or paleontologic studies the Survey cooperated through the division of geology with 17 States—Georgia, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Virginia, and Wisconsin. Informal cooperation, without specific financial obligations, exists between most of the other States having geological surveys.

The Survey cooperates with the Bureau of Mines in the metallographic study of ores, in the investigation of the invasion of California oil wells by salt water, in studies of the application of geology to engineering problems of mining and construction, and in the examination of placers and placer mining in the United States. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads in a thorough and systematic study of the building stones of the United States. Through the division of geology it also cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Forest Service, the Navy Department, the War Department, and the Lighthouse Service, as well as with a number of institutions of learning, including, in particular, the Geophysical Laboratory and Marine Biological Station of the Carnegie Institution. Services varying in extent have, during the year, been rendered to the Department of Agriculture in the examination of lands in the national forests; to the Department of Justice in connection with its suits regarding public lands; to the Navy Department in regard to oil and water supplies; to the Office of Indian Affairs in the classification of Indian lands in Arizona, Washington, New Mexico, and Oklahoma; to the War Department with reference to water supplies in its reservations; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high standard of work. Exceptions are made of the studies of detrital deposition in California, completed by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, the general descriptions by Mr. Gilbert of the structure in the Great Basin region, and the general monographic description of the geology of the Yellowstone National Park, in preparation by Arnold Hague. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

GENERAL FEATURES OF THE WORK OF THE YEAR.

The more important scientific and economic investigations in progress in the division of geology were briefly described in the report for last year, pages 34–36, 71–74; this year reference will be made only to those features of the work that may be either new or noteworthy as to progress, as to changed conditions, or as to policy.

The most important item affecting the work of the geologic branch during the year was the increase in the appropriation for geologic surveys from $300,000 to $400,000. This was a net addition of but $65,000 to the funds of the branch, however, for $35,000 of the new appropriation was required merely to replace the amount which, for several years, had been contributed by the General Land Office to the cost of the Survey work in the classification of the public lands. The net gain in available funds has been used to enlarge the operations of all sections; but the largest proportion, in accordance with the understood spirit of Congress in voting this increase, has been devoted to the classification and valuation of lands in the public domain.

In the search for potash no clue has been neglected. In accordance with plans made the previous year, a deep well was drilled in the season of 1914 near the center of the Black Rock Desert, in western Humboldt County, Nev. Because of the late date (August 1) on which the appropriation bill was passed, the beginning of work was much delayed. However, when once started, the drilling was remarkably free from delay or mishap and on November 16 was completed to a depth of 1,500 feet. The cost of the work as carried out by the Survey with its own equipment was far less than the amount named in the lowest of the bids received for it, all of which were rejected. No bed of potash or other salts, in massive form, was encountered in this well. Nevertheless, the test is not considered conclusive as to the hypothesis that buried saline deposits remain in some of these basins as the result of the drying up of the lakes of Nevada, eastern California, and southern Oregon in Quaternary time. The field to be explored is large, and both the funds and the facilities for exploration have limited the trials to a few localities. The hypothesis on which this exploration, which is in charge of H. S. Gale, has been based deserves further test in the hope that potash-rich salt muds or brines, similar to or more concentrated than those found at Searles Lake, Cal., may be found in other places. In connection with this drilling a study of the sediments composing the beds penetrated by the drill, by the use of the microscope and soil analyses, was begun by M. I. Goldman in order to procure information as to the climatic and other conditions prevailing at different times during the long period in which the lake basin was being filled and converted into a desert. All drill samples containing salts in appreciable quantities were subjected to chemical tests.

The geologic formations which, from the evidence in hand, are regarded as more likely than others to contain buried potash salts in commercial amounts are the Quaternary lake beds in the Great Basin region of the West and the Permo-Triassic red beds of the Rocky Mountain States, Kansas, Oklahoma, and Texas. Whether or not the Quaternary lake province is the one which contains the larger potash-bearing deposits, it would at least appear that the centers of desiccation can be more readily as well as more accurately located in that province and that the drilling adequate for testing can therefore be accomplished with better data for guidance as to locations, with a comparatively small number of deep holes, and at far less cost. The results of exploratory boring in Searles Lake and the shallowly buried salt beds in Death Valley, Cal., establish a degree of validity for the Quaternary lake basin hypothesis and certainly encourage testing in other basins, though it is, of course, quite possible that, on account of geologic conditions not to be detected at the surface of the ground, no other deposits of importance may be present in any other basins. Certain of the basins may safely be condemned on the physiographic and geologic evidence, but beyond the limits of geologic interpretation the question can be determined only by patient search with the drill. A new drilling outfit, specially designed for the work, was purchased in the spring of 1915, supplies were ordered, and other preparations made for drilling at the beginning of the new fiscal year, at localities already selected by Mr. Gale in the Smoke Creek Desert, Nev., which will next be tested.

Studies of the red beds have been carried on in Wyoming, Colorado, Arizona, and New Mexico, in order to define as nearly as possible the basins of sedimentation in Permo-Triassic time and so indirectly, if not directly, to locate the centers of extensive desiccation of the red-bed areas. That there has been desiccation on a great scale in these regions is shown by thick deposits of salt and gypsum in the red beds over large areas. Search is being made for the basins and portions of basins in which saline deposits are the most numerous, as well as thickest, and in which, especially, there may be evidence of the complete drying out of the sea. Samples are gathered, wherever conditions are suitable, for testing in the laboratory. In June the field examinations of the red-bed outcrops in eastern New Mexico was resumed by N. H. Darton, one of the geologists most familiar with the stratigraphy of these formations.

Hope for the discovery of potash deposits in the red beds of the Southwest is encouraged by the detection of slight potash indications in the west-central region and in the Panhandle of Texas. The first of these reported indications was noted at Spurr, in Dickens County, Tex., by Dr. J. A. Udden, of the bureau of economic geology and

technology in the University of Texas, while examining the records and drillings of wells in the Paleozoic regions of Texas, as special agent of this Survey. Subsequent drilling in the region has been investigated, with the discovery of additional traces of potash in the Panhandle, not far from Amarillo, by the State University bureau under the direction of Dr. William B. Phillips.

Evidence warranting boring especially for potash salts by the Government, if not by private parties, at some point in the red-bed region may at any time result either from the geologic examinations now in progress or, as is possibly more likely, from the chance discovery of potash indications or even of a valuable deposit in some well drilled for oil or water. The red beds are very extensive, covering portions of several States in a continuous formation. Pending the conclusions drawn from the geologic studies as to the probable centers of greatest saline deposition in this region, there may be little choice of location throughout large areas. Consequently random locations in untested areas by drillers for oil, gas, or water probably offer, if the drilling is properly conducted with adequate scientific observation, collection of cuttings and brines, and chemical analyses, as good chances for the discovery of potash salts as drill holes located by the Government in advance of the geologic studies. Hence every effort is made to cooperate with all drillers who may be boring in the regions which are under examination or which it is thought may contain large saline deposits. Sample bags and specially prepared log books are furnished to them with the request that cuttings be taken from every "screw," at least in the regions of the formations containing or adjacent to the saline or gypseous deposits. Also samples of brines are solicited. All these samples are tested for potash in the laboratory of the Survey, and the drillers are informed as to whether potash is present in considerable amounts in any of the samples. In the lack of funds sufficient to carry on the exploration more rapidly and especially to conduct boring operations in several areas at once, the effort will be made, whenever possible, to station scientific observers at the sites of new drillings in areas which would appear to be especially promising or in which indications have been reported, in order that the cuttings of the drill may be watched on the ground by a competent observer and tests made of the samples and brines as the work progresses.

It is hoped that drillers for oil and water, not only throughout the red-bed region but in the salt-bearing regions of the Salina and other formations in the Eastern States, may be interested to take advantage of the cooperation of the Geological Survey in the examination of their drill records and cuttings, in order that the possible presence of potash deposits of value in any of these regions may be recognized. In portions of the saliferous areas in the more thickly

settled Eastern States such cooperation by the drillers would easily afford adequate exploration. Wildcat borings in new districts, located in unexplored depositional basins, are of particular importance, and special effort is therefore made to engage the interest of drillers at such points in the examination of their borings by the Survey. There are, however, large areas, especially in the red-bed region, in which no boring is in progress or possibly even contemplated so far as is known to the Survey. In view of the urgent need for the discovery of potash and nitrate supplies within the territory of the United States, it is greatly to be regretted that the funds available for this search are not sufficient to permit exploration on a larger scale through the employment of several drill rigs, operating at once in a number of the relatively favorable regions.

In addition to the explorations above described, the Geological Survey is testing all samples sent to it for examination from reported discoveries of potash salts or nitrates. It has also made field investigations of reported deposits concerning which the tests have been favorable, and the information submitted with the samples has warranted the hope that the deposits might prove to be of value. Many of the samples forwarded contain no potash or nitrates in notable quantities. With few exceptions the deposits have been too lean or, especially the nitrate deposits, too small, though fairly numerous, to be commercially important. A large number of wells, earths, brines, and prospects have been examined in the field, as well as in the office, and considerable attention has been given to the examination of brines from developed salt or bromine producing fields and from the salt-dome oil fields.

In many lines the geologic work of the Survey is showing marked tendency toward greater exactness of method, with corresponding greater definition of results. The exploratory, reconnaissance, and qualitative methods are gradually being supplanted by detailed examinations, and with the more general application of engineering methods the results are in larger measure quantitative. This is most apparent in the work of land classification. In the classification of coal lands, as described in Bulletin 537, the determinations of geologic boundaries of outcrops of coal beds, and of key rocks, as to geographic position, dip, and elevation, are made instrumentally. The economically valuable beds are more frequently prospected and sampled, their variability and continuity are more systematically noted or calculated, and, finally, depths, tonnage, and values are computed. Comparable methods are now employed also in the survey of iron deposits, the examinations for possible oil pools, and the classification of phosphate lands. Gradually and systematically data are being gathered in the different regions for a tonnage estimate of the wealth of the United States in calcium phosphate. The problem of exploiting,

manufacturing, and marketing this priceless endowment of phosphate in such ways as will lead to its larger use by the American farmer is worthy of the most serious consideration. It is an economic misfortune and a reproach that so large a proportion of the phosphate rock (35 per cent of the total production of 2,734,043 tons in 1914) now mined in this country is shipped abroad to enrich the soils of foreign countries while the soils of the United States are in general becoming slowly impoverished. With a rapidly increasing urban population to be fed, we are confronted by a waning crop production to the acre, and, in the end, by an adverse balance of foreign trade that must be met by a gradual sacrifice of our unreplaceable mineral resources, either in manufactured forms or in the raw state, instead of by products of the soil that may be renewed without exhaustion of the source.

To supply the need for general information, accurate though condensed, as to the coal fields of the country, descriptive summaries, with maps, similar in some respects to those published in the Twenty-second Annual Report of this Survey, are being prepared for issue as parts of a general report on the coal fields of the United States, under the supervision of M. R. Campbell. In this report, for which there is a constant and large demand, the coal resources of the many fields will be differentiated and, with additional and more precise data than have hitherto been available, will be recalculated quantitatively in revision of the estimates by Mr. Campbell printed in Mineral Resources for 1907 and of those later prepared by the Survey for publication in "Coal resources of the world," under the auspices of the International Geological Congress which met in Toronto, Canada, in 1913.

Comparable in some respects to the engineering and quantitative methods of investigation applied to some of the nonmetalliferous and fuel deposits is the systematic study of the metalliferous deposits by natural provinces or by large geographic units, such as States. Comprehensive and systematic studies like those of the mining districts of Utah, by B. S. Butler, or of Idaho, by J. B. Umpleby, both now in progress under the direction of F. L. Ransome, can not fail to give a better knowledge of the general conditions of occurrence and modes of association of the different ores, the origin and characteristics of the deposits, and their limitations and adaptations with reference to different treatments. Nevertheless, such more comprehensive investigations can not relieve the Survey of the necessity for reconnaissance examinations of newly discovered or newly developing districts and for the special study of the geology of deposits which present new or unusual features and of those which, though not now valuable, may hereafter become so.

The progress of knowledge as to the origin of metalliferous deposits, a line of early geologic inquiry, is marked possibly more strongly than ever by a broadening of the methods of investigation. This is shown in the increasing diversity of the researches in geology, chemistry, and physics contributory to the solution of the problem. The studies of the enrichment of ore deposits demand, among other things, the understanding of paleogeographic conditions, the interpretation of geologic history, and the paleontologic determination of the time elements concerned. More observations must be made of the influence of various minerals on the deposition of metals, such as silver, or of other minerals, from solution, as is shown by E. S. Bastin and Chase Palmer in their studies of silver enrichment. Further, the metallographic microscope, with its photographic attachment, supplements the petrologic microscope and chemical methods in the differentiation of the opaque minerals and the study of their mode of association and their origin. By this means supposed chemical compounds have been shown to be mere mixtures of minerals, and relations previously unsuspected or unproved have been discovered. Inasmuch as the metallographic study of the relations and mode of association of the individual minerals in composite ores promises to give aid in separating and reducing such ores, as well as in solving the problems regarding the origin of the ores, this study is recognized as of direct and mutual concern both to the Geological Survey and to the Bureau of Mines. Accordingly, the work of F. B. Laney is carried on under the joint auspices of the two bureaus. That part of the investigation which concerns the genesis of the ores and their deposition falls naturally within the province of the Geological Survey, while the application of the ascertained facts concerning the genesis of the ore minerals, their association in the rock, and their mechanical differentiation is to be made by the Bureau of Mines in the solution of problems of successful treatment and utilization. In these studies biochemistry also must be considered, as it is in the study of the deposition of iron oxide by E. C. Harder.

Another inquiry that may have far-reaching significance with reference to the occurrence and relations of metals and other substances as now found in the earth is illustrated by the experiments made by C. E. Van Orstrand on the diffusion of solids, which are more fully mentioned in the account of the work of the division of chemistry and physics.

Recognizing that the ability to form a correct judgment as to the practical utilization and value of an ore or other mineral deposit in the ground is most effectively acquired through the field observation of operating works and processes for the exploitation and reduction of the same or similar deposits, the Survey regards it of the highest

importance that the geologist who may be called upon to appraise undeveloped mineral resources in the public domain or in other regions of the country shall keep as closely as practicable in touch with the mineral industry, and shall have a knowledge of the factors conditioning the successful treatment and utilization of the ores he is examining. In the acquisition of this necessary special knowledge of mineral deposits of a certain type and of the industry based on that type, the record of the production of that industry is, so to speak, a by-product of the estimate of the deposits and the study of the processes. Accordingly, it is found not only that the reports of mineral production in the United States can be most satisfactorily as well as economically prepared by the geologist who has specialized in the particular lines of economic geology, but also that the geologist becomes thereby better qualified for his field investigations and for service to the increasing number of applicants to the Survey for data, otherwise not obtainable, concerning ore deposits and their utilization, the marketing of ores, or the obtainment of minerals or mined products. It thus happens that the geologist may be reporting the mineral production on the one hand, while he may at the same time on the other hand be taking, perhaps on a quantitative basis, a census of the country's undeveloped reserves.

The great damage to certain oil fields, especially in California, through the entrance of water into the oil-producing sands, with the result that large quantities of oil can never be extracted, has made it necessary for the Government, as one of the large landholders in the region, to take part in the investigation of the causes and in the means for prevention. Accordingly, late in the fiscal year 1914 the Bureau of Mines and the Geological Survey jointly undertook the examination of the problem, in which the Survey has been studying the conditions of the association of water, oil, and gas in the sands, and their modes of migration with special special reference to the mechanical constitution, chemical composition, and attitude of the beds. The methods of remedying the evil and the engineering devices for conserving the oil are receiving consideration from the Bureau of Mines. The investigations conducted by the Survey are far reaching, touching even the problems of the origin of oil and gas, and may not be concluded without prolonged studies in many fields; but all the oil and gas geologists of the Survey are deeply interested in the inquiry, and it is certain that their combined researches will lead to a better understanding of the laws of the occurrence and movements of oil. Meanwhile the data relating immediately to the causes of the local damage in California are being assembled in the form of a report.

The general reconnaissance survey of the geologic formations, paleontology, and underground-water supplies of the Atlantic and

Gulf Coastal Plain has reached an advanced stage. This work, which has for a number of years been in progress under the direction of T. Wayland Vaughan, has, quite aside from its important economic products, contributed in a most invaluable way to the knowledge of the stratigraphy and geologic history, not only of this great area of the United States but of all southern North America and Central America. A part of the general problem now receiving much attention concerns the correlation of the Pleistocene terraces from region to region and from the Coastal Plain into the glaciated regions, in the effort to connect, so far as possible, the Quaternary history and physiography of the Coastal Plain regions with the glacial stages and deposits to the north.

Conclusions that are essentially by-products of the main investigations just cited are illustrated by the results of Mr. Vaughan's researches regarding the coral-reef plateaus and the continental shelf in the Antillean region and the origin of oolites and calcareous deposits, or of the studies by E. W. Shaw of the fluviatile and estuarine deposition of sediments. Investigations like Mr. Shaw's are immediately applicable to such studies as the examination of the borings made in the course of potash exploration in Nevada.

Looking forward to the day when the oil and gas resources of the United States will have become depleted, the Geological Survey is giving some attention to the carbonaceous shales of the United States and their capacity to yield petroleum, gas, and other valuable distillates. The examinations of the hydrocarbon shales in the Green River formations of Colorado and Utah are described on page 61, and preliminary statements of the results of the investigations will be published at an early date. Some experimental tests have also been made of the carbonaceous shales of Devonian age in the Eastern States and of the cannel coals and the richly carbonaceous shales associated with other coals in these States. Field tests are made by a portable apparatus carried from camp to camp. The laboratory distillations and fractional separations are performed by the Bureau of Mines.

The most important of the new cooperative projects organized within the year is that for the comprehensive study of the placer deposits of the United States. Preliminary work in accordance with this plan, which was initiated by the Geological Survey, was done by J. M. Hill, who is considering the character, geologic occurrence, and origin of the deposits. The contribution by the Bureau of Mines will relate to methods and costs of placer mining and will be made by Charles Janin, a mining engineer of that bureau. It is expected that the field work will extend over two or more field seasons.

The foregoing sketch of some of the features of the work of the division of geology that appear to be noteworthy does not include some of the most important scientific work, which is too well known to require special comment.

SCOPE OF THE WORK OF THE SECTIONS.

The work of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one-hundredth meridian, the primary object of which is to make known, mainly through folios of the Geologic Atlas, the general geology of the region studied, or to prepare scientific and educational descriptions of it, rather than to examine and describe or map the area especially on account of some geologic problem or some particular economic resource. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants. During the year the operations of the section have covered areas in Alabama, Arkansas, Delaware, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The work of the section of western areal geology (west of the one-hundredth meridian)—F. L. Ransome, geologist in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the Geologic Atlas of the United States.

Four geologic railway guides, designed primarily for the benefit of travelers to the Panama-Pacific Exposition, have been prepared under the general auspices of this section. Field work was begun by six geologists early in June, 1914, and was continued into the autumn. One of the four resulting bulletins (Bulletin 612) has already appeared and is described on page 27.[1] The activities of the section have concerned the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington.

3. The section of Coastal Plain investigations—T. Wayland Vaughan, geologist in charge—is occupied primarily with the study of the numerous geologic formations of the Atlantic and Gulf Coastal Plain, their character, extent, general structure, correlations, conditions of deposition, and geologic history, and especially of the underground-water resources of the region. Incidental attention is given to other mineral resources which are more particularly consid-

[1] The other bulletins of this series have been published since the close of the fiscal year.

ered by other sections. Because of their importance in accurately tracing the different geologic formations and in supplying a reliable basis for geologic correlation, the fossil organisms entombed in the different formations are carefully studied. Most of the areal work of this section during the year has been of the reconnaissance type. Its office investigations are comprehensive and broadly scientific, as well as economic. The National Museum, the Bureau of Fisheries, the Carnegie Institution, and a number of specialists in biology or paleontology, as well as the division of underground waters of the water-resources branch, have cooperated with or contributed to the work of this section.

Investigations have been carried on by this section during the year in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Tennessee, Texas, and Virginia.

4. The section of glacial geology—W. C. Alden, geologist in charge—is engaged in the study of the work of glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Quaternary period. The geologists occupied with these varied and specialized problems are charged with the classification and mapping of the Quaternary deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping and the preparation of reports covering areas in Illinois, Indiana, Iowa, Massachusetts, Michigan, Minnesota, New York, North Dakota, Vermont, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist in charge—is responsible for the determination of the relative age and equivalence of the strata in different areas and for the reference of the formations to a geologic time scale. The examination of current collections of fossils and the preparation of reports on them for the use of geologists engaged in areal mapping and special investigations occupy a large proportion of the time of the paleontologists. The geologists who specialize in paleontology are engaged also in working out the sequence and character of the continental changes, the physiographic and climatic conditions of the various periods, and the history of the animal and plant life of the geologic epochs. The field study of the stratigraphic distribution of the fossil floras and faunas gives the most complete key to the correlation of the beds; hence the paleontologists can most efficiently accomplish their work by close cooperation with the areal and economic geologists. The work of this section is practically coextensive with that of the divisions of geology and of Alaskan mineral resources and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure. The States receiving most

attention from this section during the year were Alabama, Arkansas, Colorado, Florida, Georgia, Idaho, Indiana, Kentucky, Maine, Maryland, Missouri, Montana, North Dakota, Oklahoma, South Dakota, Tennessee, Virginia, Wisconsin, and Wyoming.

6. The section of metalliferous deposits—F. L. Ransome, geologist in charge—not only studies metalliferous deposits and mines and investigates the conditions and methods of ore deposition, but also carries on reconnaissance geologic examinations of many new districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of special importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology. The geologists of the section have been engaged on projects in Alabama, Arizona, California, Colorado, Georgia, Idaho, Kansas, Louisiana, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Texas, Utah, Washington, and Wyoming.

7. The section of nonmetalliferous deposits—Hoyt S. Gale, geologist in charge—is concerned with the study of the deposits of nonmetallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or deposits are of paramount importance. During the year the greater part of the work of the section has been divided between the search for potash in commercial quantities in the salts of the old evaporation basins or dried-up ancient lakes of the Southwest and the classification of the phosphate-bearing lands withdrawn from entry in Idaho and Wyoming. Special investigations relating to clays, building stones, the eastern phosphate fields, and mica have also been carried on. The work in this section relates in particular to Alabama, California, Colorado, Connecticut, Georgia, Idaho, Kentucky, Massachusetts, Maryland, Minnesota, Nevada, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming.

8. The section of eastern fuels—David White, geologist in charge—conducts examinations of areas east of the one-hundredth meridian containing coal, oil, or gas. It not only investigates and describes the economic geology, but in some regions also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology. The work of the section during the year has been conducted in cooperation with the State surveys of Illinois, Missouri, Minnesota, Oklahoma, Pennsylvania, Tennessee, and Virginia. Noncooperative work has been done in Arkansas, Georgia, Indiana, Iowa, Kansas, Louisiana, Mississippi, Ohio, Texas, and West Virginia.

9. The section of western fuels—M. R. Campbell, geologist in charge—conducts examinations and surveys in the fuel-bearing areas west of the one-hundredth meridian similar to those carried on by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands of the public domain in California, Colorado, Montana, New Mexico, North Dakota, Oregon, Utah, and Wyoming, but a part of the work in this section was done in quadrangle units for folio publication, subject to the approval of the geologist in charge of the section of western areal geology.

The section of geologic-map editing—G. W. Stose, geologist in charge—is a part of the publication branch, but its work is so intimately associated with the work of the individual geologists in the division of geology that it is administered as a part of the geologic branch, in which the chief of the section is an active geologist. The geologic field investigations made by Mr. Stose are reported in the work of the sections to which they pertain.

ASSISTANCE TO OTHER DIVISIONS.

In addition to performing work in their respective sections, a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology have prepared for publication, in the annual volumes of Mineral Resources, reports on the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar. Parts of the salaries of some of these geologists are paid from the funds of the division of mineral resources, and the traveling and field expenses incurred by others in the collection of data are also paid from the funds of that division.

A number of economic geologists of this division serve as members of the special committees of the land-classification board. The paleontologists of the division report on fossils collected for the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and, through courtesy, occasionally for foreign governments and other scientific institutions.

Close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch in the investigation of underground-water movements and supplies and of sedimentary deposition. Members of the land-classification board serve in the geologic field parties.

COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is a standing committee of the geologic branch, consisting of T. W. Stanton (chairman), M. R. Campbell (vice chairman), W. C. Alden, G. H. Ashley, Arthur Keith, F. L.

Ransome, G. W. Stose, and David White. The minutes and other records are kept by the secretary, Miss M. G. Wilmarth, who also scrutinizes the geologic nomenclature and classification used in all manuscripts submitted for publication and prepares data on them for consideration by the committee. During the year 175 manuscripts, comprising 19,425 pages and involving about 3,643 geologic names, have been examined.

To meet the needs of the Survey geologists, as well as a strong demand from professional geologists in general, the work of compiling correlation charts and a stratigraphic lexicon of geologic formations in the United States and Alaska, in form for publication as bulletins, has been begun. The committee has invited the advice and cooperation of over 200 American geologists in the consideration of general questions relating to the revision of the classification and the nomenclature of North American geologic formations.

GENERAL SUMMARY.

Geologic investigations were continued in 47 States by a force of 164 geologists. Systematic detailed surveys of mining districts were carried on in Arizona, Colorado, Minnesota, Nevada, New Mexico, Oklahoma, Oregon, and Utah. Reconnaissance studies of mining districts were made in Arizona, California, Colorado, Idaho, Kentucky, Montana, Nevada, New Mexico, North Carolina, Oregon, Tennessee, Utah, and Wyoming, and general and detailed geologic and paleontologic work was continued in all parts of the country, including a large amount of geologic work in the coal and oil fields, especially in the public-land States, where also the search for commercial deposits of potash and nitrates was continued. Cooperative geologic work was carried on with the State geological surveys of 17 States, also with the Bureau of Mines, Bureau of Standards, Office of Public Roads, Bureau of Fisheries, Forest Service, Smithsonian Institution, Lighthouse Service, Geophysical Laboratory of the Carnegie Institution and the marine biologic station at Dry Tortugas.

Among the geologic investigations not relating to any particular region mention may be made (1) of the extension of the studies of sulphide enrichment, by W. H. Emmons, who has submitted a revised and greatly enlarged text replacing Bulletin 529 on this subject; and (2) of the investigation by David White into the origin of coal and petroleum and the development of the different classes of these fuels. The origin and the conditions of occurrence of oils of successively higher grades, and some conditions precluding the occurrence of oils in different regions are discussed in an address by Mr. White before the Washington Academy of Sciences and printed in the Journal of the Academy for March 19. A general paper on the origin of coal, prepared by Mr. White several years ago for

publication by the Bureau of Mines, has been printed in Bulletin 38 of that bureau.

WORK OF THE DIVISION BY STATES AND COUNTRIES.

The work of the division of geology during the year was done in 47 States, the Canal Zone, the Antilles, and the Hawaiian Islands.

ALABAMA.

The upper Eocene and Oligocene formations of Alabama have been thoroughly studied by C. Wythe Cooke, whose stratigraphic correlations have been transmitted for publication by the Survey as Professional Paper 95–I, "The age of the Ocala limestone." Mr. Cooke has in preparation also a preliminary account of the stratigraphy of the St. Stephens limestone.

Two manuscripts, one on the Catahoula formation and the other on the Pliocene of the Gulf Coastal Plain, have been submitted by G. C. Matson and E. W. Berry, Mr. Matson writing the stratigraphic descriptions and Mr. Berry the paleontologic descriptions and correlations, based on the study of the fossil plants. Mr. Berry has in preparation also a report on the fossil flora of the Claiborne group.

For the better definition and correlation of several of the formations to be described and mapped in the Bessemer-Vandiver and Montevallo-Columbiana folios, additional field examinations were made by Charles Butts, partly in conference with E. O. Ulrich, in the vicinity of Pelham and in the Shades Valley southeast of Bessemer. Paleontologic data for correlations in other regions of the State were collected by R. D. Mesler from the earlier Paleozoic formations.

In accordance with an informal cooperative agreement between the State geologists of a number of the Mississippi Valley States and the Federal Survey for the purpose of better differentiating the Mississippian formations and establishing correlations between different regions of the Mississippi, Ohio, Tennessee, and Appalachian valleys, the Carboniferous rocks of the Mississippian section near Huntsville were studied by G. H. Girty, with the object of collecting invertebrate fossils and making correlations.

The mica deposits in Randolph, Clay, Tallapoosa, and Coosa counties were examined by D. B. Sterrett, who has nearly completed the field work for a report on mica in Alabama.

A little field work was done on the red iron ores of northeastern Alabama by E. F. Burchard.

ARIZONA.

The quicksilver deposits of the Mazatzal Mountains, covering an area of about 20 square miles, were examined by F. L. Ransome, who submitted a brief report thereon (Bulletin 620–F). Mr. Ransome

also made a geologic reconnaissance of the Sierra Ancha and paid short visits to the Ray and Miami mining districts for the purpose of collecting supplementary specimens and data for his economic report on these districts. A brief paper on the Paleozoic section in the Ray quadrangle was published by Mr. Ransome in an unofficial periodical.

A report on the mineral deposits of the Santa Rita and Patagonia Mountains by F. C. Schrader was published as Bulletin 582.

A detailed examination of the Colorado River and Yuma Indian reservations, primarily for purposes of classification, was made at the request of the Office of Indian Affairs. Some of the results of this work, which was done by E. L. Jones, jr., were embodied in a paper on the placer deposits near Quartzsite (Bulletin 620–C). Mr. Jones also prepared a brief report on a reconnaissance covering perhaps 60 square miles in the Kofa Mountains (Bulletin 620–H) and has in preparation a short report on the Dos Cabezas mining district, the field work for which was done during the previous season. A preliminary draft of the Tucson folio, on which C. F. Tolman, jr., has been engaged, was submitted by him, but further field work is necessary before the text and maps will be ready for publication.

A report on the Shinumo quadrangle, in the Grand Canyon district, by L. F. Noble, appeared as Bulletin 549. Further studies of Grand Canyon geology are being prosecuted by Mr. Noble, chiefly at his own expense.

The detailed areal and economic survey of the geology of the Winkelman quadrangle has been begun by C. H. Clapp, who has mapped 173 square miles.

A reconnaissance report on northeastern Arizona and northwestern New Mexico, based on several years of field examinations by H. E. Gregory, has been nearly completed. Field work in this region is now in progress.

In connection with the preparation of the guidebook to the region along the Santa Fe Route, from Kansas City to Los Angeles, field examinations were made at a number of points in Arizona.

At the request of the Department of Agriculture an examination of some mining claims in the Grand Canyon was made by H. G. Ferguson, whose preliminary report has been transmitted to the Secretary of the Interior.

ARKANSAS.

A study of the recent geologic history in the vicinity of Moon Lake for the Department of Justice, by E. W. Shaw, has resulted in interesting observations on the processes and effects of erosion and sedimentation, which will be incorporated in Mr. Shaw's report on the Mississippi embayment.

The fossil floras of the Jackson and Claiborne groups in Arkansas are now being studied by E. W. Berry. The results of this work

will be important not only in correlations between other areas and Arkansas but in contributing to knowledge of the extinct floras of the earlier Tertiary in southern North America.

Short examinations, necessary for the correlation of the formations of the Hot Springs, Caddo Gap, and DeQueen quadrangles, were made by H. D. Miser. The Hot Springs folio is well advanced toward completion and the manuscript for the Caddo Gap-DeQueen folio is progressing satisfactorily.

A folio covering the Harrison and Eureka Springs quadrangles was completed by H. D. Miser and A. H. Purdue and has been submitted for publication.

The gypsum deposits of Arkansas have been described by Mr. Miser for publication in the revised edition of Bulletin 223. Mr. Miser also furnished the Arkansas data for use in the revision of Bulletin 585, "Useful minerals of the United States."

Water-Supply Paper 399, "Geology and underground waters of northeastern Arkansas," by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the water by R. B. Dole, has been revised and is now in the hands of the editor.

The asphalt deposits near Mena were examined by C. H. Wegemann. These deposits are interesting mainly because of the advanced carbonization of the hydrocarbon substance, which appears to have suffered alteration.

The Carboniferous faunas of Arkansas have been described by G. H. Girty in Bulletins 593, 595, and 598, in press at the close of the fiscal year.

CALIFORNIA.

A review of the deposits of salt, soda, borax, and potash at Searles Lake, San Bernardino County, was made by H. S. Gale, and a report on these deposits was issued as Bulletin 580–L. A brief report on the Amargosa nitrate area, in Inyo County, by Mr. Gale, was transmitted to the War Department, at whose request the examination was made.

Studies of the petroleum resources of the State were continued by R. W. Pack, G. S. Rogers, and W. A. English, and the investigation of the Sunset-Midway field was completed, special attention being given to the underground conditions as revealed by the drill records, in order to discover, if possible, the laws governing the accumulation of oil and gas and particularly the relation of productive pools to geologic structure and to water. A detailed resurvey, including about 300 square miles, was made of the areal geology in this field and the surrounding areas, the description of which, mainly by Mr. Pack, is now in preparation. Special attention was given by Mr. Rogers to the conditions of water movement and invasion. In prosecuting this

work he made a close study of the geologic structure and of the history and behavior of the wells. In the determination of local structure, as well as in the consideration of the water problem, Mr. Rogers contributed to the investigation of the general geology of the region.

Ralph Arnold, formerly of this Survey, assisted by J. R. Pemberton, spent 10 days in field revision of the geologic map of the Ventura quadrangle.

A detailed examination of the stratigraphy and structure of undrilled areas in Cuyama Valley, aggregating about 400 square miles, was made by W. A. English, under the general supervision of R. W. Pack, in order to determine their probable oil prospects. A report on these areas has been prepared and submitted for publication.

A report by Robert Anderson and R. W. Pack, on the geology and oil prospects along the western border of the San Joaquin Valley north of Coalinga, is now in press as Bulletin 603.

Studies in Yosemite National Park were continued by F. E. Matthes and F. C. Calkins. Mr. Calkins mapped in detail the igneous rocks of part of the tract represented by the special map of the Yosemite Valley. Mr. Matthes continued and nearly completed the physiographic study, including the detailed mapping of the moraines, of the upper Merced basin and of some adjacent ground. Messrs. Matthes and Calkins are collaborating in a popular account of the geology of the Yosemite region, which is designed primarily to give a comprehensive and scientifically exact yet readable explanation of the sculpture of the region but deals with all aspects of the geology. Mr. Matthes writes of the general geologic history and the work of streams and glaciers, and Mr. Calkins contributes an account of the hard rocks, whose distribution greatly influences the character of the sculpture.

The results of the detailed study of the Weaverville quadrangle are in preparation by J. S. Diller and H. G. Ferguson for issue in a folio.

A report on the lode deposits of the Allegheny district by Mr. Ferguson was published as Bulletin 580–I and a paper on the pocket gold deposits of the Klamath Mountains, also by Mr. Ferguson, was prepared for unofficial publication.

Lassen Peak, which was visited in June, 1914, and again in the autumn of that year by Mr. Diller while he was gathering data for the guidebook covering the Shasta Route and Coast Line (Bulletin 614) was revisited by him in June, 1915, for the purpose of studying the phenomena of the only active volcano in the United States (exclusive of Alaska), with a view to the preparation of an educational bulletin describing and illustrating Lassen Peak, its history and present changes, and its volcanic action as a whole.

A report on the geology of the east slope of the Sierra Nevada overlooking Owens Valley has been practically completed by Adolph

Knopf, who in the summer of 1914 made a preliminary field examination of the Mother Lode district in preparation for a thorough study of that district during the season of 1915–16.

A report on some mining districts in northeastern California and northwestern Nevada (Bulletin 594), by J. M. Hill, was issued during the year.

A portion of the Rock Creek quadrangle was mapped in detail by L. F. Noble for folio publication.

An area lying between latitude 34° 30′ and the Mexican boundary has been covered by a reconnaissance examination by R. T. Hill, who, after mapping about 4,000 square miles on a scale of 1:250,000, is now preparing a report on this region.

The report on the copper deposits of Shasta County, by L. C. Graton, the preparation of which has long been postponed in consequence of Mr. Graton's resignation from the Survey, is now well advanced, though Mr. Graton expects to make additional field revision during the coming year before the report is submitted for publication.

COLORADO.

