DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

THIRTY-EIGHTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1917

WASHINGTON
GOVERNMENT PRINTING OFFICE
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THIRTY-EIGHTH 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 1916–17 comprised items amounting to $1,605,520. The plan of operations as approved by the Secretary of the Interior included geologic surveys in the United States and Alaska, reconnaissance and detailed, of 40,937 square miles, topographic surveys of 32,245 square miles, stream gaging at 1,197 stations, the classification of public lands to an amount of more than 18,000,000 acres, and the collection of statistics of production and consumption from more than 90,000 producers, covering more than 75 mineral products. During the year 203 scientific and economic reports were published, and at the end of the year the Survey members holding appointments from the Secretary numbered 934, an increase of 62.

SPECIAL FEATURES.

WAR WORK.

During the greater part of the year the activities of the Geological Survey were concentrated upon lines of investigation connected with military and industrial preparedness. This mobilization has included preparation of special reports for the use of the War and Navy departments and the Council of National Defense, the making of military surveys, the printing of military maps and hydrographic charts, and the contribution of engineer officers to the Reserve Corps.

Early in the present calendar year the Survey transmitted to the War Department a series of 23 summary reports on the underground water supplies and the soil-drainage features of the areas along the Mexican border and the Gulf and Atlantic coasts. Several State surveys cooperated with the Federal geologists in the preparation of these geologic and hydrologic reports, which were transmitted in duplicate to the War College and the Engineer Corps, for use in the selection of cantonment sites. By request of the War and Navy departments special local investigations of water-supply and drainage possibilities of reservations have been made, including the problem of supplying troops with water on the island of Oahu.

In connection with the minerals that have assumed special significance under war conditions, the work of the Geological Survey has been both expanded and made more intensive. Results already at hand as the product of years of field and office investigation have been made available in special reports published for the information of the general public or prepared for the immediate use of some official commission, committee, or bureau. Geologic field work has been concentrated on the essential mineral resources, especially those of which the domestic supply falls short of present demands. Every oil geologist available is at work in the petroleum regions where increased production can be expected to follow geologic exploration. Other geologists have been assigned to the search for commercial deposits of the "war minerals"—manganese, pyrite, platinum, chromite, tungsten, antimony, potash, and nitrate.

An increasing appreciation of the military value of the topographic surveys in progress and the desire to increase this special use of the topographic corps led in January, 1917, to the formation of the division of military surveys in the topographic branch. In March the recognition of the urgent need of military surveys resulted in the plans for field work being made to conform wholly to a program drawn up by the General Staff of the Army. This program was submitted on March 26 and by the end of June 8,192 square miles of the areas had been surveyed. These military surveys will be continued as speedily as possible with the decreasing force of topographers available for this work in the United States.

War conditions not only diverted practically all the activities of the topographic branch to the urgent needs of the War Department for military surveys but also brought about the commissioning of the majority of the technical personnel of this branch as reserve officers in the Corps of Engineers, United States Army. This created a deficiency in the force of engineers available for topographic duty, and new sources of personnel became necessary. Permission has been obtained from the Civil Service Commission to appoint topographic field assistants without status in the classified service. Such appointments began on July 2, 1917, and by the end of September 58 men were thus appointed by the Survey, of whom 20 were assigned directly to topographic parties in the field and 38 reported at Washington for observation and training as to their special fitness for the various details of duty in the field. To judge of this adaptability, the candidates have been tested by actual field work in the near vicinity of Washington, under close supervision and intensive instruction.

A report on the use of the panoramic camera in topographic surveying, already in progress, was given special military value by the addition of a chapter on the application of photogrammetry to aerial surveys. The author, Capt. J. W. Bagley, Engineer Officers' Reserve

Corps, has also served as a member of the airplane mapping committee of the National Advisory Committee for Aeronautics, his time being devoted chiefly to the perfection of a camera specially adapted to airplane use. In this work Capt. Bagley is assisted by F. H. Moffit.

A large contribution to the military service is made by the map-printing establishment of the Survey. This plant has been available for both confidential and urgent work, and during the year 96 editions of maps needed for military use have been printed for the War Department and 906 editions of charts for the Navy Department. Other lithographic work was in progress at the end of the year, some of it of a complicated character.

In some respects the largest contribution of the Survey has been the group of specially trained engineers who have been commissioned in the Engineer Officers' Reserve Corps, this group including at the end of the fiscal year 1 geologist, 7 hydrographic engineers, and 61 topographic engineers. On October 1, 1917, the number of Survey representatives holding commissions aggregated 79, of whom 37 are either already in France or have been selected for service there—7 majors, 8 captains, and 22 lieutenants. The other officers—9 majors, 10 captains, and 23 lieutenants—are in active service and, pending other orders, instructed by the War Department "to report to the Director of the Geological Survey for duty in connection with the military surveys in progress." Two of the officers in France have been appointed on Gen. Pershing's staff, Maj. Alfred H. Brooks as geologic engineer and Maj. Glenn S. Smith as topographic engineer. These appointments leave the Geological Survey without chiefs of two important divisions—the division of Alaskan mineral resources and the division of military surveys, respectively. Maj. Frank Sutton and Maj. C. H. Birdseye, who are among those ordered to France, have left the Atlantic and Rocky Mountain divisions without administrative chiefs during the war.

DEVELOPMENT OF THE MINERAL INDUSTRY.

Clarence King, the first Director of this Survey, emphasized in the administrative report of 1880 the desirableness of the Federal investigation of the mineral wealth of the country and of the industry based thereon. The advantage of this type of governmental assistance to American enterprise has never been greater or more evident than during the war period that has brought about so great an expansion of the productive capacity of mine and smelter. The large domestic industrial demands for the mineral fuels and the more important metals have been met by rapidly increased output and a larger excess made available for export. In minor minerals what had formerly been imported has been replaced by material of domestic

origin. All this expansion and new development has been profitable in a national sense. America is stronger because of this larger utilization of the useful minerals.

The current geologic and statistical work of the Survey both records the results already attained and indicates the deficiency of supply not yet remedied. For a large group of "war minerals" even the several-fold increased production is not sufficient to meet the increased consumption. A speeding up has naturally followed under these conditions, but plainly the pace has not yet been reached that our natural resources and our engineering genius would seem to justify in time of emergency.

Whoever studies the mineral resources of the United States and the industries built thereon must realize that in a time of need like the present year production rather than price is the matter of prime importance; that a high price may both stimulate production and increase available reserves; that home production will result in transportation savings that are in reality a national benefit of practical value comparable with the theoretical advantage of industrial independence; and that expansion of productive capacity is possible under war conditions only as both consumer and producer can adjust their projects to the conditions that will prevail after the war, as well as to the needs of the present emergency. Illustrations of these four propositions come at once to mind.

Potash is so essential to chemical industries that a high price has been willingly paid for the small percentage thus needed, and domestic potash has come from sources that would be unproductive under more normal conditions. A potash industry to supply the other 90 per cent of our needs—mainly to fertilize the millions of acres upon which larger demands are being made for foodstuffs and cotton and tobacco—must be based upon resources or methods of recovery permitting lower costs of production.

The increase in reserves, due to higher prices and to improved mining and metallurgic practice, is shown in the case of several of the metals. Whether the margin of profit is increased by raising price or lowering costs, the beneficial tendency is to reduce the grade of ore that can be profitably utilized, and this means increasing the Nation's reserves of ore, and thus placing one industry on a more lasting foundation. This stimulating reaction of profit upon engineering efficiency is the promise of future continuance of the supply of the essential metals, such as copper and iron.

The economy of domestic production wherever possible may be shown in the present manganese situation. The Virginia miner who loads on the cars 4,500 tons of high-grade manganese ore this year is not only contributing to the steel industry that tonnage and receiving therefor compensation at the market price, but he thereby

relieves the country's shipping shortage to the extent of one ship for 38 days, not including the necessary time for loading and unloading the cargo of Brazilian ore.

Finally, the proposition that present expansion of business must take into account the future is almost self-evident, although often overlooked. Opening up pyrite mines must be based upon an assured supply of ore in the ground and an assured demand for the product for a period long enough and at prices high enough to justify the development. It is not enough for the geologist to point out the ore; the acid manufacturer needs to contract both to buy the pyrite and to sell the acid. New development must rest upon a basis of something more than risk, lest expansion of productive capacity involve after-the-war losses that will swallow up war profits.

To make America industrially independent is an aim perhaps even more desirable now than three years ago and possibly also even more of a problem than was then realized.

SPECIAL PUBLICATIONS.

Among the publications of the year several deserve special mention. The entrance of the United States into the war served to increase the already large demand for information concerning the Nation's mineral resources, and a bulletin entitled "Our mineral supplies" (Bulletin 666), was prepared to meet this need. The purpose of this publication is to supplement Bulletin 599, "Our mineral reserves," published in September, 1914. A comparison of this summary of the ability of the mineral industry to meet present-day demands with the earlier and less complete review of the mineral situation serves to make plain the larger degree of national independence which has been attained in the mining, metallurgic, and chemical industries. Twenty geologists have contributed to the present bulletin, which has been published first in separate chapters, each devoted to a "war mineral" or to some mineral product important under present conditions.

Official and general demand for up to date statistics on several of the more important minerals has been met by further response by the geologists and statisticians of the Survey. The monthly statements of railroad movement of coal and coke first issued in August, 1916, were followed in June, 1917, by the compilation of weekly statements of bituminous coal and coke production, with an analysis of causes of change in rate of output. The purpose of these statistics is to serve both the Government and the trade with an authoritative index of industrial conditions.

For similar reasons the Survey began in January the issue of monthly statements of petroleum production and consumption, these statistics showing the quantity of oil moved from field sources, the

quantity delivered to refiners or to consumers, and the amount in storage at the end of each month, for each of the major oil fields east of the Rocky Mountains.

At the request of the War Department a special military map of the vicinity of the Plattsburg training camp was issued in May. The survey of this area was the first purely military mapping done by the topographers of the Geological Survey and included an amount of detail never before undertaken. The area mapped was 90 square miles, with a publication scale of 3 inches to 1 mile and a contour interval of 5 feet. On the printed maps distinctions are made between barbed and smooth wire fences, stone walls, and rail fences, between the broad-leafed timber, the pine forests, and orchards, and between roads of different character, and every telegraph and telephone pole is located, as well as, of course, every building. It is believed that this map compares favorably with the best military maps issued by European countries, and this innovation in topographic work helped materially in fitting the Survey to furnish topographic engineers for service in France.

Work on another map of detailed character also contributed to the training of a large number of Survey topographers in refined, large-scale work, although made for another purpose. This is the map of Washington and vicinity, covering 464 square miles. This map is believed to be the best example in the United States of a map covering a large area of diversified topography which shows the physical characteristics of the country, as well as all the works of man. It was printed in four colors, showing automobile roads in red, and was issued in two editions aggregating 20,000 copies, of which over 15,000 copies have been sold and otherwise distributed.

NEW HOME.

The completion of the new Interior Department office building made it possible for the Survey to occupy its new home in May, 1917. This marks the culmination of the efforts of three Directors of the Survey to procure quarters both adequate for its work and safe for the Survey workers as well as the large accumulation of scientific records. In the Thirty-third Annual Report the general unfitness of the buildings occupied by the Survey was fully discussed, and the extent of the limitations on economy and efficiency thus forced upon the employees pointed out. For nearly a third of a century the privately owned building at 1330 F Street had been enlarged piecemeal as the Federal organization increased the scope and extent of its operations, until overcrowding reached the limit, whether viewed in regard to sanitation, safety, or efficiency. The new building remedies these conditions by providing 50 per cent more floor space,

and all of this space that is devoted to offices, laboratories, or workrooms is well lighted.

The new building was authorized March 4, 1913, ground was broken August 16, 1915, and the building was completed about two years later. The approximate cost was $2,500,000, and, measured by floor space, it is the largest public building in Washington. The statute specified a building of modern office type, and as a public building the Interior Department office building is unique in that the requirements of use for office and laboratory purposes were given first consideration, the architectural features being determined by the size of unit decided upon as best providing for the special uses within the limitations of the appropriation.

The building occupies the whole block bounded by Eighteenth, Nineteenth, E, and F streets NW. and includes approximately half a million square feet of net floor space, accommodating the Office of the Secretary, the General Land Office, the Office of Indian Affairs, the Bureau of Mines, the National Park Service, and the Alaskan Engineering Commission, as well as the Geological Survey, which, with its library and map-printing establishment, occupies nearly one-third of the building. It is believed that this move to a new home will increase efficiency as well as avoid the danger to life and property that has been so long a matter of concern to those interested in this branch of the public service.

ARNOLD HAGUE.

Arnold Hague, one of the senior geologists of this Survey, died May 14, 1917, at the age of 76 years. He graduated at the Sheffield Scientific School of Yale University in 1863 with Clarence King, and later, as a student at Freiburg, he met S. F. Emmons, and both of them joined Clarence King early in 1867 to make the Fortieth Parallel Survey. Ten years later he made official surveys in Guatemala and the following year in China.

At the time of the organization of the United States Geological Survey in 1879 under Clarence King, Arnold Hague was appointed geologist. The results of his work have appeared in Monograph 20, on the geology of the Eureka district in Nevada, and in Monograph 32, on the Yellowstone National Park. For some years he had been engaged in a special study of geysers, and this work, his last and greatest, Mr. Hague leaves practically complete.

In addition to preparing his larger reports, Mr. Hague has contributed to scientific periodicals. He was a fellow of the Geological Society of America, of which he was president in 1910, and of the Geological Society of London, and was a member of many other scientific societies. Several universities in this country and abroad conferred upon him special degrees, but the honor he most highly ap-

preciated was that of being made a member and officer of the National Academy of Sciences.

Mr. Hague was not a ready nor voluminous writer, but his writings were notably exact. He aimed rather to write well and truly than much. Few scientific men in America have had so wide a circle of devoted friends as Arnold Hague.

WORK OF THE YEAR.

PUBLICATIONS.

The publications of the year consisted of 1 annual report, 5 professional papers, 18 separates from 3 professional papers, 23 bulletins, 66 separates from 8 bulletins, 25 water-supply papers, 7 separates from 3 water-supply papers, 55 advance chapters from 2 annual reports on mineral resources, 5 geologic folios, 1 list of publications, 1 list of water-supply papers, 1 service bulletin, pamphlets entitled "Suggestions to authors (third edition)" and "Extracts from the Style Book of the Government Printing Office," a leaflet entitled "Nature and uses of topographic maps," advance statements on copper, lead, and zinc production in 1916, 2 circulars concerning maps and folios, 34 index map circulars, 47 press bulletins, and 12 monthly lists of new publications. The total number of pages in these publications was 17,255.

Brief notices of the publications of the year are given below:

THIRTY-SEVENTH ANNUAL REPORT OF THE DIRECTOR of the Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1916. 1916. 185 pages, 2 plates, 1 text figure.

A detailed account of the work of the Geological Survey during the fiscal year 1916, with a statement of the appropriation made by Congress for the Survey for that year. Under the heading "Special features" the Director discusses the need of economy in science, and shows how, in the several Federal bureaus especially, waste in scientific service can be avoided by cooperation. He also discusses the progress made in the search for potash in the United States, the need for a domestic supply of which has become urgent since the war has cut off the supply from the most abundant source of this material—Germany. The report contains abstracts of the books published by the Survey during the year and a list of the maps issued. The illustrations consist of maps showing areas covered by topographic and geologic surveys and a diagram showing the comparative number of maps sold by the Survey during each month of the fiscal years 1915 and 1916.

PROFESSIONAL PAPER 91. The lower Eocene floras of southeastern North America, by E. W. Berry. 481 pages, 117 plates, 16 text figures.

A comprehensive study of the lower Eocene plant remains of the southern Coastal Plain. The main body of the material examined in preparing the report came from beds embraced in the stratigraphic unit known as the Wilcox group, which comprises littoral and estuarine sediments; the remainder of the material came from strata regarded as the Midway formation, a typically marine series of deposits. Both these floras are of the

greatest importance to the geologist, because they furnish the much-sought means for direct comparison between the plant-bearing formations of the Rocky Mountain province and the marine Tertiary formations of the Atlantic and Gulf waters. The plant-bearing outcrops and the various species are discussed in detail. The book also contains numerous halftone plates showing specimens of the fossil plants.

PROFESSIONAL PAPER 94. Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties, Colo., by E. S. Bastin and J. M. Hill. 1917. 379 pages, 23 plates, 79 text figures.

This book forms the Survey's latest contribution to the investigation of the metalliferous deposits of the Colorado ore belt. It describes the geology of the region in the vicinity of Central City, which lies nearly west of Denver, in the heart of the Front Range of the Rockies. The ores of this region yield gold, silver, copper, and tungsten in commercial quantities, and some iron. Each mine is described in detail and the treatment of the ores is discussed. The book contains numerous illustrations, including topographic and geologic maps of the Central City quadrangle, camera lucida drawings of some specimens of the ores, geologic plans of portions of the mines, and halftone plates showing features of geologic interest.

PROFESSIONAL PAPER 97. Geology and ore deposits of the Mackay region, Idaho, by J. B. Umpleby. 1917. 129 pages, 21 plates, 14 text figures.

Describes in detail the geography and geology of the Mackay region, in southeastern Idaho, north of Snake River. The existence of ore deposits in this region has been known to mining men since 1880. The principal metal recovered is copper, although silver, gold, and lead also occur in the region. It comprises eleven mining districts, all of which are treated separately in this report. At least three of these districts are of more than ordinary promise, and the author gives practical conclusions and suggestions which should aid the prospector in discovering new outcrops of ore. The illustrations consist of a geologic sketch map of the Mackay region, plans and sections of the mines, and halftone and colored plates of specimens of ore.

Parts of Professional Paper 98. Shorter contributions to general geology, 1916, as follows:

PROFESSIONAL PAPER 98–I. A reconnaissance of the Archean complex of the Granite Gorge, Grand Canyon, Ariz., by L. F. Noble and J. F. Hunter. 1916. Pp. 95–113, Pl. XIX, figs. 9–10.

Presents the results of a brief study of the Archean rocks of the Grand Canyon, especially as to their petrographic character, origin, and structure.

PROFESSIONAL PAPER 98–J. North American Upper Cretaceous corals of the genus *Micrabacia*, by L. W. Stephenson. 1916. Pp. 115–131, Pls. XX–XXIII.

Contains systematic descriptions and illustrations of some well-preserved corals of the genus *Micrabacia* from the Atlantic and Gulf Coastal Plain and from the western interior of the United States. The scarcity of specimens of corals of this genus adds to the value of these descriptions.

PROFESSIONAL PAPER 98–K. Some Paleozoic sections in Arizona and their correlation, by F. L. Ransome. 1916. Pp. 133–166, Pls. XXIV–XXXI, figs. 11–14.

Includes a brief introductory outline of the broad topographic features of Arizona, a description of the well-exposed geologic section of the Ray-Globe region, in the central part of the State, as well as of other sections, from the Grand Canyon, in the northwestern part of the State, to Bisbee, near the Mexican border, and a discussion of the correlation of these sections.

PROFESSIONAL PAPER 98–L. The Pliocene Citronelle formation of the Gulf Coastal Plain and its flora, papers by G. C. Matson and E. W. Berry. 1916. Pp. 167–208, Pls. XXXII–XLVII, figs. 15–17.

PROFESSIONAL PAPER 98–M. The Catahoula sandstone and its flora, papers by G. C. Matson and E. W. Berry. 1916. Pp. 209–251, Pls. XLVIII–LX, figs. 15–21.

These papers discuss briefly the general character and relations of the formations named in their titles and describe the fossil plants found in these formations, which occur in the Gulf Coastal Plain of Louisiana, Mississippi, and Alabama.

PROFESSIONAL PAPER 98–N. Mechanics of the Panama Canal slides, by G. F. Becker. 1916. Pp. 253–261, figs. 22–24.

A geophysical study of the Panama Canal slides prepared as a contribution to the report of the committee on this subject appointed by the National Academy of Sciences. The author describes the essential features of the breaks on the Gaillard (Culebra) Cut, and discusses briefly the formation of ruptures, the bulging of the canal bottom, and the effect upon pressure of the form of the banks.

PROFESSIONAL PAPER 98–O. Relations of the Embar and Chugwater formations in central Wyoming, by D. D. Condit. 1916. Pp. 263–270, Pls. LXI–LXIII, figs. 25–26.

In this paper the author shows that the Embar formation, which lies between the Tensleep sandstone and the Chugwater formation, comprises several distinct facies. Each of these facies is considered in detail and some of the formational boundaries in the Big Horn Mountain region are redefined. In connection with the description of the gypsum and associated strata it is suggested that conditions were possibly also favorable for accumulation of salt beds. The chance of finding such deposits down the dip below the surface is believed to be sufficient to merit further investigation.

PROFESSIONAL PAPERS 98–P, Q, R, and S. Contributions to the geology and paleontology of San Juan County, N. Mex.

These papers describe the succession of strata in a part of the San Juan Basin with the purpose of establishing a type section for the formations exposed and of bringing out their relations to the strata immediately above and below. As an aid in identifying the formations, the authors also describe the typical fauna and flora found in them. The papers are as follows:

1 (P). Stratigraphy of a part of the Chaco River valley, by C. M. Bauer. 1916. Pp. 271–278, Pls. LXIV–LXXI, fig. 27.

2 (Q). Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, by C. W. Gilmore. 1916. Pp. 279–308, Pls. LXIV, LXXII–LXXVIII, figs. 28–42.

3 (R). Nonmarine Cretaceous invertebrates of the San Juan Basin, by T. W. Stanton. 1916. Pp. 309–326, Pls. LXXIX–LXXXIII.

4 (S). Flora of the Fruitland and Kirtland formations, by F. H. Knowlton. 1916. Pp. 327–353, Pls. LXXXIV–XCI.

PROFESSIONAL PAPER 98–T. The reef-coral fauna of Carrizo Creek, Imperial County, Cal., and its significance, by T. W. Vaughan. 1917. Pp. 355–386, Pls. XCII–CII, figs. 43–46.

A study of the fauna mentioned in the title leading to the conclusion that it is Atlantic and not Pacific in its affinities and that therefore there was interoceanic connection across Central America during upper Oligocene time. In Miocene time this connection was terminated, but the author believes that it was again established in upper Miocene or Pliocene time.

PROFESSIONAL PAPER 100–A. The coal fields of the United States: General introduction, by M. R. Campbell. 1917. Pp. 1–33, Pl. I, figs. 1–3.

The first chapter of an exhaustive report on the coal fields of the United States, to be prepared and published as rapidly as is consistent with accurate work. The object of the report is to furnish authentic information as to the quantity, quality, and geographic distribution of the coal still in the ground and available for use. Each chapter will be made up of papers treating of the coal-bearing areas of a different State, and each paper will be prepared by the geologist most familiar with the fields he describes and best acquainted with the local conditions.

Professional Paper 100–A discusses the ranks of coal and the classification of the coal areas in this country. It contains a large lithographed map of the United States showing the location of the coal fields, and so colored as to indicate the class of the coal in each field.

PROFESSIONAL PAPER 102. The inorganic constituents of marine invertebrates, By F. W. Clarke and W. C. Wheeler. 1917. 56 pages.

This paper gives the results of chemical analyses of certain fossil marine invertebrates with the object of determining just what substances each class of these organisms has contributed to the marine sediments which now form so large a part of the rocks of the earth. The organisms analyzed include Foraminifera, sponges, corals, echinoderms, Bryozoa, brachiopods, and mollusks, and the analyses show that their shells or skeletons contain silica, iron, lime, magnesia, phosphorus, and sulphur, as well as other constituents.

PROFESSIONAL PAPER 103. *Brachyceratops*, a ceratopsian dinosaur from the Two Medicine formation of Montana, with notes on associated fossil reptiles, by C. W. Gilmore. 1917. 45 pages, 4 plates, 57 text figures.

This paper gives a complete and detailed description of the skeletal anatomy of *Brachyceratops montanensis*, an extinct reptile whose fossil remains have been found in exposures of the Two Medicine formation on the Blackfeet Indian Reservation, Mont. This reptile was more than 6 feet in length and 2 feet in height and lived in late Mesozoic time. The paper is illustrated by halftone plates giving skeletal and life restorations of *Brachyceratops* and text figures picturing in detail the different parts of its bony structure.

Parts of Professional Paper 108. Shorter contributions to general geology, 1917, as follows:

PROFESSIONAL PAPER 108–A. Baked shale and slag formed by the burning of coal beds, by G. S. Rogers. 1917. Pp. 1–10, Pls. I–III.

In this paper the author discusses the causes of the burning of coal beds and its general effect on the overlying strata. The natural slags formed by this burning vary widely in mineral composition and offer a fertile field for petrologic investigation. The paper is illustrated by photomicrographs of two kinds of slag and a halftone plate showing the effects of burning coal beds in eastern Montana.

PROFESSIONAL PAPER 108–B. The Newington moraine, Maine, New Hampshire, and Massachusetts, by F. J. Katz and Arthur Keith. 1917. Pp. 11–29, Pls. IV–XII, fig. 1.

Describes a recessional moraine now represented by several segments disposed along a sinuous course of 60 miles near the Atlantic coast from Saco, Maine, to Newbury, Mass. This moraine is the result of the accumulation of glacio-fluvial detritus discharged directly into the sea, which

in places has given it the form of broad, flat, delta-like plains of sand and gravel. The author concludes that the moraine belongs to the Wisconsin substage of the Pleistocene epoch.

PROFESSIONAL PAPER 108–C. A comparison of Paleozoic sections in southern New Mexico, by N. H. Darton. 1917. Pp. 31–55, Pls. XIII–XXI, figs. 2–15.

Presents the broader features of the stratigraphy of southern New Mexico, with especial reference to the relations of the Paleozoic rocks. The principal formations are shown in columnar sections, and their distribution is indicated on a map of part of New Mexico and adjoining regions.

PROFESSIONAL PAPER 108–D. Wasatch fossils in so-called Fort Union beds of the Powder River basin, Wyo., and their bearing on the stratigraphy of the region, by C. H. Wegemann. 1917. Pp. 57–60, Pls. XXII–XXIII, figs. 16.

Discusses the age of certain Tertiary coal-bearing rocks in the Powder River basin, a broad structural basin in northeastern Wyoming bounded on three sides by mountain uplifts. These rocks, which are the uppermost of three fresh-water formations overlying the Fox Hills sandstone, have heretofore been classified as Fort Union, but after an examination of their fossils, which this paper describes, the author shows them to be Wasatch and identifies the formation immediately below them as Fort Union.

PROFESSIONAL PAPER 108–E. Geologic history indicated by the fossiliferous deposits of the Wilcox group (Eocene) at Meridian, Miss., by E. W. Berry. 1917. Pp. 61–72, Pls. XXIV–XXVI, figs. 17–18.

Describes two newly discovered fossil plants contained in a collection made at Meridian, Miss., in the spring of 1916. These plants form important additions to the flora of the Wilcox group, and the outcrop in which they occur furnishes new evidence of the unconformity between the lower Eocene Wilcox group and the middle Eocene Claiborne group.

BULLETIN 621. Contributions to economic geology (short papers and preliminary reports), 1915, Part II, Mineral fuels; M. R. Campbell and David White, geologists in charge. 1916. vii, 375 pages, 25 plates, 17 text figures, 2 inserts.

This bulletin includes 16 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. Each paper was issued separately as an advance chapter as soon as it was ready. A list of the papers arranged according to subjects follows:

Petroleum and natural gas.

The Healdton oil field, Carter County, Okla., by C. H. Wegemann and K. C. Heald.

The Loco gas field, Stephens and Jefferson counties, Okla., by C. H. Wegemann.

The Duncan gas field, Stephens County, Okla., by C. H. Wegemann.

A reconnaissance in Palo Pinto County, Tex., with special reference to oil and gas, by C. H. Wegemann.

Possibilities of oil in the Porcupine dome, Rosebud County, Mont., by C. F. Bowen.

The Lawton oil and gas field, Okla., by C. H. Wegemann and R. W. Howell.

Anticlines in the Clinton sand near Wooster, Wayne County, Ohio, by C. A. Bonine.

A reconnaissance for oil near Quanah, Hardeman County, Tex., by C. H. Wegemann.

Oil and gas near Basin, Big Horn County, Wyo., by C. T. Lupton.

Geology and oil prospects of Cuyama Valley, Cal., by W. A. English.

Structure of the Berea oil sand in the Summerfield quadrangle, Guernsey, Noble, and Monroe counties, Ohio, by D. D. Condit.

Structure of the Berea oil sand in the Woodsfield quadrangle, Belmont, Monroe, Noble, and Guernsey counties, Ohio, by D. D. Condit.

Coal.

Field apparatus for determining ash in coal, by C. E. Lesher.

The Orofino coal field, Clearwater, Lewis, and Idaho counties, Idaho, by C. T. Lupton.

Geology and coal resources of northern Teton County, Mont., by Eugene Stebinger.

Analyses of coal samples from various parts of the United States, by M. R. Campbell and F. R. Clark.

BULLETIN 624. Useful minerals of the United States, compiled by F. C. Schrader, R. W. Stone, and Samuel Sanford. 1917. 412 pages.

A thoroughly revised edition of Bulletin 585 (published in 1914) greatly enlarged and brought up to date. Like the earlier work, the present one gives concisely the location, by States and counties, of the principal deposits of useful minerals and includes a glossary showing the composition and character of each mineral, the location of its principal deposits, and its chief uses. In the revision 160 mineral names have been added to the glossary and about 1,000 new localities of mineral deposits are listed. As a mineral directory this bulletin will be useful to scientific bureaus and educational institutions that deal with inquiries from the general public concerning commercial mineralogy, as well as to the prospector, miner, manufacturer, business man, and student of economic conditions.

BULLETIN 625. The enrichment of ore deposits, by W. H. Emmons. 1917. 530 pages, 7 plates, 29 text figures.

This paper is an amplification of an earlier Survey bulletin by the same author on the enrichment of sulphide ores (Bulletin 529). It is a discussion of representative deposits, especially of the paragenesis of their ores and of the principles that underlie the processes of enrichment. These principles are already fairly well understood and have proved to be of considerable economic value as applied to the development of many mineral deposits. The book is illustrated by halftone plates of specimens of enriched ores and diagrams, cross sections, and projections of lodes and ore bodies which exemplify the principles of enrichment.

BULLETIN 627. The lignite field of northwestern South Dakota, by D. E. Winchester, C. J. Hares, E. R. Lloyd, and E. M. Parks. 1916. 169 pages, 11 plates, 3 text figures.

This report embraces the results of geologic examinations made during the summers of 1911 and 1912 for the purpose of classifying as coal or noncoal land a large tract of public land in Perkins and Harding counties, S. Dak. This tract is a rectangular area of about 4,900 square miles and includes nearly all the valuable lignite of the State. The authors give a brief description of the geography and geology of the area as a whole and

detailed descriptions of the coal beds by townships. The illustrations consist mainly of geologic maps of Harding and Perkins counties and lignite sections in these counties.

BULLETIN 630. The Chisana-White River district, Alaska, by S. R. Capps. 1916. 130 pages, 19 plates, 9 text figures.

This report deals with that part of Alaska which is drained by White and Chisana rivers and describes in detail the gold placers thus far developed in the region. The author presents evidence to show that these placers have been formed because of certain local conditions which are not likely to be repeated in other parts of the field and concludes therefore that the outlook for finding other placer deposits in this intensely glaciated region is not favorable. The evidence of wide distribution of copper and gold mineralization, however, gives promise that lode mining may be successful in this field provided it is made accessible by a railroad. The book contains topographic and geologic maps of the district, sketch maps and diagrams showing distribution of timber and geologic structure, and many halftone plates illustrating geologic features.

BULLETIN 631. The Yukon-Koyukuk region, Alaska, by H. M. Eakin. 1916. 88 pages, 10 plates, 2 text figures.

Gives the results of a reconnaissance survey in the Yukon-Koyukuk region made by the author in 1913. Although the economic results of this investigation are largely negative on account of the paucity of mineral deposits in the region, the intrusive granites to which the mineralization is due are widely distributed and thus afford some hope that auriferous deposits may still be discovered. The author presents also an analysis of the problems relating to the origin of the drainage system of the middle Yukon country.

BULLETIN 635. Spirit leveling in Georgia, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1916. 60 pages, 1 plate.

BULLETIN 636. Spirit leveling in Arkansas, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 56 pages, 1 plate.

BULLETIN 637. Spirit leveling in Texas, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 254 pages, 1 plate.

BULLETIN 638. Spirit leveling in New Mexico, 1902 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 112 pages, 1 plate.

BULLETIN 639. Spirit leveling in Mississippi, 1901 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 80 pages, 1 plate.

Reports on precise and primary leveling in the States named, showing the exact altitude above sea level of a great many places. These elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. The work in Texas during 1902, 1903, 1909, and 1910 was done in cooperation with the State. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

BULLETIN 640. Contributions to economic geology (short papers and preliminary reports), 1916, Part I, Metals and nonmetals except fuels; F. L. Ransome and H. S. Gale, geologists in charge. 1917. viii, 255 pages, 9 plates, 24 text figures.

This bulletin includes 13 papers on investigations of mineral deposits except fuels in the United States in 1916. These papers are of the two classes indicated for Bulletin 621 (p. 18). Their titles, arranged according to subjects, are given on page 21.

Gold and silver.

Reconnaissance of the Conconully and Ruby mining districts, Wash., by E. L. Jones, jr.

Lode mining in the Quartzburg and Grimes Pass porphyry belt, Boise Basin, Idaho, by E. L. Jones, jr.

The Golden Arrow, Clifford, and Ellendale districts, Nye County, Nev., by H. G. Ferguson.