The survey of the volcanic area of the San Juan Mountains was continued by Whitman Cross, assisted by E. S. Larsen, jr., and J. Fred Hunter, jr., but in accordance with the plan adopted in 1913 to complete the study of the great volcanic complex of these mountains as speedily as possible, the work was all of reconnaissance character. Of the 1,020 square miles examined in the northeastern portion of the mountains, 650 square miles were covered in reconnaissance and 370 miles in semidetail. In the area south of Tomichi Creek and Marshall Pass and west of the San Luis Valley, in the Cochetopa and Saguache quadrangles, it was found impossible to maintain the standard of geologic mapping followed in other regions, on account of the inadequacy of the Hayden topographic map and other maps available for the delineation of geologic details. A greater measure of success was achieved in the Creede quadrangle, of which a new topographic map was available. A report covering the season's field work is in preparation by Messrs. Cross and Hunter, and Mr. Cross was also engaged on a general report on the geology of the entire San Juan area. A paper describing the pre-Cambrian rocks along Gunnison River was prepared by Mr. Hunter.

The Pleistocene deposits in the San Juan Mountains (Montrose quadrangle) were studied by W. W. Atwood, assisted by Kirtley Mather. A report by Mr. Atwood, describing an extremely interesting glacial deposit of Eocene age in southwestern Colorado, has recently been published as Professional Paper 95–B.

A detailed report on the economic geology of Gilpin County and adjacent portions of Clear Creek and Boulder counties, embracing

the Central City district, by E. S. Bastin and J. M. Hill, has been transmitted for publication. A description of the ores of Gilpin County by Mr. Bastin and a paper by Mr. Bastin and Chase Palmer on the precipitative action of metallic minerals upon silver in solution have been printed in unofficial publications. Mr. Bastin also prepared a paper on the geology of the pitchblende ores of Colorado (Professional Paper 90–A).

A report on the Creede district by E. S. Larsen, jr., and W. H. Emmons is now nearing completion, that portion of the manuscript by Mr. Emmons having already been transmitted.

For the monograph on the Leadville district, in preparation by J. D. Irving, a chapter on the oxidized zinc ores has been submitted by G. F. Loughlin, and F. B. Laney is preparing a chapter on the microstructure of the ores.

Brief investigations of reported nitrate occurrences in Colorado were made by M. I. Goldman, who has reviewed in the office the somewhat voluminous literature on the subject of soil nitrates in Colorado and Utah with a view to submitting, for record and possible publication, his conclusions regarding the availability of certain soils as a commercial source of nitrates.

The description of the fossil flora of the Laramie formation in the Denver Basin is in progress by F. H. Knowlton, and a monograph covering this work and including a historical account of the Laramie problem is now nearly completed.

In northern Colorado, from Windsor and Greeley southward to Boulder, full collections representing the fauna of the Fox Hills sandstone were made by T. E. Williard and T. W. Stanton, and a preliminary study for a comparison of them with the typical Fox Hills fauna has been made by Mr. Stanton. A collection of fossil plants from the Fox Hills sandstone has been described by F. H. Knowlton.

The Ordovician section at Canon City has been reviewed by Edwin Kirk for purposes of correlation.

The detailed examination of the mineral resources of the Yampa coal field was continued in the office by E. T. Hancock, who has submitted for publication economic reports on the Meeker, Axial, and Monument Butte quadrangles. Folios covering these quadrangles are also in preparation by Mr. Hancock. A general report on the entire Yampa coal field was submitted by Mr. Hancock for inclusion in the forthcoming paper describing the coal fields of the United States. The history of a portion of Yampa River and its possible bearing on that of Green River by Mr. Hancock was published as Professional Paper 90–K. In response to numerous requests received by the Survey, further investigations of four sections of

land in the Yampa coal field for the purpose of land classification, were made by Mr. Hancock.

The investigation of the oil shale in the Green River formation in northwestern Colorado and eastern Utah, which was begun by E. G. Woodruff prior to his resignation from the Survey in 1913, was continued in greater detail by D. E. Winchester, assisted by H. M. Robinson, who made a reconnaissance examination of about 1,000 square miles. In the course of this work the oil shale beds were examined at a number of places in western Colorado, many sections were measured in detail, and numerous samples, cut from different parts of the beds, were collected and subjected to distillation tests in the field. Many samples were also shipped to Washington, where distillation tests were made in the laboratory of the Bureau of Mines by Mr. Winchester under the direction of David T. Day. The field distillation experiments were observed for a short time by Dr. Day, who, together with C. A. Davis, D. E. Winchester, and David White, revisited the De Beque region, where oil shale of unusual interest was discovered by Mr. Woodruff the previous year. Field surveys were resumed by Mr. Winchester in June, 1915, with the intention of extending the examination northward into Wyoming. A report covering the investigations of the year was completed by Mr. Winchester and submitted for publication as a chapter in Bulletin 621. In the course of brief field studies of the deposition of the oil shale at a number of points, C. A. Davis, in company with David White, collected samples of the shale and began a paleontologic investigation of its origin and composition. The oil shale was found to be composed in large part of plant remains of low orders, mainly algæ and fungi. A collection of the oil shales of Colorado, Utah, and other States, arranged by Mr. Winchester, is now on exhibition at the Panama-Pacific Exposition.

The detailed investigation of the areal and economic geology and the classification of the lands in the Red Mesa and Soda Canyon quadrangles, begun by M. A. Pishel, who resigned from the Survey in August, 1914, was continued by A. J. Collier, assisted by O. B. Hopkins. Together they surveyed 238 square miles, in which geologic mapping was done and coal outcrops were located by plane-table methods. The land has been classified, and an economic report and a folio are in preparation by Mr. Collier, who is also preparing a popular geologic guide to the Mesa Verde National Park. Mr. Collier also examined in detail the northern part of the plateau north of the Red Mesa quadrangle, in T. 35 N., Rs. 12 and 13 W., comprising an area of about 16 square miles, for the purpose of classifying and valuing the land. An economic report on this area was prepared for publication.

In the Trinidad field, near Cokedale, examinations were made by M. W. Ball for the purpose of classifying and valuing the coal lands, the report to be prepared at a later date.

In the vicinity of Austin, in Delta County, an area of about 10 square miles, including a structural dome, was hastily examined by M. R. Campbell, for the purpose of determining whether or not the geologic conditions are favorable for the occurrence of oil or gas. The conclusions, which were unfavorable, were issued in the form of a press notice for the benefit of those interested in the region. Mr. Campbell also examined a half section of coal land in the vicinity of Mattison, Elbert County, to collect data for its classification and valuation.

A report on the coal resources of North Park, by A. L. Beekly, has been published as Bulletin 596.

CONNECTICUT.

The feldspar quarries in Middlesex County, Conn., in which mica and the gem minerals tourmaline, beryl, and lepidolite are found, and the old mica, feldspar, and beryl mine near New Milford, in Litchfield County, were examined by D. B. Sterrett.

DELAWARE.

The manuscript and maps describing the areal and economic geology of the Elkton and Wilmington quadrangles, in Pennsylvania and Delaware, have been submitted by Miss Florence Bascom and B. L. Miller, for publication as a folio. The small gas emissions coming from a number of shallow-water wells near the State boundary in the region of Salisbury, Md., were investigated by G. C. Matson. (See Maryland, p. 68.)

FLORIDA.

The stratigraphic and paleontologic investigations of the upper Eocene and Oligocene formations of Florida were continued by C. Wythe Cooke, who made a special study, for correlation, of the Ocala limestone and prepared a paper on the age of that formation.

At Laurel Hill and River Junction field conferences were held by T. Wayland Vaughan with Mr. Cooke and W. C. Mansfield, and data were gathered by Mr. Cooke on the structure of the Apalachicola group by running lines of levels in both areas. The Eocene and Oligocene formations at Marianna and Chipley and the Miocene at Redbay were restudied. Mr. Cooke also made a study of the upper Oligocene and Miocene formations on Apalachicola River between River Junction and Blountstown and on Chipola River. A report on the fossil mollusks of Chipola Oak Grove and Shoal River is in preparation by Miss Julia Gardner, and two reports on the Miocene

and Pliocene foraminifers of the Coastal Plain, including Florida, by Joseph A. Cushman, have been transmitted for publication.

Investigations of the Florida Keys region were continued by T. Wayland Vaughan, who prepared and published several scientific papers on the geology and recent deposits of this part of the coast.

A report on the phosphate deposits of Florida (Bulletin 604) by G. C. Matson, is in press and "A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Fla.," by William H. Dall, was published by the United States National Museum.

GEORGIA.

In continuance of the studies of the stratigraphy and paleontology of the upper Eocene and Oligocene formations in Georgia the Ocala and Chattahoochee formations at Bainbridge and vicinity were examined by C. Wythe Cooke, assisted by W. C. Mansfield. Instrumental level lines were run over the principal sections. The correlative results of the study are contained in the paper by Mr. Cooke on the age of the Ocala limestone already mentioned. A fauna at the base of the Chattahoochee formation, because of its wide geographic distribution in the Greater and Lesser Antilles, is being described by W. H. Dall.

A report of the fossil flora of the Claiborne group is in preparation by E. W. Berry.

The paper on "Underground water resources of the Coastal Plain of Georgia" (Water-Supply Paper 341), by L. W. Stephenson and J. O. Veatch, was published during the year.

Mica prospects in Hall and Cherokee counties were examined by D. B. Sterrett.

New openings on the red iron ore beds in Walker County were examined by E. F. Burchard.

IDAHO.

Studies which are to result in a comprehensive summary report on the ore deposits of Idaho, by J. B. Umpleby, were continued during the year. No field work was done, but a large amount of material previously collected was elaborated and prepared for publication. A report on the Mackay region, which embraces the drainage areas of Little and Big Lost rivers and Birch Creek, was transmitted by Mr. Umpleby for publication as a professional paper. He also finished a short paper on the ore deposits of the Sawtooth quadrangle (Bulletin 580–K) and has completed the description of the ore deposits in the Hailey quadrangle, the geology of which has been mapped for folio publication by L. G. Westgate, assisted by R. S. Knappen. Edwin Kirk, paleontologist, gave assistance in the solution of the stratigraphic problems of the area. In response to a

request from the Office of Indian Affairs, Mr. Umpleby examined and reported on leakages near the head of the Blackfoot Reservoir.

The gravels of the Fort Hall bottoms on Snake River were, at the request of the Office of Indian Affairs, investigated by J. M. Hill, who submitted a paper on gold in the Snake River gravels for publication (Bulletin 620–J).

The geologic mapping of the Wayan quadrangle, which includes the Crow Creek, Slug Creek, Lance Creek, and Freedom 15-minute quadrangles, was completed by G. R. Mansfield, assisted by E. L. Jones, jr., P. V. Roundy, and E. H. Finch. Progress has been made by Mr. Mansfield in the preparation of folios for the Wayan and Montpelier quadrangles, and a paper on the geology of the Fort Hall Reservation was prepared for unofficial publication by Mr. Mansfield, who, with E. S. Larsen, jr., is unofficially publishing a paper describing the occurrence of nepheline basalt in the Fort Hall Reservation. The Paleozoic and Triassic formations and faunas of the Wayan quadrangle were studied both in the field and in the office by G. H. Girty.

For the Henry district land-classification data were completed and transmitted, and a report on the economic geology of the district was begun by Mr. Mansfield, who has also submitted a manuscript on the geology and phosphate deposits of the Fort Hall Indian Reservation. A detailed examination for phosphate in part of the Crow Creek and Freedom quadrangles was made in order to classify the lands.

Reported deposits of nitrates in the vicinity of Homedale, Owyhee County, were examined by Mr. Mansfield, whose report "Nitrate deposits in southern Idaho," has been issued as Bulletin 620–B.

A report on a geologic reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

A report classifying the lands in the vicinity of Orofino Creek and Clearwater River, examined in 1913, was prepared by C. T. Lupton, who also submitted a manuscript for a paper on the Orofino coal field for publication (Bulletin 621–I).

A summary report on the coal fields of Idaho, based on work of previous years, was prepared by C. F. Bowen for publication in the paper dealing with the coal fields of the United States, which is being compiled under the direction of M. R. Campbell.

ILLINOIS.

Under the arrangement for cooperation with the Illinois Geological Survey, the areal geology and mineral resources of the Mount Olive and Gillespie quadrangles were mapped in detail by Wallace Lee, who prepared an economic report describing the coal resources, oil pros-

pects, and geologic structure for publication by the State geological survey, and who has brought a folio covering these quadrangles to an advanced stage. In the mapping of the glacial and associated deposits Mr. Lee conferred with W. C. Alden and E. W. Shaw. The investigation of the stratigraphy and the mapping of the areal geology in the Equality and Shawneetown quadrangles, also cooperative, was begun by Mr. Lee, and he examined portions of the Golconda and Fords Ferry quadrangles, on the Illinois side of Ohio River.

The glacial and associated deposits in the Edgington, Milan, Canton, Colchester, Macomb, Tallula, and Springfield quadrangles were briefly studied by W. C. Alden for comparison with similar deposits in Iowa.

The dark shale and bony coal overlying the Springfield (No. 5) coal bed were examined by G. H. Ashley for the purpose of collecting material to be subjected to distillation experiments.

The Pleistocene formations and physiography of the Baldwin, Chester, Renault, Kimmswick, and Crystal City quadrangles were further studied by E. W. Shaw with a view to their description in cooperative folios.

Folios for the Carlyle, Centralia, New Athens, and Okawville quadrangles were nearly completed by Mr. Shaw, the greater part of whose time was devoted to studies of Pleistocene deposits and sedimentation in the Gulf region of the Coastal Plain.

INDIANA.

A report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, was published as Monograph 53.

In connection with the discussion and correlation of the formations in the vicinity of Cincinnati, Ohio, the Paleozoic formations and faunas in southeastern Indiana were studied by E. O. Ulrich.

Field examinations of the Devonian black shales in the New Albany region and of the dark shales and bony layers associated with some of the coal beds of the State were made by G. H. Ashley, who collected samples for laboratory distillation in order to determine their value as sources of petroleum distillates and their by-products.

IOWA.

A review of the evidence of an Iowan stage of glaciation and of its relations to the deposits of other Pleistocene stages in eastern Iowa and adjoining States occupied W. C. Alden during the greater part of the field season of 1914. This work was done in cooperation with the Iowa State Geological Survey, which furnished an assistant, Morris M. Leighton, for the season. The studies were resumed in June, 1915.

A short field conference on the mapping of the Quaternary deposits of northwestern Iowa was held between E. S. Carman, of the State Geological Survey, and Frank Leverett.

A short report containing a summary description of the coal fields and coals of Iowa was prepared by Henry Hinds for incorporation in the general report by M. R. Campbell on the coal fields of the United States.

The stratigraphy of the Mississippian formations in southeastern Iowa was examined and collections of fossils were made by F. M. Van Tuyl, of the State Geological Survey, the paleontologic supervision of the investigation being, through informal cooperation, in charge of Stuart Weller, who has conducted similar investigations for the Federal Survey in Missouri, Illinois, and western Kentucky.

KANSAS.

The description of the ore deposits of the Joplin district, Missouri, and of the Miami district, Oklahoma, with field studies extending into southeastern Kansas, was continued by C. E. Siebenthal, whose report on the origin of the zinc and lead deposits of the Joplin region (Bulletin 606) is now in press.

The Leavenworth-Smithville folio, by Henry Hinds and F. C. Greene, has been revised by Mr. Hinds.

KENTUCKY.

A detailed survey of the areal geology and mineral resources of Jefferson County, Ky., was completed by Charles Butts, assisted by T. C. Brown and J. J. Galloway. This survey was made in cooperation with the Kentucky Geological Survey, to which the report, now nearing completion, will be submitted for publication. Several quadrangles, including the Louisville and Kosmosdale, lie wholly or in part within Jefferson County, and it is planned that folios shall be prepared after certain problems have received further field consideration and after small areas lying outside of the county have been mapped.

Field studies in the stratigraphy and paleontology of the early Paleozoic formations of central Kentucky and in the Louisville quadrangle were made by E. O. Ulrich.

Several Carboniferous sections in southeastern Kentucky were examined for purposes of correlation by G. H. Girty.

The phosphate deposits in Woodford and adjoining counties have been examined partly in reconnaissance and partly in detail by W. C. Phalen, who explored portions of this relatively little known phosphate field by means of shallow drilling. A large number of samples were collected for chemical analysis. The results of these investigations are designed to be incorporated in a report on the phosphate deposits of the southern Appalachian region.

A study of the physiography and the Quaternary geology of the western part of the State, by E. W. Shaw, is in progress as a part of an investigation covering the late Pleistocene geologic history of the Mississippi embayment.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, including areas in Kentucky, is in press.

LOUISIANA.

With the object of guiding exploration in the discovery and the development of oil pools in Louisiana, preliminary reconnaissance examinations of the geologic structure with special reference to the presence of oil and gas were made by G. C. Matson, assisted by O. B. Hopkins and E. H. Finch, in a number of districts, most attention, however, being given to Bossier, De Soto, Caddo, and Red River parishes. Reports covering this work are now in preparation. At the request of the General Land Office an examination of the islands in Sabine River near Orange, Tex., was made by Mr. Hopkins for the purpose of land classification.

A report on the iron-bearing deposits in Bossier, Caddo, and Webster parishes, by E. F. Burchard, the field work for which was done in the fall of 1914, is ready for publication as Bulletin 620–G.

The upper Tertiary formations in southwestern Louisiana were examined by G. C. Matson and Alexander Deussen, and fossil plants and invertebrates from several localities and formations have been studied by E. W. Berry and C. Wythe Cooke. Reports now in preparation include a study of the floras of the Claiborne and Jackson groups by Mr. Berry and a general report on the physiography and surficial geology of the Gulf embayment by E. W. Shaw. A manuscript by Mr. Matson on the Pliocene of the eastern and central Gulf Coastal Plain and two manuscripts on the Catahoula formation, the stratigraphy being described by Mr. Matson and the fossil plants by Mr. Berry, were transmitted for publication.

Supplementary investigations of the stratigraphy, paleontology, and ground waters of the Cretaceous deposits of northeastern Louisiana were made by L. W. Stephenson.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is in press, and Bulletin 619, "The Caddo oil and gas field, Louisiana," by G. C. Matson, is in the hands of the editor.

MAINE.

Additional field examinations were made by Frank J. Katz in the Portland and Casco Bay quadrangles for the solution of problems which arose during the office preparation of a folio for these quadrangles. This review, during which Mr. Katz was joined by Arthur Keith for field conference and inspection, was not made in cooperation

with the State, though the greater part of the previous work on these quadrangles was done in cooperation. The text and maps for this folio are nearing completion.

The areal survey of the Dover and York quadrangles was commenced by Mr. Katz, who has covered about 50 square miles, and progress was made on the maps and collections in the office.

In the Boothbay quadrangle a brief reconnaissance covering about 20 square miles was made by Mr. Keith.

Professional Paper 89, "The fauna of the Chapman sandstone," by H. S. Williams, has been revised by the author and a chapter on the Ostracoda of the formation has been added by E. O. Ulrich. This paper is now in press.

MARYLAND.

The mapping of the Williamsport quadrangle, which includes portions of West Virginia and Pennsylvania, was completed by George W. Stose, who covered about 100 square miles in detail. The descriptions and maps for this quadrangle, which with the Hagerstown quadrangle will be covered by a single folio, are well advanced toward completion. This folio was provided for under cooperation with the Maryland Geological Survey. Conferences for deciding certain questions of stratigraphy and correlation were held by Mr. Stose, E. O. Ulrich, and R. S. Bassler in the Hagerstown and Frederick quadrangles.

The folio for the Elkton and Wilmington quadrangles, including parts of Pennsylvania and Delaware, was transmitted for publication. This folio was prepared by Miss Florence Bascom and B. L. Miller, in cooperation with the Geological Survey of Maryland.

The Tolchester folio, by B. L. Miller, E. B. Mathews, Arthur B. Bibbins, and Homer P. Little, also cooperative, was completed and transmitted for publication.

At the request of the Committee on Public Buildings of the House of Representatives a marble quarry near Union Bridge, Carroll County, was examined by T. N. Dale, in association with Oliver Bowles, quarry technologist of the Bureau of Mines. A short report on the rocks examined was transmitted to the committee.

In order to ascertain whether the small emissions of gas proceeding from a number of shallow wells driven for water in the region of Salisbury, Md., were of deep-seated (rock) origin, and if so whether they might be regarded as indications of possible gas or oil pools in the region, an examination was made by G. C. Matson. The results of this investigation were not sufficiently encouraging to merit formal publication.

For the more accurate differentiation and discrimination of the Pleistocene formations of the Maryland portion of the Coastal Plain

an inspection of the terraces of peninsular Maryland was made by T. Wayland Vaughan, E. W. Berry, and P. S. Smith, in conference with W. B. Clark, director of the State Geological Survey.

MASSACHUSETTS.

Reviews necessary to the completion of the descriptions of the Boston and Boston Bay quadrangles were made by Laurence La Forge. The preparation of the Boston folio, which is to cover these quadrangles, is now well advanced. Reconnaissance examinations were made by Mr. La Forge in the Haverhill, Lowell, Lawrence, Newburyport, and Salem quadrangles. A field conference was held in the Framingham quadrangle by Mr. La Forge and Arthur Keith, who inspected the geologic mapping.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, who conferred with Mr. Keith in the field.

The Sheffield-Sandisfield folio was the subject of an office conference between Arthur Keith, Joseph Barrell, and B. K. Emerson. Mr. Keith also conferred with Mr. Emerson regarding the Pittsfield and Becket geologic work and certain features of Mr. Emerson's report on the geology of Massachusetts (Bulletin 597).

Manuscript maps and geologic descriptions for the Worcester-Marlboro, Palmer-Brookfield, Webster-Blackstone, and Belchertown-Barre folios have been submitted by Mr. Emerson, and his office work on the Warwick-Winchendon folio has been continued to an advanced stage.

Field studies of the geology of Cape Cod, Nantucket, Marthas Vineyard, and the Elizabeth Islands were begun in June by J. B. Woodworth, with the object of mapping and preparing a report on the geology of this portion of the Atlantic Coastal Plain.

The field examination of the Quaternary geology of the Berlin and Greylock quadrangles, in New York and Massachusetts, was completed by F. B. Taylor, who has prepared a manuscript describing the surficial deposits for folio publication.

Deposits containing tourmaline, beryl, and lithia minerals in the vicinity of West Chesterfield and Goshen, Hampshire County, were examined by D. B. Sterrett.

MICHIGAN.

The report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, has been published as Monograph 53, and a special report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota is in preparation by Mr. Leverett.

In accordance with an informal arrangement for cooperation with the Michigan Geological Survey in paleontologic investigations, the Marshall fauna of the State has been studied by G. H. Girty.

MINNESOTA.

The work of mapping the glacial deposits of Minnesota, with special reference to the origin of the soils, was continued by Frank Leverett, assisted by F. W. Sardeson, of the State Geological Survey. A report entitled "Surface formations and agricultural conditions of northwestern Minnesota," by Frank Leverett, with a chapter on the climatic conditions of Minnesota, by U. G. Pursell, was transmitted to the State and published as Bulletin 12 of the Minnesota Geological Survey. This is the first of a series of papers to be based on this work. Manuscript for a report on the soils and surface deposits of northeastern Minnesota has been prepared by Mr. Leverett for publication by the State, and he has done considerable work, with the assistance of Mr. Sardeson, on a general report on the Quaternary deposits and history of Minnesota, to be published by the Federal Survey.

A brief reconnaissance study of the pre-Wisconsin Quaternary deposits in some of the southeastern counties of the State was made by W. C. Alden, for comparison with similar deposits in Iowa. Field conferences regarding the mapping and classification of these deposits were held between Messrs. Leverett, Sardeson, and Alden and between T. C. Chamberlin and Mr. Leverett.

Cooperative studies preliminary to a general report on the stratigraphy and economic geology of the Cuyuna iron range were made by E. C. Harder, of this Survey, and A. W. Johnstown, of the State Survey. A preliminary paper on the bacterial deposition of iron ores has been prepared by Mr. Harder for publication in "Shorter contributions to general geology." Under cooperative agreement also studies of the magnetite ores of the State were begun by F. F. Grout, of the Minnesota Survey, and H. H. Brodt.

As products of previous cooperative work conducted with the State Geological Survey a report on the clays and shales of Minnesota, by F. F. Grout, and a similar report on the building stones of the State, by Oliver C. Bowles, were completed and submitted for publication in bulletin form.

MISSISSIPPI.

Structural studies for the purpose of finding geologic conditions favorable to the occurrence of oil or gas in the Vicksburg quadrangle, Miss., were carried on by G. C. Matson, O. B. Hopkins, and E. H. Finch. A report containing the results of this investigation is now in preparation. Brief examinations were also made by Mr. Matson at Hattiesburg, Natchez, and Seminary.

Reports on the geology of the Coastal Plain of Mississippi and on the ground waters of the State are in preparation. The investigations have been carried on in cooperation with the State Geological Survey of Mississippi, field work being done by five geologists of the Federal Survey and E. N. Lowe, State geologist.

The examinations of the upper Eocene and Oligocene formations in the State were continued by C. Wythe Cooke, who has transmitted a paper entitled "The age of the Ocala limestone" (Professional Paper 95–I). This report will be of special value for correlation.

A report on the physiography, surficial deposits, and Pleistocene geologic history of the Gulf embayment, which is in preparation by Mr. Shaw, will embrace the State of Mississippi. In connection with this investigation Mr. Shaw is making a special study of the silts of the Mississippi Valley.

Additional field studies of the post-Eocene geologic formations were made by G. C. Matson, who cooperated with Mr. Shaw in a part of the investigations of the latest Tertiary and Pleistocene formations.

A report on the fossil flora of the Claiborne group, which is exposed in Mississippi, is in preparation by E. W. Berry. Reports covering the results of earlier field and office investigations submitted during the year include a manuscript on the Pliocene of the eastern and central Gulf Coastal Plain by G. C. Matson; two manuscripts on the Catahoula formation, one on the stratigraphy by Mr. Matson and one on the fossil plants by Mr. Berry; and a manuscript entitled "Erosion intervals in the Eocene of the Mississippi embayment," by Mr. Berry (Professional Paper 95–F).

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is now in press.

MISSOURI.

A report by C. E. Siebenthal on the origin of the Joplin lead and zinc ores, now in press as Bulletin 606, contains conclusions based on a long and thorough investigation of the geology and ore deposits of the Joplin region.

In response to a request of the State geologist the earlier Paleozoic formations of eastern and central Missouri were briefly studied for purposes of classification and correlation by E. O. Ulrich. On the part of the State additional investigations, both paleontologic and stratigraphic, of the Mississippian formations, mainly in Ste. Genevieve County, were made by Stuart Weller.

Further field examinations of the Pleistocene deposits in the Crystal City and Renault quadrangles, for which geologic folios are in preparation in cooperation with the Missouri Bureau of Geology and Mines, were made by E. W. Shaw.

The Green City-Queen City folio text, by F. C. Greene, was critically revised by Henry Hinds, under whose supervision the field and office work relating to these quadrangles was done. Some revisory work was also done by Mr. Hinds on the Leavenworth-Smithville folio, the geologic maps for which are now engraved.

A chapter describing in summary form the coal fields of Missouri was prepared by Mr. Hinds for inclusion in the work by M. R. Campbell on the coal fields of the United States.

MONTANA.

A portion of the Judith River coal field in northeastern Chouteau and Fergus counties, Mont., embracing about 600 square miles, was geologically surveyed in a detailed reconnaissance examination by E. R. Lloyd, assisted by W. T. Thom, jr., and W. B. Wilson. The lands of this area have been classified and an economic report has been prepared, but the publication of this report will be delayed to incorporate the results of additional field work. A paleontologic study of the Cretaceous and Eocene formations of this region was made by T. W. Stanton for purposes of correlation.

A report on the subbituminous coal and lignite regions of eastern Montana is in preparation by E. R. Lloyd for publication in the forthcoming paper on the coal fields of the United States. The completion of Mr. Lloyd's manuscript is somewhat retarded on account of his recent transfer from the geologic branch to the land-classification board, where he was made secretary of the coal board.

The geology and coal resources of northern Teton County will be described by Eugene Stebinger in Bulletin 621–K.

An area of about 1,300 square miles in the Porcupine dome, north of Forsyth, was examined in a reconnaissance way, for the purpose of land classification, by C. F. Bowen, assisted by C. A. Bonine. The possibilities of oil in the Porcupine dome have been described by Mr. Bowen in Bulletin 621–F. Mr. Bowen also submitted a report on the stratigraphy of the Montana group, with special reference to the stratigraphic position and age of the Judith River formation, which has been published as Professional Paper 90–I.

A description, with maps, of the Tullock Creek coal field, which was examined in 1912–13, was completed and submitted for publication by G. S. Rogers, and a report on the Bull Mountain coal field, by R. W. Richards and C. T. Lupton, has been submitted.

A small area of lignite land near Glendive was examined for the purpose of classification by C. E. Lesher.

The areal mapping of the coal fields of southeastern Montana, which was begun in 1913, was continued by C. M. Bauer, with the assistance of E. M. Parks and R. W. Brown. This work was done primarily for purposes of land classification, but the areal geology

was also studied and mapped. Mr. Bauer examined about 800 square miles in more or less detail, and 1,500 square miles, mainly outside of the coal field, in a rapid reconnaissance. An economic report on the Ekalaka and Long Pine Hills coal field of southeastern Montana, studied in 1913–14, is now in preparation by Mr. Bauer.

An examination of the northeast corner of this State, north of the Fort Peck Indian Reservation, was begun by A. J. Collier, assisted by W. T. Thom, jr., for the purpose of classifying the land. An investigation of the Milk River valley was undertaken by Eugene Stebinger, assisted by W. P. Woodring and J. D. Sears.

The paleontology and stratigraphy of the formations on the north side of Yellowstone River, west and north of Forsyth, were studied by T. W. Stanton, who, in cooperation with C. W. Gilmore and the field party in charge of E. R. Lloyd, also made a careful review of the type area of the Judith River formation on the Missouri near the mouth of the Judith.

The placer deposits at Ruby and Virginia City were visited by J. M. Hill in connection with his general investigation, cooperative with the Bureau of Mines, of the placer deposits of the United States.

In the Browning and Chief Mountain quadrangles, in the Glacier National Park, areal geologic mapping was continued by Eugene Stebinger, with the assistance of C. S. Corbett and H. R. Bennett, about 725 square miles being mapped in detail on the 1:125,000 scale. Progress in the preparation of a report for the area has been made by Mr. Stebinger, who also prepared text, maps, and illustrations for the Blackfoot-Cutbank folio, the areal mapping of which was completed during the previous field season.

Final revision of the text of the Philipsburg folio was completed by F. C. Calkins.

NEVADA.

In the search for potash, under the supervision of H. S. Gale, boring was continued to a depth of 1,500 feet in the Black Rock Desert, Nev., when the coming of winter terminated the work. The drill crew was superintended by D. H. Walker, to whose skill and efficiency are due the economy and speed of the work and the completeness of the data gathered. Samples of the drillings were collected by M. I. Goldman and A. T. Crandall, and these are now undergoing analytical study by Mr. Goldman. Through the courtesy of the Department of Agriculture the diatoms have been examined by Dr. Albert Mann, specialist in the Diatomaceæ. A number of reported discoveries of potash salts or nitrates within the State were investigated by Mr. Gale, and analyses of submitted samples of salts were made in the chemical laboratory. No bed of potash salts was discovered in the deep well. The reported deposits proved on examination to

be either too low in potash or nitrates or too small to be of commercial importance.

In the spring of 1915 a new drilling equipment designed especially for the work and region was purchased, and surveys were made in the Smoke Creek Desert by Mr. Gale to determine localities that would appear relatively favorable for testing. Preparations were completed by Mr. Walker to resume drilling in that desert with the new rig early in July.

Nitrate-bearing beds north and northwest of the Black Rock Desert were examined by M. I. Goldman.

The Yerington district was studied in detail by Adolph Knopf and E. L. Jones, jr., who mapped 58 square miles on the scale of 1: 24,000. The results of this survey are now being prepared for publication. The cinnabar deposits east of Beatty and Mina were examined by Mr. Knopf, the results of whose investigations have been submitted for publication under the title, "Some cinnabar deposits in western Nevada" (Bulletin 620–D). The platinum deposits in the Yellow Pine district, Clark County, were investigated by Mr. Knopf, whose report, "A gold-platinum-palladium lode in southern Nevada," has appeared as Bulletin 620–A. A paper entitled, "Plumbojarosite and other basic lead-ferric sulphates from the Yellow Pine district, Nevada," was prepared by Mr. Knopf for unofficial publication.

The Rochester mining district is described by F. C. Schrader in Bulletin 580–M, issued during the year, and a report on "Some mining districts in northeastern California and northwestern Nevada" (Bulletin 594), by J. M. Hill, was also published.

A reconnaissance report on some mining districts in eastern Nevada, mostly in Elko, White Pine, Lincoln, and Clark counties, and on the Ravenswood district, in Lander County, has been submitted for publication by Mr. Hill.

The economic geology of the National district is described by Waldemar Lindgren in Bulletin 601, recently issued; and a detailed report on the geology and ore deposits of the Ely district, by A. C. Spencer, is in the editor's hands. In the preparation of the Ely report Sidney Paige collaborated in the office with Mr. Spencer.

The oxidized zinc ores near Eureka were investigated by G. F. Loughlin, the mining districts of the Carson Sink quadrangle are being described by F. C. Schrader, and an examination of the geology and ore deposits of the Manhattan district was begun by H. G. Ferguson.

A short paper on the occurrence of wurtzite at Goldfield was unofficially published by F. L. Ransome.

The silver ores of the Tonopah district are under investigation by metallographic methods, with reference to their association and origin, by E. S. Bastin, in collaboration with F. B. Laney.

NEW HAMPSHIRE.

Mica deposits, locally with gem beryl as an associated mineral, were examined in eleven townships in Grafton, Cheshire, and Stratford counties, N. H., by D. B. Sterrett, who nearly completed the field investigation of the principal deposits, preliminary to a description of the occurrence of mica in New Hampshire. The gem deposits will be described in a report on the occurrence of precious stones in the United States now in preparation.

The areal survey of the Dover and York quadrangles, including portions of Maine, was begun by F. J. Katz, who has also begun the office compilation of the field data.

The examination of the Peterboro quadrangle was continued during a portion of the field season by B. K. Emerson, who for a time was joined in a field reconnaissance by Arthur Keith. A brief reconnaissance was made in the Keene quadrangle by Mr. Keith. Portions of the Lowell, Lawrence, and Newburyport quadrangles, lying partly in Massachusetts, were examined by Laurence La Forge.

NEW JERSEY.

The areal survey of the Easton quadrangle, in New Jersey and Pennsylvania, was completed by H. B. Kümmel, the work being carried on in cooperation with the New Jersey Geological Survey. The manuscript and maps for this quadrangle will form part of the Allentown-Easton folio and are well advanced toward completion.

In accordance with the plan of the Survey to print on the backs of topographic maps that cover large centers of population or points of unusual scenic interest popular and instructive descriptions of the geography and of the origin of the physical features, a description of this sort was prepared by G. W. Stose for the Delaware Water Gap sheet. This description is based on field work done in the quadrangle, which lies largely in Pennsylvania, by W. S. Bayley and H. B. Kümmel, and on Mr. Stose's personal knowledge of the region. The general geologic data now available as to the quadrangle will probably be amplified when the study of the adjoining Wind Gap quadrangle has been made in order that both quadrangles may be covered in a single folio.

NEW MEXICO.

In connection with the general search for deposits of potash and nitrate salts, the investigation of the depositional basins in the "Red Beds" region of New Mexico was continued by N. H. Darton, whose principal object was to discover the centers of greatest evaporation of saline waters in the past.

The chief study of metalliferous areas undertaken in New Mexico during the year was that of the copper deposits at Santa Rita (Chino district), to which A. C. Spencer was assigned. With Mr. Spencer

were associated Sidney Paige, who studied the structure and superposed the geology on the Santa Rita special map; D. F. MacDonald, who examined the mining methods, especially the open-pit mining; and J. F. Hunter, jr., who assisted in the areal geologic mapping. Toward the close of the field season the district was visited by F. L. Ransome for the discussion of problems with Mr. Spencer.

The studies of mining methods by Mr. MacDonald were carried on in connection with the general investigation of the application of geologic features to the problems of mining and engineering construction, prosecuted in cooperation with the Bureau of Mines.

A study of the zinc ores of the Magdalena district was begun by G. F. Loughlin.

The geology and water resources of Luna County are described by N. H. Darton in Water-Supply Paper 345–C, recently issued.

A study of the geology and coal resources of the Raton and Brilliant quadrangles, in the Raton coal field, Colfax County, was completed by W. T. Lee, and an economic report covering the area has been submitted for publication. A folio by Mr. Lee describing in detail the geology of the quadrangles is in preparation.

The Datil Mountain region was revisited by D. E. Winchester for the purpose of collecting additional information regarding the stratigraphy and correlation of certain coal beds. Field work is now completed in the Datil Mountain region and in the Zuni Indian Reservation, and an economic report on these areas is in preparation by Mr. Winchester.

At the request of the Office of Indian Affairs, lands coming under the Hogback canal in the Navajo Indian Reservation were examined in 1913 by M. A. Pishel. A report on the area was submitted by Mr. Pishel prior to his resignation from the Survey to accept a more remunerative position in one of the large oil companies operating in the Southwest.

A detailed examination, for the General Land Office, of lands near Gallup, McKinley County, was made by C. T. Lupton, who is now preparing a geologic report on the area.

An extended and elaborate study of the San Juan coal basin, in the northwest corner of the State, was begun by C. M. Bauer, assisted by J. B. Reeside, jr., the purpose being to obtain data for classifying the lands in the interior of this great basin and for determining the age and the correlation of the formations. The results of this investigation will be available for use in preparing the Red Mesa and Soda Canyon folios.

NEW YORK.

The mapping of the Quaternary deposits of the Berlin (N. Y.–Mass.) and Hoosick (N. Y.–Vt.) quadrangles was completed in July, and descriptions for folio publication have been nearly completed by

F. B. Taylor. The areal and economic survey of the Paleozoic formations in the Berlin quadrangle, which includes a small portion of Massachusetts, was continued by L. M. Prindle, about 125 miles having been mapped in detail.

The examination and mapping of the Paleozoic formations in the Hoosick quadrangle was completed by Mr. Prindle, who will describe this quadrangle in a folio covering also the Bennington quadrangle.

The study of the Quaternary deposits of the Cambridge and Fort Ann quadrangles was begun by Mr. Taylor.

NORTH CAROLINA.

Manuscripts and maps for a folio describing the Kings Mountain and Gaffney quadrangles, the larger part of which lie in South Carolina, has been nearly completed by D. B. Sterrett.

The Lincolnton quadrangle has been mapped by Mr. Sterrett, who has prepared descriptions for inclusion in a folio to cover also the Gastonia quadrangle, in which field work will be begun this summer.

Some mica deposits in Avery, Mitchell, and Macon counties and the results of the latest prospect work done in 1914 at the Ruby mine, in Cowee Valley, were examined by Mr. Sterrett, who visited several mica manufacturing plants to study the conditions of the industry.

In connection with a report on the marbles of the southeastern United States, which is being prepared in cooperation with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads, T. Nelson Dale devoted a short time to field investigations in this State.

The preparation of a cooperative monograph on the worms and mollusks of the Upper Cretaceous deposits of the Carolinas, by L. W. Stephenson, to be published by the North Carolina Geological and Economic Survey, has been nearly completed and the report will soon be transmitted. The Cretaceous Crustacea from the State have been described by Miss Mary T. Rathbun, of the United States National Museum, in a report to accompany Mr. Stephenson's paper, and the fossil plants have been described for the same purpose by E. W. Berry.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina, for which Dr. Paul Bartsch, of the National Museum, described several families of the smaller Mollusca, has been completed by Miss Julia Gardner. The services of all those who are engaged on this work, except Mr. Stephenson, were contributed in scientific cooperation, without expense to the Survey.

A monograph on the Pliocene and Pleistocene Foraminifera of the Atlantic and Gulf Coastal Plain, in which the Foraminifera from North Carolina are included, has been transmitted for publication by J. A. Cushman.

NORTH DAKOTA.

A detailed reconnaissance survey, covering about 590 square miles in the Oliver County lignite field, North Dakota, was made by E. T. Hancock, with the assistance of R. C. Moore. The results of this examination, which was made primarily for land classification and to solve certain problems relating to the stratigraphy of the region, have been embodied in a geologic report by Mr. Hancock, now nearly completed. In connection with the field investigations, studies relating to the stratigraphy of the Cannonball marine member of the Lance formation and to the stratigraphy and faunas of the Cretaceous and Eocene formations in surrounding regions were made by T. W. Stanton, who examined exposures north and south of Steel, near Jamestown, between Linton and Missouri River, and along Cannonball and Wisconsin rivers from Solen to Washburn.

The Fort Berthold lignite field is described and mapped in a final report submitted by C. M. Bauer, who has also prepared a short summary report on the lignite resources of North Dakota for inclusion in the general report on the coal fields of the United States.

The geology of the Edgeley and Lamoure quadrangles has been examined for folio publication by H. A. Hard under a cooperative agreement with the State Geological Survey of North Dakota.

OHIO.

A folio for the Hamilton and Mason quadrangles, which were mapped in detail by R. S. Bassler and N. M. Fenneman, as previously reported, is nearly finished, its completion awaiting only the results of additional investigations, largely paleontologic, to be made by E. O. Ulrich in the Cincinnati quadrangle. Some general review work was done by Mr. Ulrich in the quadrangle.

The areal and economic geology of the Woodsfield and Summerfield quadrangles was examined in detail by D. Dale Condit, assisted by R. V. A. Mills and for a short time by C. A. Bonine. Careful attention was given to the structure of the oil sands and the relations of the oil pools to the geologic structure and to the character of the sands themselves. Two economic reports on the structure and oil resources of these quadrangles are now nearly completed and a folio is in preparation.

Some progress has been made in the preparation of a folio text covering the Steubenville and Cadiz quadrangles, on which Mr. Condit had been previously engaged; but this work was interrupted by his detail to examine and classify supposed phosphate-bearing lands in western Wyoming.

A preliminary examination of the Wooster oil and gas field was made by C. A. Bonine, and a report on the geologic structure, the

mode of occurrence of oil and gas, and the prospects of the field has been submitted by Mr. Bonine for publication (Bulletin 621–H).

The field investigation and mapping of the Wellsville quadrangle were carried on by J. H. Hance, special attention being given to the clay deposits and the clay-bearing formations.

The richly carbonaceous Devonian shales were examined and sampled at a number of points by G. H. Ashley, with a view to determining their value for distillation.

OKLAHOMA.

In order to procure further data as to the structure of the oil sands in the Hominy quadrangle, Oklahoma, some additional reconnaissance work was done by Robert H. Wood, whose oil report for the quadrangle is nearing completion and whose folio is well advanced. Considerable progress was made by Mr. Wood on the economic report covering the Cleveland pool.

The Pawhuska quadrangle was revisited by C. D. Smith for the purpose of verifying certain conclusions he reached during the office study of his notes, and considerable progress has been made on the folio covering the quadrangle. The folio for the Claremore quadrangle, which also was visited for slight revision, was nearly completed when, at the end of January, Mr. Smith resigned from the Survey in order to make a more lucrative use, as consulting oil geologist, of his practical knowledge and experience in oil-field geology. However, Mr. Smith has agreed to complete the folio.

Considerable progress has been made by Mr. Smith in the preparation of a folio covering the Sallisaw and Sanbois quadrangles, the geologic mapping of which was begun some years ago by J. A. Taff, a former member of the Survey now in the employ of the Southern Pacific Co. The completion of this folio, which had been delayed pending the receipt of additional data from Mr. Taff, is now subject to further postponement on account of Mr. Smith's resignation.

The areal and economic survey of the McAlester quadrangle was completed a number of years ago by Mr. Taff, who is under agreement to complete a folio for this area.

The Paleozoic geology and the Quaternary deposits in the northern half of the Windingstair quadrangle and the eastern part of the Tuskahoma quadrangle was briefly reviewed by H. D. Miser. The areal work in these quadrangles was begun a number of years ago by Mr. Taff.

The Loco, Duncan, and Lawton districts were examined by C. H. Wegemann, assisted by R. W. Howell and K. C. Heald, with the object of discovering the relation of the oil pools to the geologic structure and of obtaining information for guidance in the extension of known pools and the possible discovery of new ones. Preliminary

accounts, with sketch maps covering the areas, were transmitted to the Oklahoma Geological Survey, by which they have since been published.

Work on the Healdton pool, which was begun last year, was continued by Mr. Wegemann, assisted by Mr. Heald, and a report thereon is in press as Bulletin 621–B. Reports on the Loco and Duncan (Hope) gas fields and on the Lawton gas and oil pool, by Mr. Wegemann and R. W. Howell, are in press as Bulletins 621–C, 621–D, and 621–G, respectively.

Structural examinations, with reference to the possible occurrence of oil and gas, were made in portions of Okmulgee and Okfuskee counties by A. E. Fath, assisted during part of the field season by W. B. Emery and K. C. Heald. A report on "Faulted structure in the vicinity of the recent oil and gas development near Paden, Okfuskee County, Okla.," has been submitted by Mr. Fath. He also prepared a paper for unofficial publication on the segregation of copper ores in the "Red Beds."

The economic and areal survey of the geology of the Foraker quadrangle was begun by Mr. Heald and a similar investigation of the Bristow quadrangle by Mr. Fath.

Additional examinations of the lead and zinc deposits of the Miami district were made near the close of the year by C. E. Siebenthal. The data will be used in a report on these deposits which is now in preparation by him.

"The fauna of the Wewoka formation of Oklahoma," by G. H. Girty, was published as Bulletin 544.

OREGON.

In the Sumpter quadrangle, Oregon, about half of which had previously been examined, the remaining part was geologically surveyed in detail on the scale of 1 : 125,000, for folio publication, by J. T. Pardee and D. F. Hewett under a cooperative agreement with the Oregon Bureau of Mines and Geology, to which a preliminary report on the mineral resources of the quadrangle was submitted for publication. In June Mr. Hewett made some reconnaissance examinations in the region immediately west of the quadrangle. A geologic folio for Sumpter quadrangle is now in preparation for publication by the Federal Survey.

A reconnaissance examination of the Howard mining district was made in August by G. F. Loughlin.

Nitrate prospects in Malheur County, not far from Homedale, Idaho, were visited by G. R. Mansfield, whose report was submitted for publication (Bulletin 620–B).

The investigation of the Eden Ridge coal field was completed by C. E. Lesher, who examined in detail 36 square miles and in recon-

naissance 200 square miles, covering parts of Eden Ridge and Camas Valley. The stratigraphic position of the scattered coal outcrops was determined by Mr. Lesher, thus defining the productive formation. A portable outfit devised for the field determination of the amount of ash in coals is described by Mr. Lesher in Bulletin 621–A.

PENNSYLVANIA.

The region between the Bellefonte and Huntingdon quadrangles, Pennsylvania, which have already been under examination, was reviewed in reconnaissance by Charles Butts, for the purpose of tracing certain formations between the two quadrangles and determining their stratigraphic relations. The folio for the Huntingdon and Hollidaysburg quadrangles is near completion, lacking only a review of certain details. A conference will be held by Mr. Butts and E. S. Moore, geologist engaged in the study of the Bellefonte quadrangle, before the folio for that quadrangle can be completed for publication. In connection with the description by C. D. Walcott, secretary of the Smithsonian Institution, of the Cambrian paleontology and stratigraphy of the United States, Mr. Butts spent some time in working out the Cambrian-Ordovician relations in the Hollidaysburg quadrangle.

A description of the physical features in the Delaware Water Gap quadrangle and the geography of the region was prepared by G. W. Stose. (See New Jersey, p. 75.)

Field work on the Fairfield and Gettysburg quadrangles having been completed, the manuscript and maps for a folio are in preparation by Miss Florence Bascom and G. W. Stose. A petrographic report on the Triassic lavas, for incorporation in this folio, was prepared by J. Volney Lewis.

The folio covering the Elkton and Wilmington quadrangles, by Miss Bascom and B. L. Miller, has been transmitted for publication. (See Maryland, p. 68.)

The geology of the Allentown quadrangle has been the subject of a field conference between Arthur Keith, in charge of the work, and B. L. Miller and H. B. Kümmel, geologists responsible for the mapping of the Allentown and Easton quadrangles, respectively. Mr. Miller has completed the maps and text for the Allentown quadrangle, and Mr. Kümmel is preparing similar material for the Easton quadrangle, the greater portion of which lies in New Jersey. The two quadrangles will be covered by a single folio. A report on the geology and economic resources of the Allentown quadrangle has been submitted by B. L. Miller.

Additional field work, mainly in adjustment of geologic boundaries to a new topographic base for the Reading quadrangle, has been

completed in the Reading and Boyertown quadrangles by Miss Bascom and Edgar T. Wherry, assistant. Mr. Wherry also examined recently operated quarries and mines in both quadrangles in order to complete his description of the economic geology and developments in the area. The pre-Cambrian rocks in the Reading quadrangle were mapped by Miss E. F. Bliss. Miss Bascom's work of preparing the folio is now well advanced.

The survey of the areal geology of the McCalls Ferry and Quarryville quadrangles, begun by E. B. Mathews, was continued by Miss Bliss. The results are to be published in folio form.

Field investigations were carried on by Mr. Wherry and Miss Bliss in the Quakertown and Doylestown quadrangles, the Paleozoic rocks being partly mapped by Miss Bliss and the Triassic rocks by Mr. Wherry. A portion of the folio for these two quadrangles is to be prepared by Miss Bascom and is well advanced toward completion.

Considerable progress has been made by Miss Bascom on the manuscript and maps for the Coatesville and West Chester quadrangles, which will be covered by a single folio, and on the Honeybrook-Phoenixville folio, which she expects to complete during the coming year.

Several local investigations regarding artesian-water conditions in eastern Pennsylvania have been made by Miss Bascom.

Satisfactory progress has been made in the investigation and mapping of the geology of the Frostburg and Flintstone quadrangles, which are to be covered by a single folio. The field and office work by Mr. Stose for his part of the folio has been finished for some time, and the completion of the folio manuscript awaits the descriptions to be furnished by C. K. Swartz for the Devonian and Carboniferous formations. The work is being done in cooperation with the Maryland Geological Survey.

The preparation of maps and descriptions of the geology and mineral resources of the Punxsutawney, Curwensville, and Houtzdale quadrangles has been continued by G. H. Ashley whenever his other duties gave opportunity.

The deposits of cannel coal and the richly carbonaceous shale mined or exposed at several points in western Pennsylvania were examined by Mr. Ashley, who collected a number of samples for tests in order to determine their ultimate value as possible sources of gas or petroleum distillates and distillation by-products.

Some progress has been made in the preparation of the Newcastle folio, although the demands made upon F. W. De Wolf, the author, by his duties as State geologist of Illinois are so overwhelming that little time is available for the Pennsylvania work.

The geology of the Windber quadrangle has been investigated in detail by George B. Richardson, who has submitted a folio to cover

the Windber and Somerset quadrangles, the latter having been examined during the preceding season. An economic report entitled "Geologic structure and coal resources of the Windber and Somerset quadrangles, Pennsylvania," has been nearly completed by Mr. Richardson.

RHODE ISLAND.

In connection with the investigations of the stratigraphy, paleontology, underground water resources, and physiography of the Atlantic Coastal Plain, the examination of Cape Cod and the islands off the south coast of Massachusetts and Rhode Island, including Block Island, was undertaken by J. B. Woodworth.

A report, briefly describing the Rhode Island coal field and discussing in particular the composition and adaptations of the coals of the State, by G. H. Ashley, is in press as Bulletin 615.

SOUTH CAROLINA.

The folio describing the areal and economic geology of the Kings Mountain and Gaffney quadrangles, in South and North Carolina, has been nearly completed by D. B. Sterrett, although minor field examinations at certain points may be needed before the folio can be finished.

The upper Cretaceous formations of South Carolina are discussed in the report by L. W. Stephenson on the worms and mollusks of the deposits of this age in the Carolinas. This report, which is ready for transmission, has been prepared in cooperation with the Geological and Economic Survey of North Carolina, by which it will be published.

A monograph on the Pliocene and Miocene Foraminifera of the Atlantic Coastal Plain, by Joseph A. Cushman, has recently been submitted for publication.

A paper by L. W. Stephenson, entitled "A deep well at Charleston, S. C.," with a report on the mineralogy of the water by Chase Palmer, has been published as Professional Paper 90–H.

SOUTH DAKOTA.

The preparation of a report on the Upper Cambrian geology, Tertiary igneous rocks, and mineral resources of the Black Hills to accompany a quadruple folio covering the Deadwood, Rapids, Hermosa, and Harney Peak quadrangles was continued by Sidney Paige, who investigated the ore deposits of the region. By order of the Assistant Secretary of the Interior, Mr. Paige also examined certain mining claims in the Harney National Forest. The Paleozoic and younger sedimentary formations in these quadrangles are being described by N. H. Darton.

A field study of the stratigraphy of the Cretaceous and Eocene formations in the vicinity of Mobridge was made by T. W. Stanton for purposes of correlation.

TENNESSEE.

In the Waynesboro quadrangle, Tennessee, some additional field examinations necessary to the completion of a folio were made by H. D. Miser, in cooperation with the Tennessee Geological Survey.

An investigation of the outcrops of the Clinton iron ore in the Cumberland Gap, Jonesville, Maynardsville, Morristown, Briceville, and Kingston quadrangles was made by E. F. Burchard, also in cooperation with the State, for the purpose of including the descriptions and maps of these deposits in a bulletin on the red iron ores of eastern Tennessee, northeastern Alabama, and northwestern Georgia.

The report on the Ducktown copper deposits is well advanced. The history and the descriptions of formations and structures have been written by F. B. Laney, and the description of the ore deposits by W. H. Emmons, but Mr. Emmons's part has not yet been adjusted to the part contributed by Mr. Laney and to that to be added by Arthur Keith.

In order more satisfactorily to classify and correlate the Paleozoic formations in portions of the State, sections were studied and numerous collections of invertebrate fossils were made in the eastern regions by R. D. Mesler and in central Tennessee by George H. Girty, in cooperation with H. D. Miser.

A brief field examination of the black shales at a number of points in Tennessee was made by G. H. Ashley, in connection with his study of the problem of the oil and gas resources ultimately to be realized through the distillation of these richly carbonaceous and widespread deposits.

A report on the fossil flora of the Jackson group, which covers a portion of the State, is in preparation by E. W. Berry, who also described the lower Eocene flora in Professional Paper 91, now in press.

In connection with the study of the post-Tertiary history and the physiography of the Mississippi embayment area an examination of the physiography and Quaternary geology of western Tennessee is in progress by E. W. Shaw.

In accordance with a plan for cooperating with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads in the investigation of the building materials of the United States, T. Nelson Dale examined the marble deposits of eastern Tennessee. This investigation was made in cooperation also with the State geological survey, which is expected to furnish areal and stratigraphic details, the data respecting the mechanical composition and the special characteristics and qualities of the marbles to be prepared by Mr. Dale. Physical tests of samples submitted have been furnished by the Bureau of Standards. The preparation of Mr. Dale's report is well advanced.

The phosphate deposits in the vicinity of Mount Pleasant, the center of the brown rock phosphate industry in the State, have received some preliminary field study by W. C. Phalen, who has brought up to date the mapping of the important deposits of brown rock, sampled the deposits for analyses, and studied the conservation of these important resources. The results of these studies will probably be included in a general economic report on the phosphate deposits of the southern Appalachian region.

In accordance with a cooperative arrangement between the Bureau of Mines, the Tennessee Geological Survey, and the United States Geological Survey, all the coal mines in Tennessee producing coal on a commercial scale and a number of small and intermittently operated coal mines were examined and sampled by the Geological Survey, all the samples being taken by one geologist, Frank R. Clark. The sampling was done according to the practice of the Geological Survey and the Bureau of Mines, which made the analyses. The analyses will probably be published by this Survey, by the State, and by the Bureau of Mines.

TEXAS.

A reconnaissance of the deposits of brown iron ores and iron carbonate ores in northeastern Texas was made by E. F. Burchard, whose report on the iron ores of Cass, Marion, Morris, and Cherokee counties is in press as Bulletin 620–E.

In connection with the investigation of nonmetalliferous mineral deposits in various regions, the supposed phosphate deposits in Brewster County were examined by W. C. Phalen, in company with J. A. Udden, of the bureau of economic geology and technology of the University of Texas. Mr. Phalen also inspected the cores of drillings made in exploration for sulphur at Bryan Heights. Observations noted in connection with these examinations are incorporated in his report on the production of sulphur for 1914.

In the Survey's investigation of all reported discoveries of potash salts samples have been taken for analysis at a number of points in Texas. Close attention is given to all borings in the "Red Beds" region of the State, and this Survey has offered to supplement the work of the State University through the field observation of drilling and the analyses of samples.

The relations of the Fayette, Catahoula, and Fleming formations in Texas were studied by G. C. Matson and Alexander Deussen, and a report on the Catahoula formation, prepared by Mr. Matson in cooperation with E. W. Berry, was transmitted for publication. Reports on the fossil flora of the Claiborne and Jackson groups were being prepared by Mr. Berry.

The manuscript for a report on the geology of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, is nearing

completion. The underground water supply of Lasalle and McMullen counties is discussed by Mr. Deussen and R. B. Dole in a report transmitted for publication by the water-resources branch (Water-Supply Paper 375–G).

Reconnaissance examinations, with special reference to the possible occurrence of oil or gas pools, were made by C. H. Wegemann, near Mineral Wells and Quanah, and reports containing the conclusions reached have been submitted for publication in the current volume of "Contributions to economic geology."

UTAH.

A general summary report on the ore deposits of Utah, by B. S. Butler and G. F. Loughlin, has been materially advanced during the year, and the authors expect to complete it during the coming year.

The Tintic district was revisited by Waldemar Lindgren and Mr. Loughlin to procure additional material for their report on the geology and ore deposits. This report has since been transmitted by the senior author for publication. Mr. Loughlin also made a brief visit to the Ophir district to study the occurrence of the zinc ores.

In response to a special request from mining men, Mr. Loughlin revisited Marysvale for the purpose of further examining the alunite deposits and later submitted a brief report. He also examined the ore deposits at Fortuna, near Beaver.

The search for uranium and vanadium deposits in southeastern Utah, begun by F. L. Hess but temporarily relinquished by him on account of illness, was continued by B. S. Butler, assisted by W. H. Whitehead, in Wayne, Garfield, and San Juan counties. In addition to examining the horizons at which uranium minerals are known to occur, the stratigraphy of the Colorado Plateau and Henry Mountains regions as interpreted by Dutton and Gilbert was reexamined, and correlations were made with areas farther north and east that had been mapped by C. T. Lupton and E. G. Woodruff.

A reconnaissance report on the Cottonwood-American Fork area by Messrs. Butler and Loughlin, with a section on the history of mining and production by V. C. Heikes, was submitted for publication (Bulletin 620–I).

The physiography and geologic history of the Colorado Plateau have been the subject of a general study by H. E. Gregory, which he expects to continue as opportunities arise and funds are available.

The occurrence of phosphate deposits in rocks of Mississippian age in the vicinity of Logan was investigated by E. H. Finch, whose report is in preparation.

A preliminary reconnaissance examination of the south and west slopes of the Uinta Mountains to determine whether or not phosphate is present and under what conditions it occurs was made by A. R. Schultz.

A brief examination of the salts in Salduro Salt Flat, with special reference to the possible presence of potash in commercial amounts, was made by Hoyt S. Gale.

The detailed survey begun in the Book Cliffs coal field at Sunnyside, Carbon County, in 1911, has been continued westward each succeeding year, and in the season of 1914 another 15-minute quadrangle, the Castle Gate, was covered. Nothing has yet been published on these areas, but an economic bulletin and a folio are in preparation for each quadrangle completed, namely, Sunnyside, Wellington, and Castle Gate. In this investigation the outcrop of each coal bed of economic value was traced and mapped by F. R. Clark, the geologist in charge, and many exact data were obtained regarding both horizontal and vertical locations of measured sections of the coal beds. In spite of the rugged character of the cliffs, which made the work difficult and laborious, an area of 230 square miles was examined in detail.

In addition to the Castle Gate quadrangle an area of about 80 square miles in Morgan County was examined in detailed reconnaissance by Mr. Clark to determine the possible occurrence of coal in commercial quantities. The land has been classified, and a short geologic report is now in preparation by Mr. Clark.

The ozokerite deposits near Colton, Soldier Summit, and Media were examined by H. M. Robinson, who has prepared and submitted for publication a report on the ozokerite deposits of Utah. The oil shale near Mount Pleasant was examined by Mr. Robinson in company with David T. Day, in cooperation with the Bureau of Mines.

A geologic report on the Emery coal field by C. T. Lupton has been submitted for publication, and a report on the Coalville coal field, by C. H. Wegemann, based on field work done in a previous year, has been published as Bulletin 581–E.

Some field observations of the ancient Lake Bonneville basin were made by G. K. Gilbert, in connection with his brief description of the history of the lake and of Great Salt Lake, for use in the Overland Route guidebook (Bulletin 612). In connection with the preparation of a discussion of the geologic structure in the Great Basin region, observations on the master faults associated with the mountain ranges were made by Mr. Gilbert.

VERMONT.

In the Bennington quadrangle, Vermont, detailed mapping was completed by L. M. Prindle. During this work Mr. Prindle was joined for a conference by Prof. G. H. Perkins, State geologist, and for a review of the work of Arthur Keith, who also discussed the geologic work of the Survey in Vermont with Prof. Perkins. Special investigation was made by Mr. Keith of the stratigraphy and faulted

structure of the Taconic Mountains in the Brandon, Rutland, Castleton, Pawlet, and Wallingford quadrangles for the purpose of solving some intricate problems involved in this work before the southern Vermont folios can be submitted for publication. A brief reconnaissance was made by Mr. Keith in the Ludlow and Brattleboro quadrangles.

The mapping of the Quaternary deposits of the Hoosic and Bennington quadrangles was completed by F. B. Taylor, who has nearly finished the descriptions to be incorporated in a folio covering these quadrangles. The field examination of the Quaternary deposits of the Pawlet and Equinox quadrangles was begun by Mr. Taylor.

VIRGINIA.

The detailed investigation and mapping of the southwestern Virginia coal field was continued in cooperation with the Virginia State Geological Survey. The geologic field examinations, which were contemporaneous with the topographic mapping and conducted from the topographic camp, were extended over the Virginia portions of the Hurley, Gilbert, Matewan, Iaeger, and Welch quadrangles. This work was in charge of Henry Hinds, who was assisted on the part of the State by T. K. Harnsberger. Progress was made on the Bucu and Clintwood geologic maps. The pre-Pennsylvanian rocks of the Bucu quadrangle were examined by G. W. Stose in company with Mr. Hinds.

For the purpose of comparing and correlating several of the older geologic formations in the region under detailed investigation, Mr. Hinds made a brief reconnaissance, with E. O. Ulrich and Charles Butts, of the formations exposed near Roanoke and Cleveland.

The preparation of a report embodying the results of the study of the coals in the Pocono formation of Virginia, which were examined the previous spring, was begun by R. W. Howell. This work was done in cooperation with the State Geological Survey.

In the Abingdon quadrangle detailed areal work on the Paleozoic formations was continued by G. W. Stose, who will describe and map most of them in the Abingdon folio, for which the pre-Paleozoic rocks will be treated by Arthur Keith. Although this project is not cooperative, Mr. Stose was joined for a time by T. L. Watson, State geologist, who, with F. A. Wilder, of the State Survey, is cooperating with Mr. Stose in the preparation of reports on salt and gypsum in the State.

A number of sections of the Devonian formations in southwestern Virginia were visited by Charles Butts, E. O. Ulrich, and R. D. Mesler, for the purpose of correlating the formations in this region with those in other regions and States of the Appalachian province.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina has been completed by Miss Julia Gardner.

Mica deposits in Amelia and Hanover counties and an amethyst deposit in Louisa County were examined by D. B. Sterrett.

WASHINGTON.

The Glacier coal field, in Whatcom County, Wash., was examined by M. R. Campbell for the purpose of classifying the land and valuing that which is underlain by workable coal. The report on this field, which was found to contain a considerable quantity of high-grade anthracite, has been delayed in the hope that additional prospecting would be done so as to afford fuller and more exact information relating to the coal.

Several small tracts near Molson were examined by E. L. Jones, jr., to ascertain their probable value for metal mining or agriculture. Mr. Jones also made a reconnaissance examination of about 100 square miles in the Conconully district.

A report describing the mineral deposits and geology of the Colville Indian Reservation, based on an examination made in previous seasons for purposes of classification, was submitted by J. T. Pardee for publication in "Contributions to economic geology."

WEST VIRGINIA.

Some progress has been made in the preparation of a report on the semianthracite coal resources of the Pocono formation, in West Virginia, by R. W. Howell, but further work was postponed on account of the detail of Mr. Howell for investigations in the Mid-Continent oil region.

An examination was made by G. H. Ashley of the black shale at a number of points in the State in connection with an investigation of the value of such shale for distillation.

The survey of the Williamsport quadrangle, including parts of Maryland and Pennsylvania, was completed by G. W. Stose, and the results will be published in the Williamsport-Hagerstown folio. Mr. Stose and G. P. Grimsley, of the State Survey, held a field conference in this area, the State Survey being interested in this work, although not cooperating financially.

WISCONSIN.

Special examinations of the glacial deposits of northwestern Wisconsin were made by Frank Leverett in October, 1914, and, together with Dr. Samuel Weidman, of the Wisconsin Geological and Natural History Survey, in June, 1915, in order to correlate the deposits in Minnesota with those in Wisconsin and to complete the data for a report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota.

An agreement has been made with Dr. Weidman for the completion of a folio covering the Wausau and Marathon quadrangles, in cooperation with the State Survey.

Some additions were made to the manuscript on the Quaternary geology of southeastern Wisconsin, which was submitted for publication by W. C. Alden.

In cooperation with the geologists of the State Survey the stratigraphy and paleontology of the early Paleozoic formations were investigated by E. O. Ulrich.

WYOMING.

The areal mapping and the investigations relating to the possibilities of the presence of oil and gas in the structural domes and anticlines of central Wyoming between Casper and Lander, in Natrona, Fremont, and Carbon counties, commenced in 1913, was completed by C. J. Hares, assisted by J. B. Reeside, jr., and K. C. Heald. An area of about 2,800 square miles was covered, of which 1,940 miles was mapped in detail and the remainder in detailed reconnaissance. Special attention was given to the structure of the rocks and to the late Tertiary formations. The total area mapped in the two seasons is about 5,000 square miles, upon which a short preliminary report has been submitted for publication, and a final report is now being prepared.

In the eastern portion of the Bighorn Basin a detailed geologic examination was begun by C. T. Lupton, assisted by J. D. Northrop and W. P. Woodring, special attention being given to the structure of the rocks in order to discover those structures which are favorable to the accumulation of oil and gas. A preliminary report entitled "Oil and gas near Basin, Big Horn County, Wyo." (Bulletin 621–L) and a more detailed report on oil fields in the southern part of the Bighorn Basin have been submitted by Mr. Lupton.

Field work was resumed by C. F. Bowen in the Saddleback quadrangle, forming part of an examination made primarily for the purpose of classifying and valuing the coal lands embraced in the Saddleback, Hanna, and Walcott quadrangles. Exact horizontal and vertical locations were determined by plane-table methods for all sections measured on the coal beds as well as for geologic boundaries and structural features. Economic and folio reports for the Saddleback quadrangle are being prepared by Mr. Bowen.

In the Ilo, Oregon Basin, and Meeteetse quadrangles field examinations were completed by D. F. Hewett, who has submitted for publication an economic report covering the two quadrangles last named and is also preparing folios for the area examined. The geologic mapping was done by plane-table methods and independently of the topographic sketching, which was carried on simultaneously by the topographic branch.

The survey of the central part of the Powder River coal field and the reexamination of the Salt Creek oil field were begun by C. H. Wegemann and R. W. Howell.

Reconnaissance examinations were made of ore deposits in the North Laramie Mountains and of the Atlantic gold district, in the southeastern part of the State, by A. C. Spencer, who has transmitted a report on the North Laramie Mountain region and has in preparation his report on the Atlantic district.

A field study of the Bighorn limestone as exposed in the Wind River Mountains near Lander, in the Owl Creek Mountains, and in the Bighorn Mountains was made by Edwin Kirk.

An examination for phosphate was made by G. R. Mansfield in the Salt River region east of Star Valley. Data for the classification of the land in seven townships have been submitted by Mr. Mansfield, who has completed, for publication as a bulletin, a report on the economic resources of the region.

A report of a reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

CANAL ZONE.

The investigations made for the purpose of determining the geologic formations, their correlation, and the geologic history of the Canal Zone and adjacent regions of Panama and Costa Rica have been continued during the year, and most of the series of reports planned with the cooperation of the Smithsonian Institution, the Isthmian Canal Commission, and the United States Geological Survey are approaching completion. A manuscript describing the physiography, stratigraphy, geologic structure, geologic history, and economic geology of the Canal Zone and adjacent areas, by D. F. MacDonald, is about one-third completed. A report on the fossil calcareous algæ of the Canal Zone has been submitted by Dr. M. A. Howe, of the New York Botanical Garden, and reports on the Foraminifera and on the fossil Crustacea have been completed by Joseph A. Cushman and Miss M. J. Rathbun, respectively. Progress has been made in the report on the fossil plants of higher orders by E. W. Berry, on the fossil corals by T. W. Vaughan, on the fossil echinoids by R. T. Jackson, and on the fossil Bryozoa by R. S. Bassler and F. Canu. This series of reports, which will contain important conclusions as to geologic correlation and geologic history, will be published by the Smithsonian Institution.

ANTILLES.

A series of reports similar to those relating to the Canal Zone is in preparation for the Lesser Antillean Islands. The materials, largely paleontologic, submitted for study and the opportunities for field examinations are occasional and are possible only through the courtesy of private citizens, local governments, or scientific institutions. The systematic investigations, which are under the direction of

T. W. Vaughan, have been made possible through grants by the Carnegie Institution of Washington. Most of the cooperating geologists and paleontologists are not officers of the United States Geological Survey, but, besides Mr. Vaughan, who is studying the general physiography and general geology and is describing the fossil corals, C. Wythe Cooke has already prepared a report on the fossil Mollusca from the Lesser Antillean Islands and from Cuba. A report on the Foraminifera is in preparation by Joseph A. Cushman.

The investigations relating to the Canal Zone and the Antilles are of great importance to the understanding of the geology of both the eastern and western sides of continental North America, as only by accurate paleontologic knowledge of the West Indies and Central America can the geologic formations and the fossil associations on the two sides of the continent be correlated.

HAWAII.

A report by Whitman Cross on the "Lavas of Hawaii and their relations" has been published as Professional Paper 88.

DIVISION OF ALASKAN MINERAL RESOURCES.

APPROPRIATION AND CLASSES OF WORK.

On April 6, 1914, $100,000 was appropriated for the continuation of the investigation of the mineral resources of Alaska. The availability of funds at this early date made it possible to start the field work promptly and to carry it on economically, and the results were in strong contrast to those of the two previous years, when the delay in granting funds until summer greatly hampered the field work and made it very expensive.

The work carried on under this appropriation, as in previous years, included reconnaissance and detailed geologic and topographic surveys, special investigations of mineral resources, and the collection of statistics on mineral production.

PERSONNEL.

On July 1, 1914, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographers, 3 clerks and 1 draftsman on annual salaries, 2 field assistants, and 22 camp hands and recorders. On June 30, 1915, the personnel included 1 geologist in charge, 11 geologists, 4 topographers, 1 engineer, 3 clerks, and 1 draftsman on annual salaries, 1 clerk on monthly salary, 2 geologists on per diem salary, 1 field assistant, and 28 camp hands and recorders.

FIELD OPERATIONS DURING SEASON OF 1914.

Areas covered and allotments.—Ten parties were engaged in surveys and investigations during 1914. The area covered by exploratory geologic surveys, on a scale of 1: 500,000 (8 miles to the inch), amounts to 1,000 square miles; by reconnaissance geologic surveys, on a scale of 1: 250,000 (4 miles to the inch), 7,700 square miles; by detailed geologic surveys, on a scale of 1: 62,500 (1 mile to the inch), 325 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented in terms of area. About 600 square miles was covered by exploratory topographic surveys on a scale of 1: 500,000, 10,300 square miles by reconnaissance topographic surveys on a scale of 1: 250,000, and 10 square miles on a scale of 1: 24,000 (2.64 inches to 1 mile).

The following table shows the allotment, including both field and office expenses, of the total appropriation to the districts investigated. In addition to this, a balance of about $6,000 from last year's appropriation was expended in equipping the parties for the season's field work. In preparing this table the general office expenses were divided among the districts in proportion determined by the cost of the surveys in each district, allowance being made for variations in the character of the work. The results are expressed in round numbers. The "general investigations" include the cost of special studies of geology and mineral resources which were not of an areal character. The unallotted balance has been used for equipment of field parties and expenses up to the close of the fiscal year 1915.