The Gold Log mine, Talladega County, Ala., by E. S. Bastin.

Placer deposits of the Manhattan district, Nev., by H. G. Ferguson.

Lead and zinc.

Notes on the promontory district, Utah, by B. S. Butler and V. C. Heikes.

Rare metals.

Molybdenite near Ramona, San Diego County, Cal., by F. C. Calkins.

An occurrence of nickel ore in San Diego County, Cal., by F. C. Calkins.

Tin ore in northern Lander County, Nev., by Adolph Knopf.

Tungsten deposits of northern Inyo County, Cal., by Adolph Knopf.

Miscellaneous.

Some manganese mines in Virginia and Maryland, by D. F. Hewett.

Gypsum in the southern part of the Big Horn Mountains, Wyo., by C. T. Lupton and D. D. Condit.

The Garrison and Philipsburg phosphate fields, Mont., by J. T. Pardee.

Parts of Bulletin 641, Contributions to economic geology, 1916, Part II, as follows:

BULLETIN 641–B. The oil and gas geology of the Foraker quadrangle, Osage County, Okla., by K. C. Heald. 1916. Pp. 17–47, Pls. II–III, figs. 1–10.

A brief account of the geography and geology of the Foraker quadrangle. The author describes in detail those strata which are valuable as key horizons, gives the probable positions of oil sands, portrays the geologic structure by map and stereogram, and describes fully those anticlines which he believes favorable for the accumulation of oil and gas. In conclusion he gives specific recommendations for prospecting and sets forth his reasons for believing that accumulations of oil and gas are to be found in this area.

BULLETIN 641–C. Possibilities of oil and gas in north-central Montana, by Eugene Stebinger. 1916. Pp. 49–91, Pls. IV–VII, figs. 11–12.

This paper summarizes all the available data concerning the possible occurrence of oil and gas in an area of about 22,000 square miles in north-central Montana, extending from the latitude of Great Falls northward to the international boundary, and points out a number of anticlines and other structural features in this area which seem to be favorable for prospecting. The illustrations consist of geologic sketch maps and sections showing oil and gas prospects and structural conditions.

BULLETIN 641–D. Structure of the Vicksburg-Jackson area, Miss., with special reference to oil and gas, by O. B. Hopkins. 1916. Pp. 93–120, Pl. VIII.

Describes briefly the geology of the Vicksburg-Jackson district, laying special stress on those features which indicate a possible store of oil and

gas there. The author points out which of the areas that have been examined by the Survey are considered favorable and which unfavorable for the accumulation of oil. A map of the district accompanies the report.

BULLETIN 641–E. An anticlinal fold near Billings, Noble County, Okla., by A. E. Fath. 1916. Pp. 131–138, Pl. IX, fig. 1.

Discusses the possibilities of developing an oil and gas field on a certain anticline near Billings, Okla., and gives the logs of several wells that have been drilled in this vicinity.

BULLETIN 641–F. Oil shale in northwestern Colorado and adjacent areas, by D. E. Winchester. 1916. Pp. 139–198, Pls. X–XIX, figs. 13–14.

Gives the results of an examination of the Green River formation in Colorado and Utah to determine the richness of the oil shale of that formation. Contains data showing the quantity and quality of the oil that may be distilled from the richer beds of shale, the number of such beds at the different localities examined, and the general distribution of the shale throughout northwestern Colorado and adjacent parts of Utah and Wyoming.

BULLETIN 641–G. Geology of the Upper Stillwater Basin, Stillwater and Carbon counties, Mont., with special reference to coal and oil, by W. R. Calvert. 1916. Pp. 199–214, Pls. XX–XXI.

In this paper the author compares the geology of the Upper Stillwater Basin, Mont., with that of the Red Lodge district, already studied, in order to show the relation between the coal-bearing rocks of the two areas. He concludes that while the coal in the Upper Stillwater Basin compares favorably in quality with that in the Red Lodge district, the available tonnage is much less. Lack of adequate transportation facilities at present in the Upper Stillwater field also limits its production to the local demand.

BULLETIN 641–H. Geology of the Hound Creek district of the Great Falls coal field, Cascade County, Mont., by V. H. Barnett. 1916. Pp. 215–231, Pl. XXII, fig. 15.

Describes the geologic formations and structure in the Hound Creek district with reference to the occurrence or absence of coal-bearing rocks. Concludes that development of the coal deposits will depend entirely on the local demand, not only because of the poor transportation facilities of the field but also because the coal occurs in too small quantity and is too impure to justify the establishment of a plant to mine coal for shipment.

BULLETIN 641–I. Anticlines in central Wyoming, by C. J. Hares. 1916. Pp. 233–279, Pl. XXIII, figs. 16–34.

BULLETIN 641–J. Anticlines in the Blackfeet Indian Reservation, Mont., by Eugene Stebinger. 1917. Pp. 281–305, Pls. XXIV–XXV, fig. 35.

These two papers give brief accounts of the geologic formations in the districts mentioned in their titles and detailed descriptions of the anticlines and other folds that appear to contain oil or gas. The illustrations for each paper include a map showing the anticlines described in that paper. In addition, Bulletin 641–I contains geologic sections through the anticlines and Bulletin 641–J a geologic sketch map of Blackfeet Indian Reservation, showing sections and wells drilled for oil or gas.

BULLETIN 641–K. Coals in the area between Bon Air and Clifty, Tenn., by Charles Butts. 1917. Pp. 307–310, fig. 36.

This paper was prepared in order to correct a possible misunderstanding regarding the probable coal resources of a small area in Tennessee between Bon Air and Clifty. This area is represented on an economic-geology map which forms part of the Pikeville folio (Geologic Folio 21),

issued by the Survey in 1894. The space was left unshaded on that map merely to express a lack of knowledge concerning the coal resources of the area, and not, as some readers have supposed, to indicate that it contains no workable coal beds. Present knowledge seems to justify the conclusion that two coal beds underlie this area, but their workable portions are so situated that investment or mining in the area should be preceded by careful and thorough prospecting.

BULLETIN 641–L. Oil resources of black shales of the eastern United States, by G. H. Ashley. 1917. Pp. 311–323.

Gives the results of distillation tests of samples of black shale from six States east of the Mississippi, especially as concern the oil content of the shales. Black shales have long been regarded as a possible source of oil, but the prohibitive cost of extracting the oil has so far prevented the process from being practical. The great demand for oil, however, created by the war, and the knowledge that the yield from the present known fields must sooner or later decline have renewed interest in oil-bearing shales and led to definite exploratory work on them.

BULLETIN 642. Mineral resources of Alaska—report on progress of investigations in 1915, by A. H. Brooks and others. 1916. 379 + x pages, 11 plates, 14 text figures.

This volume, which is made up of twelve papers by nine authors, is the twelfth of a series of annual bulletins treating of the mining industry of Alaska and summarizing the results achieved during the year in the investigation of the mineral resources of the Territory.

The arrangement and manner of treatment in this volume are the same as in those previously issued. The first paper deals with administrative matters, the second is a general summary of the mining industry, and the remainder deal more specifically with the economic geology of certain districts arranged geographically from south to north. In the geologic papers emphasis is laid on the conclusions having immediate interest to the miner. The papers were first published separately, in small editions. Their titles are given below:

Preface, by A. H. Brooks.
Administrative report, by A. H. Brooks.
The Alaskan mining industry in 1915, by A. H. Brooks.
Mining developments in southeastern Alaska, by Theodore Chapin.
Water-power investigations in southeastern Alaska, by G. H. Canfield.
Mineral resources of the upper Chitina Valley, by F. H. Moffit.
Mining on Prince William Sound, by B. L. Johnson.
The Turnagain-Knik region, by S. R. Capps.
Gold mining in the Willow Creek district, by S. R. Capps.
Preliminary report on the Tolovana district, by A. H. Brooks.
Exploration in the Cosna-Nowitna region, by H. M. Eakin.
Mineral resources of the Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

BULLETIN 643. Spirit leveling in South Dakota, 1896 to 1915, inclusive; R. B. Marshall, chief geographer. 1916. 100 pages, 1 plate.

Gives the results of primary and precise leveling in South Dakota in the years mentioned, showing the altitude above sea level of more than 1,000 places. Elevations are based on heights of bench marks along precise level lines of the Coast and Geodetic Survey as adjusted in 1912, and on checked primary leveling of the Missouri River Commission. The book contains a halftone plate showing Geological Survey designs for bench marks.

BULLETIN 644. Triangulation and primary traverse, 1913–1915; R. B. Marshall, chief geographer. 1916. 655 pages, 2 plates.

Gives the results of triangulation and primary traverse in the United States during the years 1913, 1914, and 1915, listing 930 triangulation stations and 7,356 traverse stations, nearly all computed on North American datum. Illustrated by a map of the United States showing the condition of astronomic location and primary control to January 1, 1916, and a halftone plate showing Geological Survey bench marks. Issued first in 18 advance chapters, each covering one State or a group of adjoining States.

BULLETIN 645. Bibliography of North American geology for 1915, with subject index, by J. M. Nickles. 1916. 144 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 1915. The book is indexed and contains lists of chemical analyses reported, and minerals, rocks, and geologic formations described.

BULLETIN 646. Spirit leveling in North Carolina, 1896 to 1914, inclusive; R. B. Marshall, chief geographer. 1916. 71 pages, 1 plate.

Gives the results of primary and precise leveling in North Carolina in the years mentioned, showing the altitude above sea level of more than 800 places. Some of these elevations have been adjusted by the United States Coast and Geodetic Survey from precise leveling. The work during 1896 and from 1902 to 1910, inculsive, was done in cooperation with the State. The bulletin contains a halftone plate showing Geological Survey bench marks.

BULLETIN 648. Notes on mining districts in eastern Nevada, by J. M. Hill. 1916. 214 pages, 6 plates, 18 text figures.

The last of a series of reconnaissance reports on the geology and ore deposits of Nevada, giving special attention to the less known and comparatively undeveloped and inaccessible districts. Gives a general outline of the geology of eastern Nevada, including a brief discussion of the nature and occurrence of the ore deposits of the region, as a whole, and detailed descriptions of individual mining districts. The illustrations include a map of eastern Nevada, showing the location of some of the districts described and sketch maps of the districts themselves.

BULLETIN 649. Antimony deposits of Alaska, by A. H. Brooks. 1916. 67 pages, 3 plates, 3 text figures.

A general account, so far as the known facts permit, of the stibnite lodes of Alaska, followed by more detailed descriptions of the principal antimony-bearing districts. Until recently the comparatively small consumption and low price of antimony have not encouraged the development of the Alaska stibnite deposits, although this ore, which bears the sulphide of antimony and is the principal source of the metal, has been noted in 67 localities in the Territory. The present unusual demand for antimony, however, has led to shipments of the ore from Alaska and renewed interest in the development of the Alaska mines. The illustrations consist of maps showing the distribution of antimony deposits and lodes and the location of stibnite mines and prospects.

BULLETIN 650. Geographic tables and formulas (fourth edition); compiled by S. S. Gannett. 1916. 388 pages, 8 text figures.

Includes coordinates for the projection of maps on different scales, areas of quadrilaterals of the earth's surface of different extent, tables of logarithms, computations of geodetic positions, and other tables and formulas used in making maps.

BULLETIN 652. Tungsten minerals and deposits, by F. L. Hess. 1917. 85 pages, 25 plates, 4 text figures.

Gives the known general facts about tungsten, describes the minerals in which it is found and the kinds of deposits from which these minerals have been obtained, and shows, by numerous illustrations, some in the natural colors, the appearance of typical specimens of the various tungsten minerals. The paper should be of interest not only to the prospector and miner but also to those who have no particular knowledge of minerals.

BULLETIN 653. Chemical relations of the oil-field waters in San Joaquin Valley (preliminary report), by G. S. Rogers. 1917. 119 pages, 7 text figures.

A study of the chemistry of the waters of the San Joaquin Valley oil fields, based on several hundred analyses of water from different depths and leading to the following conclusions: (1) That oil-field water is not necessarily salty; (2) that sulphate diminishes in amount as the oil zone is approached and finally disappears; (3) that the concentration of carbonate increases as the oil zone is approached; and (4) that the horizon, with respect to the oil zone, at which these alterations take place is different in each field. The author first presents the evidence on which the foregoing conclusions are based and discusses the interpretation of water analyses and their value from the operator's point of view, and then discusses also the chemical relations of water and oil. He hopes that this preliminary presentation will show the importance of experimental geochemical work on the interaction of the organic constituents of oils and the inorganic substances found in the oil-field waters.

BULLETIN 657. The use of the panoramic camera in topographic surveying, with notes on the application of photogrammetry to aerial surveys, by J. W. Bagley. 1917. 88 pages, 15 plates, 22 text figures, 1 insert.

Describes the field and office instruments used in topographic surveys of certain parts of Alaska in which the ordinary plane-table instruments were supplemented by the panoramic camera, shows the way they were used, and presents some of the results obtained. The method was first tried out in Alaska because that Territory contains a greater proportion of mountains favorable for phototopographic surveying than the United States proper. Includes also a discussion, based largely on French treatises, of the use of the camera in aerial surveys. The illustrations consist of maps showing positions of camera stations, photographs taken with the panoramic camera, and diagrams showing features of the instruments and details of the computations required in using them.

BULLETIN 660–A. Notes on the geology and iron ores of the Cuyuna district, Minn., by E. C. Harder and A. W. Johnston. 1917. Pp. 1–26, Pl. I.

Part of Bulletin 660, Contributions to economic geology, 1917, Part I. A brief preliminary report of the results so far obtained in a geologic examination of the Cuyuna iron district, in connection with which a study has also been made of the rock outcrops in east-central Minnesota, immediately west, south, and east of the district. Contains a map of east-central Minnesota showing the location of the Cuyuna district and a part of the Mesabi district.

BULLETIN 661–A. The Cleveland gas field, Cuyahoga County, Ohio, with a study of rock pressure, by G. S. Rogers. 1917. Pp. 1–99, Pls. I–II, figs. 1–13.

Part of Bulletin 661, Contributions to economic geology, 1917, Part II. Describes briefly the stratigraphy, structure, and gas resources of the Cleveland field, which is of special interest on account of its immediate proximity to a great manufacturing city that has long been a consumer of large quantities of natural gas. Discusses the life and decline of gas wells

in general and particularly of those in this field, which, unfortunately, is a conspicuous example of wasteful development. Contains a map showing the geologic structure of the Cleveland gas field and diagrams and curves representing the decline in rock pressure and the accompanying decrease in production in numerous wells in this field.

Parts of Bulletin 666, Our mineral supplies. This bulletin will be made up of short summaries of the mineral supplies of the United States that are useful in time of war. The following chapters have already been issued:

BULLETIN 666–A. Chromite, by J. S. Diller. 1917. 5 pages.

BULLETIN 666–B. Sulphur, by P. S. Smith. 1917. 4 pages.

BULLETIN 666–C. Manganese, by D. F. Hewett. 1917. 12 pages, 2 text figures.

BULLETIN 666–D. Platinum, by J. M. Hill. 1917. 4 pages.

BULLETIN 666–E. Gypsum, by R. W. Stone. 1917. 3 pages.

BULLETIN 666–F. Salt, bromine, and calcium chloride, by R. W. Stone. 1917. 4 pages.

BULLETIN 666–G. Sand and gravel, by R. W. Stone. 1917. 3 pages.

BULLETIN 666–H. Asbestos, by J. S. Diller. 1917. 4 pages.

BULLETIN 666–I. Talc and soapstone, by J. S. Diller. 1917. 2 pages.

BULLETIN 666–J. Phosphate rock, by R. W. Stone. 1917. 4 pages.

BULLETIN 666–K. Grinding and polishing materials, by F. J. Katz. 1917. 3 pages.

BULLETIN 666–L. Graphite, by H. G. Ferguson. 1917. 7 pages.

BULLETIN 666–M. Coal, by C. E. Lesher. 1917. 7 pages.

BULLETIN 666–N. Potash, by H. S. Gale. 1917. 4 pages.

BULLETIN 666–O. Bauxite and aluminum, by J. M. Hill. 1917. 4 pages.

BULLETIN 666–P. Alaska's mineral supplies, by A. H. Brooks. 1917. 14 pages.

BULLETIN 666–T. Clay and clay products, by Jefferson Middleton. 1917. 3 pages.

BULLETIN 666–W. Barium and strontium, by J. M. Hill. 1917. 3 pages.

WATER-SUPPLY PAPER 360. Surface water supply of the United States, 1913, Part X, The Great Basin; N. C. Grover, chief hydraulic engineer; E. A. Porter, H. D. McGlashan, F. F. Henshaw, and G. C. Baldwin, district engineers. 1916. 293 pages, 2 plates, 1 text figure.

WATER-SUPPLY PAPER 361. Surface water supply of the United States, 1913, Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. 1916. 514 pages, 2 plates, 1 text figure.

WATER-SUPPLY PAPER 362. Surface water supply of the United States, 1913, Part XII, North Pacific drainage basins; N. C. Grover, chief hydraulic engineer; G. L. Parker, W. A. Lamb, G. C. Baldwin, and F. F. Henshaw, district engineers. 1916. 764 pages, 2 plates. (Issued first in three separate chapters bearing the following titles: A, Pacific basins in Washington and Upper Columbia River basin; B, Snake River basin; C, Lower Columbia River and Rogue, Umpqua, and Siletz rivers.)

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1913. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Winter flow, Diversions, 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, current meters, and automatic water-stage recorders.

WATER-SUPPLY PAPER 380. The Navajo country, a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah, by H. E. Gregory. 1916. 219 pages, 29 plates, 29 text figures.

Gives a brief account of the history and exploration of the Navajo country, a description of its geographic features, and a detailed discussion of its water resources. The Navajo country includes six Indian reservations, comprising more than 22,000 square miles—the largest area of undeveloped Indian land in the United States. As the future of this region depends fundamentally on its water supply, the author, in his investigations, devoted his efforts primarily to the solution of this problem. The illustrations include topographic and geologic maps of the Navajo country, numerous halftone plates depicting interesting features of its geography and geology, sections of many of the wells in the region, and diagrams showing distribution of ground water and rainfall and methods of constructing wells and water catches.

WATER-SUPPLY PAPER 381. Surface water supply of the United States, 1914. Part I, North American slope drainage basins; N. C. Grover, chief hydraulic engineer; C. C. Covert, C. H. Pierce, and G. C. Stevens, district engineers. 1916. 195+xxxvii pages, 2 plates.

WATER-SUPPLY PAPER 382. Surface water supply of the United States, 1914. Part II, South Atlantic and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens and W. E. Hall, district engineers. 1916. 66+xxx pages, 2 plates.

WATER-SUPPLY PAPER 384. Surface water supply of the United States, 1914. Part IV, St. Lawrence River basin, prepared under the direction of N. C. Grover, chief hydraulic engineer, by W. G. Hoyt, A. H. Horton, C. C. Covert, and C. H. Pierce. 1916. 128+xxix pages, 2 plates.

WATER-SUPPLY PAPER 386. Surface water supply of the United States, 1914. Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb and Robert Follansbee, district engineers. 1917. 220+xli pages, 3 plates.

WATER-SUPPLY PAPER 387. Surface water supply of the United States, 1914. Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and G. A. Gray, district engineers. 1916. 60+xxxiv pages, 2 plates.

WATER-SUPPLY PAPER 391. Surface water supply of the United States, 1914, Part XI, Pacific slope basins in California; N. C. Grover, chief hydraulic engineer; H. D. McGlashan and F. F. Henshaw, district engineers. 1917. 334+xxxvi pages, 2 plates.

WATER-SUPPLY PAPER 392. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, A: Pacific drainage basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. 1916. 200 pages, 2 plates.

WATER-SUPPLY PAPER 393. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, B: Snake River basin; N. C. Grover, chief hydraulic engineer; G. C. Baldwin and F. F. Henshaw, district engineers. 1916. 248 pages, 2 plates.

WATER-SUPPLY PAPER 394. Surface water supply of the United States, 1914, Part XII, North Pacific drainage basins, C: Lower Columbia River and Pacific drainage basins in Oregon; N. C. Grover, chief hydraulic engineer; F. F. Henshaw and G. L. Parker, district engineers. 1917. 180+xlix pages, 2 plates.

These papers present briefly the results of measurements of stream flow in the basins named in the titles during the calendar year 1914. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Extremes of discharge, Diversions, 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, current meters, and automatic water-stage recorders. At the end of each book (except Nos. 392 and 393, which must be combined with No. 394 to make the complete report for the year on the north Pacific basins) is a list of all gaging stations maintained in the drainage basins covered and an annotated list of publications issued by the United States Geological Survey relating specifically to the region, 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 395. Colorado River and its utilization, by E. C. La Rue. 1916. 231 pages, 25 plates, 5 text figures.

This paper assembles the principal facts relating to the water resources of Colorado River, on the proper control of which depends the productivity and prosperity of an area extending over parts of seven States. The author has studied especially the possibility of controlling the flow of the whole river by means of storage reservoirs, so as to avoid a recurrence of the disastrous effects on Imperial Valley caused a few years ago by the diversion of the whole flow of the river instead of merely a part to the Salton Sink. Proper control would also render available for profitable use an enormous quantity of water which now flows unused and almost unusable to the Gulf of California in the form of floods.

The illustrations consist of maps showing irrigable land in parts of the Colorado River basin and diversions from this basin to that of Mississippi River and to the Great Basin, charts showing daily and annual discharge and gage heights of Colorado River, and photographic reproductions of scenes along the river.

WATER-SUPPLY PAPER 396. Profile surveys in the Colorado River basin in Wyoming, Utah, Colorado, and New Mexico, prepared under the direction of W. H. Herron, acting chief hydrographer. 1917. 6 pages, 43 plates.

Consists chiefly of maps showing outlines of river banks, islands, position of rapids, falls, and shoals, and existing dams in the Colorado River basin. The streams to which the surveys relate are fully described in Water-Supply Paper 395.

Parts of Water-Supply Paper 400, Contributions to the hydrology of the United States, 1916, as follows:

WATER-SUPPLY PAPER 400–B. Artesian water for irrigation in Little Bitterroot Valley, Mont., by O. E. Meinzer. 1916. Pp. 9–37, Pls. I–IV, figs. 1–4.

Discusses the water resources of the semiarid Little Bitterroot Valley, in northwestern Montana, which was opened to white settlers in 1910. Little Bitterroot River, which traverses the valley, does not furnish enough water to irrigate the farms, and the rainfall is also inadequate. The author recommends the use for irrigation of artesian water, the supply of which is very plentiful in the valley now, and he advocates project ownership rather than private, so that there may be no waste.

WATER-SUPPLY PAPER 400–C. The measurement of silt-laden streams, by R. C. Pierce. 1916. Pp. 39–51, figs. 5–6.

Gives the results of discharge measurements of San Juan River made near Bluff, Utah, during the summer of 1915, together with diagrams show-

ing the rating, area, and velocity curves of the stream flow. The paper should be of interest to hydraulic engineers who may have occasion to measure streams carrying heavy loads of silt.

WATER-SUPPLY PAPER 400–D. Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt. 1916. Pp. 53–59.

A discussion of the conditions affecting accuracy of records of daily discharge and of the degree of accuracy required in such records for their three principal uses—in predicting flow, in the immediate operation of hydraulic works, and in studying past flow.

WATER-SUPPLY PAPER 400–E. Ground water for irrigation in the Morgan Hill area, Cal., by W. O. Clark. 1917. Pp. 61–108, Pls. V–VII, figs. 7–11.

Describes briefly the geology and drainage of the Morgan Hill area, Cal., a part of Santa Clara Valley about 20 miles from the city of San Jose, with especial reference to its ground-water supply and the best means of utilizing it. Contains maps of the area showing positions and fluctuations of the water table at different stages, logs of wells, and tables giving water levels in many of the wells.

WATER-SUPPLY PAPER 402. Surface water supply of the United States, 1915. Part II, South Atlantic and eastern Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. C. Stevens and W. E. Hall, district engineers. 1916. 51 + xxx pages, 2 plates.

WATER-SUPPLY PAPER 405. Surface water supply of the United States. 1915. Part V, Hudson Bay and Upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. G. Hoyt and A. H. Horton, district engineers. 1917. 215 + xxx pages, 4 plates.

WATER-SUPPLY PAPER 407. Surface water supply of the United States, 1915, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee and G. A. Gray, district engineers. 1917. 43 + xxxiii pages, 2 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1915. They are similar to the reports for 1914 noticed on pages 27–28.

WATER-SUPPLY PAPER 415. Surface waters of Massachusetts, by C. H. Pierce and H. J. Dean, 1916. 433 pages, 12 plates, 6 text figures.

A compilation of available data on the flow of Massachusetts streams, including the classic records collected on the Merrimack at Lowell and Lawrence, on the Connecticut at Holyoke, and on the Cochituate and Sudbury by the Metropolitan Water and Sewerage Board, as well as records covering shorter periods, all of which have been studied in the light of the best obtainable information and revised where necessary and possible. Contains also a gazetteer of streams, lakes, and ponds in Massachusetts and illustrations, consisting of a map of the State showing the principal drainage basins and location of gaging stations, a profile of Deerfield River, curves showing the water-stage record of several of the streams, and views of dams and other devices employed to utilize their water power.

WATER-SUPPLY PAPER 416. The divining rod, a history of water witching, with a bibliography, by A. J. Ellis. 1917. 59 pages, 4 text figures.

This paper was published as a reply to the numerous inquiries that are continually received by the Survey from all parts of the country as to the efficacy of the divining rod in locating underground water. The use of a forked twig, or so-called divining rod, in locating minerals is a curious superstition that has been a subject of discussion since the middle of the sixteenth century and still has a strong hold in the popular mind. Needless to

say, the Survey advises all inquirers not to expend money for the services of a "water witch" or for the use or purchase of any machine or instrument devised for locating underground water or other minerals.

WATER-SUPPLY PAPER 417. Profile surveys of rivers in Wisconsin, prepared under the direction of W. H. Herron, acting chief geographer. 1917. 16 pages, 32 plates.

WATER-SUPPLY PAPER 419. Profile surveys in 1915 in Skagit River basin, Wash., prepared under the direction of W. H. Herron, acting chief geographer. 1916. 8 pages, 12 plates.

WATER-SUPPLY PAPER 420. Profile surveys along Henrys Fork, Idaho, and Logan River and Blacksmith Fork, Utah, prepared under the direction of W. H. Herron, acting chief geographer. 1916. 8 pages, 10 plates.

WATER-SUPPLY PAPER 421. Profile surveys in 1915 along the Rio Grande, Pecos River, and Mora River, N. Mex., prepared under the direction of W. H. Herron, acting chief geographer. 1916. 11 pages, 11 plates.

These papers describe briefly the general features of the river basins named in their titles, and give a list of the gaging stations maintained by the Geological Survey in those basins. They contain also numerous plans and profiles of the rivers, showing in outline their banks, islands, rapids, falls, shoals, dams, and crossings of ferries and roads.

WATER-SUPPLY PAPER 423. Geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys, Nev., by O. E. Meinzer. 1917. 167 pages, 15 plates, 11 text figures.

Describes the physiography and geology of three typical desert valleys in Nevada, none of which has a drainage outlet, and discusses in detail their underground-water supply and its quality. Big Smoky Valley is very much larger and more thickly settled than the other two valleys, and the author concludes that although its ground-water supply is plentiful, full utilization of that supply for irrigation is possible only by pumping and that extensive development will not be economically practicable until cheaper power or more valuable crops can be introduced than are now in sight. The illustrations include a map of each valley described, profiles across beaches in Big Smoky Valley, diagrams showing average monthly precipitation and fluctuations of the water-level in one of the wells, and halftone plates depicting geologic conditions in the region brought about by the action of water.

WATER-SUPPLY PAPER 425–A. Ground water in San Simon Valley, Arizona and New Mexico, by A. T. Schwennesen, with a section on agriculture, by R. H. Forbes. 1917. Pp. 1–35, Pls. I–III, figs. 1–2.

Discusses the water resources and agricultural possibilities of San Simon Valley, in southeastern Arizona. Although a few white settlers have been in the valley since the early seventies, its agricultural development did not begin until 1910, when artesian water was discovered at San Simon. The paper is illustrated by maps of the San Simon basin and certain portions of it showing locations of deep wells, flowing-well areas, and depths to ground-water table.

MINERAL RESOURCES OF THE UNITED STATES, 1915. Remainder of advance chapters (thirteen issued in fiscal year 1916). Volume not yet published June 30, 1917.

MINERAL RESOURCES OF THE UNITED STATES, 1916. Two advance chapters, as follows:

Fuel briquetting in 1916, by C. E. Lesher. 1917. Pp. 1–4, fig. 1.

Sand-lime brick in 1916, by Jefferson Middleton. 1917. Pp. 5–6.

GEOLOGIC FOLIO 201. (Octavo edition; folio edition issued in fiscal year 1916.) Minneapolis-St. Paul folio, by F. W. Sardeson. 1916. 100 pages+list of published geologic folios, 8 maps, 22 plates, 14 text figures.

Description and maps of the Anoka, Minneapolis, St. Paul, and White Bear quadrangles, comprising about 846 square miles in Anoka, Dakota, Hennepin, Ramsey, Scott, and Washington counties, Minn.

GEOLOGIC FOLIO 202. Eureka Springs-Harrison folio, Arkansas-Missouri, by A. H. Purdue and H. D. Miser. 1916. 21 folio pages of text, 4 maps, 1 structure-section sheet, 1 columnar-section sheet, 9 plates, 13 text figures.

Description and maps of the Eureka Springs and Harrison quadrangles, comprising about 1,925 square miles in Benton, Boone, Carroll, Madison, Newton, and Washington counties, Ark., and Barry, Stone and Taney counties, Mo.

GEOLOGIC FOLIO 203. Colorado Springs folio, Colorado, by G. I. Finlay. 1916. 15 folio pages of text, 4 maps, 1 structure-section sheet, 1 columnar-section sheet, 1 correlation sheet, 14 plates, 9 text figures.

Description and maps of the Colorado Springs and Manitou quadrangles, comprising about 995 square miles in Fremont, El Paso, Pueblo, and Teller counties, Colo.

GEOLOGIC FOLIO 204. Tolchester folio, Maryland, by B. L. Miller, E. B. Mathews, A. B. Bibbins, and H. P. Little. 1917. 14 folio pages of text, 2 maps, 1 columnar-section sheet, 10 plates, 3 text figures.

Description and maps of the Tolchester quadrangle, comprising about 925 square miles in Anne Arundel, Baltimore, Cecil, Harford, Kent, and Queen Annes counties, Md.

GEOLOGIC FOLIO 205. Detroit folio, Michigan, by W. H. Sherzer. 1917. 22 folio pages of text, 12 maps, 12 plates, 20 text figures.

Description and maps of the Wayne, Detroit, Grosse Pointe, Romulus, and Wyandotte quadrangles, comprising about 770 square miles in Macomb, Monroe, Oakland, and Wayne counties, Mich. Published also in octavo form, 162 pages.

GEOLOGIC FOLIO 206. Leavenworth-Smithville folio, Missouri-Kansas, by Henry Hinds and F. C. Greene. 1917. 13 folio pages of text, 4 maps, 10 plates, 10 text figures.

Description and maps of the Leavenworth and Smithville quadrangles, comprising about 460 square miles in Leavenworth and Atchison counties, Kans., and Platte, Clay, and Clinton counties, Mo.

Topographic and other maps as follows:

Arkansas (State).[1]
Batavia, Ohio.
Berryville, W. Va.[2]
Birds, Ill.-Ind.
Bristol Range, Nev.
Bristow, Okla.
Canaseraga, Okla.
Capon Bridge, W. Va.-Va.[2]
Castlegate, Utah.
Ceres, Cal.
Chehalis, Wash.
Cholame, Cal.[3]
Claremore, Okla.[4]
Condon, Oreg.
Copperopolis, Cal.
Coyote Rapids, Wash.
Creede, Colo.
Cressey, Cal.
Crows Landing, Cal.
Delevan, Cal.
Denair, Cal.
Diamond Lake, Oreg.
Elizabeth Lake, Cal.
Elmira, Cal.
Equality, Ill.
Ewell, Va.-Md.
Florida (State).[5]
Fords Ferry, Ky.-Ill.[6]
Gerrardstown, W. Va.-Va.[6]
Gila Butte, Ariz.
Golconda, Ky.-Ill.[6]
Greenfield, Ohio.
Heathsville, Va.-Md.
Henderson, Ky.-Ind.
Henry, Idaho.
Hopeton, Cal.
Humboldt, Nebr.
Hurley, Va.-Ky.
Indiana (State).[1]

[1] Photolithograph, 1 : 1,000,000.
[2] Office edition only, showing part of quadrangle.
[3] Sheet completed; part engraved in 1914.
[4] Resurvey.
[5] Photolithograph, 1 : 500,000.
[6] Preliminary edition, showing part of quadrangle.

Inez, Ky.
Interlachen, Fla.
Iowa (State).[1]
Jacinto, Cal.
Jacobs Corner, Cal.
Kiefer, Okla.
Kilmarnock, Va.
Kimmswick, Mo.-Ill.[2]
Kurand, Cal.[3]
Liberty, Maine.
Logan, Utah-Idaho.
Logandale, Cal.
Lyman, Cal.
Malone, N. Y.
Mathews, Va.
Mechanicsburg, Ohio.
Merced, Cal.
Milford Center, Ohio.
Minnesota (State).[1]
Mississippi (State).[1]
Missouri (State).[1]
Mitchell School, Cal.
Morrow, Ohio.
Muscle Shoals, Ala.
Nashua, Mont.
Octa, Ohio.
Pikeville, Ky.
Plattsburg training camp, N. Y.
Point of Sands, N. Mex.
Portland and vicinity, Maine.
Portneuf, Idaho.
Pounding Mill, Va.-W. Va.[3]
Priest Rapids, Wash.
Richlands, Va.[3]
Riverbank, Cal.
Rogersville, Ala.
Sabina, Ohio.
St. Charles, Mich.
San Juan Bautista, Cal.
Santa Rosa, Cal.
Sturgeon, Mo.
Talking Rock, Ga.
Three River, Mich.-Ind.
Tomah, Wis.
Tularosa, N. Mex.
Turlock, Cal.
Urbanna, Va.
Vernal, Utah.
Washington and vicinity, D. C.-Md.-Va.
Washington (national capital).
Waterford, Cal.
White Mountain, Cal.-Nev.
Willamette Valley, Oreg., sheet 7.[4]
Willamette Valley, Oreg., sheet 8.[4]
Wind Gap, Pa.
Xenia, Ohio.

[1] Photolithograph, 1 : 1,000,000.
[2] Sheet completed; part engraved in 1913.
[3] Preliminary edition, showing part of quadrangle.
[4] Photolithograph in colors.

GEOLOGIC BRANCH.

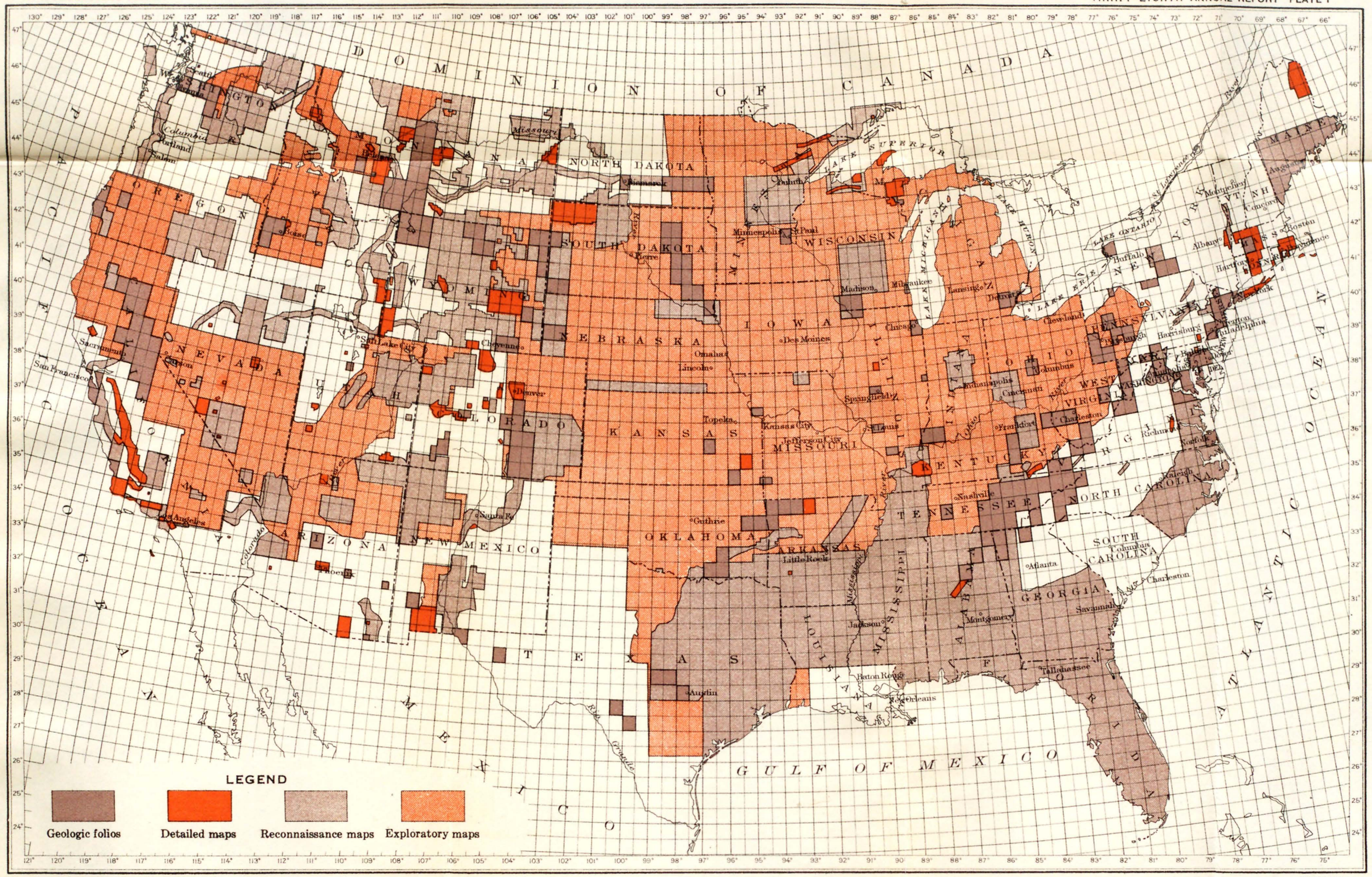
SCOPE OF WORK.

The Survey was established for "the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain" and was later authorized "to continue the preparation of a geological map of the United States." The operations of the geologic branch extend to every region of the country and to nearly every field of geology. It has taken the lead both in scientific geologic research and in assisting the development of the mineral resources of the country, as well as taking a part in both popular and technical geologic education. As a national bureau of public information on geologic matters, relating to not only all parts of the United States and Alaska but to other countries as well, the Survey's activities are shown by the range of its correspondence, which is constantly increasing.

ORGANIZATION.

The geologic branch is organized in four divisions—geology, David White, chief geologist, in charge; Alaskan mineral resources, Alfred H. Brooks, geologist, in charge; mineral resources, H. D. McCaskey, geologist, in charge; and chemical and physical researches, G. F. Becker, geologist, in charge.

The geologic investigations to be carried on by the Survey in the United States are planned by the chiefs of sections in the division of geology in council with the chief geologist. The chief geologist also gives particular attention to cooperation with State surveys and devotes such time as is available to him for field work to field inspections and conferences with chiefs of sections and geologists and to the direction and inspection of the work of the section of oil and gas investigations.



MAP OF THE UNITED STATES SHOWING AREAS COVERED BY GEOLOGIC MAPS PUBLISHED PRIOR TO JULY 1, 1917

Scale $\frac{1}{14,000,000}$

100 0 100 200 300 400 500 Miles

SNYDER & BLACK N.Y.

PUBLICATIONS.

The publications of the fiscal year 1917 prepared wholly or partly in the geologic branch embrace 36 professional papers, bulletins, etc., 105 chapters of reports later published as annual volumes, and 5 geologic folios. Titles and brief abstracts of these publications are given on pages 14–31. Besides the official publications, 44 papers were, with the permission of the Director, published by scientific societies or elsewhere in scientific and technical journals. Seven 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. One extensive report, prepared in cooperation with the Carnegie Institution, the Bureau of Fisheries, and the Panama Canal Commission, has been submitted to the National Museum for publication. In the preparation of the reports of mineral production considerable material relating to certain of the industries in the different States is compiled by the State geologists.

PROGRESS OF GEOLOGIC MAPPING.

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. This map 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 devision of Alaska mineral resources (pp. 81–91).

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The scientific force of the division of geology at the beginning of the year consisted of 72 geologists, 29 associate geologists, 31 assistant geologists, 7 junior geologists, and 17 geologic aids. During the year 14 members of the scientific staff resigned to take positions in private life at higher salaries; 3 members died; 2 were transferred to another bureau; 1 was transferred to the land-classification board; 12 were dropped from the rolls; 9 new members were appointed; and 1 was transferred from another division. The total number of geologists of various grades on the divisional staff at the end of the year was 134, there having been a net loss of 22.

For most of the year the division of geology included 10 sections, the scope of whose work was outlined in the last report. In April, on account of the increasing importance of the metals used in steel making and the special attention required for the alloy metals on

account of war conditions, a redistribution of the work among 11 sections was made, as stated on pages 43–46.

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 efficiency in operation and the scientific standard of results. Exceptions have been made of the studies of the structure in the Great Basin region by G. K. Gilbert and of the petrologic, structural, and historical researches in the San Juan region of Colorado by Whitman Cross. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist. The general monographic treatment of the geology of the Yellowstone National Park, long in preparation by Arnold Hague, was nearly completed at the time of his death early in May.

R. V. L. Stratton, of the geologic branch, received a commission as lieutenant (assistant paymaster) in the United States Navy prior to June 30, 1917.

ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1916–17 were as follows:

Geologic surveys	$350,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemical and physical researches)	16,700
	380,400

These funds were allotted as follows:

Section of eastern areal geology	$18,700
Section of western areal geology	29,820
Section of Coastal Plain investigations	14,810
Section of stratigraphy and paleontology	18,120
Section of metalliferous deposits	54,600
Section of nonmetalliferous deposits (including potash)	38,820
Section of glacial geology	6,150
Section of eastern coals	7,040
Section of western coals	18,510
Section of iron and steel alloys[1]	600
Section of oil and gas	52,380
Geologic map editing	7,020
Great Basin investigation and inspection	3,600
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	80,510
	350,680
Land-classification board	29,720
	380,400

[1] The work of this section during the spring was mainly carried in the allotments of other sections.

Of the amounts allotted to this division $272,500 was expended directly for field work, including the search for potash. Of this amount $180,800, or 66.3 per cent, was expended west of the one hundredth meridian and $91,700, or 33.7 per cent, east of the one hundredth meridian. With the $29,720 for the operations of the land classification board, 69.6 per cent of the total, exclusive of the allotment for supervision, etc., was spent for investigations west of the one hundredth meridian—that is, essentially in the public land States. The expenditures for supervision, etc., are divisible in about the same proportion 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 25 States—Alabama, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Carolina, North Dakota, Oklahoma, Ohio, Pennsylvania, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin. Informal cooperation exists between the Survey and all the States having geological surveys.

Foremost in the service rendered by the geologic branch of the Survey to other departments are the reports on the drainage and underground water supplies of the Gulf and Atlantic Coastal Plain and the information furnished as to camp locations, foundations, building materials, etc. The Survey cooperated with the Bureau of Mines in the metallographic study of ores and the investigation of the invasion of California oil wells by salt water, and with the Bureau of Mines, the Bureau of Standards, and the Office of the Supervising Architect in the grading of the Indiana limestones. A technologic paper prepared by a Survey geologist in the course of his detailed investigations of mineral deposits has been submitted for publication to the Bureau of Mines, which in turn has transmitted to the Survey a geologic report to be published as a bulletin. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads and Rural Engineering in a thorough and systematic study of the building stones of the United States. Field examinations of oil, gas, and nitrate deposits have been made for the War and Navy departments. Through the division of geology it cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Coast and Geodetic Survey, the Forest Service, the Weather Bureau, the Lighthouse Service, and the Office of Indian Affairs, as well as with a number of institutions

of learning, including in particular the Geophysical Laboratory and the Marine Biological Station of the Carnegie Institution. Services have been rendered to the Department of Justice in connection with its suits regarding public lands; to the Bureau of Foreign and Domestic Commerce in reporting the production of certain raw materials; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

GENERAL FEATURES OF THE WORK OF THE YEAR.

All phases of geologic work have been continued, though for lack of funds it has been necessary to refuse requests for field examinations in greater number than ever before. During the later part of the year, especially after the declaration of war, not only were such requests much more numerous but the offers to the Government of mineral deposits of many kinds and in many regions necessitated special examination of all available data.

The dominant feature of the work of this division during the year has been the greater concentration of effort along economic lines, particularly in the location and development of mineral deposits of special importance to the successful prosecution of the war and the continued maintenance of the industrial strength of the Nation.

In recognition of the probable deficiency of the domestic petroleum supply to meet the demands to be made upon it for war purposes, this vital question was among the first to receive attention. Careful estimates of the country's oil resources, based on the most complete and trustworthy criteria available, were made by the oil and gas geologists most familiar with the different fields and provinces. The general results of these estimates, summarized by fields and integrated as to oil contents of the public lands, naval reserves, etc., have been published. At the same time the progress of exploration by the drill has been carefully followed, and every effort has been made to extend assistance. The search for areas in which the geologic conditions, including the structure, would appear to be favorable for the occurrence of undiscovered oil pools was pushed as vigorously as was possible with the available resources in funds and trained oil and gas geologists. Mention of this work will be found in the accounts of the geologic investigations in the different States. During the year ten reports pointing out areas favorable for testing in different State have been printed; nine similar reports are in process of publication, and fifteen others are in process of criticism or ready for transmission. For some areas, in order to bring more quickly the particular results of the geologic explorations to the attention of the public, short advance statements have been distributed to the press.

In the administration of Indian lands by the Office of Indian Affairs there has been active cooperation on the part of the Geological Survey. This has been accomplished by the geologic examination of these lands prior to their leasing. The prompt publication of the results obtained by the geologist has proved an incentive to the leasing of the particular areas on which reports are made, a guide to the valuation of the leases, and a help in concentrating drilling where conditions are most favorable for large production.

The investigation of the so-called hydrocarbons or oil-shale deposits of the country, begun four years ago by the Survey, has been diligently prosecuted. The extension of the oil shales of the Uinta Basin westward toward Green River in Utah has been mapped, with the discovery of new areas, so that it is now estimated that there is enough of this shale, in beds 3 feet or more in thickness and capable of yielding more than 22 gallons of oil to the ton by distillation, to provide as much as 40,000,000,000 barrels of petroleum. The Uinta Basin contains a vast storehouse of petroleum in this form, the volume of which is better realized when it is recalled that all the oil that has yet been produced in the United States is but about 3,500,000,000 barrels. The oil fields of the United States are now producing a little over 300,000,000 barrels of petroleum a year, which is about two-thirds of all that is yearly taken from the ground the world over. What new oil pools and fields may yet be discovered in other parts of the world, particularly the less explored regions, no one can foretell, but it seems probable not only that oil will be distilled from the shales of the Green River group long after the principal oil fields of the world have been exhausted but also that the total amount that will be obtained from this source may exceed the world's total production of natural petroleum. The standard of richness named in the above estimate is said to be up to the average of the Scotch shale, which has for many years been the basis of a large industry and which is now providing distillate for British naval and military uses.

A report showing the distribution of the oil shales in Colorado and northeastern Utah and giving analyses and the results of rough tests and laboratory experimental distillations, nitrogen determinations, etc., has been issued as Bulletin 641–F, and another report describing the westward extension of the deposits, with additional details as to the composition of the shales, is now ready for publication. A report giving the results of distillation tests of richly bituminous shales in several of the Eastern States has been issued as Bulletin 641–L.

The investigation of the oil shales has been typically a preparedness measure. How soon it will be necessary to draw rapidly from this source remains to be seen, but it is worthy of note that a small commercial plant is already about to begin the treatment of the oil shales near De Beque, Colo., and that several other plants are projected or in process of construction. Undoubtedly the shales will be found somewhat richer under thick cover than where they have been sampled at the outcrop. It is gratifying also to observe that several State surveys are giving attention to the subject of recovering oil from such bituminous shales and of investigating their possible importance as a source of new as well as of already known by-products.

A new map showing the oil and gas fields of the United States and the trunk pipe lines, together with the oil-exporting points, has been prepared under the supervision of J. D. Northrop and is now in process of engraving.

Another branch of war-preparedness work to which precedence has been given in this division during the year is the systematic investigation of reported or little known deposits of minerals which are especially important to the conduct of the war but for which the country is largely dependent on importations, the attention of the public being called to such of these as may with commercial success be made to contribute to the Nation's supply. Among the more important of these minerals are potash, nitrates, manganese, pyrite, tungsten, chromite, tin, antimony, and molybdenum.

The search for commercial sources of potash and nitrates has continued with unabated zeal. As the stocks of imported potash salts have diminished almost to exhaustion and prices for these materials have increased tenfold and even more, the demand for assurance of a certain supply has become more urgent. Fortunately the most indispensable requirements have been met, although with a production in 1916 of less than 5 per cent of the normal consumption before the war, there is still much room for improvement. During the first half of 1917 the rate of production was more than twice that for 1916 and continued improvement is expected.

The greater part of the potash so produced has been derived from mineral sources, although considerable has been obtained from organic materials, such as molasses residue from distilleries and kelp and wood ashes. The most promising source of potash is the saline deposit at Searles Lake, Cal. The first published announcement of this as a potentially valuable deposit of potash was made by the United States Geological Survey in March, 1912, and it is naturally a source of some satisfaction to see this prediction fulfilled, especially as it was regarded as the opposite of scientifically conservative opinion at the time of publication. Considerable potassium sulphate has

also been recovered from the alunite of Marysvale, Utah. This deposit also was the subject of special study by the United States Geological Survey and was covered in its early publications on the prospective sources of potash. The Nebraska alkali lakes have made a surprising record of production. Although not of large extent or seeming to offer a great reserve of raw material, the exceptionally high content of potash in some of these waters made this product one of the most readily available sources for a commercial output. This source also was early reviewed in the Survey potash publications, but though the facts of its potash content were carefully stated, the occurrence was not then given the prominence that some of the other apparently more extensive resources received. For a time the Nebraska lakes held the lead as a source of commercial potash, and they still yield a very important production.

Besides those projects that have reached more successful development, many enterprises and prospects have been inspected, most of which have been absolutely disappointing. However, the principal efforts of the Government geologists have been directed to the study of raw materials which might become available as a basis of potash manufacture, although naturally this has involved more or less the consideration of processes by which this material could be utilized.

During 1916–17 nearly all the special fund allotted to the potash investigations was devoted to the exploration of buried saline deposits by drilling. The drilling of the well at Cliffside, in Potter County, Tex., was resumed as soon as it was possible to obtain delivery of the necessary equipment and to reorganize the crew after the allotment of funds for the year became available. At the end of June, 1917, this well had reached a depth of 1,657 feet, which approached the limit, 1,800 feet, set in the original plan. This limit was proposed not because it was expected that the salt beds would have been completely penetrated when that depth was reached but because it would cover the depths at which slight showings of potash salts had been reported in this region. Furthermore, it was as far as could probably be drilled with the fund that could be allotted for this purpose in a single year. The salt beds cut in this well have been very carefully tested, but as yet no valuable deposit of potash-rich material has been encountered. The test is conclusive, however, only for that portion of the section that has been explored and applies only to this one locality or district. The possibilities of finding strata of potash salts associated with the salt beds and gypsum occurring in great number and thickness in the "Red Beds" of the Southwest were discussed in the Thirty-seventh Annual Report, pages 12–14.

By courtesy of the owners borings in other areas of the salt-bearing formations in Texas and Oklahoma have also been inspected

and the cuttings tested, although, owing to the meager facilities of the Survey for work of this kind, much important boring is undoubtedly going on without adequate inspection with regard to the possibility of finding potash.

Various other lines of investigation have also been followed. A review and more adequate sampling with analysis of some of the large potash-feldspar deposits has been started, and some significant results bearing on the adequacy of the supply of this raw material for a possible future potash industry have been obtained. A report is nearly ready for publication.

The sericite deposits in Georgia and elsewhere have been examined, sampled, and tested for potash, and a review of the important greensand deposits in the Eastern States has been made to ascertain their potash contents. The results of these inquiries have been published.

The general conclusion has been reached that most of the nitrate deposits in this country are superficial and that the amount of nitrate they contain is not sufficient to make them of commercial importance. Yet investigations of all reported discoveries of nitrates have been made. In June, under the auspices of the War Department, H. S. Gale, geologist in charge of the section of nonmetalliferous deposits, made an examination of nitrate deposits in Guatemala.

A general report by E. S. Bastin, describing the graphite deposits of the country and including information as to several recently discovered and important deposits of flake graphite, has been submitted and is being prepared for publication.

The mica resources of the Eastern States are reviewed by D. B. Sterrett in a comprehensive report now ready for transmission, giving special attention to some of the more important areas.

Systematic examinations, amounting to a qualitative and quantitative census, of the known or reported deposits of platinum, pyrite, manganese, tungsten, chromite, tin, vanadium, strontium, nickel, and antimony have been in progress. Toward the end of the year cooperation in this work has been extended by State geological surveys and geologists of State defense councils.

With the cooperation of a number of State geological surveys, especially in the southern Appalachian region, special attention has been given to the problem of mining domestic pyrite of satisfactory grade sufficiently near the points of consumption and in quantities sufficiently large to take the place of a portion of the pyrite supply which has formerly been imported from Spain. Particular attention has been given also both to the sulphur deposits that may be made available and to the pyrrhotite that it will perhaps be necessary to utilize in making the large amounts of sulphuric acid needed in the manufacture of munitions and of commercial fertilizers.

The search for manganese, which is indispensable in the production of high-grade steel, has been even more comprehensive and systematic.

With the cooperation of geologists and of engineers every reported manganese deposit is in process of investigation and of qualitative and quantitative estimation, with a view to ascertaining the possible outputs of different grades of ore, this year, next year, and the year following. The more important deposits have been and are now under investigation by the geologists of the metalliferous and alloy sections of the division. Furthermore, through the cooperation of the Bureau of Mines and the War Minerals Committee, a joint committee composed of representatives of the Association of State Geologists, the geology committee of the Council of National Defense, the American Institute of Mining Engineers, the Mining and Metallurgical Society of America, the Bureau of Mines, and the Geological Survey, plans have been made to furnish the expert advisory services of some of the most eminent and well-known engineering and mining specialists of the country, who have patriotically volunteered to give practical professional advice to the miners of pyrites, tin, and manganese in certain districts where there is greatest need for such counsel as to mining and milling methods.

To render fuller service to the producer in marketing his ores and to the steel or alloy manufacturer in procuring his domestic ores, the Survey has established an efficient system of bringing them together by correspondence. To give the industry more ample data on production, while furnishing the Government with information as to the rate at which the domestic production is being built up and the rate at which imports may be discontinued, the Survey has planned the quarterly collection and compilation of reports of production of pyrites and manganese, and it is probable that this system of reporting will at an early date be placed on a monthly basis.

An investigation of the platinum deposits of the United States was undertaken early in the spring by L. M. Prindle and J. M. Hill. This work is conducted with close cooperation of the California State Mining Bureau and the State Council for Defense and is designed to cover completely the platinum deposits and possible points of origin of platinum in northern California and southwestern Oregon.

Another timely public service in which a number of the areal geologists and physiographers are engaged is the preparation of two geologic and geographic manuals covering the New England and Virginian regions. These papers, which are prepared on the recommendation of and in cooperation with the geography committee of the National Research Council, will describe the geologic features of the provinces and their origin, and though designed for general educational purposes will give special attention to the inclusion of matter of greatest value in military training and the strategy of the regions covered. Other similar manuals covering other military departments are in prospect. Plans are also being formulated for the preparation and printing of interesting and instructive popular de-

scriptions of the geologic features and their origin in the Army cantonments and surrounding areas. These popular descriptions, with accompanying military data, are to be printed on the backs of the topographic maps of areas including the vicinity of the cantonments.

The popular appreciation of the educational work of the Survey in the publication of the guides to the routes of four western railways has necessitated the issue of new editions of these bulletins. During the year the manuscript and illustrations for a similar guide to the route of the Denver & Rio Grande Railroad in Colorado and Utah has been submitted, but its publication is likely to be delayed for the issue of reports immediately connected with the successful prosecution of the war.

In general the work in economic geology has gone forward as vigorously as the available personnel and funds would permit. The metallographic studies of certain metalliferous ores and the general investigations of the geology and mineral deposits of mining districts mentioned in last year's report have made good progress. A report on the mining districts of Utah has been submitted by B. S. Butler and is now in process of editing and illustration. A revised and much extended description of the enrichment of sulphide ores, by W. H. Emmons, has been issued as Bulletin 625, and a general report on tungsten minerals and deposits, by F. L. Hess, has appeared as Bulletin 652. The report "Useful minerals of the United States," greatly amended and enlarged by F. C. Schrader and others, has been issued as Bulletin 624.

A professional paper on the geology and copper deposits of the Ray and Miami districts of Arizona, by F. L. Ransome, is nearly ready for transmission, and the general descriptions forming the main part of an exhaustive report on the Leadville district have been nearly completed by Prof. J. D. Irving. Other reports covering smaller regions are noted on later pages under the names of the several States. E. S. Larsen is preparing a report on the microscopic determination of known opaque minerals. This extensive work, the publication of which may be delayed for a time, will probably constitute a manual on the subject for the use of geologists, teachers, and students.

The introductory chapter, by M. R. Campbell, of Professional Paper 100, "The coal fields of the United States," has been issued, together with a large map showing the distribution of the coal fields of the country and the ranks of the coals. In this chapter are given short, summary descriptions of the different coal fields, with discussions of the character and qualities of the fuels, representative analyses, and estimates of the coal reserves in the various fields and of the several ranks. A second part, prepared through the courtesy of Dr. J. A. Bownocker, State geologist of Ohio, and presenting somewhat in detail the distribution, qualities, and quantities of the coals in the

coal-bearing counties of that State, is now nearly ready for issue. Parts of Professional Paper 100 describing the coal fields of a number of other States have been written, but publication of them is delayed for the preparation and publication first of papers on several other areas in the Appalachian region.

Notwithstanding some curtailment of the so-called scientific work of the division on account of economic examinations forming a part of the war work, the investigations current in the sections of areal geology, Coastal Plain investigations, and paleontology and stratigraphy have been fruitful of important results. Besides a number of minor papers noted elsewhere, mention may here in particular be made of the transmission by F. Canu, of Paris, France, and R. S. Bassler, of the National Museum, of the results of their long and searching studies on American early Tertiary Bryozoa; by F. H. Knowlton of his conclusions as to the Laramie flora of the Denver Basin, with a review of the Laramie problems; by E. W. Berry of an instructive general discussion of the middle and upper Eocene floras of southwestern America; by D. D. Condit of a description of the Paleozoic and Mesozoic stratigraphy of southwestern Montana; and by R. W. Stone and others of a report treating fully the gypsum deposits of the United States.

Progress has been made in the preparation of the report by T. N. Dale on the marbles of the Southeastern States, the work on which has been done in cooperation with the Bureau of Mines, Bureau of Standards, Office of Public Roads and Rural Engineering, and the State geological surveys of Georgia, Alabama, and Tennessee. A general description of the Tennessee marbles, prepared by Mr. Dale and C. H. Gordon, of the State Survey, has been submitted to that organization for publication.

WORK OF THE SECTIONS.

The scope of operations 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 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, Illinois, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, and West Virginia.

2. The work of the section of western areal geology (west of the one hundredth meridian)—Sidney Paige, geologist, in charge—cor-

responds to that of the section of eastern areal geology and is similar in scope. The work of this section has included areal mapping and descriptions of areal geology in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.

3. The section of Coastal Plain investigations—T. W. Vaughan, geologist, in charge—is occupied with the study of the geology of the Atlantic and Gulf Coastal Plain of the United States in the broadest practicable way. The subjects of its investigations include physiography, stratigraphy, geologic structure, paleontology, the character and origin of the sediments, and the ground waters. During the fiscal year, especially since February, the efforts of the members of the section have been devoted mostly to compiling, digesting, and systematizing information bearing on the military preparation of this country. In cooperation with the ground-water division of the water-resources branch, the section has compiled 23 digests of the water resources of the border areas of the United States, which have been transmitted in duplicate to the Secretary of War by the Secretary of the Interior.

Investigations have been made, or reports prepared, on areas in Alabama, Arkansas, California, Delaware, Florida, Georgia, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Texas, Virginia, the Canal Zone, and the West Indies.

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 those 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 or the preparation of reports covering areas in California, Illinois, Iowa, Massachusetts, Michigan, Minnesota, Montana, North Dakota, Oregon, Pennsylvania, Vermont, Washington, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist, in charge—deals with the classification and correlation of the sedimentary rocks of the entire country, and its work involves the study of all North American fossil faunas and floras and their comparison with those of other parts of the world. In this work it has the active cooperation of the United States National Museum in the identification and study of vertebrate fossils collected by the Survey. During the year members of the section have reported on fossils from Canada, China, Colombia, Cuba, the Galapagos Islands, Patagonia, Peru, the Dominican Republic, and Uruguay, in addition

to their usual routine work on numerous and large collections of fossils obtained in the different States and submitted by the geologic field parties. Some of the more important general studies of the year are as follows: A revised and enlarged catalogue of the Mesozoic and Cenozoic plants of North America has been almost completed. The pentremites of the Mississippian from Missouri, Illinois, Indiana, Kentucky, Tennessee, Virginia, and Alabama have been studied and classified and the Mississippian corals referred to the genus *Lithostrotion* have been described. The Silurian Ostracoda of the Appalachian region, especially those of Clinton age, have been studied with special reference to their bearing on stratigraphy.

6. The section of the geology of metalliferous deposits—F. L. Ransome, geologist, in charge—not only studies metalliferous deposits and mines and investigates the conditions and modes of ore deposition but also carries on reconnaissance and detailed geologic examinations of many new districts. The work of the section has embraced the investigation of metalliferous deposits in Arizona, California, Colorado, Idaho, Kansas, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Utah, Virginia, Washington, and Wyoming.

The subsection of petrology—E. S. Larsen, jr., geologist, in charge—because of its intimate relation to the study of metalliferous deposits, is attached to this section and is charged with the critical review of the petrologic work and the determination of general petrologic material submitted. The rock-cutting laboratory is under the supervision of the chief of this subsection.

7. The section of the geology of nonmetalliferous deposits—H. 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 investigation of raw materials possibly available as sources of commercial potash in various parts of the United States and special investigations relating to reported nitrate deposits; further investigation and classification of the phosphate-bearing lands in Idaho and Montana, a review of the gypsum deposits of the United States, and investigations relating to building stones have also been carried on. The work of the section relates in particular to Alabama, Arizona, California, Colorado, Georgia, Idaho, Indiana, Iowa, Kentucky, Michigan, Montana, Nebraska, Nevada, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Tennessee, Texas, Utah, Virginia, and West Virginia.

8. The section of the geology of eastern coal fields—G. H. Ashley, geologist, in charge—conducts examinations of areas east of the one hundredth meridian that contain coal. The work of the section dur-

ing the year has been done in cooperation with the State surveys of Illinois, Ohio, Pennsylvania, Tennessee, and Virginia.

9. The section of the geology of western coal fields—M. R. Campbell, geologist, in charge—conducts examinations and surveys in the coal-bearing regions west of the one hundredth meridian, similar to those made by the section of eastern coals. The greater part of the work of the western section has consisted in classifying and mapping coal lands of the public domain in Colorado, Montana, New Mexico, Utah, Washington, and Wyoming.

10. The section of the geology of oil and gas fields—David White, chief geologist, in charge—is engaged in the examination of the geologic structure and oil and gas indications in areas which are thought to have promise of oil and gas; in studies of the mode of occurrence and mutual relations of oil, gas, and water, and their relation to the structure and to the character and composition of the sands in developing pools; in observation of the chemical relations between oil, water, and the sediments in oil fields; and in the investigation and utilization of hydrocarbon or oil shales. During the year work has been done in or reports written on areas in Alabama, Arkansas, California, Colorado, Florida, Georgia, Indiana, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nevada, New Mexico, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, West Virginia, and Wyoming.

11. The section of the geology of iron and steel alloy metals—E. F. Burchard, geologist, in charge—was established in April for the purpose of conducting examinations and economic surveys of deposits of iron and the ores of the alloy metals—chromite, manganese, tungsten, molybdenum, nickel, vanadium, etc. It is essentially a war-metal section. Its work in the search for, classification and estimation of, and assistance in the development of deposits of the alloy metals, now largely imported and most indispensably necessary to the conduct of the war, has extended to Alabama, Arizona, Arkansas, California, Colorado, Georgia, Iowa, Minnesota, Oregon, Tennessee, Utah, and Virginia.

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, whose geologic field investigations are reported in the sections to which they pertain. The office work of this section is described on pages 159–160.

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.

The paleontologists of the division report on fossils collected by the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and occasionally for foreign Governments and for 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, and a number of economic geologists of this division serve as members of the special committees of the land-classification board.

COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is a standing committee of the geologic branch and consists of T. W. Stanton (chairman), G. W. Stose, W. T. Lee, Sidney Paige, and L. W. Stephenson. The chiefs of section of the division of geology and the chief of the division of Alaskan mineral resources also serve as associate members, each of whom is invited to attend meetings at which matters pertaining to his section or division are under consideration. Authors of manuscripts under discussion are expected to be present or to select someone to present their views. On each question the individual opinions of the persons present are recorded and forwarded to the chief geologist, who makes the decision, subject to appeal to the Director. The records are kept by the secretary, Miss M. G. Wilmarth, who also examines all manuscripts submitted for publication and compares the geologic nomenclature and classification used in them with the standards in current use by the Geological Survey. During the year 117 manuscripts, comprising 17,900 pages and involving about 3,190 geologic names, have been examined. Good progress has been made in preparing the manuscript of a stratigraphic lexicon of geologic formations and in compiling general correlation charts.

COMMITTEE ON PHYSIOGRAPHY.

The physiographic committee, one of the standing committees of the geologic branch, was reorganized March 1, 1916, and now consists of M. R. Campbell (chairman), F. E. Matthes, O. E. Meinzer, E. W. Shaw, and P. S. Smith. One of the important duties of the committee is to examine and pass upon papers of a physiographic char-

acter or chapters on physiography in other papers. In accordance with these instructions the committee has during the year examined, corrected, and approved 10 folio texts, 5 water-supply papers, and 5 papers of a general geologic character. The committee submitted and recommended for publication a descriptive text for the back of the Mount Rainier National Park map, prepared by F. E. Matthes.