Approximate geographic distribution of appropriation for Alaska investigations, 1914.

Southeastern Alaska	$6,000
Copper and Susitna basins	25,000
Prince William Sound	6,500
Kuskokwim and Mulchatna River basins	22,000
White and Chisana River basins	14,000
Yukon basin	2,000
Seward Peninsula	1,500
General field and office investigations	12,000
Allotted to field investigations of 1915	11,000
	100,000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same man may have carried on two different kinds of work, but this statement will help to elucidate a later table, which will summarize the complete areal surveys.

Approximate allotments to different kinds of surveys and investigations, 1914.

Geologic and topographic exploration	$4,400
Geologic reconnaissance surveys	13,000
Detailed geologic surveys	15,600
Special geologic investigations	13,000
Reconnaissance topographic surveys	22,500
Detailed topographic surveys	4,300
Collection of statistics	1,400
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	14,800
Allotted to field investigations, 1915	11,000
	100,000

Allotment for salaries and field expenses, 1914.

Scientific and technical salaries	$36,530
Field expenses	36,715
Clerical and other office and miscellaneous expenses	15,755
Allotted to field investigations, 1915	11,000
	100,000

Progress of work.—The following table exhibits the progress of investigations in Alaska and the annual appropriations since systematic surveys were begun in 1898:

Progress of surveys in Alaska, 1898–1914.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500 and larger; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Measurements of stream volume.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69	429
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68	309
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69	381
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	.....	24	185
1914	100,000	1,000	7,700	325	600	10,300	10	.....	.....	.....	.....
	1,261,189	73,200	83,735	4,396	51,680	126,880	3,652	450	72	.....	.....
Percentage of total area of Alaska		12.48	14.28	0.75	8.81	21.64	0.62	.....	.....	.....	.....

[a] The Coast and Geodetic and International Boundary surveys and the General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

General work.—Alfred H. Brooks, geologist in charge, was engaged in office work until July 6, when he started for Alaska. He visited Survey parties at Juneau, Valdez, Kotsina River, and Fairbanks, returning to Washington October 7.

George C. Martin was engaged during the summer on the Mesozoic stratigraphy of Alaska. Mr. Martin, accompanied by R. M. Overbeck as assistant, visited important localities in southeastern Alaska and in the Chitina and Yukon valleys. Arthur Hollick was employed for 64 days in continuing the study of Alaska Cretaceous and Tertiary floras.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation in addition to carrying on his own field work. E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the field season. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

Southeastern Alaska.—D. C. Witherspoon worked on detailed topographic surveys in the Juneau district. Rain prevented work on 45 days and greatly hampered it much of the rest of the season. Nevertheless, Mr. Witherspoon covered the area by triangulation and mapped 9.75 square miles on a scale of 1 : 24,000, with 50-foot contours. Mr. Eakin devoted about 10 days in the fall to the study of mining developments in the Juneau and Berners Bay districts.

Copper River and Susitna basin.—Detailed geologic mapping of the west end of the Kotsina-Chitina copper belt, begun in 1912, but interrupted in 1913, was completed in 1914 by F. H. Moffit, assisted by J. B. Mertie, who together mapped the geology and studied the mineral resources of an area of 185 square miles.

A topographic reconnaissance survey was carried by J. W. Bagley from Copper Center to the head of Klutina River and thence northwestward to the Susitna, an area of 4,000 square miles being surveyed by phototopographic methods, on a scale of 1 : 250,000, with 200-foot contours. Theodore Chapin, who accompanied the party as geologist, mapped an area of about 3,600 square miles. He also examined the gold placers of the Nelchina basin. This survey is an important connecting link between areas previously mapped in the Copper, Susitna, and Matanuska valleys.

Prince William Sound.—A detailed geologic survey and study of mineral resources of the Port Valdez district was begun in 1914 by B. L. Johnson, assisted by G. L. Harrington, covering 140 square miles.

Lake Clark-Iditarod region.—An exploration of the large, almost unknown region lying between Lake Clark and the Iditarod district was undertaken in 1914 by a party under R. H. Sargent, topographic engineer, and P. S. Smith, geologist. The topographic surveys

covered 4,800 miles and the geologic surveys 3,500 square miles. Some of the quicksilver deposits of the Kuskokwim region were also examined.

Lower Kuskokwim basin.—A. G. Maddren, assisted by Burt Kennedy, made a reconnaissance in the lower Kuskokwim basin. From Iditarod they went overland to Kuskokwim River, down that river, and up several tributary streams, making an examination of the Aniak-Tuluksak placer district and exploratory topographic surveys of about 600 square miles. Besides the gold placers, some copper and quicksilver deposits were examined.

Seward Peninsula.—In view of important developments in the York tin district a supplementary examination of this field was undertaken by H. M. Eakin, who also investigated the mining developments near Nome and made a brief study of the iron deposits in the Sinuk basin, about 40 miles from Nome.

Yukon basin.—Owing to the development of gold placers in the Chisana district in the upper Tanana Valley C. E. Giffin was detailed to extend the topographic surveys in this field. He surveyed Skolai Pass, extended the previous mapping in the Tanana and White River basins eastward to the international boundary, made reconnaissance surveys of about 1,500 square miles, for publication on a scale of 1: 250,000, and revised about 1,500 square miles of the old mapping. The wagon road from Willow Creek to Chitina, a distance of 40 miles, together with the adjacent country, was also surveyed in the autumn, making an additional area of revision of about 150 square miles. S. R. Capps made a study of the Chisana placer district and mapped the geology of an adjacent area of about 600 square miles.

H. M. Eakin devoted about three weeks to the investigation of the mining developments in the Hot Springs and Fairbanks districts.

FIELD AND OFFICE WORK FOR SEASON OF 1915.

Alfred H. Brooks will continue his general geologic investigations in different parts of Alaska. G. C. Martin will complete the preparation of a report on the Mesozoic stratigraphy of Alaska. A. G. Maddren will complete reports on the Kuskokwim region, the Yakataga region, and the international boundary region in northeastern Alaska. Arthur Hollick will continue work on a report on Cretaceous and Mesozoic floras. G. A. Waring is investigating the hot springs of Alaska and will also collect data on the quality of the surface waters. D. C. Witherspoon is continuing the preparation of a new base map of the Juneau district on a scale of 1: 24,000. The water powers of southeastern Alaska are being investigated by George H. Canfield, in cooperation with the Forest Service. Theodore Chapin is studying the geology and mineral resources of the Ketchikan district. A recon-

naissance geologic survey and investigation of the mineral resources of the upper Chitina basin is being made by F. H. Moffit and R. M. Overbeck. B. L. Johnson is completing a detailed geologic survey and study of the mineral resources of the Port Valdez district. He will later extend a reconnaissance geologic survey in the Prince William Sound region. Topographic and geologic reconnaissance surveys and investigations of mineral resources are being made in the Knik and Turnagain Arm region by J. W. Bagley and S. R. Capps. Time permitting they will also make similar surveys north of the Willow Creek district. Eliot Blackwelder is engaged in studying the Paleozoic stratigraphy of the upper part of the Yukon basin in Alaska. Topographic reconnaissance surveys of the Ruby district and the region lying to the south as far as Kuskokwim River are being made by R. H. Sargent and C. E. Giffin, and the geology and mineral resources of the same region are being studied by J. B. Mertie and G. L. Harrington. H. M. Eakin will explore the region lying between Cosna River, tributary to the lower Tanana, and the Ruby district, on the Yukon.

COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper, begun in 1905, was continued during the year. Preliminary estimates of mineral production were published on January 1, 1915. The progress report for 1914 (Bulletin 622), containing figures on mineral production, was transmitted in June. An abstract of this report, including the mineral statistics, was also transmitted in June for inclusion in the Survey's annual volume, Mineral Resources of the United States, for the calendar year 1914.

PUBLICATIONS.

During the year one professional paper (No. 87), three bulletins (Nos. 576, 578, 592), one water-supply paper (No. 342), and one separate of a water-supply paper (No. 345–F) relating to Alaska were issued.

Two Alaska maps were issued for sale—a general map of Alaska (scale 1:1,500,000) and a map of the Port Valdez district (scale 1:62,500).

Three bulletins (Nos. 605, 607, 608), one water-supply paper (No. 372), and one separate of a professional paper (No. 95-D) are in press. Manuscripts of the following reports have been completed: Mineral resources of Alaska, report on progress of investigations in 1914, by Alfred H. Brooks and others (Bulletin 622); the Yukon-Koyukuk region, Alaska, by H. M. Eakin; and the Chisana-White River district, Alaska, by S. R. Capps.

The following reports are in hand:

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright, including geologic reconnaissance map.

The Lake Clark-Iditarod region, Alaska, by P. S. Smith.

The Kotsina-Kuskulana district, Alaska, by F. H. Moffit.

The lower Kuskokwim region, Alaska, by A. G. Maddren.

The Nelchina-Susitna region, Alaska, by Theodore Chapin.

The Yakataga district, Alaska, by A. G. Maddren.

The upper Matanuska basin, Alaska, by G. C. Martin.

The Mesozoic stratigraphy of Alaska, by G. C. Martin.

Geology of the region along the international boundary, Alaska, from Porcupine River to the Arctic Ocean, by A. G. Maddren, including detailed geologic map.

The Cretaceous and Mesozoic floras of Alaska, by Arthur Hollick.

The office work on the three topographic maps named below, besides the three noted above as issued, were completed:

Broad Pass region, by J. W. Bagley; scale 1 : 250,000; contour interval 200 feet.

Matanuska Valley, by R. H. Sargent; scale 1 : 62,500; contour interval 100 feet.

Relief map of Alaska, compiled by J. H. Renshawe; scale 1 : 1,500,000.

The following maps are in hand:

Kotsina-Kuskulana district, by D. C. Witherspoon; scale 1:62,500; contour interval 100 feet.

Lake Clark-Iditarod region, by R. H. Sargent; scale 1:250,000; contour interval 200 feet.

Chisana-White River region, by C. E. Giffin; scale 1:250,000; contour interval 200 feet.

Nelchina-Susitna region, by J. W. Bagley; scale 1:250,000; contour interval 200 feet.

Juneau mining district, by D. C. Witherspoon; scale 1:24,000; contour interval 50 feet.

Lower Kuskokwim region, by A. G. Maddren; scale 1:500,000; contour interval 500 feet.

Yukon-Tanana region (compiled); scale 1:500,000; contour interval 500 feet.

SCIENTIFIC RESULTS.

Mr. Martin's investigations of the Mesozoic stratigraphy have shown that there is a wide development of Upper Triassic strata in southeastern Alaska, part of the supposed Carboniferous limestones having proved to be of Triassic age; that marine Upper Cretaceous rocks are well developed in the Chitina Valley, where no marine strata younger than the Jurassic had previously been recognized, and that the Upper Cretaceous plant-bearing beds extend up the Yukon Valley nearly to the Canadian boundary.

Mr. Maddren discovered some fossiliferous Upper Carboniferous limestones and tuffs on Kuskokwim River, many miles from any previously known Carboniferous rocks.

Mr. Capps has found a Devonian fauna in the older volcanic rocks of the Chisana district, apparently in the same general belt as the

Devonian locality discovered by Messrs. Moffit and Pogue at Broad Pass in 1913, though many miles distant. These two are the only known occurrence of Devonian rocks south of the Alaska Range, except in southeastern Alaska.

Mr. Capps discovered evidence of an older epoch of glaciation in the upper White River basin. Here there is an indurated tillite which has been more or less folded and antedates the glaciation that produced the present land forms. In the Lake Clark-Kuskokwim basin Mr. Smith found that the westward limit of glaciation was nearer the Kuskokwim than had been previously supposed. Mr. Maddren found evidence of a locally glaciated area in the mountains southeast of lower Kuskokwim River.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

This division is in charge of George F. Becker, geologist, who has immediate direction of geophysical researches. The staff in the chemical laboratory forms essentially a section in charge of F. W. Clarke, chief chemist.

The work of the chemists has consisted for the most part of routine analyses of specimens submitted to the division for determination. During the year 423 quantitative analyses and 869 qualitative determinations have been made. Nevertheless, it has been possible to carry on some researches connected with the geologic problems on which the Survey is engaged.

Continuing the investigation of the composition of the hard parts of various invertebrates living in the cold and in the warm waters of the seas, in order to ascertain the conditions under which magnesium carbonate is deposited in large amounts instead of calcium carbonate, analyses of the fossil remains of a number of brachiopods, corals, alcyonarians, and other marine animals were made by W. C. Wheeler under Mr. Clarke's direction. A paper by Mr. Clarke and Mr. Wheeler on the composition of the brachiopod shells was published in the Proceedings of the Washington Academy of Sciences. Another contribution giving the results of the analyses of the fan corals is now in preparation.

In addition to his administrative work in the laboratory, Mr. Clarke has revised and brought up to date the material for the third edition of "The data of geochemistry" (Bulletin 616). The second edition, published as Bulletin 491, was printed in 1911.

Some research work on the methods of separating vanadium from large quantities of chromium has been pursued by George Steiger, whose time, however, has been mostly taken up by routine analyses, the purchase of supplies, and other administrative duties.

In making analyses of rocks submitted by Survey geologists, R. C. Wells found that water from a mine near Idaho Springs, Colo.,

resembling ink in appearance, owed its color to the presence of nearly 8 grams of molybdenum oxide per liter; also that a rich gold ore from Goodsprings, Nev., was essentially a plumbojarosite, containing 0.22 per cent palladium and 0.05 per cent platinum. In separating salts from the water of Great Salt Lake, Mr. Wells found that in the interval between 0° and −1° C. the salt that separates is the mineral mirabilite, $Na_2SO_4.10H_2O$. A manuscript entitled "The fractional precipitation of some ore-forming compounds at moderate temperatures" was completed by Mr. Wells for publication as Bulletin 609.

As the result of his continued chemical studies of silver enrichment, Chase Palmer, who has been associated with Edson S. Bastin, of the division of geology, in the field investigations, published two papers—"Bornite as silver precipitant," in the Journal of the Washington Academy of Sciences, and "Tetranickel-triarsenide, its capacity as silver precipitant," in Economic Geology and in Zeitschrift für Krystallographie und Mineralogie. The research in silver enrichment, begun by the section of metalliferous deposits of the division of geology, is still in progress.

A report on the mineralogy of artesian well waters beneath Charleston, S. C., published in Professional Paper 90–H, contains a simplified statement by Mr. Palmer of the principles of the geochemical interpretation of water analyses. A part of Mr. Palmer's time has been given to routine quantitative and qualitative analyses of minerals and quantitative analyses of waters.

An extensive study of the vanadium minerals was made by W. T. Schaller. Analyses were made of several vanadium minerals from Utah and two new species from Peru, and of a new copper silicate from Arizona. Mr. Schaller also determined the optical properties of all the available gahnites. He made a field study of the granitic pegmatite intrusions near Pala, San Diego County, Cal., and of a reported occurrence of tin ore in the same county.

A number of analyses of phosphate rock and other miscellaneous analyses were made by W. C. Wheeler, whose work in association with Mr. Clarke has already been mentioned.

Special attention has been given by W. B. Hicks to the analyses of salts. Complete analyses were made of 13 brines, 3 salt samples, and 1 specimen of alunite, partial analyses of 80 samples, and qualitative examinations of about 85 samples. Mr. Hicks also carried on some experimental work on the solubility of minerals in solutions of ammonium chloride and on the evaporation of brines from Searles Lake, Cal. A paper on "Evaporation of potash brines" (Professional Paper 95–E) was submitted by him for publication by the Survey, and another on "Solubility of mixtures of sodium chloride and potas-

sium chloride in solutions of hydrochloric acid" was published in the Journal of the American Chemical Society.

A great many miscellaneous analyses, including about 30 complete analyses of rocks, brines, salts, and waters, and 78 partial analyses of brines, muds, nitrates, and waters, were made by R. K. Bailey, who also gave one hour each day to assisting geologists in testing and identifying minerals. Some improvements in the apparatus and methods used in the laboratory for analytical work were devised by Mr. Bailey.

The work of the physical laboratory has consisted chiefly of the continuation of geophysical investigations noted in previous reports. In addition to his administrative work G. F. Becker carried on studies of isostasy, in connection with which he published in the Journal of the Washington Academy of Sciences a paper on the "Mean density of fractured rocks." The experimental data for this paper were determined by A. F. Melcher, and are described by him in a "Note on the change of density of sulphur with rupture," issued in the same publication. Mr. Melcher shows that some of the principal orogenic phenomena are due to decrease in the density of rocks under confinement through the production of cracks and to increase of density through infiltration. "Isostasy and radioactivity" was the subject of a presidential address by Mr. Becker before the Geological Society of America. In this address he drew the conclusions that not more than about a quarter of the heat emitted by the earth can be due to radioactivity and that the ages of minerals as determined by radiologists are untrustworthy. In this address and in a paper in the Proceedings of the National Academy of Sciences he concludes that the outer shell of the earth beneath continental areas is in fact an imperfect heat engine, which furnishes the energy manifested in upheaval, subsidence, and orogeny.

In consultation and cooperation with Prof. P. W. Bridgman, of Harvard University, Mr. Becker furnished hollow cylinders of rock-forming minerals for use in pressure tests. These Prof. Bridgman subjects to hydrostatic pressure of many thousand kilograms per square centimeter with highly interesting but at as yet incomplete results. Acknowledgments are due the Bureau of Standards for courteous cooperation in the preparation of these cylinders.

The conduction of heat out of an unevenly heated globe was investigated by Mr. Becker in the hope of elucidating conditions in high latitudes.

Work on the construction of mathematical tables, experiments on the diffusion of solids, and measurements of the temperatures of deep wells were continued by C. E. Van Orstrand, assisted by A. F. Melcher and A. T. Harris. Progress has been made in preparing a volume of tables of the probability integral and related functions

adapted to the computation of diffusivities. An elaborate table of extended values of the exponential function and of the circular sine and cosine to radian argument is ready for publication.

In his experiments on the diffusion of solids Mr. Van Orstrand had the analytical cooperation of F. P. Dewey, of the Bureau of the Mint, United States Treasury. Some of the results of these experiments are to be published as Professional Paper 95–G, entitled "Preliminary report on the diffusion of solids." The experimental results confirm Roberts-Austen's values of the coefficients of diffusion of gold into solid lead at normal pressures and various temperatures. Preliminary experiments indicate an increase in the coefficient of diffusion with pressure. The results obtained at normal pressure from rolled plates and electroplates are remarkably consistent.

Measurements of the temperatures of two deep wells, one near Gaines, Pa., depth 5,500 feet, the other near McDonald, Pa., depth 7,000 feet, were made during the year by Mr. Van Orstrand. Determinations of the temperature of a well near Mannington, W. Va., about 3,000 feet deep, were made recently with an electrical resistance thermometer equipment specially designed by him for use in deep wells.

A paper on the "Calculation and comparison of mineral analyses," by Mr. Van Orstrand and F. E. Wright, of the Carnegie Institution, was published in the Journal of the Washington Academy of Sciences.

DIVISION OF MINERAL RESOURCES.

The scope of the work of the division of mineral resources has been the same as in recent years, the Survey having continued the policy of making the annual "Mineral Resources of the United States" more than a statistical compilation by recording and interpreting industrial progress and by treating in full the sources from which the mineral products of the country are obtained. This report thus becomes in fact, as well as in name, an annual inventory of the Nation's mineral resources.

During the last 12 years the separate chapters have been prepared in large part by geologists of the Survey who have specialized in the subjects treated, with a view to carrying out the provision of the organic act of the Survey which directs the examination of the mineral resources and products of the national domain.

Cooperation between the Geological Survey and the State surveys in collecting most of the mineral statistics continued in force in the preparation of the report for 1914. The 16 States which cooperated were Alabama, Florida, Illinois, Iowa, Maryland, Minnesota, Michigan, Missouri, New Jersey, New Mexico, North Carolina, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. The method employed obviates the duplication of a considerable amount of work

and, so far as applied, saves the producers the annoyance of preparing two sets of statistical returns.

During the fiscal year the report for 1913 was published in two parts—Part I (metals) in January and Part II (nonmetals) in February. Work on the report for 1914 was well advanced at the close of the year, 20 chapters having been completed and transmitted to the printer.

After the outbreak of the European war interest rapidly increased in the foreign supplies of mineral products needed in this country and also in domestic resources to supplant products hitherto imported and to fill war demands. A number of statements covering these subjects were immediately prepared for the press, and the division has carried on a large correspondence, furnishing to inquirers detailed information in regard to our mineral resources which could not be covered in general publications, such as locations of deposits of minerals wanted and names and addresses of producers.

Preliminary estimates of the production of arsenic, cement, coal, copper, gold and silver, iron ores, lead, petroleum, quicksilver, radium ores, rutile, tungsten ores, uranium ores, vanadium ores, western metals, and zinc in 1914, with reviews of the conditions that prevailed during the year, were given to the press in the form of special press bulletins during the later part of December, 1914, and in January, 1915. Advance statements giving the final figures covering the production of copper, lead, and zinc in 1914 have also been published.

The number of permanent employees in Washington who devote their entire time to the work of the division of mineral resources is 31, and 8 persons are employed in the offices of the division at Salt Lake City, Denver, and San Francisco. In addition to these employees, 21 members of other divisions of the Survey, chiefly geologists, devote a part of their time to the work of the division, making a total of 60 persons employed in the work.

During the year 192,673 pieces of first-class mail matter (chiefly inquiries for information needed for the reports, but including also, in increasing quantity, replies to inquiries made to the Survey for information) were sent out by the division, an increase of 2 per cent over 1914, and 65,401 pieces were received.

E. W. Parker continued as administrative head of the division and chief of the section of nonmetallic resources. On May 1 he tendered his resignation, to take a responsible position with the anthracite-coal interests. Mr. Parker's departure is a real loss to the United States Geological Survey. As the coal statistician of the Government since 1890, and as chief of the division since 1907, his contribution to the present standard of "Mineral Resources" has been large and important. He has also done valuable work in his studies of coal testing and conservation and has published in the engineering press

many papers on coal mining and production. It is fortunate that in his new field Mr. Parker will continue his work on these subjects, on which he has long been regarded an authority.

Mr. Parker's resignation became effective July 1, and H. D. McCaskey, geologist in charge of the metals section of the division, became geologist in charge of the division. Mr. McCaskey brings to his new position experience not only as a geologist of the Survey since 1907 and as section chief since 1912, but also as a mining engineer in the Philippine mining bureau from 1900 to 1903 and as chief of that bureau from 1903 to 1906.

C. E. Lesher, a geologist of the Survey, who has had extensive field and office experience and for two years and a half was vice chairman of the coal board of the land-classification board, succeeds Mr. Parker in the work on coal and coke.

On August 31 David T. Day, who for 21 years was chief of the division and for seven years was in charge of the preparation of reports on asphalt and bituminous rock, natural gas, petroleum, and platinum and allied metals, resigned. Dr. Day had taken large part in the constructive administration of the division, and his separation from the service removes another man of broad experience. John D. Northrop, a geologist of the Survey who has become familiar with the general trend of the petroleum industry by many years in geologic work in the oil fields of the United States, has taken up the work on asphalt and bituminous rock, petroleum, and natural gas.

During the year Mr. Parker prepared for publication by the Survey the report on the fuel-briquetting industry and a general review of the mineral products of the United States. The reports on the several mineral products were in charge of the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
E. S. Bastin	Graphite.
E. F. Burchard	Cement, fluorspar and cryolite, iron ore, pig iron, and steel.
B. S. Butler	Copper (general report), copper and silver in Michigan (mines report).
A. T. Coons	Slate.
C. A. Davis (of the Bureau of Mines).	Peat.
J. S. Diller	Asbestos, chromite, talc, and soapstone.
R. B. Dole	Mineral waters.
J. P. Dunlop	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals, metals and ores (summary report), gold, silver, copper, lead, and zinc in the Eastern States (mines report), quicksilver.
H. S. Gale	Borax, magnesite (with C. G. Yale), nitrates.
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
V. C. Heikes	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines report).
C. W. Henderson	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines report).
F. L. Hess	Antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin.
D. F. Hewett	Manganese and manganiferous ores.
J. M. Hill	Barytes, mineral paints, platinum and allied metals, strontium ore.
F. J. Katz	Abrasives, feldspar, silica (quartz).
C. E. Lesher	Coal, and the manufacture of coke.

Authors of chapters in Mineral Resources—Continued.

Author.	Subject.
H. D. McCaskey	Gold and silver (general report), summary of mineral products, quicksilver.
Jefferson Middleton	Clay, clay-working industries, fuller's earth, sand-lime brick.
J. D. Northrop	Asphalt and bituminous rock, natural gas, petroleum.
W. C. Phalen	Bauxite and aluminum, phosphate rock, potash salts, salt and bromine, sodium salts, sulphur and pyrite.
C. E. Siebenthal	Lead, zinc, and cadmium (general reports).
D. B. Sterrett	Gems and precious stones, mica.
G. F. Loughlin	Building stone, glass sand, other sand and gravel, gypsum, lime.
C. G. Yale	Borax, magnesite (with H. S. Gale), gold, silver, copper, lead, and zinc in California and Oregon (mines report).

Mr. McCaskey also has general supervision of the offices of the division in the Western States. These offices act as Survey bureaus of information and are under the direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, who also prepare the mines reports on gold, silver, copper, lead, and zinc in the Western States.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch is as follows:

Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer in charge.
Central division, W. H. Herron, geographer in charge.
Rocky Mountain division, Sledge Tatum, geographer in charge.
Northwestern division, T. G. Gerdine, geographer in charge.
Pacific division, G. R. Davis, geographer in charge.
Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

PERSONNEL.

The technical corps of the topographic branch was reduced 7 during the year by death and by resignations. With these changes the corps now includes 1 chief geographer, 9 geographers, 40 topographic engineers, 18 topographers, 41 assistant topographers, 42 junior topographers, and 8 draftsmen—a total of 159. In addition, 37 technical field assistants were employed during a whole or part of the field season. One topographic engineer, 1 topographer, 3 assistant topographers, 6 junior topographers, and 1 draftsman are on furlough. The clerical force comprises 1 senior clerk and 11 clerks of lower grades.

PUBLICATIONS.

The published work of the topographic branch for the year consists of 107 maps, which are listed on pages 36–37, and 11 book publications, namely, "Topographic instructions of the United States Geological Survey," edition of 1915, and bulletins giving results of spirit leveling

in Hawaii, Idaho, Iowa, Maryland, Michigan, Minnesota, Nebraska, Utah, Virginia, and Wisconsin. Brief summaries of these bulletins are given on page 21. Manuscripts for results of triangulation and primary traverse in the United States, 1913–1915, and of leveling in Arkansas, Georgia, Louisiana, Maine, Mississippi, New Mexico, South Dakota, Texas, and West Virginia were transmitted for publication.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1915 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
	434,200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

Allotments from funds appropriated for topographic work, fiscal year 1915.

	Topographic surveys.	Surveying national forests.
Administrative expenses of Survey	$22,896	$4,500
Clerical assistance and supervision	15,670	3,210
Map editing	6,225	1,275
Purchase and repair of instruments, stationery, etc.	12,242	2,508
Millionth-scale map	20,000	.....
Field work:		
Atlantic division	66,000	.....
Central division	53,000	.....
Rocky Mountain division	63,922	19,745
Northwestern division	36,000	26,462
Pacific division	54,045	15,000
Work by land-classification board	9,000	2,500
	359,000	75,200

COOPERATION.

Cooperation has been maintained with several States, as indicated below.

Allotments made by States for cooperative work.

Alabama	$3,032.78
California (Department of Engineering)	14,000.00
Illinois	9,000.00
Iowa	1,950.00
Kentucky	10,000.00
Maine	4,000.00
Michigan	2,500.00
Minnesota	4,500.00
Missouri	5,221.74
New York	10,000.00

Ohio	$35,000.00
Oklahoma	1,000.00
Oregon	18,000.00
Pennsylvania	4,000.00
Texas	35,000.00
Vermont	2,000.00
Virginia	4,500.00
Washington	11,500.00
West Virginia	6,758.20
Wisconsin	4,000.00
Hawaii	837.35
	186,800.07

In addition to the amounts given above, the State of Virginia allotted $485 to cover one-half the cost of the compilation of the Virginia portion of the 1:1,000,000 scale map of the United States, and the city of Los Angeles, Cal., allotted $2,500 for one-half the cost of the topographic survey of the Elizabeth Lake quadrangle.

GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary, the new 1:500,000 State maps were used when available, and results of computations for vertical and horizontal control work were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, C. E. Cooke, J. R. Ellis, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, A. C. Roberts, J. H. Wilson, Fred McLaughlin, J. F. McBeth, and J. I. Gayetty under the immediate supervision of E. M. Douglas, geographer. Computing by L. F. Biggs and C. F. Urquhart was done in the Sacramento office. S. S. Gannett, geographer, was engaged in preparing manuscript and compiling data for the bulletins submitted for publication, in miscellaneous computations, and in furnishing triangulation and leveling data for field and office use.

J. H. Renshawe was engaged during a portion of the time in preparing for the Secretary of the Interior colored relief maps of Mount Rainier, Mesa Verde, and Rocky Mountain national parks. He also prepared a colored relief map of San Francisco and vicinity, a relief map of Alaska for the division of Alaskan mineral resources, and a small model to show the Survey's work for use in preparing a large model for the exhibition at San Francisco.

In the preparation of the special topographic maps used in the four transcontinental guidebooks the available Survey atlas sheets were used, and where such sheets were not available the data were filled in on field sheets on a scale of 5 miles to the inch. The different railroads assisted in every way possible, supplying all available profile and alignment data and rendering other valuable assistance. The

maps were published on a scale of 1:500,000, or about 8 miles to the inch, and cover routes as follows:

The Northern Pacific Route, over the Northern Pacific Railway from St. Paul, Minn., to Seattle, Wash., with a branch from Livingston to Gardiner, Mont., at the north entrance to Yellowstone National Park (Bulletin 611).

The Overland Route, over the Union Pacific and Southern Pacific railroads from Omaha, Nebr., to San Francisco, with a branch from Ogden, Utah, over the Oregon Short Line, to the west entrance to Yellowstone National Park (Bulletin 612).

The Santa Fe Route, over the Atchison, Topeka & Santa Fe Railway from Kansas City, Mo., to Los Angeles, Cal., with a branch from Williams, Ariz., to the Grand Canyon (Bulletin 613).

The Shasta Route, over the Northern Pacific and Southern Pacific railroads from Seattle, Wash., to San Francisco, and the Coast Line, over the Southern Pacific Railroad from Los Angeles to San Francisco (Bulletin 614).

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1915, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, the total new area mapped was 20,508 square miles, making the total area surveyed to date in the United States 1,218,290 square miles, or 40.2 per cent of the entire country. In addition, 3,048 square miles of resurvey was completed, making the total area of surveys during the year 23,556 square miles.

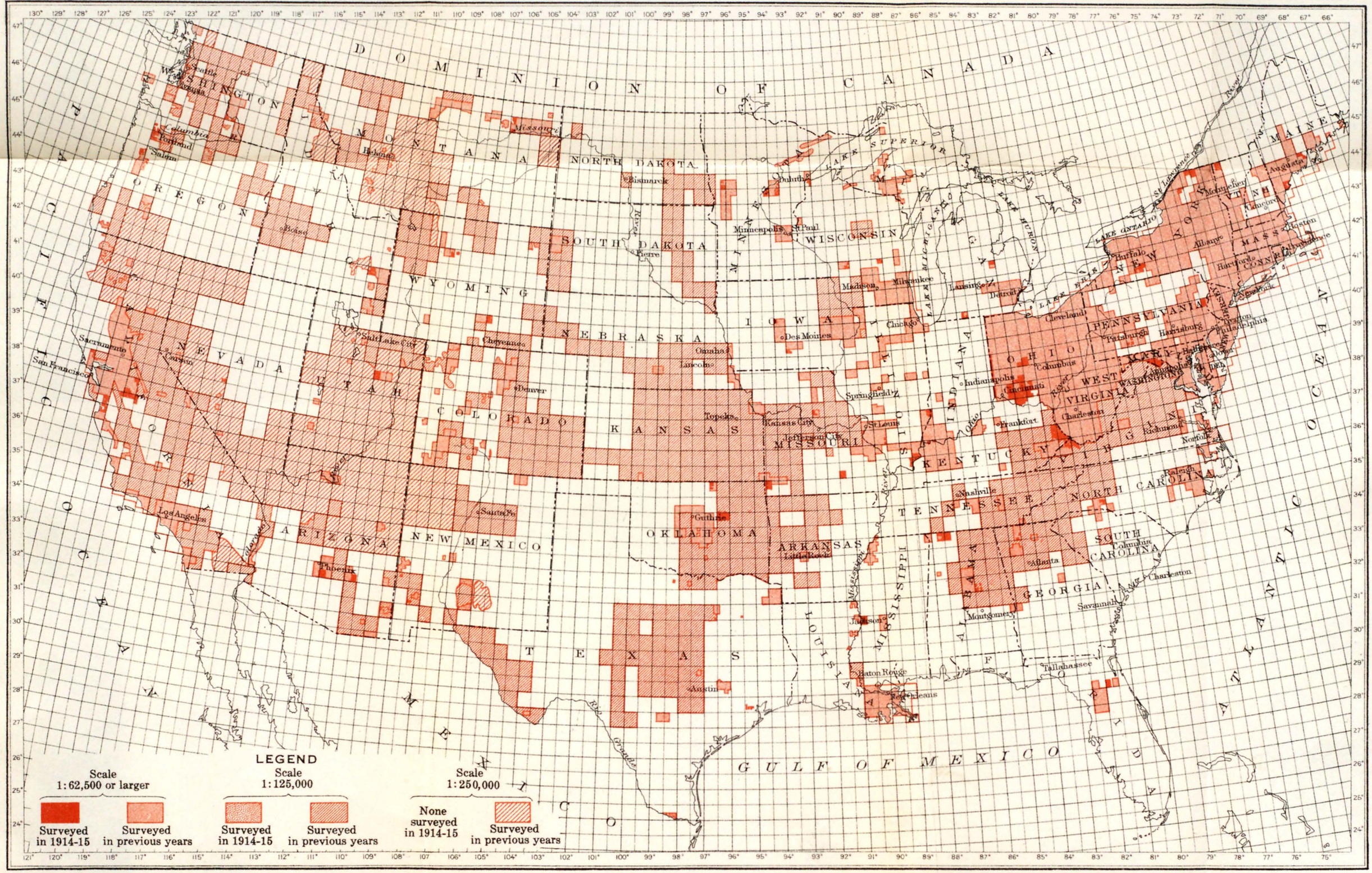
In connection with these surveys, 6,952 linear miles of primary and precise levels were run, making 254,359 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work, 1,747 permanent bench marks were established. In addition, 498 linear miles of river surveys were run.

Triangulation stations to the number of 252 were occupied and 158 were permanently marked. Primary traverse lines aggregating 2,105 miles were run, in connection with which 356 permanent marks were set. In the course of this work 32,400 square miles were covered by primary control.

The area covered by topographic surveys in Alaska during the fiscal year, as reported in detail on page 93, was 10,910 square miles.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 19 square miles, for publication on the scale of 1:31,680, making the total area surveyed to date in Hawaii 1,393 square miles.

The average cost per square mile of the work done was $22, the cost ranging from a little less than $4 in the Elizabeth Lake (Cal.) quadrangle to over $227 on the Sabine River project, Texas. Sixty per cent of the funds was expended in the public-land States.



MAP OF THE UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS PRIOR TO JULY 1, 1915

AND THE SCALE EMPLOYED FOR EACH AREA

Scale 1/14,000,000

100 0 100 200 300 400 500 Miles

SNYDER & BLACK, N.Y.

Present condition of topographic surveys of the United States and new areas surveyed July 1, 1914, to June 30, 1915.