During the year the chief geologist approved the map prepared by the Association of American Geographers, showing the physiographic provinces of the United States, and copies were distributed to geologists with the statement that the committee was prepared to consider all suggestions regarding alteration of boundary lines or changes in nomenclature. Some progress has been made in delineating these lines in greater detail. Progress has also been made in collecting and carding definitions of physiographic terms for the use of the committee in preparing new and standard definitions.

The physiographic committee, in conjunction with the geography committee of the National Research Council, has begun the preparation of a series of geographic handbooks containing information regarding the geology and physiography of the country useful in both general and military instruction. Two such handbooks have been undertaken—one for New England and one for the Middle Atlantic States of Virginia, West Virginia, Maryland, and Delaware. It is hoped that these will be completed at an early date, so that they may be available at the military training camps.

GENERAL SUMMARY OF GEOLOGIC WORK.

The geologic work of the division has extended into every State, the Canal Zone, and the West Indies. Systematic detailed surveys in metal-mining districts were carried on in Arizona, California, Minnesota, Nevada, New Mexico, and Utah, and reconnaissance studies of metal-mining districts were made in Alabama, Arizona, Colorado, Idaho, Kansas, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Utah, Virginia, Washington, and Wyoming. Potash and nitrate prospects were investigated in the States containing semiarid regions, in the "Red Beds" region of the Southwest, and through the analytical testing of brines coming from many oil, water, and salt wells in other portions of the country. Other nonmetalliferous deposits of one kind or another were investigated in nearly every State. Coal fields were examined in Colorado, Illinois, Montana, New Mexico, Ohio, Pennsylvania, Tennessee, Utah, Virginia, Washington, and Wyoming; and studies with mapping of structure with reference to oil and gas were made in Alabama, California, Colorado, Florida, Georgia, Illinois, Kentucky, Louisiana, Mississippi, Montana, New Jersey, New Mexico, Oklahoma, Pennsylvania, Texas, Virginia, and Wyoming. Reports describing mineral

deposits previously examined in other States and not mentioned above are now in preparation. General and detailed geologic and paleontologic work was continued in all regions of the country, including a large amount of geologic work in connection with the examination of the economic resources just mentioned. Work in classifying lands of the public domain and of Indian reservations was carried on in Arizona, California, Colorado, Idaho, Montana, New Mexico, North Dakota, Oregon, Utah, Washington, and Wyoming.

During the year the geologists engaged in examinations requiring areal geologic mapping or in classifying the lands have covered 28,500 square miles with exploratory and reconnaissance surveys and 6,701 square miles with geologic mapping in detail.

Field examinations for the classification of lands in the public-land States have extended over 22,875 square miles.

WORK OF THE DIVISION BY STATES.

ALABAMA.

Examinations of the marbles of Alabama were completed by T. N. Dale, who has nearly finished the Alabama section of a report on the marbles of the southern Appalachian region.

The Hatchetigbee uplift, in Choctaw, Clarke, and Washington counties, was studied and mapped by O. B. Hopkins, whose report on the oil and gas prospects of the area (Bulletin 661–H) is now in the hands of the printer.

At the suggestion of the Weather Bureau, Mr. Hopkins investigated the geologic structure and the evidence of disturbance caused by the earthquake of October 18, 1916, in the region of Pell City and Ironaton, Ala. A report showing the movement to have taken place along an old fault, seen near Ironaton, was transmitted to and published by the Weather Bureau.

In May, 1917, a structural reconnaissance along Chattahoochee River below Columbus was carried out by Mr. Hopkins and C. W. Cooke for the purpose of testing the reported presence of an anticline. Mr. Cooke, with T. W. Vaughan, prepared a digest of the ground waters of Alabama for the use of the War Department.

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of the later Eocene floras of the State; and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains accounts of Eocene and lower Oligocene Bryozoa from Alabama.

The Catahoula formation of the State is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone" (Professional Paper

98–M), and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" and by Prof. E. W. Berry in a paper on "The flora of the Citronelle formation" (both in Professional Paper 98–L). A reconnaissance of the bauxite deposits of the State was made by J. M. Hill, and a brief paper on the Gold Log mine, Talladega County, by E. S. Bastin, was published as Bulletin, 640–I.

The texts for the Bessemer-Vandiver and Montevallo-Columbiana folios have been submitted by Charles Butts and are now in process of criticism.

Manganese and ore deposits in Murphrees Valley, northeast of Birmingham, were examined in the fall of 1916 by E. F. Burchard, who also sampled three deposits of gray iron ore near Sylacauga for analysis for potash content.

A brief reconnaissance of the graphite deposits in Chilton, Clay, and Talladega counties was made by H. G. Ferguson in the spring of 1917.

ARIZONA.

The preparation of a professional paper on the copper deposits of the Ray and Miami districts was continued when administrative duties permitted, by F. L. Ransome, and has been practically completed. The work done also contributes largely toward the Ray folio, which Mr. Ransome has in hand. A paper on "Some Paleozoic sections in Arizona," prepared by Mr. Ransome, appeared as Professional Paper 98–K.

A field investigation of some of the gypsum deposits of this State was made by R. W. Stone, the results being incorporated in a general report on "The gypsum deposits of the United States."

Studies of the stratigraphy and historical geology of a portion of the Grand Canyon of the Colorado were continued by L. F. Noble, who, with the late J. F. Hunter, jr., prepared a paper entitled "A reconnaissance of the Archean complex of the Granite Gorge, Grand Canyon, Ariz." (Professional Paper 98–I).

A report of a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah, by Prof. H. E. Gregory, has been published as Water-Supply Paper 380, under the title "The Navajo country." A more extended paper by Prof. Gregory on the geology and geography of the region is now in course of publication as Professional Paper 93.

During the fall and winter of 1916 F. C. Schrader made an examination of lands on the Gila Reservation as to their mineral or nonmineral character for the Office of Indian Affairs.

Deposits of tungsten and other rare metals in various parts of the State were investigated by F. L. Hess in the spring of 1917.

ARKANSAS.

A digest of the ground waters of the Coastal Plain of Arkansas, for the use of the War Department, was prepared by L. W. Stephenson.

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains data on the later Eocene of Arkansas.

A study of the lead and zinc deposits in the Yellville quadrangle was made by E. F. Burchard. The results will be published in the Yellville folio. The Hot Springs folio, by H. D. Miser, has been revised in order to incorporate results of the field work of the previous season and is now being prepared for publication. During the field season Mr. Miser completed the mapping of terrace deposits and Trinity gravels in the DeQueen and Caddo Gap quadrangles and revised some mapping in the northwest corner of the Caddo Gap quadrangle. The text for the folio covering these quadrangles is nearly completed. Mr. Miser also made an examination of antimony mines at Gillham, of the lead and zinc mine at Davis, and of manganese deposits in the Caddo Gap and DeQueen quadrangles. A report by him on the manganese deposits of these quadrangles is now in press.

During the year the Eureka Springs-Harrison folio, by A. H. Purdue and H. D. Miser, has been published. These geologists also have in preparation a report on "Asphalt deposits of Pike and Sevier counties, Ark." A report by them on the "Gravel deposits of the Caddo Gap and DeQueen quadrangles" has been transmitted for publication, and a report on "Diamond-bearing peridotite in Arkansas" is in course of preparation by Mr. Miser.

Collections of invertebrates from formations of Chester and Pottsville age were obtained by G. H. Girty, who continued the description of the fauna of the Morrow formation. Paleozoic invertebrate fossils from the Yellville quadrangle were studied by E. O. Ulrich.

The structure at several places in the Arkansas coal field was examined by David White, who sampled the coals and richly carbonaceous shales at a number of points in the Fayetteville quadrangle and in the northwest corner of the State in order to obtain evidence as to the possibility of finding productive oil pools in the area.

Analyses of greensands, sampled to show their potash content, are given in Bulletin 660–B, by G. H. Ashley.

CALIFORNIA.

A paper on tungsten deposits of northwestern Inyo County, prepared by Adolph Knopf, was issued as Bulletin 640–L. A geologic reconnaissance report on the Inyo Range and the eastern slope of the

Sierra Nevada (Professional Paper 110), submitted by Mr. Knopf, is ready for publication.

A geologic examination of the reported strontium deposits near Barstow was made by Mr. Knopf, who submitted a brief report on the matter for incorporation in the statistical report on strontium in 1916, by J. M. Hill. A more complete statement has been submitted by Mr. Knopf for publication in "Contributions to economic geology." Newly discovered strontium deposits in San Bernardino and Imperial counties were examined by F. L. Hess.

Many potash projects about San Francisco and Los Angeles, the six plants obtaining potash from kelp near San Pedro, and the two plants near San Diego were visited by H. S. Gale.

The investigations of California oil fields were continued. The area of the Salinas Valley mapping was extended by W. A. English, who covered, either in detail or detailed reconnaissance, the larger part of the San Miguel and Cholame quadrangles and portions of the Paraiso Springs, Priest Valley, Coalinga, Lost Hills, and McKittrick quadrangles. His report on the "Geology and oil prospects of the Salinas Valley–Parkfield area" is ready for review and publication.

A special detailed study of the Belridge–Lost Hills district was carried through by R. W. Pack and Mr. English. The mapping and general description of the geology has been finished by Mr. English, but completion of the report is delayed by the resignation of Mr. Pack to enter private service. A report on the geology of the Sunset-Midway field, by Mr. Pack, is nearly ready for submission.

The results of the study of the water conditions with reference to the oil and the structure of the sands in the Coalinga field, by G. S. Rogers, are embodied in a report almost completed but interrupted on account of the assignment of Mr. Rogers to similar field examinations in the Gulf Coastal Plain.

Materials embracing manuscript and maps for a folio covering the Ventura district have been submitted in preliminary draft by Ralph Arnold, by whom the work was begun before his resignation from the Survey. In these studies Dr. Arnold has been assisted by W. A. Pemberton, who is joint author. The region of new development to the east of that covered by Messrs. Arnold and Pemberton was visited near the end of the year by W. S. W. Kew, who, assisted by J. A. Buwalda, will extend the structural investigations. A report by G. S. Rogers on the "Chemical relations of the oil-field waters of the San Joaquin Valley, Cal.," has been issued as Bulletin 653.

Description of the Tertiary invertebrate faunas of California and other Pacific Coast States was continued by W. H. Dall; a report on Tertiary plants from Marysville Buttes was made by F. H. Knowl-

ton; and Cretaceous invertebrates from the west side of San Joaquin Valley were identified by T. W. Stanton.

The geologic studies in the Yosemite National Park, undertaken for the preparation of a popular guide to the geology of the park, were completed by F. E. Matthes and F. C. Calkins. Mr. Matthes devoted his time to detailed studies of the ancient Tuolumne Glacier and distinguished two periods of glaciation. He also gave particular attention to the physiography of the region, mapping in detail about 190 square miles and on a reconnaissance scale about 50 miles. Mr. Calkins completed detailed studies of the bedrock geology, mapping 30 square miles in detail and 95 square miles on a reconnaissance scale. He also made a detailed study of a section of Merced River from the Great Valley to Yosemite Park. These two geologists are preparing a professional paper which will describe this region, with a cross section from the Great Valley of California across the Sierra Nevada.

Chromite, of which California is by far the greatest producer, was the subject of an exhaustive investigation by J. S. Diller, who made a reconnaissance survey of about 2,000 square miles, studying the sources of supply and endeavoring to increase the production.

The mild volcanic activities of Lassen Peak continued, and during July and August Mr. Diller made a reconnaissance of about 400 square miles in this region, gathering data for a bulletin on the Lassen Volcanic National Park, which is now well advanced.

The field work for a comprehensive report on the "Physiography and geology of southern California" has been completed under agreement by R. T. Hill, and office work on its preparation is far advanced.

The detailed mapping for a folio on the Mariposa quadrangle was begun by J. F. Hunter, jr., who covered about 400 square miles. Mr. Hunter lost his life by accidental drowning May 23, 1917, while engaged in field examinations in Georgia.

A study of the Tertiary formations adjacent to the Mohave Desert was undertaken by L. F. Noble and R. E. Dickerson late in June, with a view to establishing the relations between the continental and marine Tertiary formations in southern California. Mr. Noble continued detailed studies of the Rock Creek, San Antonio, and Hesperia quadrangles, mapping in all about 55 square miles. It is planned to publish a paper on that part of these quadrangles adjacent to the great San Andreas rift zone.

To confirm the report that the oil-bearing shales in the Tertiary formations of California, notably in Ventura County, were capable of yielding large quantities of oil on distillation, field examinations were made by D. E. Winchester, W. A. English, and L. F. Noble, who collected samples for distillation tests by the Bureau of Mines.

Professional Paper 98–T, "The reef-coral fauna of Carrizo Creek, Imperial County, Cal., and its significance," by T. W. Vaughan, con-

tains an account of a coral fauna of purely Atlantic affinities at the head of the Gulf of California.

Descriptions of molybdenite near Ramona and of an occurrence of nickel ore in San Diego County are given by F. C. Calkins in Bulletin 640–D.

Glacial studies were carried on in the Yosemite Valley and vicinity from July 8 to 15 by Frank Leverett, in connection with a western trip.

COLORADO.

The study of the physiographic history of the San Juan Mountains and the mapping of the Quaternary formations within that range were continued during the field season by W. W. Atwood, assisted by K. F. Mather and Arthur Iddings. While this work has been in progress a number of serious engineering problems have been encountered in connection with the reservoir sites in the eastern portion of the range. Most of these reservoirs are in mountain canyons, and the sites for the dams have been selected where the valleys are somewhat constricted, either by glacial moraines or landslide deposits. A special study of the geology associated with these reservoir sites has been made, and a report has been submitted by Mr. Atwood, entitled "Relations of landslides and glacial deposits to reservoir sites in the San Juan Mountains."

In the Creede, Summitville, and Del Norte quadrangles the detailed examination and mapping of the Quaternary formations was completed for an era of 1,600 square miles. Reconnaissance examinations were made in an area of 150 square miles bordering the Del Norte quadrangle.

Studies of the igneous rocks in the San Juan region were continued by E. S. Larsen under the general supervision of Whitman Cross. Exploratory examinations covered about 700 square miles, and a detailed reconnaissance was also made covering about 600 square miles in the Del Norte quadrangle and adjoining areas.

A reconnaissance of about 400 square miles in and near the Rocky Mountain National Park was made by W. T. Lee, who submitted a popular descriptive report thereon for publication by the National Park Service. About 500 square miles in northeastern Colorado was covered by Mr. Lee in exploratory examinations for the investigation of the stratigraphy of the Cretaceous rocks along the western foothills of the Rocky Mountains. Mr. Lee submitted a report entitled "Notes on the Jurassic and Cretaceous of the Rocky Mountains" and a paper entitled "Physiography of the Rocky Mountain National Park."

The detailed report on the "Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder counties," by E. S.

Bastin and J. M. Hill, appeared during the year as Professional Paper 94. Gilpinite, a new uranium mineral from this region, has been described by E. S. Larsen in an unofficial publication.

A chapter on the oxidized zinc ores of Leadville, by G. F. Loughlin, has been transmitted for inclusion in the monograph on the Leadville district, the text for which has just been submitted to the Survey by J. D. Irving.

Special inquiry was made into the reported discovery of very extensive deposits of alunite, which has been viewed as a possible source of potash, on Pintados Peak, in the San Juan Mountains, southern Colorado.

The question of the practicability of developing a source of nitrate from the "brown spots" in Colorado was investigated by H. S. Gale, in conference with Prof. W. P. Headden, of the State Experiment Station, Fort Collins. Mr. Gale also examined numerous reported discoveries of potash and nitrate in the vicinity of Denver.

In order to procure data as to the value of certain mine tailings as possible sources of potash, samples of potash-rich tailings from dumps of mills in the vicinity of Cripple Creek were collected by F. L. Hess for more detailed study.

A monograph on the Laramie flora of the Denver Basin was submitted for publication, and the description of the flora of the Denver formation was nearly completed by F. H. Knowlton, who also wrote a paper on a dicotyledonous flora from the type section of the Morrison formation. Cretaceous invertebrates from northern Colorado were reported on by T. W. Stanton.

The Colorado Springs folio (No. 203), by G. I. Finlay, was issued during the year.

The reconnaissance examinations of the oil shales in northwestern Colorado and northeastern Utah, with field tests to determine their capacity to yield petroleum by destructive distillation, were continued by the party in charge of D. E. Winchester. Some of the preliminary results of the work of this season were combined with the report for the preceding season and published as Bulletin 641–F. Interest in the possibilities of these oil shales has been so widespread that it was found necessary to print a second edition of the bulletin. Additional data are contained in a paper just submitted by Mr. Winchester, giving the results of his searches for oil shale in Utah and Nevada also.

CONNECTICUT.

The study of the geology of southern Connecticut was in the spring of 1917 continued by the Geological and Natural History Survey of Connecticut under the direction of Prof. H. E. Gregory, in cooperation with the Federal Survey.

The geography of this State is being described for a manual of the geography of New England, a popular report, designed also for military use, now in preparation in cooperation with the geography committee of the National Research Council. The work is done by W. M. Davis for the Council and by Arthur Keith for the Survey.

DELAWARE.

The folio on the Elkton and Wilmington quadrangles, including parts of Pennsylvania and Maryland, is in course of publication.

Analyses of greensands from several parts of the State, sampled to show their possible value as sources of potash, are given by G. H. Ashley in a report entitled "Notes on the greensand deposits of the eastern United States" (Bulletin 660–B).

FLORIDA.

G. C. Matson discusses the Catahoula formation in Florida in a paper entitled "The Catahoula sandstone" (Professional Paper 98–M), and the Citronelle formation in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

A digest of the ground waters of Florida was prepared, for the use of the War Department, by C. W. Cooke and T. W. Vaughan.

A manuscript on the stratigraphic position and faunal associates of species of orbitoid Foraminifera of the genus *Orthophragmina* from Georgia and Florida, by C. W. Cooke, and one on the species of *Orthophragmina* from the Eocene of Florida and Georgia, by J. A. Cushman, were transmitted for publication (Professional Paper 108–G).

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of upper Eocene and lower Oligocene Bryozoa.

A report on the Mollusca of the Alum Bluff formation, by Miss Julia Gardner, is almost completed. An investigation of the fossil corals of the southeastern United States, including Florida, was continued by T. W. Vaughan. A paper "On reported Pleistocene human remains at Vero, Fla.," by Mr. Vaughan, appeared in the Journal of Geology, December, 1916.

A study of the mechanical composition of Recent sediments from Florida, by E. W. Shaw, is in progress. A paper on the fauna and correlation of the Nashua marl was written by W. C. Mansfield, and several collections of Tertiary invertebrates were reported on by W. H. Dall.

In June an examination of the geologic structure and of reported oil and gas indications in the western part of the State was begun at

the request of the State geologist, who cooperated with O. B. Hopkins, of this Survey, in the field investigations.

GEORGIA.

At the request of the State geologist of Georgia an examination of the reported oil and gas and structural indications in southern Georgia was made by a cooperative party in which the Federal Survey was represented by O. B. Hopkins, C. W. Cooke, and J. F. Hunter, jr. The principal results of the investigation, which covered the region along Chattahoochee River from Columbus to Alaga and portions of Decatur, Miller, and Grady counties, have been communicated for publication by the daily press.

Field work and a part of the office work in connection with the preparation of a chapter on the marbles of Georgia was accomplished by T. N. Dale. The results are to be incorporated with other material in a comprehensive report on the "Marbles of the Southern States."

A reconnaissance of the bauxite deposits of the State was made by J. M. Hill, and field examinations of some of the feldspar deposits of Georgia, with special reference to their potash contents, were made by F. J. Katz.

A report entitled "Deposits of Claiborne and Jackson age in Georgia," by C. W. Cooke, of this Survey, and H. K. Shearer, of the Geological Survey of Georgia, was completed and has been submitted for publication as a part of Professional Paper 120.

A digest of the ground waters of the Coastal Plain of Georgia and geographic data relating to a part of the Coastal Plain were compiled by L. W. Stephenson, for the use of the War Department.

A manuscript on the stratigraphic position and faunal associates of species of orbitoid Foraminifera of the genus *Orthophragmina*, by C. W. Cooke, and one on the species of *Orthophragmina* from the Eocene of Florida and Georgia, by J. A. Cushman, were submitted for publication (Professional Paper 108–G).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of upper Eocene fossil plants from Georgia; and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, also transmitted for publication, contains accounts of Eocene and lower Oligocene Bryozoa from the State.

The study of the Tertiary corals of Georgia was continued by T. W. Vaughan.

IDAHO.

Widely scattered mining regions in Idaho were visited during the field season of 1916 by J. B. Umpleby and E. L. Jones, who col-

lected data for a general report on the ore deposits of Idaho. The field work upon which this report will be based is now completed, and the manuscript and necessary maps are in preparation.

A detailed report on the "Geology and ore deposits of the Mackay region," by J. B. Umpleby, has been recently issued as Professional Paper 97. A short report on "Lode mining in the Quartzburg and Grimes Pass porphyry belt, Boise Basin," by E. L. Jones, appeared as Bulletin 640–E, and a report on the Pine Creek district, accompanied by a geologic sketch map, also by Mr. Jones, has been submitted for publication.

A history of mining development in Idaho, which was prepared by Dr. W. P. Jenney under agreement, will be utilized in the forthcoming report on the geology and ore deposits of the State, by Messrs. Umpleby and Jones.

Detailed examinations of the phosphate deposits, with mapping of about 400 square miles, in the Henry, Cranes Flat, and Portneuf quadrangles were made by G. R. Mansfield. Field work in the Henry and Cranes Flat quadrangles was completed, both for areal mapping and for phosphate-land classification. Mr. Mansfield began during the winter the preparation of a professional paper on southeastern Idaho, covering the Montpelier, Slug Creek, Crow Creek, Lanes Creek, Freedom, Portneuf, Henry, and Cranes Flat quadrangles. The Carboniferous and Lower Triassic faunas of southeastern Idaho were discussed and characteristic species illustrated by G. H. Girty in a chapter to be embodied in this paper. Collections of Jurassic and Cretaceous invertebrates from southeastern Idaho were reported on by T. W. Stanton.

Mr. Mansfield revised the manuscript of his paper on the Fort Hall Indian Reservation, submitted for publication several years ago.

The text of the Hailey folio has been practically completed by Prof. L. G. Westgate. The Silurian and Ordovician graptolites of the quadrangle have been described by Edwin Kirk for publication in Prof. Westgate's report on the geology of the quadrangle.

A nitrate deposit in the Lanes Creek quadrangle, reported to the Survey by letter, was visited by G. R. Mansfield and found to be not of commercial size and quality.

A paper on the "Genesis of the Success zinc-lead deposit, Coeur d'Alene district," by J. B. Umpleby, has been transmitted for unofficial publication.

ILLINOIS.

The geology of the Shawneetown, Golconda, and Equality quadrangles, in the southern part of Illinois, was examined by Charles Butts, who mapped portions of the Equality quadrangle in detail, the work being carried on in cooperation with the State Geological Sur-

vey. A report on "Structure favorable to oil and gas accumulation in Hardin County, Illinois," was prepared by Mr. Butts for publication by the State.

The stratigraphy and paleontology of the Chester group, in Illinois and Kentucky, were studied by G. H. Girty and E. O. Ulrich in a field conference in which G. H. Ashley, F. W. DeWolf, and Stuart Weller also participated. Independent studies of the faunas were subsequently made by all the paleontologists, and a special study of the *Pentremites* was made by E. O. Ulrich.

The manuscript on the Quaternary geology of the Gillespie and Mount Olive quadrangles, prepared for folio publication by Wallace Lee, was revised somewhat by Frank Leverett and W. C. Alden, and the folio is now ready for publication.

INDIANA.

At the request of the Office of the Supervising Architect of the Treasury Department and the Indiana Limestone Quarrymen's Association a field investigation of the so-called Bedford or Salem limestone of Indiana was undertaken by G. F. Loughlin, for the purpose of defining and establishing the grading of the limestone. Tests on the materials collected by Mr. Loughlin are now in progress by the Bureau of Standards, also cooperating. It is expected that the State will join in the work through the areal mapping of the deposits.

A report of the distillation tests of certain of the richly bituminous shales of the State for the purpose of ascertaining their possible yield of oil is given by G. H. Ashley in Bulletin 641–L, "Oil resources of black shales of the eastern United States."

IOWA.

The study of the evidence of an Iowan stage of glaciation, a cooperative investigation by W. C. Alden and M. M. Leighton for the Federal and Iowa geological surveys, respectively, was completed and transmitted to the Iowa Survey for publication.

The iron-ore deposit at Waukon, recently developed and brought to production by improved methods of concentration, was examined by E. F. Burchard in June.

KANSAS.

Examinations of the geologic structure in the region of southern Kansas immediately north of the State line in the vicinity of the Pawhuska quadrangle were made by K. C. Heald in connection with his mapping of the structure of the northwest corner of the quadrangle.

Carboniferous invertebrates from the State were described by G. H. Girty.

Areas in western Kansas that are possibly structurally favorable for the occurrence of oil or gas are described by N. H. Darton in a paper now in process of publication.

KENTUCKY.

A report on the phosphate deposits of Kentucky was completed and transmitted for publication by W. C. Phalen, who was temporarily transferred from the Bureau of Mines in order to complete the work. This report was prepared in cooperation with the State Geological Survey of Kentucky and has been submitted to that organization for publication.

The invertebrates of the Chester group in the State were studied by G. H. Girty and E. O. Ulrich in continuance of the work of the field conference mentioned under the heading "Illinois." The boundary between the Cincinnatian and the Mohawkian was studied in the field by Mr. Ulrich in cooperation with Prof. A. M. Miller, of the University of Kentucky.

A detailed reconnaissance of the stratigraphy and correlation of the Mississippian formations in west-central Kentucky was made by Charles Butts, in cooperation with the State Geological Survey. The report by Mr. Butts, which will be transmitted for publication by the State, is nearing completion. The work is closely related with the work being carried on by Mr. Butts in southern Illinois.

Structural examinations of a part of Allen County were made early in the season by E. W. Shaw and K. F. Mather. A brief statement of the principal conclusions was promptly given publicity, and a report discussing the oil and gas possibilities of the region is now in process of publication.

A report on the structure and oil prospects of the Irvine district by Mr. Shaw is now in press as Bulletin 661-D.

LOUISIANA.

A digest of the ground waters of the Coastal Plain of Louisiana, for the use of the War Department, was prepared by L. W. Stephenson. The manuscript of a report on the clays of Louisiana, by G. C. Matson (Bulletin 660-E), was finished and submitted for publication.

An examination of the sulphur deposits of the State, with special reference to their use in the manufacture of sulphuric acid, was made by P. S. Smith.

The Catahoula formation in Louisiana is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone" and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98-M, and the Citronelle forma-

tion is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of fossil plants from Louisiana. Eocene invertebrates from the State were identified by W. H. Dall.

In connection with the study of the structure, lithology, and chemistry of the salt domes of the Gulf Coastal Plain examinations of the salt domes in the region of New Iberia were made in June, 1917, by G. S. Rogers.

A report describing the structure and discussing the oil resources of the De Soto–Red River region, by G. C. Matson and O. B. Hopkins, has been issued as Bulletin 661–C.

Inspections of the surficial geology and structural criteria at several points in eastern Louisiana were made in the winter of 1916 by O. B. Hopkins.

MAINE.

The raised Pleistocene shore line in the Portland, Gray, and Buxton quadrangles, Maine, was studied and mapped by F. J. Katz, who also made a reconnaissance examination of part of the Buxton and all of the Berwick and Kennebunk quadrangles. The results of these studies have been incorporated in the Portland–Casco Bay folio, which is being prepared. The study of similar shore lines in the Dover and York quadrangles and of the general areal geology of the Dover quadrangle was continued by Mr. Katz. A field conference was held with Arthur Keith and Laurence LaForge.

A paper on the "Stratigraphy in southwestern Maine and southeastern New Hampshire," by Mr. Katz, is in course of publication as Professional Paper 108–I, and a paper on the Newington moraine, also by Mr. Katz, has been issued as Professional Paper 108–B.

Feldspars at several points in the State were sampled by Mr. Katz to determine their value as possible sources of potash.

MARYLAND.

Office work on the maps and description of the Williamsport quadrangle, which will be a part of the Williamsport-Hagerstown folio, has been well advanced by G. W. Stose. This folio will be published in cooperation with the Maryland Geological Survey, but the quadrangle includes portions of Pennsylvania and West Virginia.

The folio for the Elkton and Wilmington quadrangles, including parts of Delaware and Pennsylvania, prepared by Florence Bascom and B. L. Miller, also in cooperation with the Maryland Geological Survey, is in course of publication. The Tolchester folio (No. 204),

by B. L. Miller, E. B. Mathews, A. B. Bibbins, and H. P. Little, also cooperative, has been published.

At the request of the United States Geological Survey a digest of the ground waters of Maryland was prepared for the use of the War Department by Prof. W. B. Clark, State geologist of Maryland.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of early Tertiary Bryozoa from formations in this State.

MASSACHUSETTS.

A report on the physiography, geology, and ground waters of Cape Cod, Nantucket, Marthas Vineyard, Block Island, and the Elizabeth Islands was completed and submitted by Prof. J. B. Woodworth, who also prepared a digest of the water resources of Cape Cod and the islands off the coast of Massachusetts and Rhode Island for the use of the War Department. The field mapping was inspected by T. W. Vaughan in conference with Prof. Woodworth.

Detailed studies of the Cambridge slate, of Pleistocene lake history, and of obscure points in bedrock geology in the Boston and Boston Bay quadrangles were made by Laurence LaForge. Mr. LaForge made reconnaissance examinations of the rocks in parts of the Lawrence and Salem quadrangles, investigated the late Pleistocene submergence of the coast near Newburyport, and carried on semidetailed mapping of the igneous rocks in the northern part of the Newburyport quadrangle. In much of this area Mr. La Forge was accompanied by Arthur Keith. During the field work Mr. LaForge found abundant evidence of a late Pleistocene submergence of northeastern Massachusetts and southeastern New Hampshire to a depth of at least 120 feet in the Merrimack estuary. This evidence is probably to be correlated with the evidence of submergence to a depth of 150 to 170 feet in the Piscataqua estuary, as recently worked out by Mr. Katz.

The mapping of the surface geology of the Groton quadrangle was continued during the field season by Prof. B. K. Emerson. During part of the time Prof. Emerson was in field conference with Mr. Keith and Mr. LaForge. Work on the revision of the texts and maps for the Fitchburg-Groton folio is well advanced toward completion. The text and maps for the Warwick-Winchendon folio are also well advanced. During April, May, and June Prof. Emerson was engaged in the preparation of a report on road materials of Massachusetts for the use of the War Department. Material for this report covering northeastern Massachusetts, was furnished by Mr. LaForge.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, and several days were spent in reconnaissance studies in southwestern Massachusetts by Mr. Keith.

During parts of May and June examinations pertaining to the establishment of the Army camp at Ayer were made at the request of the United States Army officers by Mr. LaForge.

The text and maps for the Boston folio, by Mr. LaForge, are well advanced.

MICHIGAN.

A report on the gypsum deposits of Michigan has been prepared as a part of a bulletin by R. W. Stone on the gypsum deposits of the United States. Records of wells from which bromine is obtained in the Saginaw Valley and much general information concerning the bromine and chemical industries there were obtained by W. C. Phalen.

The manuscript of a report on the glacial moraines and shore lines of the Lake Superior region, by Frank Leverett, was well advanced toward completion.

A folio covering the Wayne, Detroit, Grosse Pointe, Romulus, and Wyandotte quadrangles has been issued as Folio 205.

MINNESOTA.

A report on the surface formations and agricultural conditions of northeastern Minnesota, by Frank Leverett and F. W. Sardeson, has been published as Bulletin 13 of the Minnesota Geological Survey. Proof of a similar report on the southern half of Minnesota, by Mr. Leverett and Mr. Sardeson, for publication by the Minnesota Geological Survey, has been read. These reports are products of the work done in cooperation between the Federal Survey and the Minnesota Geological Survey. They will be followed by a general report on the Quaternary geology of Minnesota by Mr. Leverett.

The glacial moraines and shore lines of the Lake Superior region are described by Mr. Leverett in a manuscript well advanced toward completion.

The cooperative study by this Survey and the State Survey of the iron ores of the Cuyuna range was continued by E. C. Harder as the Federal Survey's representative and A. W. Johnston for the State. One preliminary report, to be published by the State Survey, has been completed and is awaiting examination by the State geologist. Another, entitled "Notes on the geology and iron ores of the Cuyuna district, Minn.," with an outline map of the iron-bearing areas, has been published by this Survey as Bulletin 660–A. A paper on the geologic activity of iron bacteria in the precipitation of iron ores has been submitted by Mr. Harder, and a detailed report on the geology and ores of the Cuyuna range is in preparation.

MISSISSIPPI.

The geologic structure in the region between Vicksburg and Jackson, Miss., has been described by O. B. Hopkins in Bulletin 641–D, the demand for which was so great as to call for reprinting. Mr. Hopkins also made examinations of certain features near Biloxi thought by some to be indications of oil.

The Catahoula formation in the State is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone," and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98–M, and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

Reports on the stratigraphy of the Cretaceous deposits of Mississippi and on the ground waters of the northeastern part of the State, by L. W. Stephenson, were practically completed. Manuscripts on the Jackson formation and the Vicksburg group in Mississippi were submitted by C. Wythe Cooke, and a paper on the stratigraphy of the Upper Tertiary of Mississippi, by G. C. Matson, was completed. A report on the Pliocene history of northern and central Mississippi was completed by E. W. Shaw, and is in press as Professional Paper 108–H, and a paper by the same author on the Quaternary history of Mississippi, including an annotated bibliography, was begun. These papers will be published as parts of reports prepared in cooperation with the Mississippi State Geological Survey. The report on the general geology of the State will be published by the State Survey and the one on the ground waters of the State will be published by the Federal Survey.

A paper entitled "Geologic history indicated by the fossiliferous deposits of the Wilcox group (Eocene) at Meridian, Miss.," by E. W. Berry, was published as Professional Paper 108–E, and a monograph entitled "Later Eocene fossil plants of southeastern North America," also by E. W. Berry, transmitted for publication, contains descriptions of the later Eocene plants of the State. A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, gives an account of the Eocene and lower Oligocene Bryozoa of Mississippi.

MISSOURI.

The study of the stratigraphy and paleontology of the Mississippian formations in southeastern Missouri has been continued by the State in cooperation with this Survey, these investigations being a part of a general plan organized and conducted in concert by the

geologists of this part of the Mississippi Valley. A field conference touching a number of the local problems was in August held by representatives of several State surveys and of the Federal Survey.

The text and maps by F. C. Greene for a folio covering the Green City and Queen City quadrangles have been revised and are ready for publication.

The original edition of Bulletin 606, by C. E. Siebenthal, on the "Origin of the zinc and lead deposits of the Joplin region, Missouri, Kansas, and Oklahoma," having been exhausted, this paper has been reprinted.

MONTANA.

Two brief reports describing the Garnet and Dunkleberg districts, based on examinations made in the fall of 1915 by J. T. Pardee of mineral-bearing districts in northwestern Montana, are in press as Bulletins 660–F and 660–G, and others are in preparation.

The general geology and structure of an area embracing 750 square miles in Teton and Lewis and Clark counties were examined and classified with special reference to oil and gas possibilities by Eugene Stebinger, assisted by M. I. Goldman. A report by Mr. Stebinger under the title "Oil and gas geology of the Birch Creek–Sun River area, Mont.," has been transmitted for publication in "Contributions to economic geology, 1918, Part II" (Bulletin 691).

The somewhat complicated structure in a large area northwest of Billings embracing the Hailstone Basin was examined and mapped in detail by E. T. Hancock, who has submitted his classification and a report on the "Geology and oil and gas resources of the Lake Basin field" for publication in the same volume.

A part of the Musselshell Valley embracing 1,200 square miles was examined, classified, and mapped in detail by C. F. Bowen, with the object of obtaining data bearing upon its oil and gas possibilities, Mr. Bowen's report on "Anticlines in a part of the Musselshell Valley, Musselshell, Meagher, and Sweetgrass counties, Mont.," has been submitted for publication in Bulletin 691.

In northeastern Montana an area of about 6,912 square miles near Malta, including what is now known as the Bowdoin dome, was examined in rapid reconnaissance with classification of the lands, by A. J. Collier, whose report on the Bowdoin dome and its oil possibilities is in press as Bulletin 661–E.

A reconnaissance examination in the Yellowstone-Helena region, which includes the Gallatin and Madison national forests, with tracing of the phosphate horizon and the discovery of hitherto unreported beds of workable quality, was carried out by D. D. Condit, assisted by E. H. Finch. A portion of the report on this work has already been

completed by Mr. Finch. Phosphate lands in Granite, Powell, and Deer Lodge counties were examined by J. T. Pardee.

The monograph on the "Geology of the Yellowstone Park," on which Arnold Hague had for many years been engaged and which will constitute his monumental work, was nearly complete at the time of Dr. Hague's death early in May.

A general reconnaissance study of the glacial and associated deposits in Sheridan, Valley, Phillips, and Blaine counties, and adjacent parts of Dawson County was made by W. C. Alden. A study of the literature of these and adjacent regions was made in the office, and a preliminary description was prepared by Mr. Alden.

NEBRASKA.

The more prominent anticlines of western Nebraska are described in a paper by N. H. Darton on the structure of parts of the central Great Plains submitted for publication in Bulletin 691.

The potash plant at Hoffland was examined by H. S. Gale.

NEVADA.

A detailed report on the geology and ore deposits of the Yerington district, Nev., has been submitted for publication as a professional paper by Adolph Knopf.

A report prepared by E. S. Bastin, in collaboration with F. B. Laney, of the Bureau of Mines, on the genesis of the ores of Tonopah, as interpreted from detailed microscopic studies of polished surfaces of the ores, is now in press as Professional Paper 104.

In addition to the report on the placers of Manhattan, H. G. Ferguson has in preparation as a professional paper a report on the geology and ore deposits of Manhattan and vicinity.

Late in the winter Adolph Knopf made a detailed geologic study of the Rochester district and a reconnaissance examination of the Arabia district. A report on the Arabia district is in preparation. A short paper on the ore deposits at Eureka is being prepared by G. F. Loughlin.

The results of an investigation of some of the gypsum deposits of the State by R. W. Stone will be found in a general description of the gypsum deposits of the United States, now ready for publication.

The oil-shale deposits of the Green River group in the vicinity of Elko, Nev., were examined by D. E. Winchester, whose descriptions, with accounts of tests, are contained in a paper now ready for submittal.

About a month was spent in Carson Sink by F. C. Schrader, completing a study of that region for an economic report on the ore deposits.

The following reports relating to mining districts in Nevada have appeared during the fiscal year:

Notes on some mining districts in eastern Nevada, by J. M. Hill (Bulletin 648).

The Golden Arrow, Clifford, and Ellendale districts, Nye County, Nev., by H. G. Ferguson (Bulletin 640–F).

Tin ore in northern Lander County, Nev., by Adolph Knopf (Bulletin 640–G).

Placer deposits of the Manhattan district, Nev., by H. G. Ferguson (Bulletin 640–J).

A paper by Mr. Knopf on "Wood tin in the Tertiary rhyolites of northern Nevada" has been transmitted for unofficial publication.

NEW HAMPSHIRE.

The raised Pleistocene shore lines in the Dover and York quadrangles, in Maine and New Hampshire, were specially studied by F. J. Katz. Reconnaissance studies in part of the Dover quadrangle, and practically all of the Berwick quadrangle were carried on by Mr. Katz, and a field conference was held by him with Arthur Keith and Laurence LaForge in the region about Rochester, N. H., and Berwick, Maine. Mr. LaForge spent two weeks in reconnaissance trips in southeastern New Hampshire and in reconnaissance mapping of Carboniferous stratified rocks west and northwest of Rochester, N. H.

A very brief reconnaissance in southwestern New Hampshire was made by Mr. Keith and a report on Pleistocene fossils from the Leda clays was made by W. H. Dall.

NEW JERSEY.

At the request of this Survey a digest of the ground waters of New Jersey was prepared, for the use of the War Department, by Dr. M. W. Twitchell, assistant State geologist, under instruction from Dr. H. B. Kümmel, State geologist.

The oil and gas explorations and the structural indications in the vicinity of Millville were examined by E. W. Shaw, at the request of the State Geological Survey.

The results of the analysis of greensands sampled at several points in the southern part of the State to show their possible value as sources of potash have been published in a report entitled "Notes on the greensand deposits of the eastern United States," by G. H. Ashley, published as Bulletin 660–B.

NEW MEXICO.

Field studies in the "Red Beds" region of New Mexico, with special reference to the history of their deposition and the possible presence of commercial amounts of potash salts associated with the

thick deposits of salt and gypsum in the series, were continued by N. H. Darton, who is preparing a report on the region and its potash prospects. Exploratory examinations were made of 1,400 square miles, a reconnaissance examination of 820 square miles, and detailed mapping of 76 square miles. Mr. Darton also submitted a report on the gypsum deposits of New Mexico for incorporation in the general report on the gypsum deposits of the United States.

A deep well bored by a private company near Carlsbad was, through the courtesy of the company, visited by R. K. Bailey, who obtained therefrom a series of samples for testing with reference to their potash contents. Nothing of value was found, but as a depth of only 500 feet was attained, the salt beds of the region were not penetrated.

The geology of the Mogollon mining district was mapped in detail by H. G. Ferguson, who, in the fall of 1916, made a study of the ore deposits for a professional paper on that district. Mr. Ferguson also made a reconnaissance examination of the Steeple Rock district, and has in preparation a brief report thereon for inclusion in the annual economic bulletin.

Completion of the report on the copper deposits of the Burro Mountains (Tyrone district), by Sidney Paige, has been delayed by his assignment as geologist in charge of the section of western areal geology.

A detailed report on the copper deposits of the Santa Rita (Chino) district is in preparation by A. C. Spencer after an intermission caused by his assignment to work in Alaska.

Field work for a detailed study of the Magdalena or Kelly district has been completed by G. F. Loughlin. In connection with this investigation, some experimental work was carried out by Prof. W. O. Hotchkiss to determine the possible applicability of magnetic methods of surveying to ore deposits other than those of iron. Prof. Hotchkiss also extended his work to the Hanover and Santa Rita districts. The method was found to promise some usefulness in tracing concealed contacts between igneous and sedimentary rocks.

A paper entitled "A comparison of some Paleozoic sections in southern New Mexico," by N. H. Darton, has been issued as Professional Paper 108–C. Mesozoic invertebrates from the Magdalena limestone were studied by G. H. Girty, and Cretaceous invertebrates from southern New Mexico were reported on by T. W. Stanton, and from northwestern New Mexico by J. B. Reeside, jr.

As scientific by-products of the structural and land classification work in the coal-bearing region of northwestern New Mexico, by C. M. Bauer, J. B. Reeside, jr., and others, the following publications, under the general title "Contributions to the geology and paleon-

tology of San Juan County," have been published as parts P, Q, R, and S, respectively, of Professional Paper 98:

Stratigraphy of a part of the Chaco River valley, by C. M. Bauer.
Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, by C. W. Gilmore.
Nonmarine Cretaceous invertebrates of the San Juan Basin, by T. W. Stanton.
Floras of the Fruitland and Kirtland formations, by F. H. Knowlton.

NEW YORK.

The areal and economic survey of the Berlin quadrangle, including a small part of Massachusetts, was continued by L. M. Prindle, who extended his geologic work into the adjacent Troy quadrangle. The folio covering the Berlin and Greylock quadrangles is nearing completion.

A study of the structure and succession of the rocks in the Hoosick and Cohoes quadrangles was made by Mr. Prindle. This areal work was reviewed by Arthur Keith, who also made a brief reconnaissance study of the formations in southeastern New York.

NORTH CAROLINA.

Feldspar deposits in the Spruce Pine district were examined by F. J. Katz in connection with his examination of the feldspar deposits of the Eastern States, the principal object of the work being to ascertain the possible value of the feldspars as sources of potash.

A report on the "Tin resources of the Kings Mountain district, N. C. and S. C.," by Arthur Keith and D. B. Sterrett, submitted early in the spring by Mr. Keith for use in "preparedness" work, is now in course of publication as Bulletin 660–D. In May and the early part of June H. G. Ferguson made special reconnaissance examinations of some of the North Carolina deposits and of those in Virginia (Irish Creek district), with reference to the possibility of their utilization for war purposes. Mr. Ferguson has begun the preparation of brief reports of the results of his work for publication in the annual "Contributions to economic geology."

The text and maps for the folio to cover the Kings Mountain and Gaffney quadrangles, the larger part of which lies in South Carolina, have been completed and submitted by Mr. Sterrett.

A digest of the ground waters of the Coastal Plain of North Carolina, for the use of the War Department, was prepared by L. W. Stephenson.

A comprehensive monograph entitled "The systematic paleontology of the Cretaceous deposits of North Carolina," prepared in cooperation between this Survey and the North Carolina Geological

and Economic Survey, was transmitted to the State geologist for publication by the State Survey. This monograph included the following papers, some of which have been contributed by cooperating geologists and paleontologists:

General stratigraphic features of the Coastal Plain of North Carolina, by W. B. Clark.
Literature of the Cretaceous deposits of North Carolina, by L. W. Stephenson.
The faunas in their stratigraphic chronologic relations, by L. W. Stephenson.
The flora of the Black Creek formation, by E. W. Berry.
The correlation of the Cretaceous formations of North Carolina, by W. B. Clark.
Coelenterata, by L. W. Stephenson.
Echinodermata, by W. B. Clark.
Vermes, by L. W. Stephenson.
Mollusca, by L. W. Stephenson.
Arthropoda, by M. J. Rathbun.
Vertebrata (Reptilia), by C. W. Gilmore.
Plantae, by E. W. Berry.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of the Eocene Bryozoa of the State.

A report on the Tertiary corals of the southeastern part of the United States, including North Carolina, by T. W. Vaughan, is in progress.

NORTH DAKOTA.

A general reconnaissance study of the glacial deposits in Divide and Williams counties and adjacent part of Burke, Mountrail, and McKenzie counties, N. Dak., was made by W. C. Alden in July, 1916. The literature of this and adjacent regions was studied in the office, and a preliminary description was prepared. When returning from a western trip in August, 1916, Frank Leverett made a brief examination of the glacial drift in the vicinity of Bismarck.

The manuscript for the Edgeley-Lamoure folio, prepared under agreement by H. A. Hard, was revised somewhat by W. C. Alden.

The invertebrate fauna of the Cannonball member of the Lance formation is under investigation by T. W. Stanton.

OHIO.

In the course of the investigations of reported indications of potash samples of brine were obtained from oil wells in Monroe and Noble counties, Ohio, by W. C. Phalen for chemical analysis, and a reported occurrence of nitrate near Ashtabula was visited twice by H. S. Gale, who was present at the boring of a 25-foot hole in this neighborhood.

A detailed report on the geology and mineral resources of the Woodsfield and Summerfield quadrangles by D. D. Condit and R. V. A. Mills has been submitted for critical review. Two reports on the

structure of the Berea sand, one (Bulletin 621–N) for the Summerfield quadrangle and the other (Bulletin 621–O) for the Woodsfield quadrangle, have been reprinted.

A report on the gas developments in and about Cleveland, by G. S. Rogers, has been issued as Bulletin 661–A.

The conditions of origin and deposition of the salts found in many wells and in pipe lines in the eastern portion of the State are the subject of a special investigation by R. V. A. Mills in association with R. C. Wells, of the division of chemistry and physics.

A folio describing the areal and economic geology of the Wellsville quadrangle and a bulletin on the structure and oil and gas resources of the quadrangle have been nearly completed, under agreement, by J. H. Hance. A folio text, covering the Steubenville and Cadiz quadrangles, by D. D. Condit, is ready for editing.

OKLAHOMA.

By courtesy of the Bureau of Mines a report by C. H. Beall, of that bureau, describing in detail the structure of the exposed rocks and of the individual oil sands, the relations of oil and gas to the structure, and the configuration of the salt-water surface in the Cushing field was cooperatively transmitted by Director Manning to the Geological Survey for publication. This paper, which is now in press, will appear as Bulletin 658.

The structure of the southern half of the Bristow quadrangle was examined in detail by A. E. Fath, and a report describing this area is now in preparation. A paper containing a description, with structure mapping, and a discussion of the oil and gas prospects of the north half of the same quadrangle is now in press as Bulletin 661–B.

Inspection of the general stratigraphy and criteria as to structure in Kingfisher County was made by Mr. Fath, who also examined and informally reported for the Office of Indian Affairs on a number of tracts of Indian land in the Iowa and Sac and Fox Indian reservations.

At the request of the superintendent of the Five Civilized Tribes and the Commissioner of Indian Affairs that the Survey furnish a geologist to make examinations of the structural conditions in certain Indian lands proposed for leasing, H. M. Robinson, associate geologist, was in March assigned to this duty.

During the summer of 1916 the structure of the northwest corner of the Pawhuska quadrangle, the areal geology of which had formerly been examined by C. D. Smith, who later resigned from the Survey, was mapped in detail by K. C. Heald, who during a part of the season was assisted by R. V. L. Stratton. A report on this area by Mr. Heald is in process of publication. Field work in the Pawhuska quadrangle was resumed in May by Mr. Heald, assisted by

K. C. Mather and, for the greater part of June, by D. E. Winchester and W. B. Emery, the investigation being carried on with the cooperation of the commissioner for the Osage Nation.

The structure and the oil and gas prospects in the Foraker quadrangle, in the Osage Nation, are described in a report by K. C. Heald, issued as Bulletin 641–B. This report has already been reprinted.

The structure of portions of the Hominy quadrangle was examined early in the winter by R. H. Wood, who in April resigned from the Survey with an agreement to complete at an early date his report on the structure and oil and gas prospects of the quadrangle. Information as to the structure in certain tracts of the Osage Nation offered for lease was furnished by Mr. Wood and Mr. Heald to the Office of Indian Affairs.

Data for the use of the Oklahoma Geological Survey in preparing a general geologic map of the State were cooperatively assembled under the supervision of Arthur Keith, chief of the section of eastern areal geology, who also furnished stratigraphic information to H. M. Robinson for his guidance in the land valuations for the Office of Indian Affairs.

Anticlines favorable for drill tests for oil and gas in Pontotoc County have been pointed out in a notice prepared by Mr. Robinson and distributed to the press by this Survey.

Examinations of the bituminous shales with sampling of coals were made by David White at a number of localities south of Muskogee and east of the Missouri, Kansas & Texas Railway, with the object of procuring additional criteria on which to base more definite conclusions as to the possible occurrence of oil in commercial amounts in the eastern part of the coal field and the southeastern part of the Paleozoic area of the State. Brief inspections were also made by Mr. White in the Bristow, Foraker, and Pawhuska quadrangles, in the Sac and Fox and Otoe Indian reservations, and at a number of points where drilling is now in progress in other parts of the State.

The two peneplains in western Arkansas were traced into the Lukfata quadrangle in the course of a reconnaissance by H. D. Miser.

Several deep wells in process of drilling were visited by R. K. Bailey, and arrangements were made for the collection of samples to be examined with reference to possible potash contents.

Collections of invertebrates from formations of Chester and Pottsville age were obtained by G. H. Girty, who also reported on other Carboniferous invertebrates from the State.

A report giving the results of a "Structural reconnaissance in the Okemah–Tiger Flats region, Okfuskee and Okmulgee counties," by A. E. Fath, has been submitted for publication in the "Contributions to economic geology." An anticlinal fold near Billings is mapped by Mr. Fath in Bulletin 641–E. The great demand for information

regarding oil prospects in Oklahoma has necessitated republication of this report and of the reports by C. H. Wegemann on the Healdton field (Bulletin 621–B) and on the Loco gas field, in Stephens and Jefferson counties (Bulletin 621–C).

OREGON.

A review of the nitrate prospects in southern Oregon, including the Sucker Creek claims, Buzzard Canyon, Stinking Lake, Rawhide, and Wagontire groups, was made by H. S. Gale.

A study of the chromite deposits of southwestern Oregon and an examination of the Great Gorge of the Columbia were carried on by J. S. Diller during a part of September.

Glacial deposits in the Cascade Mountains near Sisters, Oreg., were the subject of a reconnaissance by Frank Leverett.

PENNSYLVANIA.

The extramorainal glacial drift in parts of Lycoming, Clinton, Elk, and McKean counties was briefly studied by Frank Leverett in May.

The limestone formations of the Lebanon-Reading Valley, between the Mercersburg and Reading quadrangles, were mapped by G. W. Stose. A report giving the details of this examination is now in preparation by Mr. Stose.

The text and maps for the Fairfield-Gettysburg folio, by G. W. Stose and Florence Bascom, and for the Bellefonte folio, by Prof. E. S. Moore, have been completed and submitted for publication; and the text and maps for the Huntingdon and Hollidaysburg quadrangle have been revised by Charles Butts and the folio submitted.

A bulletin on the mineral resources of the Fairfield and Gettysburg quadrangles was prepared and submitted by Mr. Stose, and a report on the economic geology of the Allentown quadrangle, by B. L. Miller, is ready for editing.

The folio covering the Elkton and Wilmington quadrangles, by Florence Bascom and B. L. Miller, is in course of publication. These quadrangles also cover portions of Maryland and Delaware and were mapped in cooperation with the Maryland Geological Survey.

Some progress was made in field work in the McCalls Ferry and Quarryville quadrangles by E. F. Bliss and A. I. Jonas, and the text and maps for the Reading-Boyertown folio, by Florence Bascom, are nearly completed. In the Coatesville, West Chester, and Norristown quadrangles Miss Bascom was engaged in the further study of the various gneisses. Some reconnaissance work was done by Arthur Keith in southeastern Pennsylvania.

A general description of the bituminous coal fields of the State, with analyses and quantitative estimates of the coal resources in the beds and areas, by G. H. Ashley, is at an advanced stage of completion as a chapter of Professional Paper 100. A similar treatment of the anthracite fields and coals to go in the same volume is in preparation by Baird Halberstadt. Both papers are to be accompanied by maps.

Economic bulletins and folios covering the mineral resources and the general geology of the Punxsutawney, Curwensville, and Houtzdale quadrangles have been nearly completed by Mr. Ashley.

The detailed areal and structural examination of the Butler quadrangle was completed by G. B. Richardson and R. V. A. Mills, and the greater part of the Zelienople quadrangle was mapped in the season of 1916. The field studies of the Zelienople quadrangle were completed by Mr. Richardson in the spring of 1917, special attention being given to the composition and history of the waters locally found in the oil sands of the region. Mr. Richardson submitted in April an estimate of the petroleum resources remaining in the ground in western Pennsylvania.

The publication of the report on the geology of the Johnstown and Somerset quadrangles by Mr. Richardson has been delayed, pending the solution of certain problems concerning the correlations and formational boundaries as drawn in Maryland, southern Pennsylvania, and eastern Ohio. Paleontologic data on the Brush Creek coal and limestone and criteria for the determination of the Allegheny-Conemaugh boundary in the quadrangles above mentioned and in western Maryland were obtained in June, 1917, by Harvey Bassler, assisted by T. E. Williard.

The stratigraphy and fossils of the formations of central Pennsylvania were studied by E. O. Ulrich and Charles Butts in the valley region in June.

RHODE ISLAND.

The field examinations of the Cretaceous and Pleistocene deposits of the islands off the Rhode Island coast were completed by Prof. J. B. Woodworth, who, in accordance with an agreement, is engaged in the preparation of a report on the areal geology, history, and water resources of the Coastal Plain areas of southern New England.

SOUTH CAROLINA.

An investigation of the stratigraphy, structure, and ground waters of the Coastal Plain of South Carolina was begun by C. W. Cooke, who prepared, for the use of the War Department, a digest of available information on the ground waters of the State.

A "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, transmitted for publication, contains descriptions of fossil Bryozoa from South Carolina.

The maps and manuscript for a folio on the Kings Mountain and Gaffney quadrangles, which include a small portion of North Carolina, have been completed by D. B. Sterrett and submitted for publication.

SOUTH DAKOTA.

An inspection of the structural criteria and of the gas developments in the Missouri Valley in the neighborhood of Pierre, S. Dak., was made late in the autumn by E. T. Hancock, with a view to determining whether geologic structure of types favorable for the occurrence of oil or gas was present or could be recognized if present.

A report describing and mapping the lignite field of northwestern South Dakota, by D. E. Winchester, C. J. Hares, E. R. Lloyd, and E. M. Parks, has been published as Bulletin 627.

TENNESSEE.

Field and office work for a report on the marbles of Tennessee, to be incorporated in a general report on the marbles of the Southern States, was carried on by T. N. Dale.

Greensands in McNairy County, in western Tennessee, were sampled by G. H. Ashley for the purpose of obtaining more authentic information as to their value as sources of potash. The results are given in Bulletin 660–B.

The preparation of the folio covering the Waynesboro quadrangle, by H. D. Miser, has advanced somewhat, but on account of the demands on Mr. Miser's time for the preparation of reports on the geology and mineral resources of portions of Arkansas, this folio is not yet completed.

At the request of the State geologist of Tennessee, A. H. Purdue, arrangements were made for the transfer of Mr. Miser's office work to Nashville during June, in order that he might attend to the duties of the State geologist during Mr. Purdue's enforced absence for a time on account of his health.

The text and maps for a report on the coal resources of the Crossville quadrangle were revised by Charles Butts, who has submitted a short paper on the coals between Clifty and Bon Air that has been issued as Bulletin 641–K.

A comprehensive report on the Ducktown district awaits portions of the description of the general geology, by Arthur Keith and F. B. Laney.

TEXAS.

Drilling at Cliffside, Tex., for the purpose of procuring adequate information as to the reported presence of potash in the region west of Amarillo was resumed as soon as the necessary equipment and crew could be obtained. This well, which had reached a depth of about 360 feet before work had been suspended the preceding year on account of exhaustion of funds, has now reached a depth of 1,657 feet. No potash in notable amount has yet been found there.

The sulphur deposits of eastern Texas were examined by P. S. Smith with special reference to the question of drawing on them as sources of raw material for the manufacture of sulphuric acid.

Digests of the ground waters of the Coastal Plain of Texas, for the use of the War Department, were prepared by C. W. Cooke and T. W. Vaughan. A report on the ground waters of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, is in progress. A preliminary report on the stratigraphy, structure, and correlation of the Cretaceous deposits of northeastern Texas, by L. W. Stephenson, is nearly complete.

The Catahoula formation is discussed by G. C. Matson in a paper entitled "The Catahoula sandstone," and by Prof. E. W. Berry in a paper entitled "The flora of the Catahoula sandstone," both in Professional Paper 98–M, and the Citronelle formation is discussed by Mr. Matson in a paper on "The Pliocene Citronelle formation of the Gulf Coastal Plain" (Professional Paper 98–L).

A monograph entitled "Later Eocene fossil plants of southeastern North America," by E. W. Berry, transmitted for publication, contains descriptions of fossil plants from Texas, and a "Monograph of North American early Tertiary cheilostome Bryozoa," by F. Canu and R. S. Bassler, also transmitted for publication, gives accounts of fossil Bryozoa from the State.

Examinations of oil indications reported as present at a number of points in the Coastal Plain region of Texas were made by O. B. Hopkins, who paid special attention to the domes near Brenham and Palestine and has described these domes in a paper now in press as Bulletin 661–G. A report on the geologic structure and conditions of oil distribution in the Corsicana-Powell district, by G. C. Matson and O. B. Hopkins, is nearly ready to be issued as Bulletin 661–F.

Late in the spring of 1917 a somewhat exhaustive study of the salt domes of the Coastal Plain of the State, with special reference to the origin and conditions of occurrence of the salt, sulphur, oil, and gas in the domes, was begun by G. S. Rogers.

A second edition of Bulletin 629, "Natural-gas resources of parts of north Texas," by E. W. Shaw and G. C. Matson, has been issued and exhausted.

Large collections of early Paleozoic invertebrates, submitted by the Texas Bureau of Economic Geology and Technology, under the direction of J. A. Udden, were studied by E. O. Ulrich.

UTAH.

The Little Cottonwood and American Fork districts, Utah, were examined during the field season of 1916 by B. S. Butler, assisted by F. F. Hintze, and will be the subjects of a detailed report. A comprehensive report on the ore deposits of Utah by Mr. Butler and G. F. Loughlin is in preparation. A report on zinc carbonate and related copper carbonate ores at Ophir, by G. F. Loughlin, is to be published as Bulletin 690–A.

Reported deposits of molybdenum ore in the vicinity of Ouray were examined by F. L. Hess in May, 1917.

Two reports describing the location and conditions of occurrence of phosphate in the Logan quadrangle have been completed and transmitted by E. H. Finch.

Examinations for the recovery of potash at several points in the region of Salt Lake City were made by H. S. Gale. The report giving the potash content of some Utah copper ores (Bulletin 620–J) has been reprinted.

The oil shales in the Green River formation of the Uinta Basin were traced westward from Dragon by D. E. Winchester, who demonstrated the presence of a large body of productive shale in the western portion of the basin. The results of the work are given in a paper on "Oil shale in the Uinta Basin, Utah," now ready for publication as a part of Bulletin 691. Mr. Winchester also examined and sampled the oil shales at Ephraim and at several other points in the State.

A second issue of Bulletin 641–A, "Ozokerite in central Utah," by H. M. Robinson, has been necessary.

Cambrian and Devonian invertebrates from the Wasatch Range were studied by Edwin Kirk. Reports were made on Carboniferous invertebrates from a number of localities by G. H. Girty, and on fossil plants by F. H. Knowlton.

A description of the Lost Creek coal field, in Morgan County, by F. R. Clark, is ready for editing.

VERMONT.

The areal survey of the Bennington quadrangle was continued by L. M. Prindle. This quadrangle, combined with the Hoosic quadrangle (New York), will be covered by a folio, for which the text and maps are nearly completed.

The pre-Cambrian granites and gneisses and their structure in the Rutland, Wallingford, and Castleton quadrangles were further

studied and mapped in detail by Arthur Keith, who gave special attention also to the deformed shore lines in these quadrangles. A paper on these shore lines was given by him at the Albany meeting of the Geological Society of America.

VIRGINIA.

In order to ascertain more fully the physiographic and stratigraphic conditions under which the manganese deposits of the valley region of Virginia were laid down and later to test the applicability of the tentative hypothesis previously adopted by D. F. Hewett to the discovery of new ore bodies, the central part of the valley, including several mines, was in June visited by Arthur Keith, Dr. T. L. Watson, State geologist, M. R. Campbell, D. F. Hewett, G. W. Stose, Laurence LaForge, F. J. Katz, and J. B. Umpleby and a trial made. The examination and description of the manganese mines and prospects of the State is nearly completed by Dr. Watson, and the results of the Virginia manganese investigations will be published under cooperative auspices.

The tin deposits in the Irish Creek district were studied by H. G. Ferguson in the spring of 1917, and a report giving the results is in preparation.

An experimental plant near Yorktown for the extraction of potash from greensand was early in June inspected by H. S. Gale, A. C. Spencer, and W. B. Hicks, in company with H. M. Ami, of the British Embassy, for the purpose of viewing a working test of the plant.

The areal mapping of the coal field in the western part of the State and of Buchanan County in particular was continued cooperatively by Henry Hinds, of this Survey, assisted by T. K. Harnsberger for the State. A report on the geology and coal resources of Buchanan County is nearly completed, the geologic map being ready for transmission to the State for publication. A report on Carboniferous invertebrates was made by G. H. Girty.

A chapter on the Coastal Plain of Virginia, to form a part of a geographic manual on the northern Middle Atlantic States, was prepared by L. W. Stephenson.

A digest of the ground waters of the Coastal Plain of Virginia, for the use of the War Department, was prepared by L. W. Stephenson.

WASHINGTON.

A description of the geographic features of the Mount Rainier National Park and their origin has been revised by F. E. Matthes for publication on the back of the topographic map covering the park.

Glacial deposits near Spokane, Puget Sound, and Mount Rainier were studied for a few days by Frank Leverett.

A report covering a "Reconnaissance of the Conconully and Ruby mining districts, Wash.," by E. L. Jones, has been issued as Bulletin 640–B.

Invertebrate fossils from the Tertiary formations of the western part of the State are under investigation by W. H. Dall.

WEST VIRGINIA.

In the search for a very pure glass sand such as is needed for the manufacture of optical instruments to be used by the Army and Navy, the sandstone deposits in the vicinity of Berkeley Springs were examined by R. W. Stone in company with H. S. Washington, who represented the Carnegie Geophysical Laboratory.

Office work on the maps and description of the Williamsport quadrangle, which includes parts of Maryland and Pennsylvania, has been advanced by G. W. Stose. This material will form part of the Williamsport-Hagerstown folio, and the work is being done in cooperation with the State of Maryland.

WISCONSIN.

The text and maps for a folio covering the Wausau and Marathon quadrangles, studied in cooperation with the State Geological and Natural History Survey, have been completed by Samuel Weidman and the folio submitted for publication.

A report on the glacial moraines and shore lines of the Lake Superior region, by Frank Leverett, is nearing completion. In connection with the preparation of this paper some field work was done in October and a field conference was had by Mr. Leverett with Dr. Weidman. "The Quaternary geology of southeastern Wisconsin," by W. C. Alden (Professional Paper 106), is now in press.

Early Paleozoic formations in parts of the State were studied by E. O. Ulrich in cooperation with State Geologist Hotchkiss for the purpose of ascertaining the equivalents of some of the Wisconsin geologic formations as compared with those of New York, Alabama, and other areas.

WYOMING.

At the request of the National Museum lithologic collections were made in the Leucite Hills, Wyo., by E. S. Larsen.

The report on the geologic structure and oil resources of the southern portion of the Big Horn Basin, by D. F. Hewett and C. T. Lupton, has been revised and brought up to date, following further field examinations made by Mr. Hewett in October, and the report is now in press as Bulletin 656.

A report on the structure and oil prospects of the Elk Basin was prepared and submitted for publication by C. J. Hares, and a report covering the Salt Creek district, by C. H. Wegemann, has been submitted and is now in process of publication as Bulletin 670. "Anticlines in central Wyoming," by C. J. Hares, has been published and reprinted as Bulletin 641–I.

Cretaceous invertebrates from the Big Horn Basin and from eastern Wyoming were reported on by T. W. Stanton, and Mesozoic invertebrates from Carbon County were identified by J. B. Reeside, jr.

A comprehensive study of American Jurassic ammonites belonging to the family Cardioceratidae, mostly from Wyoming, was made and the first draft of a paper on them was prepared by J. B. Reeside, jr.

Carboniferous invertebrates were reported on by G. H. Girty, and the study and description of the fauna of the Big Horn limestone were continued by Edwin Kirk.

The stratigraphy of the Wind River Mountains is the subject of a paper by Eliot Blackwelder, now ready for publication as a bulletin.

A report on the "Relations of the Embar and Chugwater formations in central Wyoming," by D. D. Condit, was published as Professional Paper 98–O, and a paper by C. H. Wegemann on "Wasatch fossils in so-called Fort Union beds in the Powder River basin, Wyo.," has been issued as Professional Paper 108–D.