	New area mapped July 1, 1914, to June 30, 1915.	Total area mapped to June 30, 1915.	Percentage of total area of State mapped to June 30, 1915.
	Sq. miles.	*Sq. miles.*	
Alabama	440	19,192	37
Arizona	932	68,996	61
Arkansas	.....	21,380	40
California	3,592	114,708	72
Colorado	1,439	48,783	47
Connecticut	.....	4,965	100
Delaware	.....	1,202	51
District of Columbia	.....	70	100
Florida	259	2,339	4
Georgia	.....	17,337	29
Idaho	687	26,185	31
Illinois	539	14,551	26
Indiana	191	3,441	9
Iowa	119	11,652	21
Kansas	.....	64,159	78
Kentucky	.....	17,973	44
Louisiana	8	8,319	17
Maine	151	9,361	28
Maryland	.....	12,327	100
Massachusetts	.....	8,266	100
Michigan	273	6,018	10
Minnesota	454	6,541	8
Mississippi	237	2,126	4
Missouri	544	36,710	53
Montana	557	57,163	39
Nebraska	.....	26,524	34
Nevada	53	51,115	46
New Hampshire	.....	3,380	36
New Jersey	.....	8,224	100
New Mexico	1,315	37,247	30
New York	613	43,553	89
North Carolina	82	18,390	35
North Dakota	.....	9,716	14
Ohio	2,818	40,018	97
Oklahoma	83	39,851	57
Oregon	1,771	23,406	24
Pennsylvania	262	24,908	55
Rhode Island	.....	1,248	100
South Carolina	.....	5,640	18
South Dakota	.....	18,594	24
Tennessee	.....	21,153	50
Texas	99	67,782	25
Utah	507	68,797	81
Vermont	224	4,190	44
Virginia	.....	29,980	70
Washington	1,432	26,033	38
West Virginia	.....	24,170	100
Wisconsin	270	12,203	21
Wyoming	557	28,404	29
	20,508	1,218,290	40.2
Hawaii	19	1,393	22

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Alabama, Florida, Georgia, Maine, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia, and in a small area in Arkansas. This work comprised the completion of the survey of 11 quadrangles and of the resurvey of 5 quadrangles, in addition to which 7 quadrangles were partly surveyed and 7 were partly resurveyed. The total new area

mapped was 2,276 square miles, for publication on the scale of 1 : 62,500. The area resurveyed was 1,083 square miles, for publication on the scale of 1 : 62,500. The map of one quadrangle was partly revised, the area covered by this revision being 13 square miles. In connection with this work 1,268 miles of primary levels were run and 332 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by seven parties, the work being distributed over portions of Louisiana, Maryland, New York, and West Virginia. The total area covered by this primary control was about 2,200 square miles—1,000 square miles by primary traverse, 336 miles being run and 36 permanent marks set. Twenty-four triangulation stations were occupied and 4 were permanently marked. This work made control available in 17 quadrangles.

Topographic surveys in Atlantic division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of 1 : 62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Alabama	20	440	99	539	144	36				
Arkansas					42	3				
Florida	20	259		259						
Georgia	50		38	38						
Louisiana	10	8		8	55	13	86	12		
Maine	20	151	163	314	15	3				
Maryland							34	2		
Mississippi	10	237		237	116	34				
New York	20	613		613	443	116	117	12	9	4
North Carolina	20	82		82						
Pennsylvania	20	262		262	114	44				
Tennessee					56	5				
Vermont	20	224		224	67	17				
Virginia	50		317	317	101	27				
West Virginia	20		466	466	115	34	99	10	15	
		2,276	1,083	3,359	1,268	332	336	36	24	4

Alabama.—As stated in the previous annual report, the State geologist of Alabama allotted $10,000 to cover the cost of unfinished cooperative work done in 1911–12, when under a cooperative agreement to spend $10,000 each $7,024.93 was expended by the Federal Survey and nothing by the State, whose funds were not available. During the year, after $3,032.78 had been expended, State cooperation ceased and the work was completed with Federal funds amounting to $5,932.15. The survey of the Muscle Shoals and Center Star quadrangles in Colbert, Lauderdale, and Lawrence counties, was completed, and that of the Gravelly Springs quadrangle, in Lauderdale County, was begun by C. E. Cooke, W. H. S. Morey, T. F. Slaughter, C. S. Wells, F. W. Crisp, and R. H. Kilmer, the area mapped being

440 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Center Star quadrangle Mr. Kilmer ran 66 miles of primary levels and established 17 permanent bench marks.

In addition to the cooperative work the resurvey of the Weogufka quadrangle in Coosa, Shelby, and Talladega counties was commenced by Duncan Hannegan, W. H. Griffin, W. H. S. Morey, J. B. Metcalfe, jr., C. S. Wells, and C. W. Arnold, the area mapped being 99 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area H. S. Senseney ran 78 miles of primary levels and established 19 permanent bench marks.

Arkansas.—(See Tennessee-Arkansas, p. 113.)

District of Columbia-Maryland-Virginia.—During the year the culture on the map of Washington and vicinity was revised in the field. In connection with this work C. B. Kendall and C. A. Ecklund ran 34 miles of primary traverse and set two permanent marks.

Florida.—The survey of the Interlachen quadrangle, in Marion and Putnam counties, was completed by W. H. Griffin, J. B. Metcalfe, jr., and C. W. Arnold, the area mapped being 259 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Georgia.—The resurvey of the Talking Rock quadrangle, in Gilmer, Gordon, Murray, and Pickens counties, was completed by E. I. Ireland, K. W. Trimble, and H. S. Senseney, the area mapped being 38 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet.

Louisiana.—For the control of the Blanchard quadrangle, in Bossier and Caddo parishes, C. S. Wells and F. W. Crisp ran 86 miles of primary traverse and set 12 permanent marks and also ran 55 miles of primary levels and established 13 permanent bench marks. (See also Mississippi-Louisiana, p. 112.)

Maine.—For the continuation of cooperative topographic surveys in Maine the State Water Storage Commission allotted $4,000, which was met by the United States Geological Survey with an equal amount. The survey of the Liberty quadrangle, in Kennebec, Knox, Lincoln, and Waldo counties, was completed, and that of the Belfast quadrangle, in Knox and Waldo counties, was begun by W. H. Griffin, Duncan Hannegan, K. E. Schlachter, C. H. Davey, and E. W. Bowler, the total area mapped being 151 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Belfast quadrangle Mr. Schlachter ran 15 miles of primary levels and established 3 permanent marks.

In addition to the cooperative work in Maine, the resurvey of the Portland and Casco Bay quadrangles, in Cumberland and York

counties, was completed by Hersey Munroe, R. A. Kiger, and K. F. Maxcy, the area mapped being 163 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Mississippi-Louisiana.—The survey of the Vicksburg quadrangle, in Issaquena and Warren counties, Miss., and Madison Parish, La., was continued by C. E. Cooke, W. H. S. Morey, C. S. Wells, and F. W. Crisp, the area mapped being 245 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. Of this area 8 square miles is in Louisiana. For the control of this area and of the Natchez quadrangle, in Adams and Jefferson counties, Miss., and Concordia Parish, La., H. S. Senseney and R. H. Kilmer ran 116 miles of primary levels and established 34 permanent bench marks.

New York.—The State engineer and surveyor of New York allotted $10,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Canaseraga and Malone quadrangles, in Allegany, Franklin, and Livingston counties, was completed, and that of the Edwards, Hornell, and Moira quadrangles, in Allegany, Franklin, Livingston, Steuben, and St. Lawrence counties, was begun by G. S. Smith, Hersey Munroe, Robert Muldrow, R. C. McKinney, J. M. Whitman, A. P. Meade, jr., T. F. Slaughter, H. L. Dodge, and C. H. Davey, the area mapped being 613 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In connection with the mapping of these areas and of the Andes, Oswegatchie, Long Eddy, Walton, Sidney, and Oneonta quadrangles, in Delaware, Chenango, Herkimer, Lewis, Otsego, and St. Lawrence counties, A. P. Meade, jr., K. E. Schlachter, H. S. Senseney, A. J. Kavanagh, and F. L. Shalibo ran 422 miles of primary levels and established 114 permanent bench marks. For the control of the Malone, Edwards, and Moira quadrangles G. T. Hawkins ran 117 miles of primary traverse and set 12 permanent marks, and for the control of the Oneonta and Sidney quadrangles, in Chenango, Delaware, and Otsego counties, Mr. Hawkins occupied 6 triangulation stations and marked 4.

In addition to the cooperative work, Mr. Hawkins and F. J. McMaugh occupied 3 triangulation stations in the John Boyd Thatcher Park, in Albany County, and ran 21 miles of primary levels and established 2 permanent bench marks in the Altamont Park, Albany County.

North Carolina.—The survey of the Gastonia quadrangle, in Gaston, Lincoln, and Mecklenberg counties, was completed by G. S. Smith, J. M. Whitman, J. H. Le Feaver, and Roscoe Reeves, the area mapped being 82 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Pennsylvania.—The Topographic and Geologic Survey Commission of Pennsylvania allotted $4,000 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted an equal amount. The survey of the Windber and Windgap quadrangles, in Bedford, Cambria, Carbon, Monroe, Northampton, and Somerset counties, was completed by Robert Muldrow, Oscar Jones, R. A. Kiger, J. B. Metcalfe, jr., E. D. Monroe, and C. E. Mills, the area mapped being 262 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Windgap quadrangle and of the Stahlstown quadrangle, in Fayette, Somerset, and Westmoreland counties, C. E. Mills ran 114 miles of primary levels and established 44 permanent bench marks.

In addition to the cooperative work the revision of part of the map of the Houtzdale quadrangle, in Clearfield and Center counties, was commenced by J. I. Gayetty, the area covered being 13 square miles.

Tennessee-Arkansas.—For the control of the Memphis quadrangle, in Shelby County, Tenn., and Crittenden County, Ark., F. W. Crisp and Kostka Mudd ran 98 miles of primary traverse and set 8 permanent marks, of which 42 miles and 3 marks were in Arkansas.

Vermont.—For the continuation of cooperative topographic surveys in the State of Vermont the governor allotted $2,000 and the United States Geological Survey allotted an equal amount. The survey of the St. Albans quadrangle, in Franklin and Grand Isle counties, was completed by Duncan Hannegan and J. F. McBeth, the area mapped being 224 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In connection with this work K. E. Schlachter ran 67 miles of primary levels and established 17 permanent bench marks. The cooperative funds being insufficient to cover the completion of the St. Albans sheet, the additional expenses were borne by the Federal Survey.

Virginia.—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted $4,500 and the United States Geological Survey allotted an equal amount. The resurvey of the Bucu quadrangle and of the Virginia portions of the Hurley and Iaeger quadrangles, in Buchanan, Dickinson, and Russell counties, was completed, and that of the Richlands quadrangle, in Buchanan, Russell, and Tazewell counties, was begun by J. I. Gayetty, C. W. Arnold, F. W. Farnsworth, and Kostka Mudd, the area mapped being 316 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of these areas Mr. Mudd ran 101 miles of primary levels and established 27 permanent bench marks. (See also West Virginia, below.)

West Virginia.—In the continuation of cooperative topographic surveys in West Virginia the State geologist expended $6,758.20 and

the United States Geological Survey $1,507.49. A resurvey of the West Virginia portions of the Martinsburg, Berryville, and Gerrardstown quadrangles and of the Morgan County portion of the Capon Bridge quadrangle was completed by E. I. Ireland, Hersey Munroe, T. F. Slaughter, K. W. Trimble, and C. W. Arnold, the area mapped being 467 square miles, for publication of the scale of 1 : 62,500, with a contour interval of 20 feet. Of this area 1 square mile is in Virginia. This work completed the mapping of Berkeley, Jefferson, and Morgan counties on the scale of 1 : 62,500. In connection with this work G. T. Hawkins and J. B. Metcalfe, jr., ran 99 miles of primary traverse and set 10 permanent marks, and K. W. Trimble and H. S. Senseney ran 115 miles of primary levels and established 34 permanent bench marks.

For the control of portions of the Webster Springs, Cowen, Richwood, Winona, and Summersville quadrangles Oscar Jones occupied 15 triangulation stations. This work was done to control those portions of Nicholas and Webster counties not yet mapped on the scale of 1 : 62,500.

OFFICE WORK.

The drafting of the following sheets was completed: Muscle Shoals and Center Star, Ala.; Talking Rock, Ga.; Casco Bay, Liberty, and Portland, Maine; Canaseraga, N. Y.; Belhaven, Gastonia, and Kinston, N. C.; Windber and Windgap, Pa.; Murfreesboro, Tenn.; St. Albans, Vt.; Bucu, Va.; Iaeger, Va.-W. Va.; Winona, W. Va.

Progress in the drafting of additional sheets was made as follows: Hornell, N. Y., 20 per cent; Malone, N. Y., 50 per cent; Hurley, Va.-Ky., 67 per cent; Berryville, W. Va.-Va., 26 per cent; Capon Bridge, W. Va.-Va., 15 per cent; Gerrardstown, W. Va.-Va., 72 per cent; Martinsburg, W. Va.-Va.-Md., 91 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Center Star (Ala.), Talking Rock (Ga.), Blanchard (La.), Belfast, Liberty, and Portland (Me.), Vicksburg (Miss.), Canaseraga, Edwards, Hornell, and Oswegatchie (N. Y.), Belhaven, Bunyon, and Chocowinity (N. C.), Stahlstown, and Windgap (Pa.), Murfreesboro (Tenn.), Franklin Pond and St. Albans (Vt.), Bucu, Hurley, Iaeger, and Richlands (Va.) quadrangles.

Geographic positions were computed for the Weogufka (Ala.), Blanchard and Bossier (La.), Washington (D. C.-Md.), Natchez and Vicksburg (Miss.), Berne, Edwards, Malone, Moira, Oneonta, Oswegatchie, Sidney, and Stark (N. Y.), Belhaven, Bunyon, and Plymouth (N. C.), Berryville, Gerrardstown, and Martinsburg (W. Va.) quadrangles.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The work comprised the completion of the survey of 25 quadrangles and of the resurvey of 7 quadrangles, in addition to which 19 quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 5,208 square miles, for publication on the scale of 1 : 62,500; and the area resurveyed was 935 square miles, for publication on the scale of 1 : 62,500. In connection with this work 1,971 miles of primary levels were run and 454 permanent bench marks were established.

Primary traverse was carried on at different times by six parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Michigan, Minnesota, and Wisconsin. The total area covered by the primary control was about 4,000 square miles, of which 3,600 square miles was controlled by primary traverse, 958 linear miles of primary traverse being run and 84 permanent marks set. Five triangulation stations were occupied and 4 marked. The result of this work was to make control available in 50 quadrangles.

Topographic surveys in central division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of 1 : 62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Illinois	20	539	.....	539	461	135	373	31	.....	.....
Indiana	20	191	.....	191	61	13	.....	.....	.....	.....
Iowa	20	119	.....	119	.....	.....	82	13	.....	.....
Kentucky	50	.....	913	913	168	47	89	6	5	4
Michigan	5, 20	273	.....	273	.....	.....	151	14	.....	.....
Minnesota	10	454	.....	454	11	2	12	1	.....	.....
Missouri	20	544	22	566	300	86	.....	.....	.....	.....
Ohio	10, 20	2,818	.....	2,818	796	129	.....	.....	.....	.....
Wisconsin	20	270	.....	270	174	42	251	19	.....	.....
		5,208	935	6,143	1,971	454	958	84	5	4

Illinois.—The governor of Illinois allotted $9,000 for the continuation of cooperative topographic surveys in Illinois and the United States Geological Survey allotted an equal amount. The survey of the Coulterville and Equality quadrangles and of the Illinois portions of the Shawneetown, Birds, Fords Ferry, and Golconda quadrangles in Perry, Randolph, St. Clair, Washington, Gallatin, Hardin, Pope, Saline, Crawford, and Lawrence counties was completed, and that of the Brownfield quadrangle, in Johnson, Massac, and Pope counties,

was begun by C. W. Goodlove, Fred Graff, jr., Gilbert Young, J. A. Duck, R. G. Clinite, R. M. Herrington, and W. S. Gehres, the total area mapped being 539 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Brownfield, Morris, Birds, Good Hope, Paducah, Woodhull, Quincy, Orion, Alexis, Augusta, Monmouth, Meredosia, La Harpe, Mount Sterling, Camp Point, Griggsville, Pittsfield, and Barry quadrangles, in Johnson, Massac, Pope, Grundy, Kendall, Crawford, Lawrence, McDonough, Warren, Henry, Knox, Mercer, Adams, Pike, Rock Island, Brown, Schuyler, Hancock, Cass, Fulton, Henderson, Morgan, Scott, and Greene counties, S. R. Archer, E. C. Bibbee, G. W. Lucas, and R. G. Clinite ran 461 miles of primary levels and established 135 permanent bench marks. For the control of the Augusta, Beardstown, Good Hope, Lomax, Oquaka, Monmouth, Meredosia, La Harpe, Rushville, Kirkland, Wilmington, Sycamore, Shabbona, Quincy, Mount Sterling, Morris, Liberty, Earlville, Dwight, Camp Point, and Yorkville quadrangles, in Adams, Brown, Schuyler, Hancock, Cass, Fulton, McDonough, Warren, Henderson, Pike, Scott, Morgan, Ogle, Dekalb, Boone, Winnebago, Will, Kankakee, Kane, Lee, Grundy, Kendall, La Salle, and Livingston counties, E. L. McNair ran 373 miles of primary traverse and set 31 permanent marks.

Indiana.—The mapping of the Indiana portions of the Uniontown and Henderson quadrangles, in Posey and Vanderburg counties, was completed by C. W. Goodlove, W. S. Gehres, and R. M. Herrington, the area mapped being 148 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas S. R. Archer and Marvin Lee ran 61 miles of primary levels and established 13 permanent bench marks. The survey of the Indiana portion of the Birds quadrangle, in Knox and Sullivan counties, was completed by Fred Graff, jr., the area mapped being 30 square miles, for publication on the same scale as the Illinois portion. The mapping of the Indiana portion of the Three Rivers quadrangle was completed by L. L. Lee and H. E. Burney, the area mapped being 13 square miles, for publication on the same scale as the Michigan portion.

Iowa.—The State geologist allotted $1,750 for the continuation of cooperative topographic surveys in Iowa and the Federal Survey allotted an equal amount. The survey of the Boone quadrangle, in Boone, Hamilton, and Webster counties, was completed, and that of the Chariton quadrangle, in Lucas, Marion, and Warren counties, was begun by W. L. Miller, the area mapped being 119 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Chariton quadrangle, and also of the Melrose, Attica, Humeston, New Virginia, and Albia quadrangles,

in Lucas, Marion, Warren, Appanoose, Wayne, Clarke, Monroe, and Mahaska counties, E. L. McNair ran 82 miles of primary traverse and set 13 permanent marks.

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys in Kentucky and the United States Geological Survey allotted an equal amount. The resurvey of the Laynesville and Inez quadrangles, in Floyd, Johnson, Lawrence, Martin, and Pike counties, and of the Kentucky portion of the Naugatuck, Hurley, Matewan, and Williamson quadrangles, in Lawrence, Pike, and Martin counties, was completed, and that of the Kentucky portion of the Regina quadrangle, in Pike County, was begun by J. R. Eakin, E. I. Ireland, C. P. McKinley, J. M. Rawls, Howard Clark, S. A. Judson, W. A. Reiter, F. W. Farnsworth, G. W. Lucas, W. S. Gehres, Klett McKinley, and Sylvan Price, the area mapped being 913 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of the Laynesville, Hurley, Matewan, Naugatuck, Regina, and Williamson quadrangles S. R. Archer and Mr. Lucas ran 168 miles of primary levels and established 47 permanent bench marks. For the control of the Kuttawa quadrangle and of the Kentucky portions of the Fords Ferry, Golconda, and Smithland quadrangles, in Crittenden, Livingston, Marshall, Cracken, and Trigg counties, J. H. Wilson ran 89 miles of primary traverse and set 6 permanent marks, and for the control of the Paintsville and Goodloe quadrangles, in Breathitt, Magoffin, Johnson, Morgan, Lawrence, and Floyd counties, C. L. Nelson occupied 5 triangulation stations and marked 4.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted $2,500 and the United States Geological Survey allotted an equal amount. The survey of the St. Charles quadrangle and of the Michigan portion of the Three Rivers quadrangle, in Midland, Saginaw, and St. Joseph counties, was completed by C. L. Sadler, L. L. Lee, and H. E. Burney, the area mapped being 273 square miles, for publication on the scale of 1 : 62,500, with contour intervals of 5 and 20 feet. For the control of the Perrington, Elsie, Chesaning, and Saginaw quadrangles, in Bay, Clinton, Gratiot, Saginaw, and Shiawassee counties, J. H. Wilson ran 151 miles of primary traverse and set 14 permanent marks.

Minnesota.—The State drainage engineer of Minnesota allotted $4,500 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Aitkin, Pelican Rapids, and Wealthwood quadrangles, in Aitkin, Becker, Clay, and Ottertail counties, was

completed, and that of the Brainerd quadrangle, in Crow Wing County, was begun by F. B. Barrett, J. H. Wilson, E. L. Hain, and L. B. Roberts, the area mapped being 454 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. (See also Wisconsin, p. 119.)

Missouri.—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted $5,221.74 and the United States Geological Survey allotted an equal amount. The survey of the Neosho and Eminence quadrangles, in McDonald, Newton, and Shannon counties, was completed by C. G. Anderson, R. L. Harrison, F. W. Hughes, J. M. Rawls, G. W. Lucas, R. H. Randall, W. F. Hicks, and R. M. Herrington, the area mapped being 477 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Bandyville, Low Wossie, Upalika, Puxico, Grandin, Greenbrier, Hendrickson, Advance, Cape Girardeau, and Morley quadrangles, in Oregon, Shannon, Carter, Ripley, Butler, Wayne, Stoddard, Bollinger, Cape Girardeau, and Scott counties, G. W. Lucas and E. C. Bibbee ran 300 miles of primary levels and established 86 permanent bench marks. The resurvey of the Sturgeon quadrangle, in Audrain, Boone, Howard, and Randolph counties, was completed by C. G. Anderson and W. L. Miller, the area mapped being 22 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

In addition to the cooperative work, the mapping of the Missouri portion of the Kimmswick quadrangle, in Jefferson and St. Louis counties, was completed by F. W. Hughes, R. H. Randall, and W. F. Hicks, the area mapped being 67 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Ohio.—For the continuation of cooperative topographic surveys in Ohio the governor allotted $35,000 and the United States Geological Survey allotted $10,000. The survey of the Mechanicsburg, Greenfield, Milford Center, Octa, Xenia, Sabina, Morrow, Hillsboro, Sardinia, and Batavia quadrangles and of the Ohio portions of the Lawrenceburg, Richmond, Harrison, Lynn, and Portland quadrangles, in Adams, Brown, Butler, Champaign, Clark, Darke, Highland, Hamilton, Preble, Logan, Madison, Mercer, Union, Fayette, Ross, Clinton, Greene, Warren, and Clermont counties, was completed, and that of the West Union, Piketon, and Bainbridge quadrangles and of the Ohio portions of the Georgetown and Liberty quadrangles, in Adams, Brown, Butler, Preble, Highland, Pike, and Ross counties was begun, the total area mapped being 2,818 square miles for publication on the scale of 1 : 62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, A. B. Searle, Gilbert Young, Fred Graff, jr., R. L. Harrison, E. L. Hain, J. A. Duck, J. H. Wilson, F. B. Barrett, M. A. Roudabush, S. L. Parker,

E. C. Burt, R. M. Wilcoxon, Howard Clark, W. A. Reiter, H. E. Burney, W. S. Gehres, and S. A. Judson. For the control of these areas and of the Piketon and Roxabell quadrangles and the Ohio portions of the Bethel, Maysville, Morningview, and Liberty quadrangles, in Pike, Butler, Ross, Brown, Preble, Hamilton and Clermont counties, F. L. Whaley, J. M. Perkins, Mr. Parker, S. R. Archer, and E. C. Bibbee ran 796 miles of permanent levels and established 129 permanent bench marks.

Wisconsin.—For the beginning of cooperative topographic surveys in Wisconsin the State geologist allotted $4,000 and the United States Geological Survey allotted an equal amount. The survey of the Neshkoro and Ripon quadrangles, in Fond du Lac, Green Lake, Marquette, Winnebago, and Waushara counties and of the Wisconsin portion of the Old Superior quadrangle, in Douglas County, was begun by L. L. Lee, L. B. Roberts, and R. M. Herrington, the area mapped being 198 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas E. C. Bibbee and J. M. Perkins ran 173 miles of primary levels and established 44 permanent bench marks, of which 11 miles and 2 marks were in Minnesota. For the control of these areas and of the Fisk, Chaffey, Ripon, Rockmont, Oshkosh, Carlton, Poy Sippi, Montello, Spring Lake, Portage, Cambria, and Fox Lake quadrangles in Fond du Lac, Portage, Columbia, Dodge, Winnebago Douglas, Green Lake, Marquette, Waushara, Outagamie, and Waupaca counties, Wis., and Carlton and St. Louis counties, Minn., E. L. McNair ran 263 miles of primary traverse and set 20 permanent marks, of which 12 miles and 1 mark were in Minnesota.

In addition to the cooperative work the survey of the Wilton quadrangle in Monroe County was completed by R. T. Evans, O. H. Nelson, D. H. Watson, and J. M. Perkins, the area mapped being 72 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area Mr. Perkins ran 12 miles of primary levels.

OFFICE WORK.

The drafting of the following sheets was completed: Birds, Ill.-Ind.; Coulterville and Equality, Ill.; Shawneetown, Ill.-Ky.; Henderson and Uniontown, Ind.-Ky.; Boone, Iowa; Inez, Laynesville, and Virgie, Ky.; St. Charles, Mich.; Three Rivers, Mich.-Ind.; Aitkin, Pelican Rapids, and Wealthwood, Minn.; Kimmswick, Mo.-Ill.: Neosho and Sturgeon, Mo.; Batavia, Greenfield, Mechanicsburg, Milford Center, Morrow, Octa, Sabina, St. Paris, and Xenia, Ohio; Wilton, Wis.

Progress in the drafting of additional sheets was made as follows: Brownfield, Ill.-Ky., 10 per cent; Fords Ferry, Ill.-Ky., 9 per cent; Golconda, Ill.-Ky., 32 per cent; Chariton, Iowa, 25 per cent;

Brainerd, Minn., 30 per cent; Eminence, Mo., 70 per cent; Hillsboro, Ohio, 70 per cent; Sardinia, Ohio, 55 per cent; Old Superior, Wis.-Minn., 35 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Birds, Brownfield, Camp Point, Equality, Good Hope, La Harpe, Lomax, Meredosia, Morris, Paducah, Pittsfield, Quincy, Shawneetown, and Sparta (Ill.), Alzey and Evansville (Ind.), Hurley, Inez, Laynesville, and Matewan (Ky.), Advance, Eminence, Neosho, Salem, and Sinkin (Mo.), Bainbridge, Batavia, Bethel, Hillsboro, Lawrenceburg, Morrow, Piketon, Portland, Richmond, Roxabell, and Sabina (Ohio), Old Superior and Wilton (Wis.) quadrangles.

Geographic positions were computed for the Augusta, Beardstown, Camp Point, Good Hope, La Harpe, Liberty, Lomax, Meredosia, Monmouth, Morris, Mount Sterling, Oquawka, Quincy, Rushville, and Shabbona (Ill.), Attica and Chariton (Iowa), Chesaning, Elsie, and Perrinton (Mich.), Eminence, Knobnoster, Neosho, Odessa, and Warrensburg (Mo.), Cambria, Fisk, Fox Lake, Montello, Neshkoro, Old Superior, Oshkosh, Portage, Poy Sippi, Ripon, and Spring Lake (Wis.) quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming, and in a small area in Minnesota. This work comprised the completion of the survey of 10 quadrangles and 1 special area and the resurvey of 2 quadrangles and 1 special area, in addition to which 10 quadrangles and 2 special areas were partly surveyed and 1 special area was partly resurveyed. The total new area mapped was 3,855 square miles, 3,247 square miles for publication on the scale of 1 : 125,000, 429 square miles for publication on the scale of 1 : 62,500, 149 square miles for publication on scale of 1 : 31,680, and 30 square miles for publication on the scale of 1 : 12,000. The total area resurveyed was 526 square miles, 484 square miles for publication on the scale of 1 : 62,500, and 42 square miles for publication on the scale of 1 : 24,000. In addition the map of 1 quadrangle was revised and that of 1 quadrangle was partly revised, the area covered being 1,215 square miles. In connection with this work 2,179 miles of primary levels were run and 592 permanent bench marks were established.

Primary traverse and primary triangulation were carried on at different times by 7 parties, the work extending over portions of Colorado, New Mexico, Oklahoma, Texas, and Wyoming. The total area covered by this primary control was about 15,400 square miles,

of which 1,440 square miles was controlled by primary traverse, 662 miles being run and 196 permanent marks set. Ninety triangulation stations were occupied and 56 marked. This work made control available in 60 quadrangles.

Topographic surveys in Rocky Mountain division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—					
		1:125,000.	1:62,500.		1:31,680.	1:24,000.	1:12,000.
		New.	New.	Re-survey.	New.	Re-survey.	New.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Colorado	5,100	1,338			101		
Montana	20,100	389	50				
New Mexico	25, 50, 100	1,238				42	
Oklahoma	25		83	484			
Texas	2, 5, 25		21		48		30
Wyoming	25, 50	282	275				
		3,247	429	484	149	42	30

State.	Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Sq. mi.	*Miles.*		*Miles.*			
Colorado	1,439	552	152			58	35
Montana	439						
Nebraska		13	2				
New Mexico	1,280	689	180			10	8
Oklahoma	567	160	48	94	13		
South Dakota		3	2				
Texas	99	588	175	568	183	18	12
Wyoming	557	142	25			1	
Arizona		23	6				
Minnesota		9	2				
	4,381	2,179	592	662	196	87	55

Arizona.—(See New Mexico, p. 123.)

Colorado.—The mapping of the Craig quadrangle, in Moffat County, and the San Luis Lake special area, in Alamosa County, was completed, and that of the Naturita quadrangle, in Montrose and San Miguel counties, was begun by C. L. Nelson, C. W. Rowell, J. H. Wilke, C. T. Moore, R. W. Berry, E. P. Davis, Basil Duke, and R. R. Monbeck, the area mapped being 736 square miles, 635 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 101 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas and of the Coventry and Montrose quadrangles, in Montrose, San Miguel, Ouray, Gunnison, and Hinsdale counties, J. R. Ellis, Mr. Monbeck, R. W. Burchard, Mr. Rowell, and Mr. Moore ran 487 miles of primary levels and established 131 permanent bench marks, and for the control of the Naturita quadrangle C. F. Urquhart occupied

8 triangulation stations and permanently marked 9. The survey of the Creede quadrangle, lying partly in the San Juan, Cochetopa, and Rio Grande national forests, in Mineral, Rio Grande, and Saguache counties, was completed, and that of the Del Norte and Home quadrangles, lying partly in the Rio Grande, Cochetopa, Arapahoe, and Colorado national forests, in Alamosa, Jackson, Larimer, Rio Grande, and Saguache counties, was begun by Mr. Duke, C. A. Ecklund, R. C. Seitz, Cornelius Schnurr, and C. C. Holder, the area mapped being 703 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 324 square miles is in the national forests. For the control of the Home quadrangle Mr. Ecklund and Roscoe Reeves ran 65 miles of primary levels and established 21 permanent bench marks. For the control of the Del Norte, Glenwood Springs, Kremmling, Home, Pagoda, Rabbit Ears Peak, Eagle, Leadville, Leon Peak, Mount Powell, Snow Mass Mountain, Gateway, Delta, Livermore, Grand Junction, Pinon Valley, Cameo, and De Beque quadrangles, Colorado, and the Sherman quadrangle, Wyoming, lying partly in the Leadville, Holy Cross, Sopris, Arapahoe, Colorado, Routt, White River, Gunnison, and Battlement national forests, in Eagle, Garfield, Rio Blanco, Routt, Grande, Jackson, Delta, Mesa, Moffat, Lake, Peak, Larimer, Summit, Chaffee, Pitkin, and Gunnison counties, Colo., and Albany and Laramie counties, Wyo., C. F. Urquhart, C. B. Kendall, and Mr. Ellis occupied 51 triangulation stations (1 in Wyoming) and marked 26.

The roads in the Mesa Verde National Park were located on the administrative map of the park by C. L. Nelson for the Department of the Interior, all the expenses of the work being borne by the Department.

Minnesota.—(See South Dakota, North Dakota, and Minnesota, p. 124.)

Montana.—The survey of the unmapped portion of the Nashua quadrangle, in Dawson and Valley counties, was completed, and that of the unmapped portion of the Nameless quadrangle, in Valley County, was begun by R. C. Seitz, the area mapped being 50 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The portions of these quadrangles lying in the Fort Peck Indian Reservation were mapped by the General Land Office. The survey of the unmapped portion of the Heart Butte quadrangle, lying partly in the Lewis and Clark National Forest, in Flathead and Teton counties, was completed by R. T. Evans, O. H. Nelson, and D. H. Watson, the area mapped being 389 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet, 153 square miles being in the national forest. The remainder of this quadrangle, lying in the Blackfeet Indian Reservation, was mapped by the General Land Office. (See also Idaho-Montana, p. 127.)

Nebraska.—For the control of the Stella and Falls City quadrangles in Richardson County, S. H. Birdseye ran 13 miles of primary levels and established 2 permanent bench marks.

New Mexico.—The mapping of the Tularosa and Tres Hermanos quadrangles, in Dona Ana, Otero, Socorro, and Lincoln counties, was completed, and that of the Reserve quadrangle, lying partly in the Socorro National Forest, in Socorro County, was begun by R. C. Seitz, C. C. Gardner, S. T. Penick, C. C. Holder, and D. H. Watson, the total area mapped being 1,238 square miles, for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet. Of this area 462 square miles was in the national forest. For the control of these areas and of the Koehler, Soudders, Magdalena, Leura Springs, Datil, Mogollon, and Nutrioso quadrangles, in Sierra, Colfax, and Socorro counties, N. Mex., and Apache and Greenlee counties, Ariz., Mr. Holder and R. W. Burchard ran 712 miles of primary levels and established 186 permanent bench marks, of which 23 miles and 6 marks were in Arizona. For the control of the Koehler quadrangle Mr. Ellis occupied 10 triangulation stations and permanently marked 8. The resurvey of the Tyrone special area, in Grant County, was completed, and that of the Mogollon special area, in Socorro County, was begun by B. A. Jenkins and R. W. Berry, the area mapped being 42 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The map of the Deming quadrangle, in Luna County, was revised by E. P. Davis, the area covered by this revision being 1,009 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. (See also Arizona, p. 131.)

North Dakota.—(See South Dakota, North Dakota, and Minnesota, p. 124.)

Oklahoma.—The director of the Oklahoma Geological Survey allotted $1,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Foraker quadrangle, in Osage County, was completed by S. T. Penick and R. R. Monbeck, the area mapped being 83 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. The resurvey of the Kiefer and Bristow quadrangles, in Creek, Tulsa, and Okmulgee counties, was completed by R. T. Evans, Mr. Penick, C. C. Gardner, R. H. Reineck, Mr. Monbeck, A. O. Burkland, D. H. Watson, and C. R. Fisher, the area mapped being 484 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of these areas Mr. Fisher and Mr. Monbeck ran 160 miles of primary levels and established 48 permanent bench marks, and C. B. Kendall and Mr. Fisher ran 94 miles of primary traverse and set 13 permanent marks. The cooperative funds being insufficient to cover the

completion of the mapping of these areas, the additional expenses were borne by the Federal Survey.

In addition to the cooperative work the revision of the map of the Hominy quadrangle, in Osage, Pawnee, Tulsa, and Creek counties, was completed by R. W. Berry, the total area covered by this revision being 206 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet.

South Dakota, North Dakota, and Minnesota.—For the control of the White Rock quadrangle, in Roberts County, S. Dak., Richland County, N. Dak., and Traverse County, Minn., A. J. Kavanagh ran 12 miles of primary levels and established 4 permanent bench marks, of which 9 miles and 2 marks were in Minnesota and 3 miles and 2 marks in South Dakota.

Texas.—For the cooperative topographic survey of Harris County the county allotted $35,000 and the United States Geological Survey allotted $5,000. The mapping of the Erin, Deepwater, and Rice 7½-minute quadrangles was begun by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, O. H. Nelson, J. H. Wilke, T. P. Pendleton, and F. A. Danforth, the area mapped being 48 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 5 feet. For the control of these quadrangles and of the Settegast, Vollner, Hillendahl, Missouri City, Pearland, Strang, Almeda, Clodine, Barker, Katy, Swanson, Cypress, Ashford, Hockley, Rose Hill, Waller, Number Two, Louetta, Spring, Humble, Aldine, Kliber, Pauli, Huffman, Crosby, Hermaston, Fauna, and Stuebner quadrangles, E. L. McNair and W. F. Hicks ran 470 miles of primary traverse and set 147 permanent marks, and R. R. Monbeck ran 281 miles of primary levels and established 89 permanent bench marks.