The gypsum deposits in the southern part of the Big Horn Mountains are described by C. T. Lupton and D. D. Condit in Bulletin 640–H.

CANAL ZONE AND WEST INDIES.

The following monographs prepared in compliance with an agreement made in 1912 between the Canal Commission, the United States Geological Survey, and the Smithsonian Institution have been transmitted to the Secretary of the Smithsonian Institution for publication:

Introduction to Contributions to the geology and paleontology of the Canal Zone, Panama, and geologically related areas in Central America and the West Indies, by T. W. Vaughan.

On some fossil and recent Lithothamnieae of the Panama Canal Zone, by M. A. Howe, with plates 1–11.

The fossil higher plants from the Panama Canal Zone, by E. W. Berry, with plates 12–18.

The smaller fossil Foraminifera of the Panama Canal Zone, by J. A. Cushman, with plates 19–33.

The larger fossil Foraminifera of the Panama Canal Zone, by J. A. Cushman, with plates 34–45.

Fossil Echini of the Panama Canal Zone and Costa Rica, by R. T. Jackson, with plates 46–52 and text figures 1–3.

Fossil Bryozoa of the Panama Canal Zone and Costa Rica, by F. Canu and R. S. Bassler, with plate 53.

Crustacea and Decapoda from the Panaman region, by M. J. Rathbun, with plates 54–66.

Cirripedia from the Panama Canal Zone, by H. A. Pilsbry, with plate 67.

The following papers also are nearly ready for transmission:

Fossil Madreporaria from Panama and geologically related areas in Central America and the West Indies, with about 70 plates, by T. W. Vaughan.

The stratigraphic relations and biologic character of the serimentary formations of the Panama Canal Zone and geologically related areas in Central America, by T. W. Vaughan and D. F. MacDonald, with two maps and several text figures.

Correlation of the sedimentary geologic formations of Panama in their relation to the geologic history of Central America and the West Indies, by T. W. Vaughan.

Prior to his resignation from the United States Geological Survey, D. F. MacDonald completed an extensive monograph on the physiography, stratigraphy, geologic history, and economic geology of the Canal Zone. This paper will be submitted to the Smithsonian Institution for publication as soon as information procured through the paleontologic investigations can be incorporated in it.

As paleontologic studies collateral to those of the Tertiary formations of the southeastern United States and the Canal Zone, J. A. Cushman has monographically described collections of fossil Foraminifera from the Leeward Islands, the Dominican Republic, and Jamaica and nearly finished a similar account of collections from Cuba. T. W. Vaughan has nearly finished a general monograph of the fossil corals of the West Indies; all material in the United States National Museum, except a few species from the islands of Antigua and Anguilla, has been described and figured.

Other similar faunal monographs for the West Indies, mostly by specialists not connected with the Survey, are either complete or almost complete. These careful, comprehensive investigations of the stratigraphic paleontology of the West Indies furnish a basis for accurate stratigraphic work in that area. As the United States has so many interests in the West Indies, the results obtained through the investigations mentioned are of particular importance.

DIVISION OF ALASKAN MINERAL RESOURCES.

APPROPRIATION AND CLASSES OF WORK.

Under the appropriation of $100,000 made for the continuation of the investigation of the mineral resources of Alaska, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys, special investigations of mineral

resources, reconnaissance and detailed topographic surveys, investigations of water resources, and collection of statistics of mineral production.

PERSONNEL.

On July 1, 1916, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographic engineers, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries, 1 field assistant, and 31 camp hands and recorders. On June 30, 1917, the personnel included 1 acting geologist in charge, 9 geologists, 1 topographic engineer, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries, and 1 clerk on per diem salary. The field force also included 6 camp hands and recorders.

The following members of the division of Alaskan mineral resources received commissions on or prior to June 30, 1917:

Alfred H. Brooks, major, Engineer Officers' Reserve Corps.
J. W. Bagley, captain, Engineer Officers' Reserve Corps.
E. M. Aten, captain, Quartermaster's Department.
C. E. Giffin, captain, Engineer Officers' Reserve Corps.

FIELD WORK DURING THE SEASON OF 1916.

Areas covered and allotments.—Twelve parties were engaged during 1916 in Alaska surveys and investigations. Of these parties seven were engaged in geologic surveys, three in topographic surveys, one was a combined topographic and geologic party, and one was engaged in stream gaging. The areas covered by geologic reconnaissance surveys on a scale of 1:250,000 (4 miles to an inch) amount to 5,100 square miles; by detailed geologic surveys on a scale of 1:62,500 (1 mile to an inch), 636 square miles. The results of investigation of special problems relating to mineral occurrence can not be expressed areally. About 9,700 square miles of topographic reconnaissance surveys on a scale of 1:250,000 (4 miles to the inch) and 65 square miles on a scale of 1:62,500 (1 mile to an inch) were made. In cooperation with the Forest Service, stream gaging in southeastern Alaska was also continued.

With increased knowledge of Alaska's geology and the new facts made available by mining operations, it has become necessary to revise some of the previous interpretations of the geology, especially those made before accurate base maps were available. Therefore, the revision of some of the mapping of the earlier years becomes of vital importance, and to this work some time is devoted each year. In 1917 an area of 36 square miles adjacent to Juneau, previously surveyed geologically on a scale of 1:62,500, was mapped on the larger scale of 1:24,000. The geologic mapping of about 1,500 square miles on a scale of 1:250,000 was also revised.

To state the work geographically, four parties worked in southeastern Alaska, one in the Copper River region, two on Prince William Sound, and four in the Yukon basin, and one was engaged in general investigations in the Yukon basin and Seward Peninsula. Among the important results of the year were the completion of the detailed topographic and geologic survey of Juneau and vicinity, the completion of the reconnaissance geologic survey of the southern part of the Ketchikan district, and the detailed survey of a part of the Nenana coal field.

The following tables show the allotments, including both field and office work, of the total appropriation of $100,000 for the fiscal year 1916 to the regions investigated. In addition to this a balance of about $6,000 from last year's appropriation was expended in equipping parties for the season's field work. General office expenses are apportioned to the several allotments. Salaries of the permanent staff are included up to the close of the fiscal year 1917, but expenses other than these include only the cost of field and office work during 1916. The "general investigations" include, among other things, the cost of collecting mineral statistics and of office work relating to the field investigations of previous seasons. A balance of about $6,000 has been utilized for equipping field parties in 1917.

Approximate geographic distribution of appropriation for Alaska investigations, 1916–17.

Southeastern Alaska	$22,500
Copper River	7,000
Prince William Sound	14,500
Yukon basin	42,500
Seward Peninsula	1,000
General investigations	6,500
Allotted to field work, 1917	6,000
	100,000

Approximate allotments to different kinds of surveys and investigations, 1916–17.

Geologic reconnaissance surveys	$15,000
Detailed geologic surveys	20,000
Special geologic investigations	11,600
Reconnaissance topographic surveys	19,000
Detailed topographic surveys	4,500
Water resource investigations	4,900
Collection of mineral statistics	1,600
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	17,400
Allotted to field work, 1917	6,000
	100,000

Allotments for salaries and field expenses, 1916–17.

Scientific and technical salaries	$39,843
Field expenses	37,615
Clerical and office salaries	16,542
Allotted to field work, 1917	6,000
	100,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a varying amount is spent each year on special investigations that yield results which can not be expressed in terms of area.

Progress of surveys in Alaska, 1898–1916.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources (gaging stations maintained part of year).
		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.	
		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
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	.....	.....
1914	100,000	1,000	7,700	325	600	10,300	10	.....	.....	.....
1915	100,000	.....	10,700	200	.....	10,400	12	3	2	9
1916	100,000	.....	5,100	636	.....	9,700	67	.....	.....	20
	1,461,189	73,200	99,535	5,232	51,680	146,980	3,731	453	74	.....
Percentage of total area of Alaska	.....	12.48	16.80	0.89	8.81	25.05	0.64	.....	.....	.....

[a] The Coast and Geodetic Survey, International Boundary Survey, and 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 24, when he started for Alaska. He joined Mr. Chapin at Ketchikan on August 2 and devoted the next two weeks to the study of the geology of the Ketchikan district. The time from August 19 to 26 was spent in the Juneau district with Mr. Spencer and Mr. Eakin. Here a conference was also had with

Mr. Canfield. A study of the geology of the Latouche district of Prince William Sound was made in company with Mr. Johnson from August 30 to September 10. A brief visit was then made to Anchorage, and several more days were spent at Juneau on the return trip. Seattle was reached on September 24.

In the office Mr. Brooks devoted 56 days to geologic studies, 24 days to the critical reading and revision of manuscripts, 13 days to the writing of the progress report, 10 days to field plans, 8 days to mineral statistics, 5 days to proof reading, and 4 days to preparation of the annual press bulletin on mining in Alaska. Mr. Brooks was absent from the office the month of June and part of May, and during this time G. C. Martin was engaged chiefly in executive work as acting geologist in charge of the division.

R. H. Sargent continued the general supervision of the Alaska topographic surveys and map compilation, in addition to carrying on his own field work, until May 26, when he went to Peking on furlough to act as professor of surveying triangulation in the Government Institute of Military Survey of China. Mr. Sargent's administrative duties were then assigned to Mr. Bagley and Mr. Witherspoon.

During the last six years J. W. Bagley has been investigating the use of photographic methods in Alaska topographic surveys. In this work he has devised both methods and instruments, whose utility has been proved by actual use. During 1916 he prepared a report on the results of this work, which has been published as Bulletin 657.

Arthur Hollick was employed for one month in writing the description of the Cretaceous and Tertiary floras of Alaska.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during Mr. Brooks's absence in the field. He also continued to assist in collecting statistics of production of precious metals in Alaska.

Southeastern Alaska.—The geologic reconnaissance survey of the southern half of the Ketchikan district, begun in 1913 and continued in 1915, was completed in 1916. These investigations were made by Theodore Chapin, who devoted the time between May 20 and September 20 to the work. In addition to revising the previous geologic map an area of some 500 square miles was surveyed on a reconnaissance scale. Considerable time was also devoted to a study of the ore deposits and an investigation of mining developments.

The making of a detailed base map of the region adjacent to Juneau, which was begun in 1914, was completed in 1916. The large scale adopted, 1:24,000 (2.64 inches to the mile), and the ruggedness of the region, together with heavy timber and adverse climatic conditions, have made this survey exceedingly difficult and expensive.

The area covered is 36 square miles, of which 12½ square miles was surveyed in 1916. Owing to the high cost of the survey it has been necessary to confine it to those areas which are of greatest present economic importance. D. C. Witherspoon, who did this work, was engaged in field work from May 29 to September 27, inclusive.

The area covered by the base map above referred to was surveyed geologically during 1916 by A. C. Spencer and H. M. Eakin, who also made a detailed investigation of the ore deposits. Field work was begun on July 11 and continued until October 6, covering an area of 36 square miles. Mr. Eakin also devoted about three weeks to a study of the Porcupine placer district. This district had not been investigated by a geologist since 1903, during which time some developments had been made. Mr. Eakin also devoted about a week to collecting data on mining developments in the more isolated parts of the Juneau district.

The investigation of the water resources of southeastern Alaska, begun in 1915 under a cooperative agreement with the Forest Service, was continued throughout 1916. G. H. Canfield, who had charge of this work, maintained 8 automatic gages throughout the year. In addition, 12 other gages were installed in cooperation with various individuals and corporations. This work could not have been carried on without the cordial cooperation of the Forest Service. Many members of that service have given substantial aid, but particular acknowledgment should be made to W. G. Weigle, special agent at Ketchikan, and to Leonard Lundgren, district engineer at Portland, Oreg.

Copper River region.—Though much the larger part of the Chitina basin has been covered by geologic surveys, there are still many unsolved problems relating to the stratigraphy, structure, and ore deposits. These can be solved only by a more or less intensive study of special areas, and to this task F. H. Moffit was assigned. He devoted the time from June 23 to September 29 to this work. In addition to making a special study he also made geologic reconnaissance surveys of about 300 square miles.

Prince William Sound.—The rapid development of mining in the Prince William Sound region has made a demand for further surveys and investigations. During 1916 B. L. Johnson made a somewhat detailed survey of the Latouche district, in which he covered an area of about 400 square miles. In addition to this he made some investigations of the mining developments in other parts of the Prince William Sound region. Mr. Johnson devoted the time from June 11 to October 18 to this work.

J. W. Bagley began topographic reconnaissance surveys in the Port Wells district of the Prince William Sound region on June 8 and extended these surveys eastward, continuing his field work until Sep-

tember 12. He covered an area of 1,900 square miles on a scale of 1:250,000, using photographic methods. In addition he surveyed in detail (scale 1:62,500) an area of 65 square miles lying adjacent to Jack Bay, this work connecting the previously mapped areas of the Ellamar and Port Valdez districts.

Yukon basin.—G. C. Martin, assisted by A. G. Maddren and R. M. Overbeck, made a detailed geologic study of the western part of the Nenana coal field. The base map was provided for this work by the surveys made by the General Land Office. The field work was begun on June 16 and continued to August 24, and the total area surveyed was 236 square miles on a scale of 1:62,500.

S. R. Capps and C. E. Giffin were charged with the duty of making a reconnaissance survey of the Kantishna placer district. The surveys were begun on Nenana River and extended westward to include the Kantishna district and southward to the crest line of the Alaska Range. Mr. Capps, who had charge of the geologic investigations, began work on June 26 and continued until August 25, surveying an area of about 1,000 square miles on a scale of 1:250,000. He also revised previous geologic mapping over an area of about 2,000 square miles. Mr. Giffin, who made the topographic survey, began field work on June 26 and completed it on August 29. He covered an area of 4,500 square miles, using photographic methods.

The important developments in the Tolovana district led to an investigation of this field during 1916. J. B. Mertie, jr., was detailed for this work and began field work in the Tolovana district on July 7, continuing until August 4. Besides studying the placers he made a geologic reconnaissance map of about 240 square miles. The time from August 8 to 31 was devoted by Mr. Mertie to an investigation of the ore deposits of the Fairbanks district. In this field he devoted special attention to the occurrence of tungsten.

Important mining developments in the Marshall district of the lower Yukon have made an urgent demand for a survey of this field. Therefore a combined geologic and topographic party under the direction of R. H. Sargent, with G. L. Harrington as geologist, was assigned to this field. This party began work on June 16 and continued until September 6. The topographic and geologic surveys cover an area of some 3,300 square miles.

Seward Peninsula.—J. B. Mertie, jr., was detailed to make a supplementary investigation of the lodes in the Nome and other districts of Seward Peninsula. He devoted the time from September 19 to October 13 to this work and paid special heed to the tungsten and antimony deposits. In addition he collected data on mining developments.

FIELD WORK FOR THE SEASON OF 1917.

Field work was begun before the end of the fiscal year (during June) by four parties, as indicated below. S. R. Capps began the investigation of the mineral resources of the region tributary to that part of the Government railroad under construction, lying between Anchorage and Broad Pass, except the Matanuska coal field and the Yentna placer district. G. L. Harrington began the examination of the reported occurrences of platinum in the Tolstoi region of the Innoko district, the Dime Creek region of the Koyuk district, and the Bear Creek region of the Fairhaven district. A. G. Maddren started for southwestern Alaska to investigate the sulphur deposits on Unalaska Island and the beach placers near Red River, on the west shore of Kodiak Island, which are reported to carry platinum. Time permitting, he will also investigate the recent lode mining developments on Unga Island and the occurrence of sulphur on Makushin Volcano. D. C. Witherspoon began a topographic reconnaissance survey (scale, 1:250,000) of the region adjacent to or accessible from tidewater of that part of Prince William Sound extending from Point Whitehead, south of Cordova, northward to the Ellamar district. G. H. Canfield from January throughout the year has continued the investigation of the water powers of southeastern Alaska in cooperation with the Forest Service. All these surveys and investigations will continue into the fiscal year 1917–18.

COLLECTION OF STATISTICS.

The collection of the statistics of production of precious metals in Alaska, begun by the Alaska division in 1905, was continued as usual. Preliminary estimates of mineral production for 1916 were published on January 1, 1917. The progress report for 1916 (Bulletin 662–A), containing the full statement and tables on mineral production, was transmitted on May 5, 1917.

PUBLICATIONS.

During the year the Survey published six bulletins (Nos. 630, 631, 642, 649, 657, and 666–P) and one water-supply paper (No. 382) relating to Alaska. Two topographic maps (Pl. I, Bulletin 630, and Pl. I, Bulletin 631) were published during the year.

Three bulletins (Nos. 655, 662, and 666–P), one water-supply paper (No. 418), and three topographic maps (lower Matanuska Valley, by R. H. Sargent, scale 1:62,500, contour interval 50 feet; Juneau and vicinity, by D. C. Witherspoon, scale 1:24,000, contour interval 50 feet; and Lake Clark-central Kuskokwim, by R. H. Sargent, scale 1:250,000, contour interval 200 feet) were in press at the end of the year.

Manuscripts of the following reports are completed:

The Canning River region, northern Alaska, by E. de K. Leffingwell (Professional Paper 109).

The Cosna-Nowitna region, Alaska, by H. M. Eakin (Bulletin 667).

The Nelchina-Susitna region, Alaska, by Theodore Chapin (Bulletin 668).

The upper Chitina Valley, Alaska, by F. H. Moffit (Bulletin 675).

The marble resources of southeastern Alaska, by E. F. Burchard.

The Kantishna region, Alaska, by S. R. Capps.

The Anvik-Andreafski region, including the Marshall district, Alaska, by G. L. Harrington.

The following reports are in hand:

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

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

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

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

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren.

The Yakataga district, by A. G. Maddren.

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

The Valdez district, by B. L. Johnson.

The Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington.

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

The Nenana coal field, by G. C. Martin.

The Porcupine district, by H. M. Eakin.

The Ketchikan district, by Theodore Chapin.

The structure and stratigraphy of Gravina and Revillagigedo islands, by Theodore Chapin.

The geology of Latouche Island, by B. L. Johnson.

Office work on the 12 maps listed below has been completed:

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

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

Juneau and vicinity, 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, 400 feet.

Cosna-Nowitna region, by H. M. Eakin; scale, 1:250,000; contour interval, 200 feet.

Ruby district, by C. E. Giffin and R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

Lower Yukon region, by R. H. Sargent; scale, 1:250,000; contour interval, 100 feet.

Marshall district, by R. H. Sargent; scale, 1:250,000; contour interval, 100 feet.

Canning River region, by E. de K. Leffingwell; scale, 1:250,000; sketch contours.

North Arctic coast, by E. de K. Leffingwell; scale, 1:500,000; no contours.

Martin Point to Challenge Entrance, by E. de K. Leffingwell; scale 1:125,000; no fixed contour interval.

Challenge Entrance to Thetis Island, by E. de K. Leffingwell; scale, 1:125,000; no fixed contour interval.

The following topographic maps are in hand:

Innoko-Iditarod region, by R. H. Sargent and C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

Anchorage-Matanuska region, by R. H. Sargent and others; scale, 1:250,000; contour interval, 200 feet. (This includes maps of the "Matanuska region" and "Turnagain-Knik region," which were previously reported separately.)

Yukon-Tanana Valley; compiled; scale, 1:500,000; contour interval, 400 feet.

Glacier Bay region; compiled; scale, 1:250,000; contour interval, 200 feet.

Kantishna region, by C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

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

Jack Bay district, by J. W. Bagley; scale, 1:62,500; contour interval, 50 feet.

Upper Chitina Valley, by F. H. Moffit; scale, 1:250,000; contour interval, 200 feet.

SCIENTIFIC RESULTS.

Each of the geologists who has been at work in Alaska during the year has, as in previous years, added greatly to the volume of knowledge concerning the geology of that Territory. It is not possible to enumerate here all the important discoveries that have been made, but those of widest interest or of most far-reaching importance will be mentioned.

In southeastern Alaska Upper Triassic fossils were discovered by A. C. Spencer and H. M. Eakin in a series of slates and andesites of the Juneau district. This not only adds a new Triassic locality to those previously known in Alaska but gives new and very important evidence concerning the age of the metamorphic rocks of this district. This does not mean, however, that the slates of southeastern Alaska are all Triassic, for there has also been a new discovery, by Theodore Chapin, of Jurassic or Cretaceous fossils in the slate and graywacke of Gravina Island, which have previously been tentatively assigned by some to the Triassic and by others to the Paleozoic. Mr. Chapin has also determined that the structure of the Ketchikan district is that of a syncline overturned toward the southwest and has discovered important lower Carboniferous fossil localities on the west coast of Prince of Wales Island. Mr. Eakin determined that both the original and the secondary structural features in the Funter Bay district dip at low angles. This structure has, apparently, an important influence on the ore deposits, as it caused the ore-bearing solutions to form large fissure veins instead of the more diffused stockworks of the areas of nearly vertical dip. Valuable information concerning the extent of the Quaternary submergence was obtained by A. C. Spencer and H. M. Eakin, who found marine fossils and beach lines at an elevation of 600 feet in the vicinity of Juneau—nearly twice as high as they had previously been known at this locality—and by Theodore Chapin, who found marine fossils at an elevation of 80 feet on Gravina Island. Mr. Eakin found evidence in the Porcupine district of two

distinct ice advances, each followed by intrenchment of hanging valleys and by concentration of placer gold deposits.

The investigation of the copper deposits of Prince William Sound by B. L. Johnson revealed the fact that chalmersite ($CuFe_2S_3$), a mineral previously known only as small crystals from South America and not as an ore, occurs as an abundant constituent of the copper ores at several of the prospects on Knight Island.

In the Copper River region F. H. Moffit obtained collections of fossils which seem to indicate that the Kennicott formation may be Cretaceous instead of Upper Jurassic, as has been hitherto supposed.

In the Yukon Valley J. B. Mertie, jr., discovered an important and previously unrecognized chert formation, possibly several thousand feet thick, of Devonian or Carboniferous age, in the Tolovana district. S. R. Capps, working in the Kantishna district, on the north front of the Alaska Range, obtained evidence indicating that the Cantwell formation is considerably older than the Tertiary coal-bearing rocks and is possibly separated from those rocks by a significant unconformity. The Cantwell formation and the Tertiary coal-bearing rocks have been supposed to be of the same age, as they both apparently carry the Kenai flora. G. C. Martin, A. G. Maddren, and R. M. Overbeck, working in the Nenana coal field, discovered that the burning of the coal beds, which is still in progress, began during or before Pleistocene time. The Pleistocene gravels contain abundant worn fragments of burned shale and clinker derived from the burned Tertiary coal beds. This fact proves that these gravels, previously referred tentatively to the Tertiary, are separated from the Tertiary coal-bearing strata by an unconformity, and it affords a criterion for the recognition of the younger gravels, which in obscure outcrops can not otherwise be readily distinguished from the gravel members of the Tertiary beds. Mr. Mertie discovered that in the Fairbanks district and also on Seward Peninsula the tungsten and gold mineralization were apparently independent of each other.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 265 quantitative analyses and 1,490 qualitative determinations of rocks and minerals were reported during the year, the samples tested consisting chiefly of minerals sent in for inspection.

F. W. Clarke, in cooperation with W. C. Wheeler, completed for publication Professional Paper 102, "The inorganic constituents of marine invertebrates." He also published papers entitled "The constitution of melilite and gehlenite" and "Geochemical evidence as to early forms of life." The work on marine invertebrates is being extended still further. At its centennial celebration, in January, the

Russian Mineralogical Society elected Mr. Clarke an honorary member.

George Steiger, in cooperation with Dr. T. L. Watson, State geologist of Virginia, published a note on the effect of manganese on the coloration of amethyst and rose quartz. In cooperation with E. S. Larsen he published "Mineralogic notes." Mr. Steiger had charge of the administrative work of the division and also during the winter and spring he devoted much time to drawing plans, making estimates, and moving the laboratory to the new building.

W. T. Schaller continued his work on a number of unfinished manuscripts, prepared for the division of mineral resources reports on mica, precious stones, lithium, thorium, zirconium, and rare-earth minerals, published papers on the two new minerals crandallite and magnesioludwigite, and continued his study of uranium and vanadium minerals. An investigation of a water-soluble blue molybdenum mineral from Utah showed it to be ilsemannite, which was proved to be a sulphate of molybdenum. Mr. Schaller also prepared an exhibition of specimens in the National Museum illustrating the occurrence and association of the gem tourmalines of southern California and undertook a field investigation of the deposits of phlogopite mica in the United States. Much of Mr. Schaller's time was taken up with routine mineralogic and chemical investigations.

Experimental work on several problems involving physical chemistry was carried on by R. C. Wells. In addition to analyzing a number of rocks from Panama, including some that have been involved in the slides, Mr. Wells found that these rocks are particularly susceptible to the moisture conditions of the atmosphere and that they gain and lose weight in definite dependence on the humidity of the air. These results were transmitted to Mr. D. F. MacDonald, the geologist investigating the slides, in a report "The variable water content of certain rocks from Panama." In cooperation with R. V. A. Mills, Mr. Wells has begun a new line of study of oil-field waters with reference to their evaporation and concentration by natural gases. This work, which is nearly completed, has included analyses of waters, evaporation crusts, and rocks and the determination of the solubility of certain compounds under the special conditions involved, as well as a study of the water content of natural gases and the relative amounts of gas and water and of salts dissolved in water present in oil-field sands. Mr. Wells prepared a paper "On the solubility of calcite in sea water in contact with the atmosphere, and its variation with temperature," to be published in a Carnegie Institution publication with papers by T. W. Vaughan and others on similar subjects, and a report on "New determinations of carbon dioxide in water of the Gulf of Mexico," to be published in the Survey's "Shorter contributions to general geology." In cooperation with E. S. Larsen, Mr. Wells

published a paper on "Lorettoite, a new mineral." His routine analytical work included analyses of six pegmatites, two platinum ores, a chromite, four lead ores, five iron ores, and two so-called "paraffin earths."

W. B. Hicks devoted nearly all of his time to routine work, consisting mainly of the analyses of miscellaneous samples, including glauconite and brines, with special reference to their potash content. In conjunction with Mr. Bailey he described a new method for determining potash in glauconite, which has been published as a part of G. H. Ashley's report on greensands (Bulletin 660–B).

R. K. Bailey was engaged in routine work from July to October in connection with the Survey's potash investigation. Since October, 1916, he has been at Cliffside, Tex., where the Survey is drilling a well in search for potash, and has been testing the samples as they come from this and other wells. He has also visited other drilling operations in the vicinity and collected samples and well records.

Chase Palmer devoted a large part of his time to routine work, consisting of miscellaneous chemical analyses of rocks, minerals, oil shales, brines, oil-field waters, and distillates from oil shales. He was also occupied with research on the relations of oil-field waters from California. During the year he published in Economic Geology an article called "Diarsenides as silver precipitants." The conduct of several arsenical minerals has been determined, and their capacities as precipitants of metallic silver have been measured. The chemical nature of iron in the mineral löllingite has also been determined. A reagent by which the proportion of a simple arsenide may be determined in mineral mixtures containing also arsenosulphides and bisulphides is given in the article. The chemical facts which have been thus learned afford a rational explanation of the replacement deposits of metallic silver in the rich silver district of Cobalt, Ontario.

In the physical laboratory the investigations noted in previous reports have been continued under the direction of C. E. Van Orstrand. Considerable time has been given to an extension of the paper on earth temperatures. Temperature measurements were made in six wells of exceptional depth in the vicinity of Clarksburg, W. Va. A. F. Melcher made a number of determinations of the porosity of oil and gas bearing sands and devoted considerable time to the preparation of a paper dealing with the subject. He also assisted R. V. A. Mills in conducting an experiment on the migration of natural oil in certain sands.

In addition to his administrative work as chief of the division G. F. Becker has been occupied mainly in studies of capillarity and heat conduction from the geologist's point of view. His paper on "Mechanics of the Panama Canal slides" appeared as Professional Paper 98–N.

During the fiscal year a total of 1,231 letters were written in the division, of which 868 were numbered letters and 363 were for the signature of members of the division.

DIVISION OF MINERAL RESOURCES.

The Survey has continued its policy of making the annual report "Mineral Resources of the United States" more than a statistical compilation by recording and interpreting industrial progress and especially by treating in full the sources from which the mineral products of the country are obtained. This report is an annual inventory of the Nation's mineral resources.

During the last 14 years the separate chapters have been prepared in large part by geologists of the Survey who have specialized in the respective 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 1916. The 15 States that cooperated were Alabama, Florida, Illinois, Iowa, Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, North Carolina, Oregon, Virginia, Washington, and Wisconsin. By this cooperation duplication of a considerable amount of work is obviated, and the producers are saved the annoyance of preparing two sets of statistical returns. On June 30, 1917, the manuscripts of 11 chapters for the report for 1916 had been completed and transmitted to the printer.

The entrance of this country into the war has served to increase the demand for information concerning our mineral resources, and as a result a bulletin entitled "Our mineral supplies," supplementing Bulletin 599, "Our mineral reserves," is being prepared. This bulletin reviews in a brief way the condition of the mineral industry with reference to its ability to supply the many and varied demands caused by war. Thirty chapters of this bulletin have been prepared during the year. The Council of National Defense was furnished a complete set of manuscript statements for every mineral of importance, showing production, imports, consumption, and sources of supply, with diagrams. This information was furnished promptly—within two or three days after being called for—and represented in tabloid form the up to the minute data available through the division of mineral resources. Through its committees the council has also called upon the Geological Survey for more detailed information concerning mineral resources. An increased demand has been made for information concerning the basic mineral resource—coal. The publication of monthly statements of shipments of coal was begun during the year. This information was of much value to the coal

committee of the Council of National Defense, but the call for more detailed information as to mine capacity, shipping facilities, etc., could be supplied only by enlarging the scope of the inquiry carried on by the Geological Survey. To accomplish this end the force was temporarily increased by the addition of five employees, and the publication of weekly statements of coal shipments was also begun.

The Tariff Commission also availed itself of the information at hand in the Geological Survey and called for a statement of condensed figures and data concerning nearly every mineral. This information also was furnished promptly. All these inquiries and the preparation of Bulletin 666 have been undertaken with comparatively little increase of force, causing, however, some delay in the publication of the annual report.

In response to a general demand for prompt and impartial statistics relating to the broader phases of the petroleum industry, the division began the collection and publication of monthly statistics showing the quantity of crude oil moved from field sources, the quantity delivered to refiners or to consumers, and the quantity in storage at the end of each month for each of the major fields of oil production east of the Rocky Mountains. These summaries are necessarily incomplete, for owing to the magnitude of this great industry in the United States complete statistics of production can be obtained but once a year, and even then require at least six months for their collection and compilation. The monthly statements, which include comparative statistics for the current month, the month immediately preceding, and the corresponding month in 1916, are compiled from reports submitted voluntarily by about 200 pipe-line and refining companies and furnish a valuable and timely index to the status of the industry in each field, accounting for between 90 and 95 per cent of the crude oil marketed each month in the area designated.

Preliminary estimates of output in 1916 were issued in December, 1916, or January, 1917, with reviews of the conditions that prevailed during the year, in the form of special press bulletins on the following subjects: Bauxite and aluminum; cement; chromite; coal; coke; copper, gold, and silver (general); gold and silver in Alaska; iron ore; lead; lime; mineral products; petroleum; potash; quicksilver; sulphur; zinc; and metal production in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, and Washington (mine reports). Advance statements giving the final figures for the production of copper, lead, and other substances in 1916 have also been published.

The employees who devote their entire time to the work of the division in Washington number 36, and 8 are stationed in the field offices at Salt Lake City, Denver, and San Francisco. In addition

to these, 24 specialists give part of their time to the work of the division, making a total of 68 persons.

During the year 217,986 pieces of first-class mail matter were sent out by the division and 77,315 pieces were received.

H. D. McCaskey continued as geologist in charge of the division, in charge of the metals section, and of the three offices of the division in the Western States; E. F. Burchard was geologist in charge of the nonmetals section of the division during the year and continued as an author of several chapters of Mineral Resources of the United States; and G. F. Loughlin has been designated as geologist acting in charge of the nonmetals section of the division to assist him. Owing to the death of R. B. Dole the preparation of the report on mineral waters has been assigned to O. E. Meinzer, of the water-resources branch. E. S. Bastin, who has been on leave of absence, has been succeeded by H. G. Ferguson in the preparation of the report on graphite. The reports formerly prepared by W. C. Phalen, who has been transferred to the Bureau of Mines, have been assigned to other geologists already on the staff of the division, except that on sulphur and pyrite, which has been assigned to P. S. Smith.

The reports on the several mineral products were prepared by the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
A. H. Brooks	Gold, silver, and copper in Alaska.
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).
Martha B. Clark	Mineral products of United States (summary) (with H. D. McCaskey).
J. S. Diller	Asbestos; chromite; talc and soapstone.
J. P. Dunlop	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals; metals and ores (summary report); gold and silver (general report) (with H. D. McCaskey).
H. G. Ferguson	Graphite.
H. S. Gale	Borax; magnesite (with C. G. Yale); nitrates.
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines reports).
V. C. Heikes	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines reports).
C. W. Henderson	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines reports).
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	Aluminum and bauxite; barytes; mineral paints; platinum and allied metals; strontium ore; gold, silver, copper, lead, and zinc in the Eastern States (mines report).
F. J. Katz	Abrasives; feldspar; silica (quartz).
C. E. Lesher	Coal; fuel briquetting; the manufacture of coke.
G. F. Loughlin	Building stone; lime; slate.
H. D. McCaskey	Gold and silver (general report) (with J. P. Dunlop); mineral products of the United States (summary report) (with Martha B. Clark); quicksilver.
O. E. Meinzer	Mineral waters.
Jefferson Middleton	Clay-working industries; fuller's earth; sand-lime brick.
J. D. Northrop	Asphalt and bituminous rock; natural gas; petroleum.
C. E. Siebenthal	Lead; zinc and cadmium (general reports).
W. T. Schaller	Gems and precious stones; mica.
P. S. Smith	Sulphur and pyrite.
R. W. Stone	Gypsum; phosphate rock; sand and gravel; salt, bromine, and calcium chloride.
J. S. Turp	Peat.
C. G. Yale	Borax; magnesite (with H. S. Gale); gold, silver, copper, lead, and zinc in California and Oregon (mines report).