In addition to the cooperative work, the mapping of the Henrietta quadrangle, in Clay, Archer, and Wichita counties, was begun by C. A. Ecklund and A. O. Burkland, the total area mapped being 21 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of this area and of the Walter quadrangle, in Clay and Wichita counties, Roscoe Reeves ran 141 miles of primary levels and established 38 permanent bench marks, and for the control of these areas and of the Archer City and Eschite quadrangles, in Archer, Wichita, and Wilbarger counties, J. R. Ellis and Mr. Ecklund occupied 18 triangulation stations and marked 12. The mapping of the Sabine and Trinity River projects, in Wood, Smith, Dallas, Ellis, and Kaufman counties was commenced by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, and R. R. Monbeck, the area mapped being 30 square miles, for publication on the scale of 1 : 12,000, with a contour interval of 2 feet. For the control of these areas E. L. McNair, Mr. Birdseye, and Mr. Monbeck ran 166 miles of primary levels and established 48 permanent bench marks,

and Mr. McNair ran 98 miles of primary traverse and set 36 permanent marks.

Wyoming.—The mapping of the Blue Mesa and Saddleback Hills quadrangles, in Carbon, Hot Springs, and Washakie counties, was completed by R. H. Reineck, C. C. Gardner, S. T. Penick, and C. R. Fisher, the total area mapped being 275 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The mapping of the Moorcroft quadrangle, in Crook and Weston counties, was begun by Messrs. Gardner, Reineck, and Fisher, the area mapped being 282 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of these areas Mr. Fisher and G. R. Ruby ran 142 miles of primary levels and established 25 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Craig, Creede, and San Luis Lake, Colo.; Heart Butte and Nashua, Mont.; Deming (revision), N. Mex.; Tres Hermanos, Tularosa, and Tyrone special, N. Mex.; Bristow, Foraker, and Kiefer, Okla.; Claremore and Hominy (revision), Okla.; Mission, Sabine River, San Juan, and Trinity River, Tex.; Blue Mesa and Saddleback Hills, Wyo.

Progress in the drafting of additional sheets was made as follows: Del Norte, Colo., 18 per cent; Home, Colo., 7 per cent; Naturita, Colo., 22 per cent; Nameless, Mont., 83 per cent; Moorcroft, Wyo., 8 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Nutrioso (Ariz.-N. Mex.), Coventry, Del Norte, Home, Hooper, La Jara, Lay, Montrose, Naturita, Saguache, and Silesia (Colo.), Dodson and Hays (Mont.), Datil, Tres Hermanos, Koehler, Luera Springs, Magdalena, Ojo Caliente, Patterson, Reserve, Shiprock, Soudders, Pineville, and Tularosa (N. Mex.), Blue Butte and Elbowoods (N. Dak.), Nuyaka (Okla.), Archer City, Eschite, Henrietta, Walter, Almeda, Deepwater, Erin, Missouri City, Pearland, Rice and Strang, and the Wills Point and Mineola (Sabine River project) and Dallas and Kaufman (Trinity River project) (Tex.), Thermopolis and Widdowfield (Wyo.) quadrangles.

Geographic positions were computed for the Del Norte, Grand Junction, Eagle, Glenwood Springs, Kremmling, Leadville, Leon Peak, Naturita, Meeker, Mount Jackson, Mount Powell, Pagoda, Rabbit Ears Peak, DeBeque, Delta, Gateway, Palisades, Rifle, and Snow Mass Mountain (Colo.), Koehler (N. Mex.), Bristow and Kiefer (Okla.), Almeda, Archer City, Eschite, Henrietta, Bonham, Dallas (Trinity River project), Wills Point (Sabine River project), Almeda, Deepwater, Erin, Missouri City, Paris, Pearland, Petrolia, Rice,

Strang, Webster, Barker, Clodine, Cypress, Hillendahl, Katy, Missouri City, Swanson, Vollner, Aldine, Ashford, Hockley, Louetta, Rose Hill, Spring, and Waller (Harris County) (Tex.) quadrangles.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Idaho, Oregon, and Washington and in a small area in Montana. This work comprised the completion of the survey of 10 quadrangles and the partial survey of 10 quadrangles. The total new area mapped was 4,008 square miles; 2,974 square miles for publication on the scale of 1 : 125,000; 870 square miles for publication on the scale of 1 : 62,500; and 164 square miles for publication on the scale of 1:31,680. In connection with this work 747 miles of primary levels were run and 202 permanent bench marks were established. In addition, profile surveys were made of portions of 5 rivers, the distance traversed being 262 linear miles for publication on the scale of 1 : 31,680.

Primary triangulation and primary traverse were carried on at different times by five parties in portions of Idaho, Montana, Oregon, and Washington. The total area covered by this primary control was about 7,200 square miles, of which about 575 square miles was controlled by primary traverse, 149 miles being run and 40 permanent marks set. Sixty-five triangulation stations were occupied and 58 permanently marked. This work made control available in 23 quadrangles.

Topographic surveys in northwestern division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		1:125,000	1 : 62,500	1 : 31,680		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Idaho	50, 100	334	351	2	687	178	35	.....	.....	62	58
Oregon	5, 25, 50, 100	1,305	304	162	1,771	357	112	79	20	.....	.....
Washington	25, 50	1,217	215	.....	1,432	212	55	70	20	.....	.....
Montana	100	118	.....	.....	118	.....	.....	.....	.....	3	.....
		2,974	870	164	4,008	747	202	149	40	65	58

Idaho.—The mapping of the Henry and Portneuf quadrangles, in Bannock County, was completed, and that of the Mink Creek quadrangle, lying partly in the Cache National Forest, in Bannock, Bear Lake, and Franklin counties, was begun by Albert Pike, J. L. Lewis, and C. G. Anderson, the area mapped being 563 square miles, 351

square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet, and 212 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 80 square miles was in the national forest. For the control of these areas and of the Soda Springs quadrangle, in Bannock and Bear Lake counties, F. L. Whaley ran 178 miles of primary levels and established 35 permanent bench marks. For the control of these areas, and of the Malad City and Sterrett quadrangles, and the south half of the Ammon quadrangle, in Bannock, Bingham, and Oneida counties, H. H. Hodgeson and T. M. Bannon occupied 22 and marked 21 triangulation stations. A profile survey of Snake River was commenced by C. G. Anderson, the distance traversed being 48 linear miles in Madison County. In connection with this work 2 square miles covering a power site were surveyed.

Idaho-Montana.—The mapping of the Avery quadrangle, lying partly in the Lolo, Cabinet, St. Joe, and Cœur d'Alene national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was completed, and that of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in the same counties, was begun by J. E. Blackburn, the total area mapped being 240 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 178 square miles is in the national forests and 118 square miles in Montana. In connection with the mapping of the Avery quadrangle 5 square miles of the map of the Cœur d'Alene National Forest was revised. For the control of the Salmon, Noble, Gibbons Pass, Vinegar Hill, Casto, Rabbit Foot, May, Custer, Bay Horse, Mackay, and Hailey quadrangles, lying partly in the Bitterroot, Selway, Beaverhead, Salmon, Lemhi, Idaho, Sawtooth, Nez Perce, and Challis national forests, in Lemhi and Custer counties, Idaho, and Ravalli and Beaverhead counties, Mont., T. M. Bannon occupied 43 triangulation stations (3 in Montana) and marked 37.

Oregon.—For the continuation of cooperative topographic surveys in Oregon the State engineer allotted $18,000 and the United States Geological Survey allotted an equal amount. In the survey of the Willamette Valley the mapping of the Salem, Corvallis, Lebanon, and Brownsville quadrangles, in Benton, Marion, Linn, and Polk counties, was continued, and that of the Dallas quadrangle, in Polk County, was begun by Charles Hartmann, Olinus Smith, J. H. Le Feaver, R. B. Kilgore, and D. S. Birkett, the total area mapped being 162 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas Mr. Birkett and E. M. Bandli ran 82 miles of primary levels and established 27 permanent bench marks. The mapping of the Tualatin and Condon quadrangles, in Clackamas, Washington, Jefferson, Yamhill, Gilliam, Morrow, Sher-

man, and Wheeler counties, was completed, and that of the Hillsboro quadrangle, in Columbia, Multnomah, and Washington counties, was begun by C. H. Birdseye, Albert Pike, C. L. Sadler, Fred Graff, jr., S. G. Lundey, O. H. Nelson, and J. H. Le Feaver, the total area mapped being 959 square miles, 655 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet, and 304 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Condon and Hillsboro quadrangles and also of the Twickenham and Heisler quadrangles, in Crook, Jefferson, Wheeler, and Wasco counties, E. M. Bandli ran 134 miles of primary levels and established 45 permanent bench marks, and for the control of the Hillsboro quadrangle L. F. Biggs ran 79 miles of primary traverse and set 20 permanent marks. Profile surveys of portions of Willamette, Umpqua, and White rivers were made by Albert Pike and C. P. McKinley, the distance traversed being 172 linear miles in Douglas, Lane, and Wasco counties. Of this distance 60 miles lies in the Cascade and Umpqua national forests.

In addition to the cooperative work in Oregon, the mapping of the Diamond Lake quadrangle in the Crater, Cascade, Paulina, and Umpqua national forests, in Douglas, Klamath, Jackson, and Lane counties, was completed, and that of the Kerby quadrangle, lying partly in the Siskiyou National Forest, in Curry and Josephine counties, was begun by J. G. Staack, A. O. Burkland, R. B. Kilgore, R. M. Wilson, and John McCombs, the total area mapped being 650 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 600 square miles is in the national forests. For the control of this area and of the Diamond Peak, Disston, Wendling, and Eugene quadrangles, lying partly in the Cascade, Paulina, Santiam, and Umpqua national forests, in Douglas, Lane, Klamath, and Linn counties, R. M. Wilson ran 141 miles of primary levels and established 40 permanent bench marks. A profile survey of the portion of North Umpqua River in the Diamond Lake quadrangle was made by Mr. Kilgore, the distance traversed being 42 linear miles, for publication on the scale of 1:48,000, with contour intervals of 5 and 25 feet.

Washington.—For the continuation of cooperative topographic surveys in Washington the State Board of Geological Survey allotted $11,500 and the United States Geological Survey allotted an equal amount. The mapping of the Coyote Rapids, Priest Rapids, and Pasco quadrangles, in Benton, Grant, Kittitas, Yakima, Franklin, and Walla Walla counties, was completed by H. L. McDonald and S. G. Lunde, the total area mapped being 816 square miles, 215 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet, and 601 square miles for publication on the scale

of 1 : 125,000, with a contour interval of 50 feet. The mapping of the Chehalis quadrangle, lying partly in the Rainier National Forest, in Lewis, Pierce, and Thurston counties, was completed, and that of the Prosser quadrangle, in Benton, Klickitat, and Yakima counties, was begun by W. O. Tufts, H. L. McDonald, N. E. Ballmer, L. V. Fees, John McCombs, and A. L. Wilson, the area mapped being 616 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet. Of this area 1½ square miles is in the national forest. For the control of the Chehalis quadrangle L. F. Biggs ran 7 miles of primary traverse and set 3 permanent marks. For the control of the Prosser quadrangle and also of the Wallula quadrangle, in Benton, Franklin, and Walla Walla counties, D. S. Birkett ran 123 miles of primary levels and established 36 permanent bench marks.

In addition to the cooperative work, for the control of the Mount St. Helens and Eatonville quadrangles, lying partly in the Columbia and Rainier national forests, in Clarke, Cowlitz, Lewis, Pierce, Skamania, and Thurston counties, Mr. Biggs and C. P. McKinley ran 63 miles of primary traverse and set 17 permanent marks, and for the control of the Mount St. Helens quadrangle and also of the Kalama quadrangle, in Cowlitz County, Mr. Biggs ran 89 miles of primary levels and established 19 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Henry and Portneuf, Idaho; Avery, Idaho-Mont.; Condon, Diamond Lake, North Umpqua River, Tualatin, Umpqua River, White River, and Willamette River, Oreg.; Chehalis, Coyote Rapids, Pasco, and Priest Rapids, Wash.

Progress in the drafting of additional sheets was made as follows: St. Regis, Idaho-Mont., 33 per cent; Brownsville, Oreg., 15 per cent; Corvallis, Oreg., 30 per cent; Dallas, Oreg., 17 per cent; Lebanon, Oreg., 37 per cent; Salem, Oreg., 45 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Bruneau, Portneuf, Henry, Lanes Creek, Mink Creek, Mountain Home, Riddle, and Tindall (Idaho); Brownsville, Condon, Corvallis, Diamond Lake, Diamond Peak, Disston, Heisler, Hillsboro, Lebanon, and Twickenham (Oreg.); Kalama, Mount St. Helens, and St. Helens (Wash.) quadrangles.

Geographic positions were computed for the Bay Horse, Casto, Custer, Dickey, May, Nicholia, Noble, Rabbit Foot, and Vinegar Hill (Idaho); Junction, Polaris, Noble, and Salmon (Idaho-Mont.); Hillsboro (Oreg.); and Kalama and Mount St. Helens (Wash.) quadrangles.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work comprised the completion of the survey of 19 quadrangles and the resurvey of 4 quadrangles and 1 special area, in addition to which 4 quadrangles were partly surveyed. The map of a partial quadrangle was revised to bring it up to date with the new work, the area covered by this revision being 210 square miles. The total new area mapped was 5,161 square miles, 3,641 square miles for publication on the scale of 1 : 125,000, 995 square miles for publication on the scale of 1 : 62, 500, and 525 square miles for publication on the scale of 1 : 31,680. The area resurveyed was 504 square miles, 167 square miles for publication on the scale of 1 : 125,000, 299 square miles for publication on the scale of 1 : 62,500, and 38 square miles for publication on the scale of 1 : 24,000. In connection with this work 787 miles of primary and precise levels were run and 167 permanent bench marks were established. In addition, profile surveys were made of 7 rivers, the distance traversed being 236 linear miles.

Primary triangulation was carried on at different times by four parties, the work being distributed over portions of California and Nevada. The total area covered by this primary control was about 3,600 square miles, 71 triangulation stations being occupied and 37 marked. The result of this work was to make control available in 44 quadrangles.

Topographic surveys were made in the Territory of Hawaii, covering portions of one island (Hawaii). The survey of one 15-minute quadrangle was completed, the area mapped being 19 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 10 feet.

Topographic surveys in Pacific division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—						Total area surveyed.	Primary and precise levels.		Triangulation.	
		1:125,000		1:62,500		1:31,680	1:24,000					
		New	Resurvey.	New	Resurvey.	New	Resurvey.		Distance run.	Bench marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*			
Arizona	25,100	642	.....	290	.....	.....	.....	932	165	32	.....	.....
California	5, 25,100	2,362	.....	705	69	525	.....	3,661	429	86	63	32
Nevada	5	53	.....	.....	.....	.....	38	84	150	39	8	5
Utah	50,100	507	167	.....	230	.....	.....	911	43	10	.....	.....
New Mexico.	100	77	.....	.....	.....	.....	.....	77	.....	.....	.....	.....
		3,641	167	995	299	525	38	5,665	787	167	71	37
Hawaii	10	.....	.....	.....	.....	19	.....	.....	.....	.....	.....	.....

Arizona.—The survey of the Gila Butte and Christmas quadrangles, in Maricopa, Gila, and Pinal counties, was completed by T. P. Pendleton and C. A. Stonesifer, the total area mapped being 290 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. In connection with the mapping of the Gila Butte quadrangle, the map of the area previously surveyed was revised, the total area covered by this revision being 210 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Christmas and Ray quadrangles, in Gila and Pinal counties, S. H. Birdseye ran 50 miles of primary levels and established 10 permanent bench marks. The mapping of the San Simon quadrangle, lying partly in the Chiricahua National Forest, in Cochise, Graham, and Greenlee counties, Ariz., and Grant County, N. Mex., was completed by F. A. Danforth and Cornelius Schnurr, the area mapped being 719 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. Of this area 61 square miles is in the national forest and 77 square miles in New Mexico. For the control of this area and of the Duncan, Solomonsville, San Carlos, Bisbee, and Pearce quadrangles, lying partly in the Apache, Chiricahua, Crook, and Gila national forests, in Gila, Cochise, Graham, Greenlee, and Pinal counties, Ariz., and Grant County, N. Mex., Mr. Birdseye ran 115 miles of primary levels and established 22 permanent bench marks, all this work being in Arizona. (See also New Mexico, p. 123.)

California.—For the continuation of cooperative topographic surveys in California the department of engineering allotted $14,000 and the United States Geological Survey allotted an equal amount. In continuation of the survey of the San Joaquin Valley the mapping of the Denair, Cressy, Ceres, Crows Landing, Mitchell School, Winton, Merced, Hopeton, and Turlock 7½-minute quadrangles and of the Copperopolis 15-minute quadrangle, in Calaveras, Merced, Stanislaus, and Tuolumne counties, was completed by A. O. Burkland, H. W. Peabody, A. J. Ogle, J. B. Leavitt, S. H. Birdseye, F. A. Danforth, and C. A. Stonesifer, the total area mapped being 683 square miles, 525 square miles for publication on the scale of 1 : 31,680, with a contour interval of 5 feet, and 158 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Crows Landing, Mitchell School, Turlock, Stevinson, No. VII, No. VIII, No. IX, No. X, Deadman Creek, Kearney Peak, Le Grand, Jesbel, Clovis, Chowchilla Slough, Minturn, Berendo, Fresno, Friant, Herndon, Planada, Plainsberg, Sharon, Madera, Bridge, No. XV, No. XVI, No. XVII, No. XIX, No. XX, No. XXI, Merced, Newman, Ingomar, Owens Creek, Las Garzas Creek, San Luis Creek, Mariposa Slough, Salt Slough, Gustine, Volta, Los Banos, Elgin, Center School, and Daulton 7½-minute quadrangles

and the Indian Gulch 15-minute quadrangle, in Madera, Fresno, Merced, Stanislaus, Mariposa, and San Joaquin counties, C. L. Nelson, C. F. Urquhart, and L. F. Biggs occupied 63 triangulation stations and marked 32, and for the control of the Copperopolis, Trigo, Bachelor Valley, No. VII, No. IX, No. X, Deadman Creek, Owens Creek, Indian Gulch, Le Grand, Madera, Berendo, Sharon, Planada, Plainsberg, La Grange, Daulton, Snelling, and Merced Falls quadrangles, in the same counties, Roscoe Reeves and D. S. Birkett ran 141 miles of primary levels and established 37 permanent bench marks.

In addition to the funds for regular cooperative surveys in California, $2,500 was allotted by the University of California for the survey of the Santa Rosa quadrangle, in Napa and Sonoma counties, and the United States Geological Survey allotted an equal amount. The funds from the university were made available in the spring of 1914, as stated in the previous report, when field work was commenced. During the year the survey of the Santa Rosa quadrangle was completed by J. P. Harrison, B. A. Jenkins, and A. J. Ogle, the area mapped being 159 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

The city of Los Angeles allotted $2,500 for the cooperative topographic survey of the Elizabeth Lake quadrangle, lying partly in the Santa Barbara National Forest, in Los Angeles and Kern counties, and the United States Geological Survey allotted an equal amount. The mapping of this quadrangle was completed by D. L. Reaburn, C. P. McKinley, N. E. Ballmer, Roscoe Reeves, and J. W. Muller, the total area mapped being 981 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 221 square miles is in the national forest. The services of Mr. Reaburn were provided by the city of Los Angeles, by which his salary and expenses were paid. In connection with the mapping of this quadrangle Mr. Ballmer mapped 44 square miles in the Kramer quadrangle, which lies directly east of the Elizabeth Lake area.

In addition to the cooperative work the survey of the Seiad and Sawyers Bar quadrangles, lying partly in the Klamath, Siskiyou, and Trinity national forests, in Humboldt, Siskiyou, and Trinity counties, was completed, and that of the Preston quadrangle, in the Klamath and Siskiyou national forests, in Del Norte and Siskiyou counties, was begun by J. P. Harrison, J. W. Muller, and W. R. Chenoweth, the area mapped being 744 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This entire area is within the national forests. In connection with the mapping of these quadrangles profile surveys of portions of Klamath, Scott, and Salmon rivers were made by Messrs. Harrison, Muller, and Chenoweth, the distance traversed being 149 linear miles, for publication on the

the scale of 1:48,000, with contour intervals of 5 and 25 feet. For the control of the Preston quadrangle Mr. Biggs ran 72 miles of primary levels and established 20 permanent bench marks. The resurvey of the Mare Island quadrangle was completed by Mr. Leavitt, the area mapped being 69 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Pajaro and Morgan Hills quadrangles, in San Benito, Santa Clara, Santa Cruz, and Monterey counties, was begun, and that of the Cholame quadrangle, in Fresno, Kern, Kings, Monterey, and San Luis Obispo counties was continued by E. P. Davis, J. E. Blackburn, A. T. Fowler, H. W. Peabody, A. J. Ogle, Olinus Smith, J. H. Le Feaver, N. E. Ballmer, and J. B. Leavitt, the total area mapped being 742 square miles, 354 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 388 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Bridgeport, Mount Lyell, Mount Morrison, and Bishop quadrangles, in Mono, Fresno, and Inyo counties, T. P. Pendleton and D. S. Birkett ran 73 miles of primary levels and established 20 permanent bench marks. L. F. Biggs completed a precise level line across the Tehachapi Pass from Bakersfield to San Pedro, 143 miles being run and 9 permanent bench marks established in order to check elevations previously established so as to determine possible earth movement.

California-Nevada.—The mapping of the White Mountain quadrangle, lying partly in the Inyo and Mono national forests, in Mono County, Cal., and Mineral and Esmeralda counties, Nev., was completed, the area mapped being 292 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 136 square miles is in the national forests, 239 square miles in California, and 53 square miles in Nevada.

Nevada.—The resurvey of the Manhattan mining district, in Nye County, was completed by A. T. Fowler, the area mapped being 38 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. For the control of this area Mr. Fowler occupied 8 triangulation stations and marked 5. For the control of the Pioche district, in Lincoln County, and of the Carson Sink and Wadsworth quadrangles, in Churchill County, D. S. Birkett and T. P. Pendleton ran 151 miles of primary levels and established 39 permanent bench marks, of which 7 miles and 1 mark were in the Utah portion of the Pioche quadrangle.

Utah.—The survey of the Logan quadrangle, lying partly in the Cache National Forest, in Cache, Boxelder, and Rich counties, was completed by H. H. Hodgeson, the area mapped being 507 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. Of this area 187 square miles is in the national

forest. In connection with the mapping of the Logan quadrangle profile surveys of Logan and Blacksmith Fork rivers were made by Mr. Hodgeson, the distance traversed being 37 linear miles, for publication on the scale of 1 : 48,000, with a contour interval of 25 feet. The resurvey of the Vernal, Wellington, and Castle Gate quadrangles, in Uinta and Carbon counties, was completed by E. R. Bartlett and Cornelius Schnurr, the total area mapped being 397 square miles—167 square miles for publication on the scale of 1 : 125,000, with a contour interval of 100 feet, and 230 square miles for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of the Castle Gate quadrangle Mr. Schnurr ran 42 miles of primary levels and established 10 permanent bench marks. (See also Nevada, p. 133.)

Hawaii.—To complete the cooperative topographic work begun under the agreement for the fiscal year 1914 the Territory of Hawaii allotted $837.35 and the United States Geological Survey allotted $305. The survey of the island of Hawaii was continued, the area mapped being 19 square miles, for publication on the scale of 1:31,680, with a contour interval of 10 feet. This work, which was done by A. T. Fowler, completed the mapping of the Hilo 15-minute quadrangle.

OFFICE WORK.

The drafting of the following sheets was completed: Gila Butte, Pearce, and San Simon, Ariz.; Ceres, Copperopolis, Cressy, Crows Landing, Denair, Riverbank, Klamath River, Mare Island, Merced, Mitchell School, Hopeton, Salmon River, Santa Rosa, Sawyers Bar, Scott River, Seiad, Stanislaus River, Turlock, Waterford, and Winton, Cal.; San Francisco and vicinity (revision), Cal.; Manhattan mining district and Yerington mining district, Nev.; Blacksmith Fork River, Castle Gate, Duchesne River, Green River, Logan, Logan River, Uinta River, Vernal, Wellington, and White River, Utah.

Progress in the mapping of additional sheets was made as follows: White Mountain, Cal.-Nev., 70 per cent; Hilo, Hawaii, 74 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Christmas, Maricopa, and Pearce quadrangles (Ariz.), the Nutrioso and San Simon quadrangles (Ariz.-N. Mex.), the Bridgeport, Copperopolis, Elizabeth Lake, Mount Lyell, and Mount Morrison quadrangles, and the San Joaquin Valley (Cal.), the Aura, Carson Sink, Delamar, Elko, Kumiva, Panaca, Pyramid, Reno, and Wadsworth quadrangles (Nev.), and the Castle Gate (Utah) quadrangle.

Precise leveling was adjusted for new lines from Kern via Mohave to Orange and from Florence to San Pedro, Cal., and for old lines from Benicia to Kern and from Barstow to Mohave, Cal.

Geographic positions were computed for the Santa Rosa (Cal.), Hilo (Hawaii), Vernal (Utah) quadrangles and for the Mitchell School, Turlock, Cressy, Winton, Hopeton, Stevinson, No. VIII, Atwater, Merced, Planada, Mariposa Slough, and Owens Creek (Cal.) 7½-minute quadrangles.

SECTION OF FIELD EQUIPMENT.

During the year 1914 a section of field equipment was organized for the custody of all field equipment of the three field branches of the Survey. The personnel of the section consists of E. M. Douglas, two clerks, and one laborer.

During the year this section received and recorded all incoming field instruments and supplies, and packed and shipped all outgoing instruments. The custody of topographic notebooks and field records was assigned to the section, as well as the general supervision of instrument repair work in the Survey instrument shop. With the exception of extensive repairs to such instruments as aneroid barometers, leveling rods, cameras, and microscopes, for which the Survey shop is not at present fitted, the shop, under the immediate charge of Ernest Kübel with one assistant, made repairs or alterations to more than 2,000 different articles, including 205 standard telescopic alidades, 53 Gale alidades, 62 Y levels, 12 transits, 11 theodolites, 175 box compasses, 119 Brunton and other compasses, 50 tally registers, and 133 sight alidades. The instrument shop also made, resurfaced, or electrotyped over 140,000 square inches of plates.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

J. H. Renshawe spent two months in inspecting field work in the Atlantic division. W. M. Beaman visited topographic parties in the central, Rocky Mountain, and northwestern divisions and made frequent field inspections of the work on the large-scale map of Washington, D. C., and vicinity. A. M. Walker inspected field parties in the Atlantic and central divisions. Mr. Beaman spent one month and Mr. Walker two months in field work on the Washington and vicinity map.

The office duties of Messrs. Beaman and Walker included supervision of the inking of all topographic field sheets and office preparation of river-profile and land-classification sheets and reports and final examination of them prior to photolithography, engraving, and proper transmission; also attention to the referred matter of a technical nature pertaining to the branch as a whole rather than to any particular topographic division. Mr. Beaman's office duties also included special attention to river-profile surveys, the supervision of the map of Washington and vicinity, and cooperation with M. R.

Campbell in the preparation of a set of 50 topographic sheets illustrating physiographic and engineering features for the use of schools and in the selection and description of an exhibit of topographic sheets for the Panama-Pacific Exposition at San Francisco.

Mr. Renshawe's entire office time was spent in preparing colored relief maps of national parks and in similar work, as reported in detail on page 107.

MILLIONTH-SCALE MAP OF THE UNITED STATES.

Of the work in progress last year on the 1 : 1,000,000 scale map of the United States, under the direction of A. F. Hassan, the base map of Oregon (portions of sheets K–10, K–11, L–10, and L–11) was completed, as was the contouring of sheet K–18. New work included the adjustment of 35 per cent of the township lines and 20 per cent of the compilation and inking of the base map of Idaho (portions of sheets K–11, K–12, L–11, L–12, and M–11), the completion of the base map of the Navajo country, Arizona, and New Mexico (portions of sheets I–12, I–13, J–12 and J–13), and the compilation and inking of the contours for 60 per cent of sheet J–18, 80 per cent of sheet J–17, 15 per cent of sheet J–16, 40 per cent of sheet J–15, 25 per cent of sheet I–17, 40 per cent of sheet I–16, 20 per cent of sheet I–15, and 65 per cent of the United States portion of sheet K–17. Roads were compiled and inked for 30 per cent of sheet J–17, for 75 per cent of sheet J–18, and for 25 per cent of sheet K–18.

Three tracings and 21 maps were also prepared for the Bureau of Fisheries, all the expenses of the work being borne by that bureau.

Tracings of six sheets of an enlargement of the map of San Luis Valley, Colorado, were also prepared for the Reclamation Service.

WATER-RESOURCES BRANCH.

ORGANIZATION AND SCOPE OF WORK.

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each of which is subdivided into sections for field work. The organization is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.
Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.
Division of ground waters, O. E. Meinzer, geologist, in charge.
Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force of the water-resources branch has been reduced 10 by transfers, resignations, and deaths and has been increased 9 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 28 assistant engineers, 25 junior engineers, 1 hydrographer, 1 geol-

ogist, 1 associate geologist, 3 assistant geologists, 1 geologic aid, 1 chemist, 1 assistant chemist, and 1 junior chemist, a total of 76. Of this number, 1 hydraulic engineer, 3 assistant engineers, 1 assistant chemist, and 3 junior engineers are on furlough; and 1 hydraulic engineer, 1 hydrographer, 3 assistant engineers, and 1 assistant geologist are employed occasionally.

In the clerical force there were 2 separations and 3 accessions. At the end of the year the force consisted of 2 senior clerks, 1 clerk, 9 junior clerks, 9 under clerks, 1 copyist, 1 stenographer, 1 clerk-stenographer, 1 draftsman, and 1 messenger boy.

ALLOTMENTS.

The appropriation was the same as in the preceding year ($150,000). The cooperative funds made available by State allotments have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

The appropriation for the fiscal year was allotted as follows:

Allotments of appropriation for investigation of water resources, 1914–15.

Administrative expenses of the Survey		$10,344
Branch administration		8,250
Computations and reports		17,000
Inspection		1,500
Stream gaging in—		
New York and New England States	$5,650	
Virginia and Maryland	600	
South Atlantic and Gulf States	5,500	
Ohio Valley	6,000	
Upper Mississippi Valley States	5,000	
Colorado and Wyoming	6,500	
Montana	4,500	
North Dakota	300	
Utah	4,500	
Nevada	2,500	
Idaho	4,500	
Oregon	4,500	
Washington	4,500	
California	4,500	
New Mexico	4,500	
Arizona	3,000	
Hawaii	5,000	
Yellowstone National Park	200	
		71,750
Investigation of ground waters, including quality of waters		17,500
Land-classification board		11,000
Water-power investigations		11,000
Contingent		1,656
		150,000

Of the total appropriation, 64 per cent was allotted for work in public-land States.

COOPERATION.

States.—Cooperative funds were allotted by several States as follows:

Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.

Alabama		$170
Arizona		3,900
California—		
State engineer	$6,700	
Conservation commission	1,300	
City of San Diego	1,000	
City of San Francisco	4,200	
		13,200
Colorado		480
Connecticut		1,000
Hawaii		15,400
Idaho		1,900
Illinois		3,400
Iowa		450
Kentucky		670
Maine		75
Massachusetts		3,350
Minnesota		2,100
Montana		2,500
Nevada		1,800
New Mexico		7,200
New York—		
State engineer	$1,400	
Conservation commission	10,500	
		11,900
North Dakota		350
Oregon		11,000
South Dakota		960
Utah		4,100
Vermont		900
Washington		5,950
West Virginia		400
Wisconsin		8,800
Wyoming		1,600
		103,555

The work done under cooperative agreements in the several States has been limited to stream gaging, except as indicated below.

In addition to a large amount of stream gaging in California, investigations of ground water were made in San Diego County and in Sacramento and Santa Clara valleys, and measurements of depths to the ground-water level were made in southern California.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii, besides stream gaging, measurements of precipitation and studies of water losses in irrigation canals were made.

A compilation of stream-flow records in Oregon is now in press.

A detailed study of the water supply and the present and possible future use of Sevier River, Utah, begun in 1914, was still in progress at the end of the fiscal year.

In addition to the cooperative work tabulated above, in which the States have furnished part of the money for examinations made by the Survey staff, investigations of ground waters in cooperation with the agricultural experiment stations of New Mexico and Arizona were continued as in previous years, the experiment stations making analyses of samples of water and soluble salts collected.

Reclamation Service.—Cooperation with the Reclamation Service in stream gaging has been continued. The gaging stations operated at the expense of the reclamation fund are on streams that are to furnish water to reclamation projects under construction by that Service. The field work of stream gaging is done by Survey engineers who are engaged in such work in the locality, and repayment of actual cost is made by the Reclamation Service through a transfer of funds.

Office of Indian Affairs.—Investigations and reports have been made at the request of the Commissioner of Indian Affairs in connection with the classification of lands within Indian reservations with regard to water-power and reservoir sites and for the purpose of locating ground-water supplies, as follows:

The investigation of the occurrence and availability of ground water in the Hopi and Navajo reservations was completed during the year, and a report was prepared for publication.

A report was made on the possibility of developing water power on Hogback Canal, in T. 12 N., Rs. 1 and 2 W., and T. 13 N., R. 2 W., New Mexico meridian, in the Navajo Reservation.

An investigation was made to determine the practicability of developing ground-water supplies for irrigation on the San Carlos Reservation.

A report was made on the power-site and reservoir possibilities on the Wind River Reservation.

Stream gaging was continued on the following Indian reservations, in accordance with authorizations of the Office of Indian Affairs: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Queniult, Rosebud, San Carlos, Standing Rock, Warm Springs, and Yakima.

Public Health Service.—Special stream-gaging work in cooperation with the Public Health Service in connection with an investigation of the pollution of Ohio River, begun in the previous year, was completed.

United States Engineer Office.—Stream gaging in connection with navigation and flood studies in the Ohio basin is in progress in cooperation with the United States Engineer Office.

City of San Francisco.—Stream gaging is in progress on Tuolumne River, in cooperation with the city of San Francisco, in connection

with the utilization of the water of that river, to be stored in the Hetch Hetchy Valley as a water supply for the city.

PUBLICATIONS.

The publications prepared by the water-resources branch comprised 33 water-supply papers and 18 separate chapters. Titles and brief summaries of these publications are given on pages 27–35. At the close of the year 24 other reports were in press and 6 manuscripts were in hand awaiting editing.

GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained 1,350 gaging stations for measuring the discharge of streams in 41 States and Hawaii. It is, however, only through extensive cooperation with States and other Federal organizations that the relatively large amount of work now in progress can be carried on. Twenty-six cooperating States (including Hawaii) have contributed more than $100,000 for work in those States, and the Reclamation Service, Indian Office, Army Engineers, and Public Health Service have also cooperated, largely in the study of the flow of particular rivers. The cooperating States include many Northern and Eastern States and all the States in the Rocky Mountain, Great Basin, and Pacific groups where water is necessary for agriculture by irrigation. At the close of the year gaging stations were being maintained at 1,350 points, including 129 in Hawaii. In addition, records were received from about 250 stations maintained by private enterprises. The resulting records of river discharge are published in an annual progress report consisting of 14 water-supply papers and in special water-supply papers.

Investigations of ground water have been made in 12 States, but the lack of funds prevents the comprehensive study of the occurrence, quantity, and quality that is commensurate with the importance of such water. This work should be greatly extended, especially in those sections of the arid States where further agricultural development can be made only by use of ground water. Several water-supply papers are published yearly containing the results of ground-water investigations.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of the public lands, with special reference to their use for power under permit or for agriculture under the enlarged-homestead, desert-land, or Carey acts. The results of such investigations appear generally in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

G. K. Gilbert, geologist, who has worked under the joint auspices of the geologic and water-resources branches, revised and enlarged his report on the "Hydraulic mining débris of the Sierra Nevada, California." The field work necessary for this revision consisted of two series of current observations—one series made in the Golden Gate opposite Fort Point, for the purpose of ascertaining certain tidal constants which affect the estimates of movements of mining débris delivered by the rivers to the San Francisco Bay system, and one series made in a slough near Ravenswood, Cal., for the purpose of determining the quantity of tidewater received and delivered by marshlands. Mr. Gilbert received important aid in these observations from the Lighthouse Service, the United States Army engineers, and the United States Coast and Geodetic Survey.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers, but includes also special investigations of conditions affecting stream flow and utilization of the streams. In carrying on the work the United States is divided into 16 districts, including Hawaii. Two of these districts were established during the year—New England, which was formed by dividing the North Atlantic district, and Arizona, which was formed by dividing the Arizona and New Mexico district. The New Mexico district was discontinued on June 30, 1915, and the work consolidated with that of the Rocky Mountain district. The following list gives the districts, names of the district engineers, and location of offices:

New England: C. H. Pierce, Customhouse, Boston, Mass.
New York: C. C. Covert, Federal Building, Albany, N. Y.
Middle Atlantic: G. C. Stevens, Washington, D. C.
South Atlantic and eastern Gulf: Warren E. Hall, Federal Building, Atlanta, Ga.
Ohio Valley: A. H. Horton, Federal Building, Newport, Ky.[1]
Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffice, Old Capitol Building, St. Paul, Minn.
Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.
Rocky Mountain: Robert Follansbee, Chamber of Commerce Building, Denver, Colo.
Great Basin: E. A. Porter, Federal Building, Salt Lake City, Utah.
Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.
Oregon: Fred F. Henshaw, Couch Building, Portland, Oreg.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.
Arizona: C. C. Jacob, 417 Fleming Building, Phoenix, Ariz.
New Mexico: G. A. Gray, Capital City Bank Building, Santa Fe, N. Mex.
Hawaii: G. K. Larrison, Kapiolani Building, Honolulu.