The offices of the division at Denver, Salt Lake City, and San Francisco are under direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively, who prepare the mine reports on gold, silver, copper, lead, and zinc in the Western States. They also act in cooperation with other members of the Survey where necessary, both in the field and in the office, and by keeping in close touch with the mining regions of the West they procure and disseminate much valuable information not readily obtained otherwise. These offices are, therefore, general Survey headquarters and bureaus of information in their respective regions. The Denver office, at 409 New Post Office Building, prepares the metal-mine reports for South Dakota, Wyoming, Colorado, and New Mexico; the Salt Lake City office, at 312 Post Office Building, covers in the same way the States of Montana, Idaho, Washington, Utah, Nevada, and Arizona; and the San Francisco office, at 305 Customhouse, is the headquarters for California and Oregon.

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, C. H. Birdseye, topographic engineer, in charge.
Northwestern division, T. G. Gerdine, geographer, in charge.
Pacific division, G. R. Davis, geographer, in charge.
Division of military surveys, Glenn S. Smith, topographic engineer, in charge.
Inspector of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

PERSONNEL.

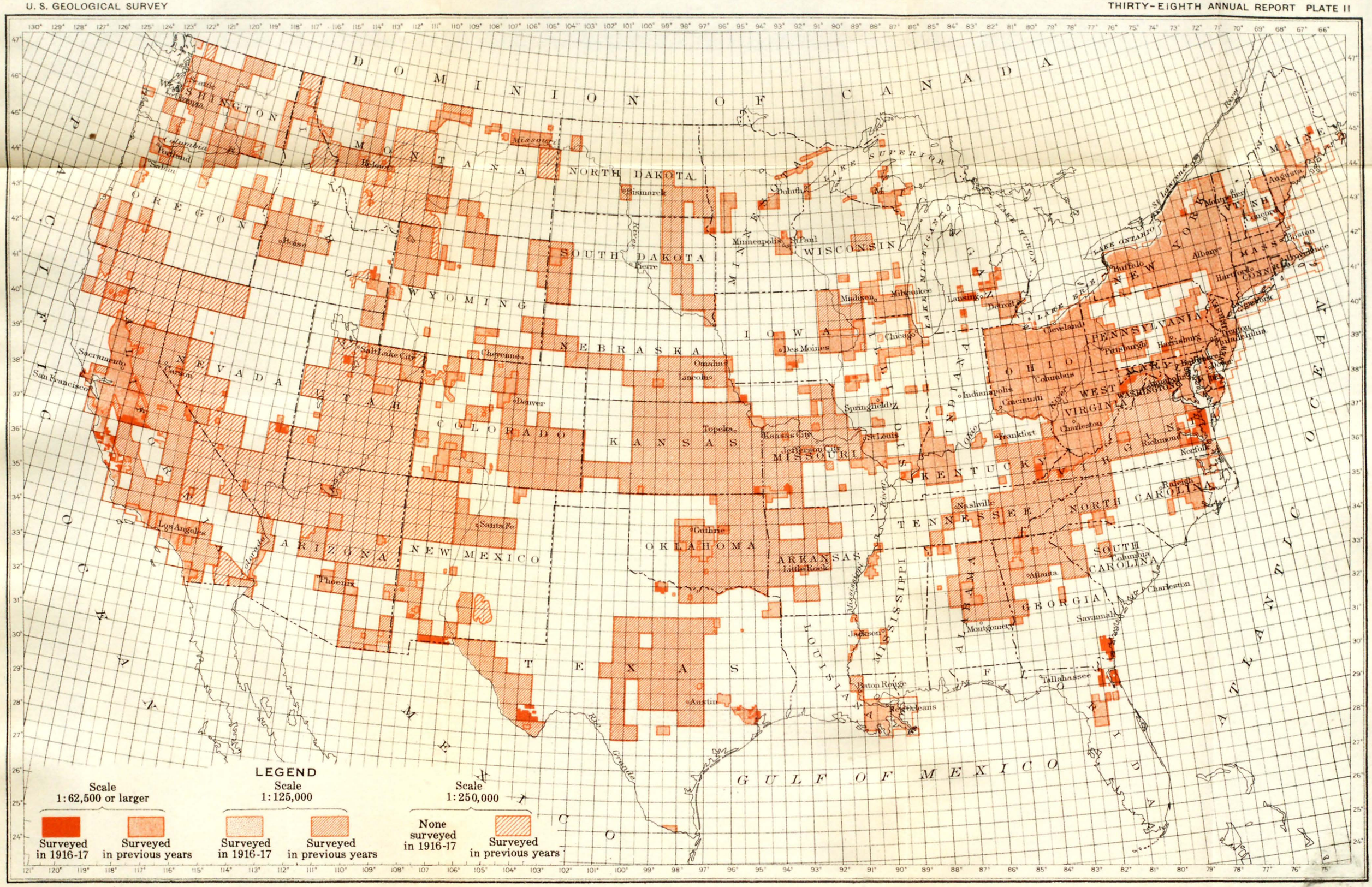
The technical corps of the topographic branch was increased during the year by the reinstatement of two topographic engineers and one junior topographer and by the appointment of 14 junior topographers and the transfer of 1 draftsman, and was reduced 16 by death and resignations. With those changes the corps now includes 1 chief geographer, 8 geographers, 38 topographic engineers, 17 topographers, 41 assistant topographers, 44 junior topographers, and 6 draftsmen—a total of 155. In addition, 40 technical field assistants were employed during the whole or a part of the field season. One topographer, 1 assistant topographer, and 6 junior topographers are on furlough. The clerical force comprises 11 clerks of various grades.

The following members of the topographic branch received commissions in the Engineer Officers' Reserve Corps on or prior to June 30, 1917:

Maj. W. M. Beaman.
Maj. R. H. Chapman.
Maj. W. H. Griffin.
Maj. G. T. Hawkins.
Maj. W. H. Herron.
Maj. J. H. Jennings.
Maj. R. B. Marshall.
Maj. Robert Muldrow.
Maj. A. C. Roberts.
Maj. G. S. Smith.
Maj. Frank Sutton.
Maj. A. M. Walker.
Maj. J. H. Wheat.
Capt. R. W. Berry.
Capt. C. H. Birdseye.
Capt. Basil Duke.
Capt. A. T. Fowler.
Capt. C. E. Giffin.
Capt. Duncan Hannegan.
Capt. H. H. Hodgeson.
Capt. E. I. Ireland.
Capt. B. A. Jenkins.
Capt. C. B. Kendall.
Capt. E. L. McNair.
Capt. W. L. Miller.
Capt. Albert Pike.
Capt. C. L. Sadler.
Capt. A. B. Searle.
Capt. J. G. Staack.
Capt. W. O. Tufts.
First Lieut. J. E. Blackburn.
First Lieut. A. O. Burkland.
First Lieut. J. R. Eakin.
First Lieut. R. T. Evans.
First Lieut. S. P. Floore.
First Lieut. R. A. Kiger.
First Lieut. E. L. Hain.
First Lieut. L. L. Lee.
First Lieut. L. S. Leopold.
First Lieut. T. H. Moncure.
First Lieut. W. H. S. Morey.
First Lieut. O. H. Nelson.
First Lieut. A. J. Ogle.
First Lieut. S. T. Penick.
First Lieut. T. F. Slaughter.
Second Lieut. S. H. Birdseye.
Second Lieut. D. S. Birkett.
Second Lieut. E. C. Burt.
Second Lieut. Howard Clark.
Second Lieut. F. A. Danforth.
Second Lieut. C. H. Davey.
Second Lieut. W. S. Gehres.
Second Lieut. W. F. Hicks.
Second Lieut. R. M. Herrington.
Second Lieut. J. B. Leavitt.
Second Lieut. Kostka Mudd.
Second Lieut. J. M. Rawls.
Second Lieut. L. B. Roberts.
Second Lieut. M. A. Roudabush.
Second Lieut. O. G. Taylor.
Second Lieut. J. H. Wilson.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 85 published maps and 7 bulletins, giving results of spirit leveling in Arkansas, Georgia, Mississippi, North Carolina, New Mexico, South Dakota, and Texas. Brief summaries of the book publications (Bulletins 635, 636, 637, 638, 639, 643, and 646) are given on pages 20, 23 and 24. The remaining 16 parts of Bulletin 644, "Triangulation and primary traverse in the United States, 1913–1915," were published separately and were also combined with the two parts previously published and issued in one volume. A new edition of "Geographic tables and formulas" (Bulletin 650) was published, and the report on spirit leveling in Ohio (Bulletin 651) was practically ready for distribution at the end of the fiscal year. Manuscript for the results of leveling in Nevada, New York, Illinois, Kentucky, and Washington was transmitted for publication.



MAP OF THE UNITED STATES SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS PRIOR TO JULY 1, 1917

AND THE SCALE EMPLOYED FOR EACH AREA

Scale $\frac{1}{14,000,000}$

100 0 100 200 300 400 500 Miles

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1917 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
Special military maps	35,000
	469,200

Allotments of these appropriations were made as follows:

Allotments from funds appropriated for topographic work, fiscal year 1917.

	Topographic surveys, statutory salaries, and special military maps.	Surveying national forests.
General administration	$26,798	$5,250
Clerical assistance and supervision	15,040	3,080
Map editing	3,436	704
Purchase and repair of instruments, stationery, etc.	34,426	3,466
Millionth-scale map	20,000	.....
Work by land-classification board	9,000	2,500
Field work:		
Atlantic division	58,000	.....
Atlantic division, special military maps	35,000	.....
Central division	45,000	.....
Rocky Mountain division	60,000	16,000
Northwestern division	40,000	25,500
Pacific division	47,500	18,500
	394,200	75,000

COOPERATION.

Cooperation has been maintained in 16 States, which contributed the following amounts:

California	$14,000.00	New York	$10,000.00
California, special river surveys	1,000.00	Oregon	1,000.00
Illinois	9,000.00	Texas	9,636.07
Iowa	1,750.00	Vermont	2,500.00
Kentucky	10,000.00	Virginia	4,500.00
Maine	5,000.00	Washington	11,500.00
Michigan	15,000.00	West Virginia	4,304.62
Minnesota	4,250.00	Wisconsin	3,000.00
Missouri [1]	3,000.00		
			109,440.69

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1917, distinguished as to scale, etc., is shown on Plate II.

[1] Agreement was entered into, but the State money did not become available until after the Federal funds were diverted to military mapping.

As shown in the following tables, the total new area mapped was 20,103 square miles, making the total area surveyed to date in the United States 1,257,623 square miles, or 41.5 per cent of the entire country. In addition, 2,377 square miles of resurvey was completed, making the total area of surveys during the year 22,480 square miles.

In connection with these surveys, 6,190 linear miles of primary levels were run, making 266,011 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,512 permanent bench marks were established. In addition, 208 linear miles of river surveys were run.

Triangulation stations to the number of 243 were occupied and 203 were permanently marked. Primary traverse lines aggregating 4,058 miles were run, in connection with which 358 permanent marks were set.

The area covered by topographic surveys in Alaska during the fiscal year, as reported in detail on pages 82–87, was 9,765 square miles.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1916, to June 30, 1917.

	New area mapped July 1, 1916, to June 30, 1917.	Total area mapped to June 30, 1917.	Percentage of total area of State mapped to June 30, 1917.
	Sq. mi.	*Sq. mi.*	
Alabama		19,192	37
Arizona	594	70,136	62
Arkansas		21,494	40
California	2,648	119,618	76
Colorado	530	50,980	49
Connecticut		4,965	100
Delaware	534	1,736	73
District of Columbia		70	100
Florida	1,016	3,355	6
Georgia	1,320	18,907	32
Idaho	942	28,196	33
Illinois	702	15,946	28
Indiana		3,609	10
Iowa	151	11,916	21
Kansas		64,159	78
Kentucky	80	18,094	45
Louisiana		8,366	17
Maine	210	9,975	30
Maryland		12,327	100
Massachusetts		8,266	100
Michigan	1,103	8,198	14
Minnesota	389	7,354	9
Mississippi		2,126	4
Missouri	188	36,913	53
Montana	722	58,511	40
Nebraska	65	26,817	35
Nevada	26	51,141	46
New Hampshire	99	3,479	37
New Jersey		8,224	100
New Mexico	1,469	40,049	33
New York	304	44,663	91
North Carolina		18,390	35
North Dakota		9,814	14
Ohio		41,040	100
Oklahoma	57	39,908	57
Oregon	259	24,662	26
Pennsylvania	228	25,136	56
Rhode Island		1,248	100
South Carolina		5,640	18
South Dakota	139	19,032	25
Tennessee		21,283	50

Present condition of topographic surveys of the United States and new area surveyed July 1, 1916, to June 30, 1917—Continued.

	New area mapped July 1, 1916, to June 30, 1917.	Total area mapped to June 30, 1917.	Percentage of total area of State mapped to June 30, 1917.
	Sq. mi.	*Sq. mi.*	
Texas	1,676	70,976	27
Utah	228	69,025	82
Vermont	67	4,473	47
Virginia	2,004	31,984	75
Washington	1,579	29,325	42
West Virginia	.....	24,170	100
Wisconsin	90	12,692	23
Wyoming	684	30,043	31
Total, United States	20,103	1,257,623	41.5
Hawaii	1,393	.....	.....

SPECIAL MILITARY SURVEYS.

Summary.—The special appropriation of $35,000 which was made by Congress for the War Department for the topographic survey of such areas as it might select was allotted to the Geological Survey and devoted entirely to mapping in Virginia. This work in Virginia was continued and the mapping of other areas was commenced after March 26, under the arrangement that the total available balance of funds in the topographic branch should be used in making maps to meet the urgent needs of the War Department. Under this arrangement surveys were commenced in New Hampshire, Delaware, and Pennsylvania under the direction of Mr. Sutton; in Georgia and Florida under the direction of Mr. Herron; in Texas under the direction of Mr. Birdseye; and in Arizona and New Mexico under the direction of Mr. Gerdine; while in California the mapping in progress at the request of the War Department was continued and that of new areas was undertaken under the direction of Mr. Davis. The mapping of this class accomplished before the end of the fiscal year amounted to —— square miles, and the results are given below by States.

Arizona.—The survey of the United States portion of the Perilla quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, Ariz., and Grant County, N. Mex., was completed by J. E. Blackburn and Cornelius Schnurr, the area mapped being 223 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 13 square miles is within the national forest.

California.—The survey of the Piedras Blancas, Point Sur, and Posts quadrangles, lying partly in the Monterey National Forest, in Monterey and San Luis Obispo counties, was completed, and that of the Jamesburg, Lucia, King City, Junipero Serra, Metz, Gonzales,

San Simeon, Gorda, Bryson, Adelaida, and San Miguel quadrangles, lying partly in the Monterey National Forest, in Monterey, San Benito, and San Luis Obispo counties, was begun by T. P. Pendleton, C. A. Stonesifer, W. B. Upton, jr., N. E. Ballmer, E. G. Hamilton, William Stranahan, C. R. Fisher, Roscoe Reeves, R. C. Seitz, K. W. Trimble, C. P. McKinley, C. A. Ecklund, J. P. Harrison, R. M. Wilson, E. P. Davis, Charles Hartmann, R. T. Evans, W. G. Carson, C. W. H. Nessler, Bruce Jameyson, E. T. Walker, and Fred Rider, the total area mapped being 1,057 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Of this area 153 square miles is included within the national forest. For the control of these areas and of the San Benito, Bonanza, and Hollister quadrangles, in the same counties, R. C. Seitz and L. F. Biggs ran 594 miles of primary levels and established 129 permanent bench marks, and C. F. Urquhart and Mr. Biggs occupied 42 triangulation stations and marked 21. In addition, 79 miles of primary levels were run, and 12 permanent bench marks were set to close other level circuits. In connection with the mapping of the Adelaida and San Miguel quadrangles, Mr. Upton made a plan and profile survey of portions of Salinas, Nacimiento, and San Antonio rivers, the distance traversed being 48 linear miles, for publication on the scale of 1:48,000.

Delaware.—The survey of the Millsboro quadrangle, in Sussex County, was completed, and that of the Harrington, Cedar Creek, and Cape Henlopen quadrangles, in Sussex and Kent counties, was begun by W. H. Griffin, F. W. Crisp, R. A. Kiger, S. P. Floore, A. B. Searle, C. E. Cooke, A. P. Meade, L. B. Glasgow, J. F. McBeth, and J. H. Wilson, the total area mapped being 543 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work includes 9 square miles of resurvey in Caroline County, Md. For the control of these areas Mr. Wilson ran 123 miles of primary traverse and set 8 permanent bench marks, and S. H. Birdseye ran 129 miles of primary levels and established 22 permanent bench marks.

Florida.—The survey of the Lawtey quadrangle, in Baker and Bradford counties, was completed, and that of the Middleburg, Maclenny, Orange Park, Cambon, Jacksonville, Palm Valley, Fernandina, and Mayport quadrangles, in Duval, Baker, Nassau, St. Johns, and Clay counties, was begun by J. H. Jennings, Gilbert Young, Fred Graff, jr., M. A. Roudabush, C. L. Sadler, O. G. Taylor, R. M. Harrington, W. L. Miller, J. B. Leavitt, Horace Raynor, and C. W. Stump, jr., the total area mapped being 1,070 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area 64 square miles is in Charlton County, Ga. For the control of these areas and of the Hilliard, St. Marys, Green Cove

Springs, and St. Augustine quadrangles, in Clay, Duval, Nassau, and St. Johns counties, C. B. Kendall, E. L. McNair, and H. S. Senseney ran 471 miles of primary traverse and set 37 permanent marks, and W. S. Gehres, S. L. Parker, and J. C. Hilliard ran 297 miles of primary levels and set 64 permanent bench marks.

Georgia.—The survey of the Everett City, Bladen, and Hortense quadrangles, in Camden, Charlton, Wayne, and Liberty counties, was completed and that of the Nahunta, Kingsland, Jesup, and Moniac quadrangles, in Camden, Charlton, Wayne and Liberty counties, was begun by Albert Pike, R. L. Harrison, L. L. Lee, J. M. Rawls, C. W. Goodlove, J. A. Duck, T. H. Moncure, F. W. Farnsworth, E. J. Essick, W. F. Hicks, and R. H. Kilmer, the total area mapped being 1,211 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these areas and of the Boulogne, Folkstone, Hinesville, Savannah, Winokur, Ludowici, Limerick, Darien, Offerman, Brunswick, Travisville, Eulonia, Glenville, Waycross, Coffee, Sessoms, Wilcox, Broxton, Leliaton, Fargo, Haylow, Naylor, Valdosta, Sparks, Tifton, and Homerville quadrangles, in Camden, Charlton, Liberty, Chatham, Ware, Pierce, McIntosh, Wayne, Clinch, Echols, Coffee, Jeff Davis, Appling, Glynn, Berrien, and Colquitt counties, Oscar Jones, E. L. McNair, and H. S. Senseney ran 1,164 miles of primary traverse and set 93 permanent bench marks, and R. G. Clinite and Messrs. Hicks and Senseney ran 495 miles of primary levels and established 145 permanent bench marks. Of the primary traverse, 18 miles and 2 permanent marks are in South Carolina.

New Hampshire.—The survey of the Mount Pawtuckaway, Alton, and Gilmanton quadrangles, in Strafford, Rockingham, Belknap, and Merrimack counties, was commenced by Hersey Munroe, L. B. Roberts, A. J. Kavanagh, J. B. Metcalfe, jr., and Robert Muldrow, the total 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 these areas and of the Suncook quadrangle, in Merrimack, Rockingham, and Hillsboro counties, G. T. Hawkins and Mr. Metcalfe occupied 13 triangulation stations and marked 11, and C. H. Semper ran 116 miles of primary levels and established 26 permanent bench marks.

New Mexico.—The survey of the United States portions of the Columbus, Hermanas, Mount Riley, and Camel Mountain quadrangles, in Dona Ana and Luna counties, was completed, and that of the Noria quadrangle, in Dona Ana and Luna counties, was begun by J. E. Blackburn, A. J. Ogle, Bishop Moorhead, C. C. Gardner, F. A. Danforth, J. G. Staack, H. K. McDonald, J. L. Lewis, R. H. Reineck, F. L. Whaley, W. R. Chenoweth, C. E. Giffin, and G. C. Douglas, the total area mapped being 985 square miles, for publication on the scale of 1:62,500, with contour intervals of

10 and 50 feet. For the control of these areas and of the Cancitillo, Ash Springs No. 1, Victorio, and Big Hatchet Peak quadrangles, in Dona Ana and Grant counties, C. L. Nelson, G. T. Hawkins, and B. H. Yoakum occupied 38 triangulation stations and marked 39, and F. A. Danforth, R. B. Steele, and R. W. Burchard ran 437 miles of primary levels and established 125 permanent bench marks.

Pennsylvania.—For the control of the Pocono quadrangle, which includes the artillery range in the vicinity of Tobyhanna, in Monroe and Lackawanna counties, R. H. Chapman and E. C. Burt occupied 6 triangulation stations and marked 3, and Mr. Burt ran 30 miles of primary levels and established 11 permanent bench marks.

Texas.—The survey of the Tascotal Mesa and Agua Fria quadrangles, in Brewster and Presidio counties, was completed and that of the Buck Hill, Jordan Gap, Santiago Peak, and Nine Point Mesa quadrangles, in Brewster County, was begun by A. O. Burkland, S. G. Lunde, R. W. Berry, O. H. Nelson, S. T. Penick, C. C. Holder, H. H. Hodgeson, C. G. Anderson, H. E. Simmons, W. O. Tufts, R. R. Monbeck, and J. R. Eakin, the total area mapped being 983 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet For the control of these areas and of the Hood Spring, Bone Spring, Bullis Gap, and Dove Mountain quadrangles, in Brewster and Presidio counties, Mr. Anderson and J. R. Ellis occupied 10 triangulation stations and marked 8; D. S. Birkett and R. R. Monbeck ran 268 miles of primary levels and established 66 permanent bench marks; and Mr. Burkland established 5 permanent bench marks by vertical angulation.

Virginia.—The survey of the Kilmarnock, Mathews, Urbanna, Heathsville, and Morattico quadrangles and the resurvey of the Ewell quadrangle, in Middlesex, Mathews, Lancaster, Gloucester, King and Queen, Northumberland, and Richmond counties, was completed, and the survey of the Toano, Disputanta, Tappahannock, Charles City, Aylett, and Surry quadrangles, in Charles City, Henrico, New Kent, King and Queen, James City, King William, Caroline, Hanover, Surry, Prince George, and Essex counties was begun by T. F. Slaughter, Albert Pike, L. B. Roberts, W. H. S. Morey, R. L. Harrison, E. I. Ireland, J. B. Metcalfe, jr., C. H. Davey, Klett McKinley, J. I. Gayetty, J. A. Duck, S. H. Birdseye, S. T. Penick, J. M. Whitman, Duncan Hannegan, F. W. Hughes, Kostka Mudd, W. J. Lloyd, Fred McLaughlin, A. T. Fowler, Olinus Smith, C. S. Wells, J. H. Wilke, and P. W. McMillen, the total new area surveyed being 2,004 square miles and that resurveyed being 17 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. Of the area resurveyed 9 square miles is in Somerset County, Md. For the control of these areas E. L. McNair, J. H. Wilson, and Olinus Smith ran 721 miles of primary traverse and set 63 permanent marks,

and F. J. McMaugh, F. L. Shalibo, DeWitt McLaughlin, E. E. Harris, Stanley Druhot, Kostka Mudd, and S. R. Archer ran 1,009 miles of primary levels and established 234 permanent bench marks.

GENERAL OFFICE WORK.

Results of computations for vertical and horizontal control were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, D. S. Birkett, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, E. L. McNair, J. B. Metcalfe, jr., C. L. Nelson, H. S. Senseney, J. G. Staack, S. G. Lunde, S. R. Archer, and J. H. Wilson, 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 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 the year in preparing relief maps of the United States, of Salem, Oreg., and vicinity, and of the State of Ohio and in revising the relief map of Alaska.

The preparation of the special topographic maps to be used in the transcontinental guidebooks was continued by A. C. Roberts and R. C. McKinney. The different railroads supplied all available profile and alinement data and rendered other valuable assistance.

INSPECTION OF TOPOGRAPHIC MAPPING.

W. M. Beaman continued the supervision of the field and office work on the map of Washington and vicinity, spent three months inspecting field work in the Rocky Mountain, Northwestern, and Pacific divisions, and two months in revision work in Arizona. A. M. Walker spent three months in the field inspection of work in the Atlantic, Central, and Rocky Mountain divisions. The office duties of Messrs. Beaman and Walker covered the supervision of the preparation of all topographic field sheets for engraving and photolithography. In the examination of sheets prior to their transmission they were assisted throughout the year by L. S. Leopold.

J. H. Renshawe spent the entire year in the office on special work in relief shading, as reported in detail above.

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 Idaho (parts of sheets K–11, K–12, L–11, L–12, and M–11) was completed. About 10,000 additional square miles of the base map of

Colorado (part of sheet J–13) was compiled. The mapping of the Coastal Plain area of Texas, between Brazos River and the Rio Grande, was 90 per cent completed, and the base maps of South Carolina and Minnesota were revised. Four base maps of areas in the vicinity of Saypo, Billings, Bozeman, and Bowdoin, Mont., and one of Clarke, Choctaw, and Washington counties, Ala., were prepared for the geologic branch.

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the year topographic mapping was carried on in Delaware, Florida, Georgia, Maine, Mississippi, New York, New Hampshire, Pennsylvania, Vermont, Virginia, and West Virginia. This work included the completion of the survey of 15 quadrangles and of the resurvey of 2 quadrangles, in addition to which 31 quadrangles were partly surveyed and 2 were partly resurveyed.

Primary triangulation and primary traverse were carried on by nine parties in Delaware, Florida, Georgia, Maine, New Hampshire, New York, Pennsylvania, Vermont, and Virginia.

Topographic surveys in Atlantic division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Primary levels.		Primary traverse.		Triangulation stations.	
		1:62,500		1:21,120		Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
		New.	Resurvey.	New.							
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Delaware	10, 20	534	.....	.....	534	129	22	123	8	.....	.....
Florida	10	1,016	.....	.....	1,016	297	64	471	37	.....	.....
Georgia	10	1,320	.....	.....	1,320	494	145	1,146	91	.....	.....
Maine	20	210	106	.....	316	115	28	.....	.....	19	24
Maryland	10	.....	18	.....	18	.....	.....	.....	.....	.....	.....
New Hampshire	20	99	136	.....	235	132	29	.....	.....	13	11
New York	20	214	.....	90	304	45	11	185	26	.....	.....
Pennsylvania	20	228	.....	.....	228	91	32	.....	.....	6	3
South Carolina	.....	.....	.....	.....	.....	.....	.....	18	2	.....	.....
Vermont	20	67	.....	.....	67	53	16	.....	.....	9	9
Virginia	10, 50	2,004	332	.....	2,336	1,062	249	721	63	.....	.....
West Virginia	50	.....	412	.....	412	88	23	.....	.....	.....	.....
		5,692	1,004	90	6,786	2,506	619	2,664	227	47	47

Maine.—For the continuation of cooperative topographic surveys the Public Utilities Commission allotted $5,000 and the United States Geological Survey allotted an equal amount. The survey of the Winn quadrangle, in Penobscot County, was completed by W. H. Griffin, J. B. Metcalfe, jr., and C. W. Arnold, the total area mapped being 210 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Winn and Seboeis quadrangles, in Penobscot County, J. C. Beam ran 90 miles of primary levels and established 21 permanent bench marks. For the control of the Millinocket and Mattewamkeag quadrangles, in Penob-

scot County, and of the Brooks and Burnham quadrangles, in Waldo, Somerset, and Kennebec counties, Oscar Jones occupied 19 triangulation stations and marked 24.

Maine and New Hampshire.—The resurvey of the Dover quadrangle, in York County, Maine, and Rockingham and Strafford counties, N. H., was completed by Hersey Munroe, and that of the York quadrangle, in the same counties, was continued by J. H. Wheat, W. H. Griffin, C. W. Arnold, and Robert Muldrow, the total area mapped being 242 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area 106 square miles is in Maine. For the control of these areas C. W. Arnold and C. H. Stewart ran 41 miles of primary levels and established 10 permanent bench marks, of which 25 miles and 7 marks were in Maine.

New York.—For the continuation of cooperative topographic surveys the State engineer and surveyor allotted $10,000 and the United States Geological Survey an equal amount. The survey of the Oswegatchie quadrangle, in Herkimer, Lewis, and St. Lawrence counties, was completed and that of the Cranberry Lake quadrangle, in the same counties, was continued by W. J. Lloyd, A. P. Meade, J. M. Whitman, and G. H. Guerdrum, the total area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Andes quadrangle, in Delaware, Sullivan, and Ulster counties, F. J. McMaugh ran 22 miles of primary traverse and set 5 permanent marks. For the control of the Cranberry Lake, Stark, Nicholville, Childwood, and Rathbone quadrangles, in Hamilton, Herkimer, St. Lawrence, Franklin, and Steuben counties, C. B. Kendall ran 116 miles of primary traverse, set 21 permanent marks, and occupied 37 secondary triangulation stations along the lake shore, and K. E. Schlachter and F. L. Shalibo ran 45 miles of primary levels and established 11 permanent bench marks.

In addition to the cooperative work in New York, a survey of an area, including the Plattsburg training camp, in Clinton County, was made for the use of the United States Army by C. E. Cooke, F. W. Crisp, and E. W. Bowler, the area mapped being 90 square miles, for publication on the scale of 3 inches to 1 mile, with a contour interval of 5 feet. For the control of this area Mr. Crisp ran 47 miles of primary traverse.

Pennsylvania.—The survey of the Newville quadrangle, in Cumberland, Adams, Perry, and Franklin counties, was completed by Duncan Hannegan, R. A. Kiger, and C. H. Davey, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area DeWitt McLaughlin ran 51 miles of primary levels and established 21 permanent bench marks.

Vermont.—For the continuation of cooperative topographic surveys the governor of Vermont allotted $2,500 and the United States Geological Survey an equal amount. The survey of the Waitsfield quadrangle, in Addison and Washington counties, was commenced by W. H. S. Morey and K. E. Schlachter, the area mapped being 67 square miles for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Waitsfield, Bolton, Montpelier, Northfield, Hyde Park, and Barre quadrangles, in Washington, Lamoille, Addison, and Orange counties, Oscar Jones and C. B. Kendall occupied and marked 9 primary triangulation stations, and for the control of the Waitsfield quadrangle Mr. Schlachter ran 53 miles of primary levels and established 16 permanent bench marks.

Virginia.—For the continuation of cooperative topographic surveys the State geologist allotted $4,500 and the United States Geological Survey an equal amount. The resurvey of the Wise quadrangle and that of the coal area within the Coeburn quadrangle, in Russell, Wise, and Scott counties, was completed by Fred McLaughlin, T. F. Slaughter, Kostka Mudd, and J. B. Leavitt, the total area mapped being 324 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. McLaughlin ran 53 miles of primary levels and established 15 permanent bench marks.

West Virginia.—For the continuation of cooperative topographic surveys the State geologist allotted $4,304.62 and the United States Geological Survey allotted $2,000. A resurvey of the portions of the Davis, Elk Garden, Onego, Keyser, and Horton quadrangles lying in Mineral and Tucker counties was completed by E. I. Ireland, J. I. Gayetty, and Klett McKinley, the total area mapped being 412 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area E. E. Harris ran 76 miles of primary levels and established 20 permanent bench marks. For the control of the Piedmont quadrangle, in Tucker, Mineral, and Grant counties, K. F. Maxcy ran 12 miles of primary levels and established 3 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Black Lake, Ga.; Winn, Maine; Dover, Maine-N. H.; Oswegatchie and Plattsburg training camp, N. Y.; Newville, Pa.; Kilmarnock, Mathews, Urbanna, Heathsville, Ewell, and Morattico, Va.

Progress in the drafting of additional sheets was made as follows: York, Maine-N. H., 40 per cent; Memphis, Tenn.-Ark., 70 per cent; Waitsfield, Vt., 15 per cent; Coeburn, Va., 43 per cent; Davis, W. Va., 58 per cent; Elk Garden, W. Va., 5 per cent; Keyser, W. Va., 25 per cent.

Primary-level circuits were adjusted for the following quadrangles: Black Lake, Ga.; Seboeis, Winn, and York, Maine; Dover, N. H.; Childwold, Cranberry Lake, Plattsburg, Potsdam, Rathbone, and Stark, N. Y.; Newville, Pa.; Charles City, Kilmarnock, Heathsville, Mathews, Morattico, Surry, Disputanta, Tappahannock, Toano, and Urbanna, Va.; Waitsfield, Vt.; Davis, Elk Garden, and Keyser, W. Va.