[1] Office temporarily closed during the year; work conducted from Washington office.

CHARACTER AND METHODS OF WORK.

Field investigations incident to the work are made from the district offices, where the results are sufficiently analyzed to insure their accuracy and completeness. At selected places, known as gaging stations, measurements of discharge are made and other data are collected from which the daily flow of the streams is computed. At the end of the year 1,350 gaging stations were maintained. During the year 408 stations were discontinued and 412 stations established. In addition, records ready for publication were received for about 250 stations from other Government bureaus and private persons. During the year 8,040 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

The following table shows the distribution of the stations and measurements by States and the number of stations maintained by cooperating parties:

Report of gaging stations and cooperating parties for the year ending June 30, 1915.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama				1				4				5		1	6	
Arizona		3		4	2			18		2	4	25	1	2	432	34
California		7	41	2		2	3	166	14	55	119	171	21	13	1,225	196
Colorado	3		29			1		12		5	2	48	6	18	208	3
Connecticut								1				1	1	2	14	2
Georgia	2					4			3	11	2	18	6		88	6
Idaho	5	10	7	10		3			1	28		64	3	32	303	41
Illinois						1		24				25	30	6	158	8
Indiana						1				1		2	1		1	1
Iowa						2		14			2	14	13	10	32	
Kentucky						1		5				6	5		7	4
Maine								14		8		22	25	3	19	
Maryland	3											3			19	
Massachusetts								11		7	1	17	7	2	84	20
Michigan								1	1	3		5				
Minnesota					2	2	1	28		1	6	28	4	13	111	1
Montana	11	55	16	7		1	2	20		1	1	112	2	16	385	25
Nebraska														13		
Nevada		5		2		1		38		15	19	42	21	39	286	97
New Hampshire										5		5	1		14	
New Jersey	1											1		1	1	
New Mexico		6	2	2				10		11	1	30	3	41	362	5
New York					1	3		40	1	5	10	40	3	3	264	58
North Carolina	2					1				8		11		1	9	
North Dakota				1				7				8			32	
Ohio	1				5		1		1			8	5	1	17	6
Oklahoma		4										4	1		2	
Oregon	5	1	4	5	1	4	1	20	3	44		88	31	45	345	169
Pennsylvania														3	2	4
Rhode Island										1		1	1			
South Carolina							1					1	1		14	
South Dakota				4				2				6	3	2	55	2
Tennessee	2					3				4		9	4		21	5
Texas	2	4				6			1			13	10	1	115	8
Utah		4	2					132		83	89	131	83	95	938	86
Vermont								7		2	1	8	4	6	36	8
Virginia	8					1				4		13	1	1	24	
Washington	7	22	8	12			2	6	1	31	1	88	18	20	378	32
West Virginia	18				13	1		7				39	16	1	71	4
Wisconsin				3	1			46		15	19	46	8	4	297	3
Wyoming		6	1			1	4	54			2	63	50	3	158	14
Hawaii					3			129		56	59	129	23	10	496	169
Total	70	127	110	52	29	39	15	816	26	406	338	1,350	412	408	7,029	1,011

NOTE.—Total for Hawaii June 30, 1914, should have been 116 instead of 141.

Results of field data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review insures accuracy in the data and brings the results from different parts of the country to a uniform standard. Regular field inspections are made and annual conferences of the engineers are held, whereby the work in the several districts is standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, as shown in the following table, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions. Prior to 1914 the records for each division were contained in a single water-supply paper; beginning with 1914 the reports for the twelfth division will be published as three separate papers.

In 1913 a seasonal or climatic year—October 1 to September 30—was adopted for the presentation of reports on regions west of the Rocky Mountains and on upper Mississippi and Ohio rivers; in 1914 the use of the climatic year was extended to all districts.

Numbers of water-supply papers containing results of stream measurements, 1910–1914.

Part—	Area.	1910	1911	1912	1913	1914
I	North Atlantic	281	301	321	351	381
II	South Atlantic and eastern Gulf of Mexico	282	302	322	352	382
III	Ohio River	283	303	323	353	383
IV	St. Lawrence River and Great Lakes	284	304	324	354	384
V	Hudson Bay and upper Mississippi River	285	305	325	355	385
VI	Missouri River	286	306	326	356	386
VII	Lower Mississippi River	287	307	327	357	387
VIII	Western Gulf of Mexico	288	308	328	358	388
IX	Colorado River	289	309	329	359	389
X	Great Basin	290, 291	310	330	360	390
XI	California	291	311	331	361	391
XII	North Pacific	292	312	332	362	.....
	Pacific basins in Washington and upper Columbia River	.....	.....	332–A	362–A	392
	Snake River basin	.....	.....	332–B	362–B	393
	Lower Columbia River and Pacific basins in Oregon	.....	.....	332–C	362–C	394

In addition to the regular progress reports, special reports on various hydraulic subjects have been completed for publication during the year, as is indicated in the list on pages 27–35.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The main function of the division of ground waters is to make a survey of the underground waters of the country with reference to their utilization. The investigations of each year form part of a comprehensive plan that includes the entire country. Because of

the great interest throughout the West in irrigation with ground water and the prospects for considerable developments of this kind, most of the work has been done in the arid and semiarid States and with special reference to irrigation.

The chemical investigations, which are under the supervision of R. B. Dole, cover both surface and ground waters. Progress was made in the preparation of a comprehensive report on the chemical composition of the surface waters of the United States by Mr. Dole, assisted by E. C. Bain, C. D. Parker, and A. A. Chambers. The chapter on the production of mineral waters for the annual volume Mineral Resources of the United States, with a history of the mineral-water trade of the United States since 1883, was prepared by Mr. Dole. Maps and manuscripts for geologic folios were reviewed so far as they related to ground water.

Nearly 40 investigations of ground water or quality of water (including the reports in press) were in progress, covering areas in Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Maine, Mississippi, Montana, Nevada, New Mexico, Oregon, Texas, and Washington. The work in Arkansas, Florida, Georgia, Mississippi, and Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch, and the work in Idaho was done by the division of water utilization. During the year 11 reports were completed and 10 were published.

WORK BY STATES.

Arizona.—A comprehensive report on the ground water of the Hopi and Navajo Indian reservations, in Arizona and adjacent parts of New Mexico and Utah, was completed by H. E. Gregory, who has been in charge of the investigation since its beginning in 1909. The report will be published as Water-Supply Paper 380. The ground-water conditions of an area west of Little Colorado River have also been investigated by Prof. Gregory, and a report covering the area is in preparation. Both investigations were made in cooperation with the Office of Indian Affairs.

By direction of the Secretary of the Interior, an investigation of the ground water in Paradise Valley, with special reference to its utilization for irrigation, was made by O. E. Meinzer and A. J. Ellis. A report on this investigation was completed and sent to press to be published as Water-Supply Paper 375–B. Analyses of water from this valley were made by the Arizona Agricultural Experiment Station.

An investigation of the ground water in the San Carlos Reservation with respect to its availability for irrigation was undertaken for the Office of Indian Affairs by A. T. Schwennesen, who completed the field work and is now preparing a report.

A short time was spent by Mr. Schwennesen in the San Simon Valley for the purpose of obtaining data on the yield and pressure of artesian wells in that valley. The San Simon investigation was begun in 1913 and was resumed in the summer of 1915. The water analyses are made by the Arizona Agricultural Experiment Station, through the cooperation of R. H. Forbes, director.

Arkansas.—The report on the geology and underground-water resources of eastern and northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters by R. B. Dole, was completed by the authors before the beginning of the fiscal year and is being prepared for the printer. It is to be published as a water-supply paper.

California.—A comprehensive report on the springs of California, by G. A. Waring, was published as Water-Supply Paper 338. It is based on extensive field work done by Mr. Waring in earlier years.

The field work for the ground-water survey of the Sacramento Valley, which was begun in September, 1912, was continued by Kirk Bryan, assisted by J. W. Muller, and was completed about January 1, 1915. A preliminary report by Mr. Bryan on ground water for irrigation in the Sacramento Valley was published as Water-Supply Paper 375–A, and considerable work was done on the maps and manuscript for the final report on the region.

Good progress was made during the year by W. O. Clark in the ground-water survey of the Santa Clara Valley, on which he has been engaged since August, 1912. A report on the ground-water resources of the Niles cone, which is a part of the Santa Clara Valley, was prepared by Mr. Clark and was published as Water-Supply Paper 345–H.

The final report on ground water in the San Joaquin Valley, by W. C. Mendenhall, R. B. Dole, and Herman Stabler, was completed and sent to the printer to be published as Water-Supply Paper 398. Some work was also done by W. C. Mendenhall and G. A. Waring on the San Jacinto Valley investigation.

An investigation of the ground-water resources of the part of San Diego County lying west of the divide was undertaken by A. J. Ellis and C. H. Lee, and most of the field work and considerable of the office work was completed. The results are to be embodied in a comprehensive report on the water resources of the county. The analytical work was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

Since 1900 measurements of depths of the water level in a series of wells in southern California have been made at intervals for the purpose of obtaining a record through many years of the relations between the contributions to the underground reservoirs in the rainy

seasons and the withdrawals from them in the dry seasons, when ground water is pumped for irrigation and when evaporation and transpiration are most rapid. Most of the records for the period prior to 1909 have been published in Water-Supply Papers 213 and 251; the records for 1909, 1910, and 1912, together with a brief discussion by W. C. Mendenhall, were published during the year in Water-Supply Paper 331. The work is at present being carried on by F. C. Ebert, who has selected companion wells and otherwise improved the methods. Mr. Ebert has also made progress in the tabulation of all available water-level data for the region.

All the ground-water work in California is supported by financial cooperation of the State Department of Engineering.

Connecticut.—The report on ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, by H. E. Gregory and A. J. Ellis, which was completed before the beginning of this fiscal year, is now in press as Water-Supply Paper 374.

The report on ground water in the Waterbury area, by A. J. Ellis, was completed during the year and was sent to the printer to be published as Water-Supply Paper 397.

An investigation of the relations between precipitation, ground-water storage, evaporation, and run-off in the Pomeraug Valley, begun in July, 1913, by A. J. Ellis, was continued, observations being made regularly during the year and the data tabulated and plotted.

A ground-water survey of the Meriden area was made by G. A. Waring, and 25 samples of water were collected for mineral analysis.

A ground-water survey of the Plainville area was made by H. S. Palmer, and at the close of the year work was in progress in other towns in the northeastern section of the State.

All the work in Connecticut is done in cooperation with the State Geological and Natural History Survey, W. N. Rice, superintendent, and is under the supervision of H. E. Gregory. The results of the various surveys will be published in water-supply papers.

Florida.—Some progress was made during the year on the investigation of the quality of ground waters in Florida, and work on this project is to be resumed by Mr. Dole in the near future. Daily samples of sea water from Fowey Rocks Light were tested for chlorine content in connection with Mr. Vaughan's study of oceanographic phenomena on the Florida coast.

Georgia.—The report on the ground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, with a discussion of the chemical character of the waters by Mr. Dole, was published as Water-Supply Paper 341. The investigation on which this report is based was conducted in cooperation with the Georgia Geological Survey.

Idaho.—An investigation of the ground water in the Fort Hall Indian Reservation was made by W. B. Heroy, and a report prepared by him was incorporated in a general paper on the geology and resources of the region which is to be published as a bulletin.

At the request of the division of drainage investigations, Department of Agriculture, an examination of water-level problems on irrigated lands in the vicinity of Twin Falls was made by Mr. Heroy, and a manuscript report by him on the causes and cure of the rising water levels was transmitted to the Department of Agriculture.

Maine.—At the request of the Secretary of the Navy, a brief examination of available water supplies in the vicinity of the Portsmouth Navy Yard was made by O. E. Meinzer.

Mississippi.—The division of ground water continued its cooperation with the section of Coastal Plain investigations of the geologic branch in the general investigation of ground water in Mississippi. (See pp. 50–51.) The analytical work was supervised by Mr. Dole.

Montana.—The report on the water resources of Butte, Mont., by O. E. Meinzer, was published as Water-Supply Paper 345–G.

Through the cooperation of the division of surface waters and A. W. Mahon, State engineer of Montana, steps were taken near the close of the year to collect the records of the most important wells in the State.

Nevada.—The report on ground water in southeastern Nevada by Everett Carpenter was published as Water-Supply Paper 365.

Additional field work was done by O. E. Meinzer in Big Smoky Valley, chiefly on the contributions of the streams to the underground supply. A preliminary report on this valley was prepared and sent to the printer to be published as Water-Supply Paper 375–D. The final report on the geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys was completed by Mr. Meinzer. The chemical work was done by S. C. Dinsmore.

Near the close of the year an investigation of water levels on the Truckee-Carson project was undertaken for the Department of Justice by C. H. Lee and W. O. Clark.

New Mexico.—The report on the Tularosa Basin and adjacent areas, by O. E. Meinzer and R. F. Hare, prepared in cooperation between the New Mexico Agricultural Experiment Station and the Survey, was published as Water-Supply Paper 343.

Work on the ground-water resources of southern Grant County, including the Animas, Playas, and Hachita valleys, was continued by A. T. Schwennesen, of the Survey, and Mr. Hare, of the experiment station, and at the close of the fiscal year the report was nearly completed.

The report on ground water in the Hopi and Navajo reservations, by H. E. Gregory, covers a part of northwestern New Mexico. (See Arizona, p. 144.)

A number of samples of water collected by Mr. Schwennesen in Luna County were analyzed by Mr. Hare at the experiment station.

Oregon.—The report on the quality of surface waters of Oregon, by Walton Van Winkle, prepared in cooperation with J. H. Lewis, State engineer of Oregon, was published as Water-Supply Paper 363.

Texas.—The work in Texas was done in cooperation with the section of Coastal Plain investigations, geologic branch, and was confined to the Coastal Plain.

The report on the geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen, was published as Water-Supply Paper 335.

A report on the ground-water supply of Lasalle and McMullen counties, by Alexander Deussen and R. B. Dole, was completed and is to be published as Water-Supply Paper 375–G.

Work was continued on the ground-water resources of the part of the Texas Coastal Plain not covered by Water-Supply Paper 335, and two papers are being prepared.

Washington.—The report on the quality of the surface waters of Washington, prepared by Walton Van Winkle in cooperation with the State board of health, was published as Water-Supply Paper 339.

DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization has been continued during the year, as described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been done in part by Messrs. La Rue and Murphy and in part by W. B. Heroy, geologist, and W. N. White, assistant classifier, in the land-classification board, who were detailed to the work during a portion of the field season. In addition to routine field work, Mr. La Rue has devoted about six months to the preparation of a manuscript relative to the present and probable future utilization of Colorado River for irrigation, power, and navigation. The report is practically complete and will be published as Water-Supply Paper 395. Mr. Murphy has made a field examination of the possibilities of water-power and reservoir development in Arizona and in the Gila drainage basin in New Mexico in order that lands valuable for such purposes may be designated in accordance with the act of Congress admitting Arizona and New Mexico to statehood. Reports based on these examinations were completed late in the year.

LAND-CLASSIFICATION BOARD.

ORGANIZATION.

Since the land-classification board became a separate branch, on May 1, 1912, its organization and its functions have remained practically stable. The work of the board consists of the receipt from the field branches of the results of investigations made for or adaptable to public-land classification and the transformation of those results into actual classifications, which become the basis of that part of the Department of the Interior's administration of the public-land laws that depends on the character of the lands.

The geologic branch, for example, examines the coal lands of the public domain. The results of the field examination are prepared in accordance with regulations and suggestions formulated by the board and are transmitted to it for use in making reports on the character of the lands or in preparing withdrawals, restorations, or valuations, as may be required. The geologic branch also studies the oil fields of the public domain and likewise reports the results, and after a careful consideration of these results by the land-classification board, the Director transmits to the Secretary of the Interior appropriate recommendations for the creation of petroleum reserves or for their cancellation, or takes any other appropriate action that will assist in the administration of the public-land laws applying to oil.

The topographic branch furnishes a share of the field data that form the basis of classification, not merely by the preparation of general topographic maps and the accompanying classification plats, which permit a study of drainage areas and irrigation possibilities, but by special profile surveys of streams that appear to have power value. These surveys enable the board to make close classification of lands according to their power value, and are valuable in the administration of the laws that control water-power development.

The water-resources branch, by its general work in the gaging of streams, is constantly assembling data essential to the classification of lands both as to power value and as to irrigability. Its ground-water division ascertains facts that are used in the classification required by the enlarged-homestead acts, and its division of water utilization makes examinations that furnish the groundwork necessary for the public-land classifications required by the laws which provide for the disposal of lands through the use of water.

The classifications required by our public-land laws fall into two broad groups—a group dependent on the presence or absence of mineral deposits in the land and a group dependent on the presence or absence of water. The board, in its organization, following this natural grouping of its problems, is composed of two divisions, a division of mineral classification and a division of hydrographic

classification. Sections are organized within each division to deal with each of the major subjects with which the division deals. The organization in outline is as follows:

W. C. Mendenhall, chief.
Elsie Patterson, secretary.
Division of mineral classification: Coal section, G. H. Ashley, chairman; E. R. Lloyd, vice chairman. Oil section, M. W. Ball, chairman. Phosphate section, A. R. Schultz, chairman. Metalliferous section, A. R. Schultz, chairman.
Division of hydrographic classification: Section of utilization, Herman Stabler, chairman. Section of classification, W. B. Heroy, chairman.

The staff of the board during the year, although it has varied because of temporary assignments made from time to time, has averaged about 37 persons, of whom 8 are geologists, 8 engineers, 3 draftsmen, 16 clerks of various grades, and 2 messengers. Several changes in the personnel have resulted from assignments of members of the board staff to other branches of the Survey and of assignments to the board to fill vacancies thus created or to take up work not heretofore adequately provided for.

FUNDS.

One of the primary functions of the Geological Survey specifically mentioned in "the organic act" approved March 3, 1879, is the classification of the public lands. Each of the three field branches of the organization, the geologic, the topographic, and the water resources, spends a part of its appropriation in field examinations whose results are submitted to the board for use in official land classification. Specific allotments for the board's office work are made by the Director from the general appropriations. These allotments for the fiscal year 1915 amounted to $58,000 and were distributed among the general appropriations as follows:

Geologic surveys	$31,500
Topographic surveys	11,500
Gaging streams	11,000
Salaries of scientific assistants	4,000
	58,000

GENERAL FEATURES OF THE WORK.

The field examinations made for coal-land classification during the last nine years have covered approximately the following areas in townships, a township comprising 23,040 acres.

Areas examined for coal-land classification by fiscal years from 1907 to 1915, measured in townships.

	Townships.		Townships.		Townships.
1907	296	1910	322	1913	188
1908	583	1911	339	1914	183
1909	443	1912	358	1915	96

The area remaining in coal withdrawals at the end of the fiscal year amounts, roughly, to 2,100 townships, which at the rate of examination this year will require about 22 years for classification.

The classifications of oil, potash, and metalliferous mineral lands during the year have affected smaller areas and the phosphate classifications somewhat larger areas than during preceding years. Most of the public lands in which the possibilities of the existence of valuable deposits of petroleum, phosphate, and potash are considered favorable have already been withdrawn, so that the field work of 1914–15 revealed relatively small additional promising areas, except as to phosphate. The tracing of the phosphate-bearing rocks around the west end of the Uinta Mountains in Utah added considerably to the phosphate territory heretofore known. The greater part of the nonoil and nonpotash lands had been eliminated from the reserves of those minerals as a result of earlier work. Consequently the changes in the areas reserved because of these resources have been relatively slight. Large eliminations were made from the phosphate withdrawals as a result of detailed mapping of parts of the reserves. These changes are summarized in the following table:

Lands withdrawn and restored to entry during the fiscal year ended June 30, 1915.

	Withdrawn.	Restored.
	Acres.	*Acres.*
Oil	197,073	180,818
Phosphate	273,221	454,894
Potash	119,224	2,880

Classification discriminating metalliferous from nonmetalliferous lands during the year covered nearly 1,000,000 acres, chiefly of Indian lands in Washington, Idaho, Arizona, and California. Much the greater part of this area proved to be nonmineral land.

The first great designations of land as nonirrigable for entry under the enlarged homestead acts were made promptly upon the passage of the first act—the act of February 19, 1909 (35 Stat., 639). Large areas were designated during the two succeeding years; small areas were added during 1912 and 1913, when the regulations required that only unpatented lands might be designated; and large areas have been designated during the last two years as a result of the increasing demand and the application of the law to several new States. The gross designations made each fiscal year since the passage of the act are indicated in the accompanying table.

Lands designated as irrigable or nonirrigable during the fiscal years 1909–1915.

	Acres.		Acres.
1909	161,428,184	1913	2,323,612
1910	18,383,201	1914	33,102,289
1911	11,030,598	1915	17,485,259
1912	1,201,513		

The increasing demand for this work and the responses that the board's limited force has been able to make to this demand are indicated in the following table of petitions for designation received during each year since the passage of the act and the number of the requests acted upon:

Petitions for designation of irrigable or nonirrigable lands received and acted on, 1909–1915.

Year.	Received.	Acted on.
1909	89	49
1910	256	245
1911	248	162
1912	511	299
1913	1,944	946
1914	5,709	5,399
1915	5,666	3,996

On June 30, 1915, there were 3,327 petitions pending and under consideration.

The changes during the year in the areas withdrawn as valuable for power development have been relatively small, the new withdrawals during the year aggregating 292,134 acres and the restorations 55,646 acres, the total area included in power site reserves at the end of the year being 2,228,105 acres.

SUMMARY.

No coal lands were withdrawn during the year, but 2,363,646 acres were restored, leaving outstanding withdrawn at the end of the year 48,244,274 acres. There was a decrease of 113,088 acres during the year in the area of coal land to which values had been given. This decrease is due to a reclassification as noncoal of certain areas heretofore classified as coal land and appraised. At the end of the year 19,489,771 acres had been valued at an average price of $40.60 an acre.

During the year 197,073 acres of oil land were withdrawn and 180,818 acres of nonoil land eliminated from withdrawals, leaving the net area included in oil withdrawals at the end of the year 4,774,418 acres.

The phosphate classifications during the year resulted in a withdrawal of 273,221 acres and a restoration of 454,894 acres, leaving the net area outstanding at the end of the year 2,660,376 acres.

During the year 119,224 acres were withdrawn for potash explorations and 2,880 acres were eliminated from existing withdrawals, leaving the withdrawn area at the end of the year 342,013 acres. On the basis of containing metalliferous minerals 967,210 acres, chiefly in Indian reservations, were classified. Of this total 929,916 acres were classified as nonmineral and 37,294 acres as mineral land. The

new withdrawals of land valuable for power sites during the year amounted to 292,134 acres, the restorations to 55,646 acres, leaving the area withdrawn at the end of the year for this purpose 2,228,105 acres. During the year 17,485,259 acres were classified as nonirrigable and were designated for entry under the enlarged-homestead act. The total area thus designated at the end of the year amounted to 235,596,180 acres.

NEW LEGISLATION.

During the fiscal year that ended June 30, 1915, several acts and amendments to acts were passed which affect the work of classifying the public lands. One of the most important of these was the act of July 17, 1914 (38 Stat., 509), which provides for "the appropriation, location, selection, entry, or purchase" under the nonmineral land laws of all lands withdrawn, classified, or valuable for phosphate, nitrate, potash, oil, gas, or asphaltic minerals with the reservation to the United States of the minerals for which the lands are withdrawn or are valuable. This act supplements the acts of March 3, 1909 (35 Stat., 844), June 22, 1910 (36 Stat., 583), and April 30, 1912 (37 Stat., 105), providing for nonmineral entry on coal lands, and permits agricultural entry and development on practically all lands now included in mineral reserves, which constitute much the greater portion of the total areas withdrawn under the act of June 25, 1910 (36 Stat., 847).

The total area withdrawn on June 30, 1915, was 58,494,844 acres. Of this total all the lands included in coal, oil, phosphate, and potash reserves, aggregating 56,021,081 acres, may now be entered under the nonmineral land laws, the remaining withdrawals of miscellaneous types, aggregating 2,473,763 acres, being not yet subject to agricultural entry. The passage of these acts thus greatly reduced the interference of the withdrawal policy with agricultural development and it can be still further reduced by a provision for agricultural entry of lands in power-site reserves with a reservation of all water-power rights to the Government. Legislation of this type has been advocated by the department, and such a provision has been included in the Ferris bill (H. R. 16673, 63d Cong., 3d sess.).

Four new laws, or amendments to old laws, were passed at the close of the third session of the Sixty-third Congress, which very definitely affect the rights of homesteaders and the procedure under the enlarged-homestead acts. The act of March 3, 1915 (38 Stat., 953), and section 2 of the act of March 4, 1915 (38 Stat., 1163), extended the residence provisions of the enlarged-homestead acts to two additional States, namely, Kansas and South Dakota, so that these acts now apply to 14 States. The amendment of March 3, 1915 (38 Stat., 956), the act of March 4, 1915 (38 Stat., 1162), and section 1

of the act of March 4, 1915 (38 Stat., 1163), constitute a series of supplementary acts which together form important new legislation affecting homesteaders and the administration of the enlarged-homestead laws. Before these acts were passed, homestead entrymen who had received final certificates or patents on 160-acre homesteads were barred from participation in the advantages of the enlarged-homestead laws. Applicants for designations under these laws secured no recognized rights or equities by virtue of their application, and before the desired additional land could be classified it might be acquired under the ordinary homestead laws by another entryman and the applicant under the enlarged-homestead act be left without remedy. The amendment of March 3, 1915 (38 Stat., 956), provides that any homestead entryman who, although he may have submitted final proof or received patent to his entry, still owns and occupies the land entered shall have the right to enter a tract contiguous to the original entry, provided that the two entries together shall not exceed 320 acres in area. Section 1 of the amendment of March 4, 1915 (38 Stat., 1163), provides that an application to enter lands under the enlarged-homestead acts shall operate to reserve these lands from other entry until the Secretary of the Interior shall have determined whether they are subject to acquisition under the enlarged-homestead act. If his decision is favorable and he designates the land, the applicant shall then have a preference right to enter the lands. This series of supplementary laws is completed by the act of March 4, 1915 (38 Stat., 1162), which provides that enlarged homestead entries which were pending on January 1, 1914, but were invalid because title to the original entry had already been acquired under the homestead laws, are validated if the original entry was for less than 160 acres.

Since the act of March 4, 1915, provides that those who desire to secure a preference right to entry, subject to the designation by the Secretary of the Interior of the lands as nonirrigable, must file their applications with the register and receiver of the land district in which the land desired is located, and since the majority of the applicants under the enlarged-homestead laws desire to take advantage of the preference right feature of this law, most of the applications are now received through the General Land Office instead of directly by the Geological Survey or the Secretary's office as heretofore. The General Land Office and the Geological Survey have provided for this new procedure. Regulations have been prepared and issued defining it and a circular on the subject may be obtained at local land offices by applicants who desire to take advantage of this act.

CORRESPONDENCE.

During the fiscal year just closed 19,151 letters were referred to the board, an increase of about 23 per cent over the preceding year. In addition, about 6,000 copies of letters from other bureaus were sent to the board for its information and files. During the same period 18,457 letters, reports, acknowledgments, and notifications were prepared in the board, an average of about 63 incoming and 60 outgoing pieces of mail for each working day of the year.

PUBLICATIONS.

During the year a bulletin entitled "Petroleum withdrawals and restorations affecting the public domain" has been prepared by Max W. Ball and Lucetta W. Stockbridge and submitted for publication. This bulletin gives true and accurate copies of all petroleum withdrawals and restorations. It contains chapters on purpose of the withdrawals, history of the withdrawals, oil-land law, and orders and correspondence, and is illustrated by seven maps. No bulletin of this kind has ever been published, and it is believed that it will be of great value to the Survey, to the Land Office, and to individuals interested in the oil industry in the public-land States.

COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey through which the Survey's information on the mineral and power value of lands sought under the public-land laws is made available to the department, through the General Land Office, was partly suspended during the fiscal year 1913–14 because the land board's staff and allotments were insufficient to keep the work current. As a consequence of the suspension the cases awaiting action in the Survey were nearly all disposed of by the beginning of the fiscal year 1915 and cooperation was resumed in part soon thereafter. As a result of this resumption, the Survey received during the year 9,046 requests from the General Land Office for information as to the mineral character or the relations to water supplies of public lands sought, and it furnished information in 7,364 cases. It also received 2,710 reports of the field examiners of the Land Office for consideration, and it acted on 2,576 reports of this character.

The following table shows the year's record in the several classes of cooperative cases, including those discussed and including also requests for the designation of lands under the enlarged-homestead act. With the passage of the preference-right act (38 Stat., 1163) and the tendency as a consequence to file enlarged-homestead petitions in the local land offices instead of in the Geological Survey, this type of work comes to resemble more closely, in the manner in which it is handled, the other cooperative work between the two bureaus.

General summary of cooperative cases for the fiscal year 1915.

Classes of cases.	Pending July 1, 1914.	Received during fiscal year.	Disposed of during fiscal year.	Pending June 30, 1915.	Gain (+) or loss (−).
Mineral character only:					
General Land Office requests for information	12	451	283	180	− 168
General Land Office field service reports	85	1,458	1,387	156	− 71
Applications for reclassification as to coal	0	10	9	1	− 1
Applications for classification as to coal	3	18	17	4	− 1
	100	1,937	1,696	341	241
Water resources only:					
General Land Office requests for information	14	125	118	21	− 7
General Land Office field service reports	16	67	65	18	− 2
Cases in national forests	2	67	63	6	− 4
Applications for reclassification as to water resources	13	49	51	11	+ 2
Applications for rights of way	110	460	465	105	+ 5
Lists under Carey Act	0	7	6	1	− 1
Petitions under enlarged-homestead act	1,657	5,666	3,996	3,327	−1,670
Desert-land proofs under irrigation projects	119	151	180	90	+ 29
	1,931	6,592	4,944	3,579	−1,648
Mineral character and water resources:					
General Land Office requests for information	137	7,944	6,382	1,699	−1,562
General Land Office field service reports	60	659	643	76	− 16
General Land Office requests for information as to water resources, accompanied by field service reports as to mineral character	36	526	481	81	− 45
Indian Office requests for information	35	123	148	10	+ 25
	268	9,252	7,654	1,866	−1,598
	2,299	17,781	14,294	5,786	−3,487

MINERAL CLASSIFICATION.

COAL.

Regulations.—The regulations governing the classification and valuation of coal lands approved by Secretary Fisher February 20, 1913,[1] have continued in force during the fiscal year, except that by a decision of Secretary Lane on February 16, 1915, the last part of paragraph 2 was revoked, the department holding that legally classification of coal land must be made by quarter quarter sections and surveyed lots and not by minor subdivisions of $2\frac{1}{2}$ or 10 acres. In the comparatively short time that these regulations have been in force they have proved the soundness of the principles underlying them. Certain modifications may become necessary as knowledge of the chemistry of coal is increased and as further statistics are collected bearing on cost of mining and other factors affecting the value of coal lands. The regulations as they now stand furnish what is believed to be a sound and conservative standard for the classification and valuation of land underlain by coal of any quality or thickness.

Withdrawals and restorations.—No withdrawals of coal land were made during the year. The policy of reducing the outstanding withdrawals was continued in so far as the data available and the demands of other work would permit.

[1] U. S. Geol. Survey Bull. 537, pp. 96–97, 1913.

Classifications.—During the last year, as in previous years, every effort has been made to obtain information with regard to withdrawn areas which were believed to be largely noncoal land in order that, as rapidly as possible, those areas might be eliminated from the withdrawals. The results in acreage classified—2,902,628 acres—are far below those of previous years, partly because of the previous elimination from withdrawal of the larger noncoal areas and a consequent restriction of field examination to more detailed work on coal lands, but chiefly because of the short season of field work in 1914. Reexamination of parts of Wyoming, Colorado, and Utah which had previously, on very meager evidence, been classified as coal land resulted in the reclassification of large areas, so that the net result of the classifications during the fiscal year is a reduction of outstanding classified coal lands by 24,568 acres.

In the following four tables the results of restorations, classifications, and appraisals during the year are summarized by States:

Coal land restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	118,718	.....	118,718
California	17,764	121	17,643
Colorado	4,746,663	137,097	4,609,566
Idaho	338,452	.....	338,452
Montana	14,203,365	1,204,250	12,999,115
Nevada	83,833	.....	83,833
New Mexico	5,549,883	126,228	5,423,655
North Dakota	15,202,533	465	15,202,068
Oregon	26,561	.....	26,561
Utah	5,988,064	291,448	5,696,616
Washington	1,380,928	533,036	847,892
Wyoming	2,951,156	71,001	2,880,155
	50,607,920	2,363,646	48,244,274

Coal lands classified and appraised during the fiscal year 1915, in acres.

State.	Total classification.		Reclassification.		Net increase or decrease (shown by minus sign) in outstanding classification.		Coal land appraised.	
	Coal land with and without valuation.	Noncoal.	Coal land reclassified as coal.	Noncoal reclassified as coal.	Coal.	Noncoal.	Total coal land appraised.	Appraised coal land reclassified as noncoal.
California	.....	121	.....	.....	.....	121	.....	.....
Colorado	183,302	226,793	191,544	81,454	— 8,242	145,339	182,487	191,544
Montana	83,635	1,278,744	72,891	1,668	10,744	1,277,076	82,117	72,891
New Mexico	7,073	340,394	5,448	.....	1,625	340,394	7,073	5,448
North Dakota	319	40	.....	.....	319	40	319	.....
South Dakota	.....	10	10	.....	— 10	10	.....	10
Utah	1,980	291,686	2,138	80	— 158	291,606	1,980	2,138
Washington	86,867	175,573	.....	.....	86,867	175,573	640	.....
Wyoming	18,039	208,052	133,752	26,595	—115,713	181,457	[a] 18,079	133,752
	381,215	2,521,413	405,783	109,797	— 24,568	2,411,616	292,695	405,783

[a] Includes 40 acres previously classified but not appraised.

Net result of coal-land classification to June 30, 1915, in acres.

State.	Outstanding classification July 1, 1914.		Net result of classifications during fiscal year (decrease in area shown by minus sign).		Outstanding classification June 30, 1915.		
	Coal.	Noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.
Arizona	.....	42,492	.....	.....	.....	42,492	42,492
Arkansas	60,715	70,038	.....	.....	60,715	70,038	130,753
California	8,720	228,381	.....	121	8,720	228,502	237,222
Colorado	3,373,389	9,101,579	— 8,242	145,339	[a] 3,365,147	9,246,918	12,612,065
Idaho	2,113	7,936,925	.....	.....	2,113	7,936,925	7,939,038
Montana	4,844,646	18,910,206	10,744	1,277,076	4,855,390	20,187,282	25,042,672
Nevada	5,880	2,428	.....	.....	5,880	2,428	8,308
New Mexico	976,419	3,232,564	1,625	340,394	978,044	3,572,958	4,551,002
North Dakota	2,099,324	2,911,631	319	40	2,099,643	2,911,671	5,011,314
Oregon	14,921	1,044,448	.....	.....	14,921	1,044,448	1,059,369
South Dakota	249,897	6,956,334	— 10	10	[a] 249,887	6,956,344	7,206,231
Utah	1,066,622	2,627,892	— 158	291,606	[a] 1,066,464	2,919,498	3,985,962
Washington	62,073	1,386,098	86,867	175,573	148,940	1,561,671	1,710,611
Wyoming	7,736,838	14,659,271	—115,713	181,457	[a] 7,621,125	14,840,728	22,461,853
	20,501,557	69,110,287	— 24,568	2,411,616	[a] 20,476,989	71,521,903	91,998,892

[a] Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

Valuation of coal lands June 30, 1915.

State.	Appraised coal land July 1, 1914.	Net result of appraisals during fiscal year (decrease in appraised areas during year shown by minus sign).	Total appraised land outstanding June 30, 1915.	Total valuation of appraised coal land.	Average value per acre.
	Acres.	*Acres.*	*Acres.*		
Arkansas	60,715	.....	60,715	$1,473,762	$24.20
California	7,720	.....	7,720	585,086	75.70
Colorado	2,871,920	— 9,057	[a] 2,862,863	186,110,238	65.00
Idaho	2,113	.....	2,113	51,824	24.50
Montana	4,731,621	9,226	4,740,847	116,180,286	24.50
Nevada	5,880	.....	5,880	117,600	20.00
New Mexico	958,467	1,625	960,092	21,252,657	22.10
North Dakota	2,099,324	319	2,099,643	34,065,935	16.20
Oregon	4,672	.....	4,672	79,259	16.90
South Dakota	249,897	— 10	[a] 249,887	2,756,227	11.00
Utah	1,048,501	— 158	[a] 1,048,343	44,080,759	42.00
Washington	100	640	740	16,000	21.60
Wyoming	7,561,929	—115,672	[a] 7,446,256	385,344,887	51.70
	19,602,859	—113,088	[a] 19,489,771	792,114,520	40.60

[a] Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

Applications for classification and reclassification.—During the fiscal year the Survey received 18 applications for the classification of withdrawn lands either as coal or noncoal land and 10 applications for the revision of outstanding coal and noncoal classifications. Because three of these applications asked for noncoal classification in withdrawn areas regarding which the Survey has no detailed data, and because the evidence submitted by the applicants to show that the land is noncoal was of little value, these requests were not granted. On the other hand, most of the applications for classification as coal

land have related to lignite areas, and the applicants have been able to supply sufficient information to warrant the action requested. More than two-thirds of the applications for classification have been granted. The requests for reclassification as noncoal have related mainly to areas of flat-lying beds where, because no coal is exposed on or near the land, claimants have been unwilling to accept the coal classification. Five such applications have been made and denied.

OIL.

The classification of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California and Wyoming.

In California more than 43,000 acres, principally in Kern County, but in part in San Luis Obispo County, were restored to entry, field examination by the Survey having shown these lands to be barren of oil. No withdrawals were made in California during the year. A recomputation of the acreage included in existing withdrawals was made, however, and it indicated that the area reported as outstanding on June 30, 1914 (see Thirty-fifth Annual Report, p. 135), was too small by more than 140,000 acres.

In Wyoming, as a result of geologic evidence obtained by detailed field examination, nearly 130,000 acres were restored in Natrona County and approximately 7,500 acres in Hot Springs County. In Natrona County more than 12,000 acres, and in the Bighorn Basin, in the north-central part of the State, approximately 183,000 acres, were withdrawn as a result of field work by the Survey. The lands withdrawn in the Bighorn Basin lie largely in Hot Springs County, but include also areas in Park County and a small area in Washakie County. There was a net increase during the period of a little less than 60,000 acres in the area withdrawn in Wyoming. The areas withdrawn in Arizona, Colorado, Louisiana, and Utah have not been either increased or decreased during the year.

The following table shows the areas withdrawn during the fiscal year and the total areas included in reserves at its close:

Oil lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	230,400	.....	.....	230,433
California	1,550,848	(a)	43,301	a 1,507,547
Colorado	87,474	.....	.....	87,474
Louisana	414,720	.....	.....	414,720
Utah	1,952,326	.....	.....	1,952,326
Wyoming	522,395	197,073	137,517	581,951
	4,758,163	197,073	180,818	4,774,418

a Recomputation of outstanding oil withdrawals in California shows that the areas previously reported should be increased by 140,404 acres.

Of especial interest during the year was the creation of Naval Petroleum Reserve No. 3. This reserve includes 9,481 acres in Natrona County, Wyo., and covers the Teapot dome immediately southwest of the Salt Creek field. This dome is as yet untouched by the drill. The lands included in the reserve were segregated from an outstanding withdrawal, so that its creation did not involve an increase in the acreage of lands withdrawn.

PHOSPHATE.

The classification of phosphate deposits in Florida, Idaho, Utah, and Wyoming was continued during the fiscal year without change in procedure. The regulations governing the withdrawal and restoration of phosphate lands have not been modified since they were adopted by the Survey on March 2, 1912.

Phosphate classification during the fiscal year was based on preliminary examinations in new areas and on detailed examinations in the withdrawn areas. These detailed examinations by the Geological Survey have resulted in material modifications of the outstanding reserves in Idaho and Wyoming. No phosphate examinations were made by the Survey in Florida, but field investigation by the General Land Office resulted in the withdrawal of a small area in that State. Of especial interest is new information, gathered during the year, showing the presence of phosphate on both the north and south sides of the Uinta Range in Utah. The reconnaissance field work in this region led to the withdrawal of additional lands, aggregating 224,558 acres, not previously known to contain phosphate beds.

The results of the phosphate examinations for the fiscal year, in so far as action toward classification has been taken, are set forth in the following summary:

Phosphate lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Florida	120,377	120	280	120,217
Idaho	1,001,276	5,678	40,577	966,377
Montana	130,215	.....	.....	130,215
Utah	36,193	224,558	.....	260,751
Wyoming	1,553,988	42,865	414,037	1,182,816
	2,842,049	273,221	454,894	2,660,376

The year's activities resulted in a net reduction of 181,673 acres in the reserves outstanding at the beginning of the year, this figure representing the excess of the restorations over the withdrawals.

POTASH.

Field work by the Survey in search of potash was continued during the fiscal year. As in previous years, the work was largely exploratory. Experimental drilling in old lake basins is being followed by

sinking deep exploratory wells. The year's activities resulted in the withdrawal of 119,224 acres in the Smoke Creek Desert, in Nevada, and in the additional restoration of 2,880 acres of unsurveyed lands west of Searles Lake, in California, included in Potash Reserve No. 2, California No. 1, other lands in that reserve having been restored during the preceding fiscal year.

Potash lands withdrawn and restored during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
California	94,087	.....	2,880	91,207
Nevada	131,582	119,224	.....	250,806
	225,669	119,224	2,880	342,013

METALLIFEROUS LANDS.

The act of February 26, 1895 (28 Stat., 683), made provision for classifying, with respect to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 739). At the request of the General Land Office the work is being done by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work was continued during 1911, 1912, 1913, 1914, and 1915 and is nearing completion. The results of the Northern Pacific Railroad classification work for the five years are shown in the following table:

Lands in Northern Pacific Railroad grant in Idaho and Montana classified by the United States Geological Survey, by fiscal years, 1911–1915, in acres.

State.	1911	1912	1913	1914	1915	Total.
Idaho:						
Mineral	45,645	19,144	1,000	.....	.....	65,789
Nonmineral	90,712	53,055	1,200	.....	.....	144,967
	136,357	72,199	2,200	.....	.....	210,756
Montana:						
Mineral	130,386	1,134	19,800	480	6,629	158,429
Nonmineral	21,802	83,981	65,570	7,696	7,911	186,960
	152,188	85,115	85,370	8,176	14,540	345,389
Total:						
Mineral	176,031	20,278	20,800	480	6,629	224,218
Nonmineral	112,514	137,036	66,770	7,696	7,911	331,927
	288,545	157,314	87,570	8,176	14,540	556,145

In addition to the above work, examinations were made of the Colorado Indian Reservation in Arizona and California in 1914 for the Office of Indian Affairs, and classification of the reservation was reported to the Commissioner of Indian Affairs in March, 1915.

During the summer of 1914 an examination of the Snake River gravels in the Fort Hall Indian Reservation was completed by the Survey for the Office of Indian Affairs.

An examination of the Yuma Indian Reservation, in California, during the field season of 1914 resulted in the completion of the mineral classification for the Office of Indian Affairs, and the completed classification has been reported to that office.

During the summer of 1914 the Queniult Indian Reservation, Washington, was examined for the Office of Indian Affairs, and the lands therein were classified and reported on as to their value for all minerals except the oil and gas in a few sections.

Metalliferous classifications made during the fiscal year 1915, in acres.

State.	Mineral.	Non-mineral.	Total.
Arizona	31,934	214,048	245,982
California	5,360	78,338	83,698
Idaho	.....	447,940	447,940
Washington	.....	189,590	189,590
	37,294	929,916	967,210

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

Withdrawals and restorations.—The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1913, the area included in outstanding withdrawals was 1,898,405 acres. During the year 292,134 acres additional were withdrawn and 55,646 acres previously included in power-site reserves were restored to the public domain. On June 30, 1914, the total area withdrawn in connection with water power was 2,228,105 acres.

The following table shows the action taken during the year and the areas outstanding, classified by States:

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	New withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1915.
Alabama	120			120
Alaska		68,200		68,200
Arkansas	17,704			17,704
Arizona	190,431	147,000		337,431
California	222,769	33,201	280	555,690
Colorado	270,390			270,390
Idaho	272,759	5,082	24,868	252,973
Michigan		1,240		1,240
Minnesota	11,020			11,020
Montana	157,041	510	2,200	155,351
Nebraska	761			761
Nevada	19,087	7,224		26,311
New Mexico	13,577			13,577
Oregon	266,710	656	4,040	263,326
Utah	378,147	2,603	18,160	362,590
Washington	97,537	7,507	988	104,056
Wyoming	73,564	18,911	5,110	87,365
	1,991,617	292,134	55,646	2,228,105

Applications for reclassification.—At the beginning of the fiscal year 13 applications for the reclassification of lands included in power-site reserves were awaiting action and during the year 49 were received. Out of this total of 62 cases action was taken on 51, leaving 11 pending at the close of the year.

Right-of-way applications.—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1253, 1254), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes relating to the development of water power. Such applications, when received in proper form at the General Land Office, are now forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared setting forth terms on which the use of the desired right of way is to be conditioned, and a report is made on the circumstances in the case. On June 29, 1915, the Attorney General held that the act of February 15, 1901, is applicable to the Territory of Alaska, the field for development of power under permit being thereby extended.

In addition to applications for rights of way for hydroelectric development a large number of applications for rights of way of other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respec-

tively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way under the act of March 3, 1891 (26 Stat., 1095), for irrigation uses on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply. The number of each type received and the action taken thereon is indicated in the following table:

Applications for rights of way during the fiscal year 1915.

Classes.	Pending July 1, 1914.	Received during fiscal year.	Acted on during fiscal year.	Pending June 30, 1915.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 404), etc	30	118	119	29
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc	16	218	205	29
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1253, 1254), etc	53	31	45	39
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 11, 1898 (30 Stat., 404), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc	11	93	96	8
Total number of applications for original consideration	110	460	465	105
Additional applications for reconsideration	47	67	76	38

NOTE.—The first application received from the Secretary's office was dated Oct. 11, 1909; from the General Land Office Nov. 11, 1909; from the Office of Indian Affairs Dec. 23, 1909.

IRRIGATION.

Reservoir withdrawals.—A number of reservoir sites, valuable principally for the storage of water for irrigation, have been examined by the Geological Survey, and, on its recommendation, the lands they include have been withdrawn from entry. The area included in such withdrawals at the close of the fiscal year is shown in the following table:

Reservoir sites restored to entry during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Restorations during fiscal year.	Outstanding June 30, 1915.
Arizona	33,040	.....	23,040
Montana	15,640	.....	15,640
North Dakota	1,569	.....	1,569
Oregon	10,619	.....	10,619
South Dakota	8,542	8,542	.....
Washington	35,943	.....	35,943
	95,353	8,542	86,811

Carey Act segregations.—During the year 7 proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands, and reports on 6 of these lists had been submitted before the fiscal year closed. Supplemental reports on 3 other lists were also furnished.

Irrigation projects.—The Geological Survey, by instructions of the Secretary of the Interior dated March 15, 1913, furnishes to the Commissioner of the General Land Office all information at hand relative to the available water supply and the feasibility of irrigation projects whose water rights or shares are presented as evidence of compliance with the requirements of the desert-land act. During the year 151 such cases were received and 119 were carried over from the preceding year. Of these 270 cases 162 were reported on and 90 were pending June 30, 1914. Supplemental reports were rendered on 18 cases.

ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), and June 13, 1912 (37 Stat., 132), was continued during the year. By the act of March 3, 1915 (38 Stat., 953), the enlarged-homestead act was extended to Kansas, and by the act of March 4, 1915 (38 Stat., 1163), to South Dakota, making the act now applicable to 14 States. Designations during the fiscal year have added a large area of land to that previously classified, the added land having been included as a result of investigations of surface and underground water. The following table summarizes the work of the year:

Enlarged-homestead designations during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Designations during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1915.
Arizona	24,530,036	501,981	.....	25,032,017
California	850,506	1,146,092	.....	1,996,598
Colorado	24,293,297	539,947	111,082	24,722,162
Idaho:				
Sections 1–5	7,193,220	1,289,074	27,189	8,455,105
Section 6	53,316	33,598	121	86,793
	7,246,536	1,322,672	27,310	8,541,898
Kansas	.....	277,605	.....	277,605
Montana	42,997,071	3,766,349	2,607	46,760,813
Nevada	46,303,933	1,264	.....	46,305,197
New Mexico	19,045,996	4,328,545	.....	23,374,541
North Dakota	8,379,764	360,057	314	8,739,507
Oregon	14,869,825	2,066,723	.....	16,936,548
South Dakota	.....	1,756,332	.....	1,756,332
Utah:				
Sections 1–5	6,966,309	181,244	160	7,147,393
Section 6	1,217,106	2,606	680	1,219,032
	8,183,415	183,850	840	8,366,425
Washington	3,660,853	384,688	28,654	4,016,887
Wyoming	17,920,496	849,154	.....	18,796,650
	218,281,728	17,485,259	170,807	235,596,180

The general provisions of the acts, which apply in all 14 States, permit the entry by one person of 320 acres of "nonmineral, nonirrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, "susceptible of successful irrigation at a reasonable cost from any known source of water supply." Under the provisions of section 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho, the Secretary may further designate lands which do not have upon them "such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible," and entrymen upon such lands are relieved of the necessity of residence. By the act of March 3, 1915 (38 Stat., 956), the enlarged homestead act was amended so as to permit, under certain conditions, an additional entry, though final proof has already been submitted on the original entry.

Designations under the enlarged-homestead act are made either in large, compact areas, as a result of field investigations covering rather large districts, or in small units, as a result of investigations made at the request of prospective entrymen. These requests are referred to as enlarged homestead petitions, and because of the fact that the larger areas of land to which the acts are believed to be applicable have already been designated, the record of the year shows a large increase in the number of petitions received. This has in part been the result of the extension of enlarged homesteads to two additional States and in part of the passage of the act of March 4, 1915 (38 Stat., 1163), which provides that a preference right to enter the lands designated can be secured by the filing of an application at the local land office of the district in which the lands are situated. The following table indicates the disposition made of petitions received during the year:

Action on petitions under the enlarged-homestead acts during the fiscal year 1915.

State.	Pending July 1, 1914.	Received during fiscal year.	Action taken.			Total acted on.	Pending June 30, 1915.	Cases reconsidered.
			All designated.	Part designated.	Refused.			
Arizona	8	51	37	2	7	46	13	3
California	66	333	210	0	27	237	162	10
Colorado	54	257	106	12	51	169	142	17
Idaho	481	826	473	45	397	915	392	122
Kansas	0	194	63	1	1	65	129	0
Montana	619	1,803	1,061	124	162	1,347	1,075	81
Nevada	0	12	3	0	0	3	9	0
New Mexico	42	293	174	35	38	247	88	22
North Dakota	67	111	131	7	17	155	23	46
Oregon	136	336	327	40	41	408	64	35
South Dakota	0	905	52	1	1	54	851	0
Utah	79	197	41	3	18	62	214	3
Washington	39	127	104	7	7	118	48	3
Wyoming	66	221	126	26	18	170	117	30
	1,657	5,666	2,908	303	785	3,996	3,327	372

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations June 30, 1915, has been printed.

PUBLIC WATER RESERVES.

As information has become available recommendations have continued to be made for the creation of public water reserves, in order that important springs and sources of stock water on the desert and semiarid range lands may remain accessible to the public. Additions amounting to 19,257 acres have been made during the year to reserves of this type. The action taken is summarized in the following table:

Public water reserves withdrawn from entry and restored to entry during the fiscal year 1915, in acres.

State.	Outstanding July 1, 1914.	Withdrawn during fiscal year.	Restored to entry during fiscal year.	Outstanding June 30, 1915.
Arizona	1,200	1,918	126	2,992
California	43,524	7,030	.....	50,554
Colorado	480	.....	.....	480
Idaho	.....	5,765	.....	5,765
Montana	.....	1,040	.....	1,040
Nevada	.....	1,464	.....	1,464
New Mexico	1,440	.....	.....	1,440
Oregon	2,500	.....	.....	2,500
Utah	32,707	1,520	240	33,987
Wyoming	81,911	520	.....	82,431
	163,762	19,257	366	182,653

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 48,911 pages of manuscript were edited and prepared for printing and proof sheets for 21,407 final printed pages were read and corrected. This work involved the handling of 5,099 galley proofs and 35,522 page proofs. The corresponding figures for 1913–14 were 47,751 pages of manuscript, 16,786 final printed pages, 4,574 galley proofs, and 28,202 page proofs. Indexes were prepared for 66 publications, covering 16,723 pages; the figures for the previous year were 56 publications and 11,143 pages. The list given on pages 16–37 shows the number, scope, and character of the reports issued during the year.

At the close of the fiscal year eight persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 3,553, comprising 191 maps, 765 photographs prepared for reproduction, 905 diagrams and sections, 1,480 paleontologic drawings and photographs, and 212 miscellaneous. The processes used for the reproduction of the illustrations sent to the printer and the number reproduced by each process were as follows: Chromolithography and photolithography, 185 subjects; halftone engraving, 674 subjects; zinc etching, 553 subjects; wax engraving, 1 subject; cuts already engraved, 74 subjects. Proofs to the number of 2,000, including 380 revises, were received and compared critically. The finished work representing all the lithographs furnished by contractors was examined. Electrotypes of 99 cuts were furnished to outside applicants. At the close of the year material for illustrating 24 reports was in preparation.

As in previous years, a cost record has been maintained. The personnel of the section at the close of the year consists of the chief of the section, 9 draftsmen, 1 under clerk, and 1 messenger boy.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 187 new books, 16 reprinted books, 3 new geologic folios, 17 geologic maps, 3 revised and reprinted geologic folios, 8 revised geologic maps, 4 reprints of geologic maps, 90 new topographic maps, 9 revised maps, 8 photolithographs, and 98 reprints of maps, a total of 443 publications. The total of all editions received was 689,192 books, 24,066 geologic folios, and 711,711 maps, a grand total of 1,424,969. This does not include pamphlets for administrative use, such as lists of publications and index maps.

There were distributed 596,649 books, 23,588 folios, and 487,049 maps, including 136 books, 16,583 folios, and 342,404 maps sold, a total of 1,107,286, an increase in books and maps and a decrease in folios, the demand originating from the low-priced sale of folios because of fire damage being largely satisfied last year.

The total amount received and turned into the Treasury as the result of sales of publications was $27,711.12. The sales of topographic and geologic maps amounted to $26,030.97, of topographic and geologic folios $1,400.15, and of books $280.

Sixteen persons were employed in this section during the year, and 84,788 letters were received and answered during that period.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

This section continued in charge of George W. Stose, geologist, who directed the publication of the maps and illustrations of the geologic folios and critically reviewed all geologic maps intended for publication in other reports of the Survey.

Twenty-seven folios were handled in the section during the year. Six folios were completed and published during the year—Nos. 193 to 195, inclusive, and reprints of Nos. 112, 148, and 155, which were out of stock and were revised and brought up to date. The three new folios are noticed in the list of publications on page 36.

At the close of the fiscal year the maps and illustrations of folios 196 (Philipsburg, Mont.), 197 (Columbus, Ohio), and 198 (Castle Rock, Colo.) were complete and their texts were in proof, so that these three folios will be issued soon. The maps and structure sections of folios 199 (Silver City, N. Mex.), 200 (Galena-Elizabeth, Ill.), and 202 (Eureka Springs-Harrison, Ark.) were also printed, and the other illustrations of these folios were near completion. The maps and sections of the Colorado Springs (Colo.) folio were in press, the maps of the Leavenworth-Smithville (Mo.-Kans.) folio were in stone proof, and the maps of folio 201 (Minneapolis-St. Paul, Minn.) were engraved and in part in stone proof. The engraving of the maps for the Deming (N. Mex.), Detroit (Mich.), and Tolchester (Md.) folios was begun. The Colchester-Macomb (Ill.), Elkton-Wilmington (Md.-Del.), and Herman-Morris (Minn.) maps have been prepared for engraving, which will be begun as soon as the texts are completely criticized and revised. The Cleveland (Ohio), Pittsfield-Becket (Mass.), and Sheffield-Sandisfield (Mass.) maps have been partly prepared for engraving, but are awaiting slight field inspection. The Bellefonte (Pa.), Bessemer-Vandiver (Ala.), and Montevallo-Columbiana (Ala.) maps have been examined, but are awaiting field conference and office revision before preparation for engraving.

Two draftsmen, specially qualified to read and prepare geologic maps, sections, and other drawings, are employed in the section under the direction of the geologist in charge.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 183 atlas sheets and maps of special areas were on hand for publication and the accessions during the year were 102, making a total of 285. Of these, 107 (90 new engraved maps, 9 engraved maps which are new editions or new in form of publication, and 8 photolithographs) were published. The following statement shows the comparative status of map editing and publication on June 30 for the last five years:

Progress of map publication for five years ended June 30, 1915.

	1911	1912	1913	1914	1915
Published during the year	86	114	101	102	107
In process of engraving	56	65	89	69	87
Unedited	95	102	105	114	91

The manuscripts edited during the year comprise 117 topographic atlas sheets and other maps prepared for engraving, 3 of which were afterward withdrawn from publication, 26 sheets of plans and profiles of 11 rivers, corrections for 128 engraved maps about to be reprinted, and 226 maps or sheets for the illustration of 33 Survey reports. The proof read comprises 98 new topographic maps, corrections to 57 old maps, 2 panoramic views, and 15 maps reproduced under contract. The index maps for 11 circulars of the series 9–323 were revised and reprinted during the year, and a text was adapted for each of 14 new State index circulars which have been published.

Six men were continuously employed in this work.

DIVISION OF ENGRAVING AND PRINTING.

MAPS AND FOLIOS.

During the fiscal year 90 topographic maps were engraved and printed; 9 topographic atlas sheets were corrected after field revision and new editions printed; and 7 State maps, scale 1:500,000, and 1 three-color topographic map were photolithographed and printed during the year, making the total number of new maps and new editions printed 107.

Corrections were engraved on the plates of 118 sheets, including 112 for reprinted editions and 6 for other purposes. Of those corrected for reprinting, including new maps (engraved and photolithographed), 206 different editions were printed and delivered to the map room. This is a decrease of 95 editions and 232,011 copies of regular office maps from the previous year.

Three new geologic folios and three reprinted folios were published during the year, the number published in the preceding year. Of the new folios one is a double folio and one (the San Francisco) contains five sets of geologic maps. State editions of two folios and octavo editions of two folios were issued during the year. Editions and partial editions of folios and octavos amounting to 24,066 copies were printed and delivered, a decrease of 4,164 copies during the year.

CONTRACT ENGRAVING AND PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual report of the governor of Hawaii; annual report of the Commissioner General of Immigration; annual report of the Commissioner of Indian Affairs; annual report of the Chief of Engineers, United States Army; annual report of the governor of Alaska; annual report of the Board of Regents, Smithsonian Institution; annual reports of the War Department, volume 2 (War Document 480); Fiscal regulations, Department of Agriculture, 1915; Limnological study of the Finger

Lakes of New York, Bureau of Fisheries; American Ephemeris and Nautical Almanac, 1915; American Ephemeris and Nautical Almanac, 1918; Report on education of the natives of Alaska; Statistical Atlas of the United States, 1910; Department of Agriculture Bulletins 181, 198, and 204; Census reports, volumes 1–3, population, volume 5 (agriculture, general report and analysis); Department of Agriculture, Office of the Secretary, Report 100, Potash from kelp; Plane-table manual (Appendix 7, report of the Superintendent of the Coast and Geodetic Survey, 1905); United States Coast Pilot, part 4, Point Judith to New York; Inside Route Pilot, Key West to New Orleans; Inside Route Pilot, coast of New Jersey; Revenue-Cutter Service Bulletin 3, International ice observation and ice patrol in the north Atlantic Ocean; Bureau of Mines Bulletin 98, report of the Selby Smelter Commission; Interstate Commerce Commission reports, volume 24; House Document 971, Sixty-third Congress, second session—Red Lake Reservation; illustrations for Geological Survey Bulletins 527, 531–B, 575, 576, 578, 580–K, 580–M, 581–D, 582, 586, 589, 590, 592, 592–A, 596, 600, 602, 604, 606, Professional Papers 87, 90–I, 90–J, 95–B, Water-Supply Papers 306, 309, 319, 338, 342, 343, 344, 346, 347, 348, 349, 350, 366, 367, 368, 369, Mineral Resources, The stone industry in 1912, The stone industry in 1915, and Topographic instructions of the Geological Survey. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of six bird reservations and one elk reservation; panoramic views of Yosemite, Yellowstone, Glacier, Mount Rainier, and Crater Lake national parks; maps showing glaciers of Glacier and Mount Rainier national parks; map showing origin of the scenic features of Glacier National Park; Photometric lamp-sheet test, Form 174; township blank, Form 4–675a; map of National Zoological Park; map of the United States by counties; map of the world (Department of Agriculture); map showing the areas quarantined for the gypsy moth and brown-tail moth, 1914 (Department of Agriculture); Protractor, Form 678 (Department of the Interior); sectional diagram (Department of the Interior); identification cards (Department of the Interior); sample markings for brass caps (Department of the Interior).

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 17 national forests, 11 fire folders and tourists maps, 5 proclamation diagrams of national forests, 4 enlargements of field sheets, annual programs of work, 1914 and 1915, annual estimate blank, blank form (grazing classification), diagram, Form 493, homestead entry plats, lookout station protractor, map showing national forest areas, map of North America 7½ by 10 inches, map of North America 15 by 20 inches, North America outline map, map of southern Appalachian region, United

States contour map, section diagrams, and other miscellaneous work; for the General Land Office, 1,492 township plats, 677 mineral plats, 12 State maps showing homesteads, maps of two Indian reservations, 21 plats of villa sites, and other miscellaneous works; for the Office of Indian Affairs, maps of 4 Indian reservations; for the Panama Canal, 10 maps of Canal Zone and 1 map showing Isthmus and completed canal. Work was also done for the Reclamation Service, Alaska Boundary Survey, War Department (Corps of Engineers, United States Army), Interstate Commerce Commission, District of Columbia (public schools), War Department (Students' Military Instruction Camp), Panama-Pacific International Exposition, Bureau of Mines, Bureau of Standards, Bureau of Education, Weather Bureau, Public Health Service, Department of the Interior, Smithsonian Institution, Alaskan Engineering Commission, Bureau of Lighthouses, Department of Labor, Department of Agriculture (Bureau of Chemistry), War Department (Army Service Schools and Coast Artillery School), Department of Labor (Immigration Service), Navy Department (United States Marine Corps), Bureau of Labor Statistics, Hydrographic Office, Bureau of American Ethnology, National Museum, Post Office Department, Bureau of Soils, and United States and Canada Boundary Survey. In addition to the above, a large amount of miscellaneous work was done for other divisions and branches of the Survey. This work for various branches of the Government amounted to about $72,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for Houghton, Mifflin & Co., Heliotype Co. of Boston, Norris Peters Co., Geological Survey of New Jersey, J. M. Kennedy, Department of Chemical Engineering, University of Michigan, War Department (United States Engineers Office, Philadelphia, Pa.), and N. C. Grover, and the money received in payment for the work, amounting to about $350, was turned into the Treasury of the United States to be credited to miscellaneous receipts. Under cooperative agreements, transfer impressions were furnished without charge to the State surveys of Kentucky, Illinois, and Pennsylvania.

There was also a large amount of miscellaneous office work, including index circulars, list of geologic folios and topographic maps, State maps, etc. This work, for which no refund was obtained, amounted to about $4,500.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 2,803,428, which required approximately 3,850,004 printings. The total number of copies printed, including topographic maps and geologic folios, was 3,533,726, requiring ap-

proximately 8,525,104 impressions. On requisition of the Government Printing Office, 333 transfer impressions were made and shipped by contracting printers.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 15,095 negatives, of which 2,378 were dry, 3,652 were wet, 664 were paper, 7,437 were field negatives developed, 964 were lantern slides, and 2,361 were photolithographic; 3,824 zinc plates, 278 zinc etchings, 248 celluloids, and 48,734 prints, of which 22,906 were maps and diagrams and 25,828 were photographs for illustrations. In addition 2,110 prints were mounted and 192 slides colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work in the executive division was of the usual scope except that the work of the stores section and the shipping and receiving clerk was transferred to the division of accounts.

Mails, files, and records.—During the year 138,791 pieces of mail, of which 2,443 were registered, were opened and referred. In addition, 90,395 letters were received direct by the other divisions, a total of 229,186 for the Survey.

Of the letters opened in this division, 24,037 contained a total of $28,521.80 remitted for Survey publications, a decrease of 1 per cent in number of letters, and $1,283.93 in amount, compared with the fiscal year 1914.

The recording, referring, filing, and mailing of correspondence required practically the entire services of seven clerks. The number of letters mailed through the division was 136,827, an increase of about 13 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 11,960 pieces, or 239,559 pieces of letter mail sent direct from the other divisions—a total of 388,346 for the Survey, an increase of 6 per cent over 1914.

Personnel.—The roll of Secretary's appointees numbered 909 at the close of the fiscal year, 18 more than at the close of the fiscal year 1914. The total number of changes in the personnel for the year was 586, which included 131 new appointments, 112 separations, 305 promotions, 2 reductions, and 36 miscellaneous changes.

During the year 15,037 days of annual leave and 2,771 days of sick leave were granted, being 66 per cent of the amount of annual leave and 12 per cent of the amount of sick leave which it is permissible to grant under the law; 5,288 days of leave without pay were also granted.

DIVISION OF ACCOUNTS.

During the year the handling of express and freight shipments and issuing of stationery supplies from stock was transferred from the executive division to the division of accounts. During the year 3,504 pieces of freight and express were handled, of which 970 were outgoing and 2,534 were incoming, and 6,338 requisitions were filled from stock in the stationery room.

A condensed statement covering the financial transactions during the fiscal year is given below, including disbursements up to September 30. The unexpended balances of that date largely represent outstanding obligations.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1915.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00	.....	$35,340.00	$35,198.83	$141.17
Salaries, scientific assistants	29,900.00	.....	29,900.00	29,800.00	100.00
Skilled laborers, etc	20,000.00	.....	20,000.00	19,999.66	.34
Gaging streams, etc	150,000.00	$33,634.72	183,634.72	182,750.14	884.58
Chemical and physical researches	40,000.00	12.04	40,012.04	38,487.77	1,524.27
Preparation of illustrations	18,280.00	.....	18,280.00	18,200.41	79.59
Mineral resources of United States	75,000.00	43.33	75,043.33	74,792.50	250.83
Geologic maps of United States	110,000.00	73,325.61	183,325.61	160,959.53	22,366.08
Books for the library	2,000.00	.....	2,000.00	1,326.25	673.75
Topographic surveys	350,000.00	1,134.72	351,134.72	349,653.86	1,480.86
Geologic surveys	400,000.00	3,018.37	403,018.37	388,413.39	14,604.98
Mineral resources of Alaska	100,000.00	.77	100,000.77	94,586.45	5,414.32
Surveying national forests	75,000.00	3.57	75,003.57	73,866.19	1,137.38
	1,405,520.00	111,173.13	1,516,693.13	1,468,034.98	48,658.15

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1915.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery, drafting, etc., supplies.
Salaries, office of the Director	$35,198.83	$35,198.83										
Salaries, scientific assistants	29,800.00	29,800.00										
Skilled laborers, etc	19,999.66	19,999.66										
Gaging streams, etc	182,750.14	135,892.45	$17,571.34	$1,136.39	$9,926.37	$507.48	$898.61	$1,857.22	$4.20	$1,692.89	$1,527.66	$1,902.33
Chemical and physical researches	38,487.77	25,659.12	1,380.07	1,570.77	802.75	27.29	95.61	8.52	371.13	171.71	1,237.91	697.07
Preparation of illustrations	18,200.41	16,973.17		1.49			19.49	972.47		1.78	3.27	189.92
Mineral resources United States	74,792.50	67,983.71	1,704.55	76.98	1,118.03	.33	627.07	689.08		291.40	1.31	953.12
Geologic maps	160,959.53	130,519.99	122.90	58.22	77.40		66.23	1,450.39	2,131.28	2,072.59	4,524.41	15,554.22
Books for the library	1,326.25			4.10			.95					
Topographic surveys	349,653.86	238,285.20	27,921.78	3,735.75	41,743.63	9,936.41	835.36	3,793.26		2,145.34	1,267.23	2,068.52
Geologic surveys	388,413.39	304,081.61	27,623.47	2,221.29	20,233.29	4,937.20	1,191.70	6,204.24	12.35	4,509.70	446.71	2,672.62
Mineral resources of Alaska	94,586.45	61,161.12	14,069.96	2,627.80	4,174.42	404.60	180.85	1,255.30		593.51	235.82	763.79
Surveying national forests	73,866.19	48,178.69	4,052.65	543.90	7,673.66	5,068.84	135.58	146.20		762.25	267.76	445.73
	1,468,034.98	1,113,733.55	94,446.72	11,976,69	85,749.55	20,882.15	4,051.45	16,376.68	2,518.96	12,241.17	9,512.08	25,247.32

Appropriation.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent.
Gaging streams, etc	$142.63	$381.14	$2.65	$35.50	$134.21	$172.73	$4.55	$97.92	$6,121.42	$332.00	$2,408.45
Chemical and physical researches	325.27	87.31	19.97	2.05	145.33	847.92		30.73	4,820.04		187.20
Preparation of illustrations									38.82		
Mineral resources United States		.72	10.80						978.10		357.30
Geologic maps	95.61	558.92	276.64			18.95	7.72		3,424.06		
Books for the library									1,321.20		
Topographic surveys	284.10	44.77	37.19	1.34	4,726.36	3,195.06		72.08	7,345.73	2,131.10	83.65
Geologic surveys	177.86	69.34	40.72	14.00	1,407.45	4,140.36	155.84	242.86	7,993.28		37.50
Mineral resources of Alaska	180.91	12.51	54.81	88.65	1,361.47	2,907.07	58.72	77.73	4,292.73		84.68
Surveying national forests	72.36	7.38	56.37	1.02	2,701.59	1,784.97		10.30	1,894.25	59.68	3.01
	1,278.74	1,162.09	499.15	142.56	10,476.41	13,067.06	226.83	531.62	38,229.63	2,522.78	3,161.79

LIBRARY.

The library has acquired during the year all the important new publications of geologic interest or bearing on the work of the Survey. The European exchanges were somewhat less numerous than usual on account of the war. Altogether 12,795 books, pamphlets, and periodicals and 1,218 maps were received.

The cataloguing included current accessions and also the final cataloguing of older sections of the collection, embracing the geological surveys of Finland, Greenland, India, Mysore Province, Netherlands, Prussia, Rumania, the Transvaal, and the Union of South Africa; 60 sets of periodicals; and monographs on chemistry and on general, dynamic, structural, historical, and economic geology. The library furnished 777 title entries to the Library of Congress for printing; 11,968 cards were added to the catalogue.

Recorded loans numbered 8,069 books and 272 maps, this number not including the books and maps used in the library by 9,022 readers. The classification scheme and the catalogue have served as guides for the librarians of a number of geologic libraries, who have visited the Survey library and studied its working methods.

During the last nine months of the year about 600 books from the Washington City Public Library have been deposited in this library for recreative and educational reading by members of the Survey. From this deposit 1,713 loans were made, of which about 12 per cent were books on biography, poetry, travel, and the social sciences.

The bibliography of North American geology for 1913 was published as Bulletin 584. The bibliography for 1914 has been completed and is passing through the press as Bulletin 617. Work has continued throughout the year on the bibliography and index comprising all the published literature of American geology.

Exchange copies of Survey publications have been distributed promptly both to domestic and foreign libraries, with the exception of those for libraries in the countries now at war. These have been necessarily withheld until the Smithsonian International Exchange shipments shall be resumed.

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