Geographic positions were computed for the following quadrangles: Cedar Creek, Harrington, Rehoboth, and Millsboro, Del.; Cambon, Hilliard, Ates Creek, Boulogne, Green Cove Springs, Kingsland, Middleburg, Orange Park, St. Marys, Jacksonville, Lawtey, and Maclenny, Fla.; Black Lake, Eulonia, Griswoldville, Hinesville, Jesup, Limerick, Ludowici, Maclenny, Ossabaw Island, Moniac, Bladen, Nahunta, Glennville, and Savannah, Ga.; Brooks, Burnham, Mattawamkeag, Millinocket, and Seboeis, Maine; Andes, Childwold, Cranberry Lake, Nicholville, Plattsburg, Stark, and Tupper Lake, N. Y.; Aylett, Charles City, Disputanta, Doswell, Heathsville, King William, Montross, New Kent, Piney Point, Morattico, Surry, Tappahannock, Toano, Urbanna, and Williamsburg, Va.; Bolton, Burlington, Montpelier, Northfield, and Waitsfield, Vt.; Davis, Elk Garden, and Keyser, W. Va.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Wisconsin. The work included the completion of the survey of 18 quadrangles and the resurvey of 3 quadrangles, in addition to which 6 quadrangles were partly surveyed.

Primary triangulation and primary traverse were carried on by three parties in Illinois, Kentucky, Michigan, and Wisconsin.

Topographic surveys in central division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of 1:62,500.		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation stations.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Illinois	20	702	30	732	122	29	163	7	.....	.....
Iowa	20	151	.....	151	.....	.....	.....	.....	.....	.....
Kentucky	20, 50	80	468	548	61	11	.....	.....	2	1
Michigan	5, 10, 20	1,103	.....	1,103	543	143	376	33	.....	.....
Minnesota	10	191	.....	191	98	22	.....	.....	.....	.....
Missouri	10	25	201	226	24	4	.....	.....	.....	.....
Ohio	.....	.....	.....	.....	148	22	.....	.....	.....	.....
Wisconsin	20	90	.....	90	68	16	77	6	.....	.....
	.....	2,342	699	3,041	1,064	247	616	46	2	1

Illinois.—The governor of Illinois allotted $9,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Vienna, Vermont, Goodhope, La Harpe, and Dixon quadrangles and of the Illinois portion of the Campbell Hill quadrangle, in Johnson, Massac, Pulaski, McDonough, Warren, Henderson, Hancock, Randolph, Lee, and Ogle counties, was completed by J. A. Duck, L. B. Glasgow, M. A. Roudabush, Gilbert Young, L. L. Lee, C. W. Goodlove, Ralph Wilcoxon, R. L. Harrison, and F. W. Hughes, the total area mapped being 702 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Wilmington quadrangle, in Will and Kankakee counties, was completed by Mr. Harrison, the area mapped being 30 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Vermont and Dongola quadrangles, in Fulton, McDonough, Schuyler, Union, Johnson, and Pulaski counties, J. H. Wilson ran 163 miles of primary traverse and set 7 permanent marks. For the control of the Dixon and Oregon quadrangles, in Lee and Ogle counties, H. S. Senseney ran 122 miles of primary levels and established 29 permanent bench marks.

Iowa.—The State Geological Survey allotted $1,750 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Chariton quadrangle, in Lucas and Warren counties, was completed and that of the Attica quadrangle, in Lucas, Monroe, and Marion counties, was begun by W. L. Miller, the total area mapped being 151 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The resurvey of the Harlan and Hyden quadrangles, in Harlan, Leslie, and Perry counties, was completed by J. R. Eakin, F. W. Farnsworth, S. A. Judson, and E. J. Essick, the total area mapped being 468 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the Kentucky portion of the Golconda quadrangle, in Livingston and Crittenden counties, was continued by C. W. Goodlove and W. S. Gehres, the area mapped being 80 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Harlan and Hyden quadrangles S. R. Archer ran 61 miles of primary levels and established 11 permanent bench marks, and E. L. McNair occupied 2 triangulation stations and marked 1.

Michigan.—For the continuation of cooperative topographic surveys the State geologist allotted $15,000 and the United States Geo-

logical Survey allotted an equal amount. The survey of the Elsie, Perrinton, Cedar Springs, Kalamazoo, Ionia, Lowell, Saginaw, Bay City, and Mount Pleasant quadrangles, in Clinton, Shiawassee, Gratiot, Saginaw, Ionia, Montcalm, Kent, Kalamazoo, Allegan, Barry, Eaton, Saginaw, Bay, and Isabella counties, was completed by L. L. Lee, J. G. Staack, Fred Graff, jr., E. L. Hain, S. H. Birdseye, A. B. Searle, Robert Muldrow, A. L. Opdycke, J. H. Jennings, E. C. Burt, C. L. Sadler, A. T. Fowler, and R. M. Harrington, the total area mapped being 1,103 square miles, for publication on the scale of 1:62,500, with contour intervals of 5, 10, and 20 feet. For the control of the Ionia, Lowell, Fenwick, Rives Junction, Big Prairie, Grove, and Springport quadrangles, in Ionia, Montcalm, Jackson, Ingham, Barry, Eaton, Kent, Allegan, Calhoun, Newaygo, and Mecosta counties, E. C. Bisbee and R. G. Clinite ran 543 miles of primary levels and established 143 permanent bench marks. For the control of the White Cloud, Big Prairie, Grove, Smyrna, Howard City, Big Rapids, Hersey, Nirvana, Tustin, Luther, Manton, Mesick, Fife Lake, Kalkaska, Bellaire, Elk Rapids, East Jordan, Torch Lake, Bay Shore, and Inwood quadrangles, in Newaygo, Mecosta, Montcalm, Kent, Osceola, Wexford, Grand Traverse, Kalkaska, Antrim, and Charlevoix counties, J. H. Wilson and H. S. Senseney ran 376 miles of primary traverse and set 33 permanent bench marks.

Minnesota.—The State drainage engineer of Minnesota allotted $4,250 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the St. Francis and Pillager quadrangles, in Anoka, Isanti, Cass, Crow Wing, and Morrison counties, was completed by F. B. Barrett, W. S. Gehres, S. G. Lunde, J. L. Lewis, and J. M. Rawls, the total area mapped being 191 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Belle Prairie and Cushing quadrangles R. G. Clinite ran 98 miles of primary levels and established 22 permanent bench marks.

Missouri.—The State geologist of Missouri allotted $3,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. However, the State funds did not become available, and the work was continued with Federal money alone. The resurvey of the Halltown quadrangle (a portion of which had previously been resurveyed as the Aurora special), in Lawrence, Christian, and Greene counties, was begun, and the resurvey of that portion of the Stotts City and Greenfield quadrangles included within Greene County was completed by F. W. Hughes, the total area resurveyed being 201 square miles, for publication on the scale of 1:62,500, with a contour inter-

val of 10 feet. The survey of the Missouri portion of the Campbell Hill quadrangle, in Perry County, was completed by Gilbert Young and M. A. Roudabush, the area mapped being 25 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Stotts City and Sarcoxie quadrangles, in Lawrence and Jasper counties, F. L. Whaley ran 24 miles of primary levels and established 4 permanent bench marks.

Ohio.—For the purpose of correcting discrepancies that were known to exist in a few scatered bench-mark elevations, S. R. Archer ran 148 miles of primary levels and established 22 permanent bench marks.

Wisconsin.—The State geologist of Wisconsin allotted $3,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount. The survey of the Mazomanie quadrangle, in Iowa, Dane, and Sauk counties, was begun by R. M. Herrington, the area mapped being 90 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. H. Wilson ran 77 miles of primary levels and set 6 permanent marks, and R. G. Clinite ran 68 miles of primary levels and established 16 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Vienna, Goodhope, La Harpe, Dixon, and Wilmington, Ill.; Lynn, Ind.; Chariton, Iowa; Harlan, Nolansburg, and Hyden, Ky.; Elsie, Perrinton, Cedar Springs, Kalamazoo, Ionia, Lowell, Saginaw, Bay City, and Mount Pleasant, Mich.; St. Francis and Pillager, Minn.; Halltown, and Spring City mining district, Mo.; Campbell Hill, Mo.-Ill.; Kelleys Island and Peebles, Ohio; Ripon, Wis.

Progress in the drafting of additional sheets was made as follows: Vermont, Ill., 18 per cent; Attica, Iowa, 55 per cent; Golconda, Ky.-Ill., 65 per cent; Greenfield, Mo., 8 per cent; Mazomanie, Wis., 40 per cent.

Primary-level circuits were adjusted for the following quadrangles: Lynn, Ind.; Dixon, Ill.; Fords Ferry, Golconda, Harlan, Hyden, and Nolansburg, Ky.; Bay City, Big Prairie, Carson City, Cedar Springs, Fenwick, Grove, Ionia, Kalamazoo, Lowell, Mount Pleasant, Muir, Rives Junction, Saginaw, Smyrna, and Springport, Mich.; Carthage, Greenfield, Halltown, Sarcoxie, and Stotts City, Mo.; Belle Prairie and Cushing, Minn.; Beardsley and Peever, Minn.-S. Dak.; Oak Hill, Roxabel, South Charleston, Springfield, Vermilion, and Wellington, Ohio.

Geographic positions were computed for the following quadrangles: Dongola, Jonesboro, Mound City, Thebes, and Vermont, Ill.; Barbourville, Corbin, Harlan, Hyden, Logmont, Middlesboro, and Pineville, Ky.; Bay City, Bay Shore, Bellaire, Big Prairie,

Big Rapids, Elk Rapids, Fife Lake, Grove, Hersey, Howard City, Kalkaska, Luther, Manton, Nirvana, Smyrna, Torch Lake, Tustin, and White Cloud, Mich.; Joplin district, Mo.; Craig, Maitland, Tarkio, and Atchison, Mo.-Kans.-Nebr.; Cross Plains, Denzer, Lone Rock, and Mazomanie, Wis.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, Kansas, Minnesota, Missouri, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. The work included the completion of the survey of 27 quadrangles and the resurvey of 1 quadrangle and 1 special area, in addition to which 15 quadrangles were partly surveyed. Primary traverse and primary triangulations were carried on by four parties in Kansas, Missouri, Nebraska, North Dakota, Oklahoma, New Mexico, Texas, and Wyoming.

Topographic surveys in Rocky Mountain division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of—					Total area surveyed.
		1:125,000 (new).	1:62,500.		1:31,680 (new).	1:24,000 (resurvey).	
			New.	Resurvey.			
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Colorado	50	530	.....	.....	.....	.....	530
Kansas	10	.....	.....	236	.....	.....	236
Minnesota	10	.....	198	.....	.....	.....	198
Missouri	20	.....	163	.....	.....	.....	163
Nebraska	20	.....	65	.....	.....	.....	65
New Mexico	10,50,100	387	985	.....	.....	8	1,380
North Dakota	.....	.....	.....	.....	.....	.....	.....
Oklahoma	25	.....	57	.....	.....	.....	57
South Dakota	10	.....	139	.....	.....	.....	139
Texas	1,5,25	.....	983	.....	693	.....	1,676
Wyoming	100	684	.....	.....	.....	.....	684
	.....	1,601	2,590	236	693	8	5,128

State.	Primary levels.		Primary traverse.		Triangulation stations.	
	Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Miles.		*Miles.*			
Colorado	90	24	.....	.....	.....	.....
Kansas	171	18	6	.....	.....	.....
Minnesota	68	20	.....	.....	.....	.....
Missouri	19	5	55	5	.....	.....
Nebraska	.....	.....	14	.....	.....	.....
New Mexico	519	150	.....	.....	48	53
North Dakota	.....	.....	61	7	.....	.....
Oklahoma	26	5	492	58	.....	.....
South Dakota	5	1	.....	.....	.....	.....
Texas	371	90	.....	.....	14	12
Wyoming	115	30	.....	.....	.....	.....
	1,384	343	628	70	62	65

Colorado.—The survey of the Home and Naturita quadrangles, in Jackson, Larimer, Montrose, and San Miguel counties, was completed by Basil Duke, D. H. Watson, and C. A. Stonesifer, the total area mapped being 438 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The mapping of the Daton Peak quadrangle, in Routt and Moffat counties, was completed by Mr. Duke, the area mapped being 92 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Naturita and Daton Peak quadrangles R. W. Burchard ran 90 miles of primary levels and established 24 permanent bench marks. In connection with the mapping of the Naturita quadrangle Mr. Burchard made a plan and profile survey of portions of San Miguel and Dolores rivers, the distance traversed being 83 linear miles, for publication on the scale of 1:48,000.

Kansas.—The resurvey of the Columbus quadrangle, in Cherokee County, was completed by R. A. Kiger, F. L. Whaley, and R. M. Herrington, the area mapped being 236 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of this area Mr. Whaley ran 171 miles of primary levels and established 18 permanent bench marks.

Missouri-Nebraska.—The survey of the Craig quadrangle, in Holt County, Mo., and Richardson County, Nebr., was completed by C. L. Sadler, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area, 163 square miles is in Missouri. For the control of the Craig quadrangle J. H. Wilson ran 75 miles of primary traverse—55 in Missouri, 14 in Nebraska, and 6 in Kansas—and set 5 permanent bench marks, all in Missouri, and H. S. Senseney ran 19 miles of primary levels and established 5 permanent bench marks, all in Missouri.

Minnesota-South Dakota.—The survey of the Peever and Beardsley quadrangles, in Roberts County, S. Dak., and Traverse and Big Stone counties, Minn., was completed by S. P. Floore and A. J. Kavanagh, the total area mapped being 337 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area, 139 square miles is in South Dakota. For the control of these areas Mr. Kavanagh ran 73 miles of primary levels and established 21 permanent bench marks, 5 miles and 1 bench mark being in South Dakota.

North Dakota.—For the control of the Wilton quadrangle, in Oliver County, J. H. Wilson ran 61 miles of primary traverse and set 7 permanent marks.

New Mexico.—The survey of the Pelona quadrangle, lying partly in the Datil National Forest, in Socorro County, was completed by C. C. Gardner, the area mapped being 387 square miles, for publica-

tion on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 200 square miles is within the national forest. For the control of the Hagerman, Queen, Orange, Carlsbad, Avis, and Hope quadrangles, in Eddy, Otero, Lincoln, and Chaves counties, C. L. Nelson and B. H. Yoakum occupied 9 triangulation stations and marked 13. For the control of the Hagerman quadrangle R. W. Burchard ran 82 miles of primary levels and established 25 permanent bench marks.

The revision of the map of the Tyrone district, in Grant County, was completed by O. G. Taylor, the area covered being 8 square miles.

Oklahoma.—The survey of the Hominy quadrangle, in Osage County, was commenced by C. C. Holder and R. R. Monbeck, the area mapped being 57 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Hominy, Sac and Fox, Mallon, Yale, Skedee, Gray Horse, and Belford quadrangles, in Osage, Okfuskee, Lincoln, Creek, Payne, Pawnee, Kay, and Noble counties, B. H. Yoakum and W. F. Hicks ran 492 miles of primary traverse and set 58 permanent marks. For the control of the Hominy quadrangle Mr. Yoakum ran 26 miles of primary levels and established 5 permanent bench marks.

Texas.—For the completion of the cooperative topographic survey of Harris County the county contributed $9,636.07 and the United States Geological Survey allotted $5,000. The mapping of the Burnett Bay, Fauna, Humble, Crosby, La Porte, and Louetta quadrangles, the City of Houston portions of the Settegast, Houston Heights, Bellaire, and Park Place quadrangles, and the Harris County portions of the Moonshine Hill, Rose Hill, Scott Ranch, Spring, Stuebner, Walley, Weeden, Cedar Bayou, and Morgan Point quadrangles was completed, the total area mapped being 405 square miles, for publication on the scale of 1:31,680, with contour intervals of 1 and 5 feet. This work was done by S. T. Penick, T. P. Pendleton, Olinus Smith, C. A. Stonesifer, W. F. Hicks, B. A. Jenkins, Cornelius Schnurr, C. C. Holder, H. W. Peabody, F. A. Danforth, D. H. Watson, O. H. Nelson, L. B. Roberts, E. R. Bartlett, T. H. Moncure, R. R. Monbeck, J. B. Leavitt, A. J. Ogle, and O. G. Taylor.

In addition to the cooperative work the mapping of the West Wichita Falls, Iowa Park, Fowlkes, Beaver Creek, and Electra quadrangles, in Wichita and Wilbarger counties, was completed by R. W. Berry, E. R. Bartlett, R. R. Monbeck, J. G. Staack, and R. W. Burchard, the total area mapped being 288 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. Monbeck ran 103 miles of primary levels and established 19 permanent bench marks. In connection with the scheme of triangulation in New Mexico C. L. Nelson and B. H.

Yoakum occupied and marked 1 triangulation station for the control of the Guadalupe Peak quadrangle, in El Paso County.

Wyoming.—The mapping of the Afton quadrangle, lying partly in the Wyoming National Forest, in Lincoln County, was continued by J. H. Wilke, Cornelius Schnurr, R. H. Reineck, and A. J. Ogle, the area mapped being 684 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 615 square miles lies within the national forest. For the control of the Afton and Daniel quadrangles, in Lincoln County, D. C. Birkett ran 115 miles of primary levels and established 27 permanent bench marks and Mr. Wilke established 3 permanent bench marks by vertical angles. For the control of the Leo, Hanna, and Saddleback Hills quadrangles, in Carbon County, C. L. Nelson occupied and marked 3 triangulation stations.

OFFICE WORK.

The drafting of the following topographic maps was completed: Home and Daton Peak, Colo.; Columbus, Kans.; Craig, Mo.-Nebr.; Peever and Beardsley, Minn.-S. Dak.; Pelona, Tyrone district, Columbus, and Hermanas, N. Mex.; Aldine, Cedar Bayou, City of Houston, Burnett Bay, Fauna, Humble, Crosby, La Porte, Louetta, Settegast, Satsuma, Houston Heights, Harmaston, Hockley, Huffman, Bellaire, Park Place, Spring, Genoa, Moonshine Hill, Morgan Point, Rose Hill, Scott Ranch, Seabrook, Trinity Bay, Stuebner, Swanson, Walley, Weeden, Waller-Holik-Joseph, West Wichita Falls, Iowa Park, and Electra, Tex.

The drafting of the profile sheets of Dolores and San Miguel rivers, Colo., and Gila River, N. Mex., was 90 per cent completed.

Progress in the drafting of additional sheets was made as follows: Naturita, Colo., 39 per cent; Fowlkes, Tex., 35 per cent; Afton, Wyo., 96 per cent.

Primary-level circuits were adjusted for the following quadrangles: Naturita and Daton Peak, Colo.; Joplin district, Kans.; Hagerman and Roswell, N. Mex.; Hominy, Okla.; Beardsley and Peever, S. Dak.-Minn.; Daniel and Afton, Wyo.

Geographic positions were computed for the following quadrangles: Columbus and Joplin district, Kans.; Atchison, Maitland, Craig, and Tarkio, Kans.-Mo.-Neb.; Washburn and Wilton, N. Dak.; Pelona, N. Mex.; Belford, Claremore, Gray Horse, Hominy, Kaw, Mallon, Pawhuska, Sac and Fox, Skedee, and Yale, Okla.; Brenham, Katy, Liberty, Sealy, and Waller, Tex.; Hanna and Saddleback Hills, Wyo.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Idaho, Montana, Oregon, and Washington. The work included

the completion of the survey of 4 quadrangles, in addition to which 7 quadrangles were partly surveyed. A profile survey was made of two rivers, the distance traversed being 77 linear miles. Primary traverse and primary triangulation were carried on by five parties in Idaho, Montana, Oregon, and Washington.

Topographic surveys in northwestern division from July 1, 1916, to June 30, 1917.

State.	Contour intervals.	For publication on scale of—		Total area surveyed, new.	Primary levels.		Primary traverse.		Triangulation stations.	
		1:125,000	1:62,500		Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Idaho	100	702	240	942	135	50	.....	.....	5	5
Montana	100	722	.....	722	206	58	.....	.....	9	9
Oregon	25, 50, 100	240	19	259	.....	2	.....	.....	25	25
Washington	50, 100	1,579	.....	1,579	129	28	150	15	.....	.....
	.....	3,243	259	3,502	470	138	150	15	39	39

Idaho.—The survey of the Paradise Valley quadrangle, in Bannock, Bingham, and Bonneville counties, was completed and that of the Ozone quadrangle, in the same counties, was begun by C. G. Anderson, the total area mapped being 240 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these quadrangles Mr. Anderson occupied and marked 5 triangulation stations and E. M. Bandli ran 56 miles of primary levels and established 18 permanent bench marks. The survey of the Custer quadrangle, lying partly in the Challis and Sawtooth national forests, in Custer County, was continued by Albert Pike and H. E. Burney, the area mapped being 620 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 550 square miles is included in the national forests. In connection with the mapping of the Custer quadrangle, Mr. Pike made a profile survey of upper Salmon River, the distance traversed being 30 linear miles, for publication on the scale of 1:31,680. For the control of the Custer and Challis quadrangles, in Custer County, Mr. Bandli ran 79 miles of primary levels and established 32 permanent bench marks.

Idaho-Montana.—The mapping of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was completed by J. E. Blackburn, the area mapped being 232 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This area lies entirely within the national forests, 82 square miles being in Idaho.

Montana.—The mapping of the Drummond quadrangle, in Granite, Missoula, and Powell counties, was continued and that of the

Swan Lake quadrangle, lying within the Lewis and Clark, Kootenai, and Cabinet national forests, in Flathead and Missoula counties, was begun by K. W. Trimble, R. C. Seitz, and J. W. Muller, the total area mapped being 572 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 within the national forests. For the control of the Swan Lake quadrangle Mr. Seitz ran 60 miles of primary levels and established 10 permanent bench marks and Mr. Muller established 3 permanent bench marks by vertical angles. For the control of the Huntley, Elso, Fattig, and Flat Willow quadrangles, in Yellowstone, Fergus, and Musselshell counties, G. T. Hawkins occupied and marked 9 triangulation stations and D. S. Birkett ran 146 miles of primary levels and established 45 permanent bench marks. In connection with the mapping of the Swan Lake quadrangle Mr. Muller made a profile survey of the lower part of Swan River, the distance traversed being 47 linear miles, for publication on the scale of 1:48,000.

Oregon.—For the continuation of cooperative topographic surveys the State engineer allotted $1,000 and the United States Geological Survey an equal amount. The mapping of the Oregon portion of the Troutdale quadrangle, in Multnomah County, was completed by Charles Hartmann, the area mapped being 19 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Cline Falls, Heisler, Prineville, and Round Mountain quadrangles, in Crook and Wasco counties, Mr. Hartmann occupied and marked 11 triangulation stations.

In addition to the cooperative work in Oregon, the mapping of the Twickenham quadrangle, lying partly in the Ochoco National Forest, in Wasco, Wheeler, and Crook counties, was continued by A. O. Burkland, the area mapped being 240 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. None of the area mapped is within the national forest. For the control of the Twickenham quadrangle Mr. Burkland established 2 permanent bench marks by vertical angles. For the control of the Diamond Peak, Maiden Peak, Mount Washington, Disston, and McKenzie Bridge quadrangles, in Linn, Lane, Crook, Klamath, and Douglas counties, J. G. Staack and S. G. Lunde occupied and marked 14 triangulation stations.

Washington.—For the continuation of cooperative topographic surveys the Washington State Board of Geological Survey allotted $11,500, and the United States Geological Survey allotted an equal amount. The mapping of the Connell quadrangle, in Adams, Franklin, and Walla Walla counties, was completed, and that of the Walla Walla quadrangle, in Columbia and Walla Walla counties, was continued by Fred Graff, jr., R. H. Reineck, H. L. McDonald, J. L. Lewis, S. G. Lunde, and A. O. Burkland, the total area mapped

being 1,391 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of the Connell, Othello, Wallula, and Red Rock quadrangles, in Franklin, Adams, Walla Walla, and Lincoln counties, D. S. Birkett ran 129 miles of primary levels and established 28 permanent bench marks.

In addition to the cooperative work in Washington, the mapping of the Mount St. Helens quadrangle, lying partly in the Rainier National Forest, in Clarke, Lewis, Cowlitz, and Skamania counties, was completed by J. L. Lewis, the area mapped being 188 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 103 square miles is within the national forest. For the control of the Mount Rainier and Eatonville quadrangles, in Pierce and Lewis counties, G. T. Hawkins ran 150 miles of primary traverse and set 15 permanent marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Paradise Valley, Idaho; St. Regis, Idaho-Mont.; Porcupine Valley, Mont.; Connell and Mount St. Helens, Wash.

The drafting of profile sheets of the following rivers was completed: Upper Salmon, Idaho; lower Swan, Mont.

Progress in the drafting of additional sheets was made as follows: Custer, Idaho, 80 per cent; Drummond, Mont., 67 per cent; Troutdale, Oreg.-Wash., 33 per cent; Twickenham, Oreg., 33 per cent; Walla Walla, Wash., 69 per cent.

Primary-level circuits were adjusted for the following quadrangles: Ammon, Bay Horse, Custer, Cranes Flat, and Shelley, Idaho; Elso, Fattig, Huntley, and Swan Lake, Mont.; Troutdale, Oreg.; Connell, Hicksville, Othello, Priest Rapids, Red Rock, and Wallula, Wash.

Geographic positions were computed for the following quadrangles: Casto, Custer, and Rabbit Foot, Idaho; Fattig, Mont.; Cline Falls, Diamond Peak, Disston, Heisler, McKenzie Bridge, Maiden Peak, Mount Washington, Round Mountain, Prineville, and Wendling, Oreg.; Connell, Eatonville, Mount Rainier, Mount St. Helens, Riparia, and Tacoma, Wash.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work included the completion of the survey of 25 quadrangles and 1 special area and the resurvey of 1 quadrangle and 2 special areas, in addition to which 22 quadrangles were partly surveyed and 1 was partly

resurveyed. In addition, a profile survey was made of portions of three rivers, the distance traversed being 48 linear miles. Primary triangulation was carried on by two parties in Arizona, California, and Nevada.

Topographic surveys in Pacific division from July 1, 1916, to June 30, 1917.

State.	Contour interval.	For publication on scale of—						
		1:125,000 (new).	1:62,500.		1:31,680 (new).	1:24,000.		1:12,000 (resurvey).
			New.	Resurvey.		New.	Resurvey.	
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Arizona	25,100	594					67	8
California	5,25,100	465	1,230		953			
Nevada	25,50			355		26		
New Mexico	100	97						
Utah	50		228					
		1,156	1,458	355	953	26	67	8

State.	Total area surveyed.	Primary levels.		Triangulation stations.	
		Distance run.	Bench marks.	Occupied.	Marked.
	Sq. mi.	*Miles.*			
Arizona	669	55	13	4	3
California	2,648	690	144	80	41
Nevada	381	21	8	9	7
New Mexico	97				
Utah	228				
	4,027	766	165	93	51

Arizona.—The survey of the Chiricahua quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, Ariz., and Grant County, N. Mex., was completed by J. E. Blackburn and Cornelius Schnurr, the area mapped being 468 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 97 square miles is within New Mexico, and 305 square miles within the national forest. The resurvey of the Oatman mining district, in Mohave County, and of Ray and vicinity, in Pinal County, was completed by B. A. Jenkins, D. H. Watson, and W. M. Beaman, the area resurveyed being 67 square miles for publication on the scale of 1:24,000 and 8 square miles for publication on the scale of 1:12,000, with a contour interval of 25 feet. For the control of the Oatman district L. F. Biggs occupied 4 triangulation stations and marked 3 and ran 53 miles of primary levels and established 13 permanent bench marks.

California.—For the continuation of cooperative topographic surveys in California the Department of Engineering allotted $14,000 and the United States Geological Survey an equal amount. In the

continuation of the mapping of San Joaquin Valley the survey of the San Luis Creek, Plainsberg, Lingard, Las Garzas Creek, Bliss Ranch, Chowchilla, Volta, Berendo, Los Banos, Sandy Mush, Kismet, Turner Ranch, Elgin, Daulton, No. 10, and San Luis Ranch 7½-minute quadrangles and of the Indian Gulch 15-minute quadrangle, in Merced, Madera, Stanislaus, Fresno, and Mariposa counties, was completed by N. E. Ballmer, Roscoe Reeves, J. H. LeFeaver, R. M. Wilson, R. T. Evans, C. A. Ecklund, and E. P. Davis, the total area mapped being 1,056 square miles—909 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet, and 147 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the valley work L. F. Biggs occupied 20 triangulation stations and marked 4.

The Department of Engineering allotted an additional $1,000 for special river surveys in San Joaquin Valley. The survey of the Herndon, Friant, Kings River, No. 21, Wahtoke, Sanger, and Bridge quadrangles, in Madera and Fresno counties, was begun by R. T. Evans and C. A. Ecklund, the area mapped being 44 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Wahtoke and Sanger quadrangles Mr. Ecklund ran 17 miles of primary levels and established 3 permanent bench marks.

In addition to the cooperative work in California, the survey of the New Almaden, Double Point, and Point Reyes quadrangles, in Santa Clara, Santa Cruz, and Marin counties, was completed, and that of the Trimmer quadrangle, lying partly in the Sequoia and Sierra national forests, in Fresno and Tulare counties, was begun by C. A. Ecklund, R. T. Evans, J. P. Harrison, and C. P. McKinley, the total area mapped being 491 square miles—465 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 26 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. Of this area 347 square miles lies within the national forests. For the control of the Paynes Creek, Burney, Dixie, and Prattville quadrangles, in Shasta, Lassen, Plumas, and Tehama counties, C. F. Urquhart occupied 18 triangulation stations and marked 16.

Nevada.—The survey of the Rochester mining district, in Humboldt County, was completed by T. P. Pendleton, the area mapped being 26 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The resurvey of the Highland quadrangle, in Lincoln County, was completed, and that of the northwest quarter of the Panaca quadrangle, in the same county, was continued by H. H. Hodgeson and W. B. Upton, jr., the area mapped being 355 square miles, for publication on the scale of 1:62,500, with a con-

tour interval of 50 feet. For the control of the Rochester mining district L. F. Biggs occupied 9 triangulation stations and marked 7 and ran 21 miles of primary levels and established 8 permanent bench marks.

Utah.—The survey of the Stockton quadrangle, in Tooele County, was completed by Gilbert Young and C. R. Fisher, the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

OFFICE WORK.

The drafting of the following topographic maps was completed: Chiricahua and Salt River, Ariz.; Little Table Mountain, Berendo, Bliss Ranch, Lingard, Turner Ranch, Chowchilla, Sandy Mush, Plainsberg, Sulphur Springs, Le Grand, Raynor Creek, Indian Gulch, Kings River, New Almaden, Point Reyes, Double Point, La Grange, Ingomar, Kismet, San Luis Ranch, Merced Falls, Haystack Mountain, San Joaquin River, Point Sur, and Posts, Cal.; Highland and Rochester mining district, Nev.; Goodsprings, Cal.-Nev.; and Stockton, Utah.

Progress in the drafting of additional sheets was made as follows: Verde River, Ariz., 95 per cent; Daulton, Cal., 5 per cent; Elgin, Cal., 40 per cent; Los Banos, Cal., 45 per cent; No. 10, Cal., 40 per cent; Timmer, Cal., 20 per cent; northwest quarter Panaca, Nev., 62 per cent.

Level circuits were adjusted for the following quadrangles: Camp Verde and Kingman, Ariz.; Arroyo Grande, Cayucos, Jamesburg, Los Banos, Paso Robles, Sanger, San Miguel, Point Sur, and Wahtoke, Cal.; Lovelocks and Rochester mining district, Nev.

Geographic positions were computed for the following quadrangles: Oatman mining district, Ariz.; Point Sur, Jamesburg, Lucia, Metz, King City, Bradley, San Miguel, Bryson, San Simeon, Paynes Creek, Burney, Dixie, Prattville, Los Banos, Laguna Seca Ranch, No. 15, Elgin, No. 18, Mendota, No. 10, Sheep Ranch, No. 19, Center School, Firebaugh, Jamison, Dos Palos, No. 23, Kerman, Oxalis, Chaney Ranch, Carrisalito Springs, and Tranquillity, Cal.; Rochester mining district, Nev.

SECTION OF FIELD EQUIPMENT.

The section of field equipment has the custody of all field property, as well as topographic field notebooks and computation books. During the year it indexed and filed 354 triangulation and primary-traverse records and 194 spirit-leveling records. Equipment, consisting of three lathes, one drill press, 1 buffer and grinder, one universal grinder, and a few smaller tools, was ordered for the in-

strument-repair shop. No additions of importance were made to the stock of instruments other than the usual repair parts and supplies. In the distributing shop 159,000 square inches of plates were made, resurfaced, or electrotyped, besides usual repair work.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The organization of the water-resources branch 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.

Division of enlarged stock-raising homesteads, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force of the branch has been reduced 12 by transfers, resignations, and deaths, and has been increased 15 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 4 engineers, 21 assistant engineers, 28 junior engineers, 1 geologist, 2 associate geologists, 1 assistant geologist, 1 geologic aid, 1 assistant chemist, and 1 classifier, a total of 73. Of this number 1 assistant engineer and 2 junior engineers are on furlough, and 1 hydraulic engineer and 3 assistant engineers are employed occasionally.

The following members of the water-resources branch received commissions on or prior to June 30, 1917:

A. H. Davison, Second Lieutenant, Engineer Officers' Reserve Corps.
H. J. Dean, First Lieutenant, Engineer Officers' Reserve Corps.
W. E. Dickinson, Second Lieutenant, Engineer Officers' Reserve Corps.
O. W. Hartwell, First Lieutenant, Engineer Officers' Reserve Corps.
C. C. Jacob, Captain, Engineer Officers' Reserve Corps.
G. K. Larrison, Captain, Artillery, Hawaii National Guard.
C. H. Pierce, First Lieutenant, Engineer Officers' Reserve Corps.

In the clerical force there were 4 separations and 8 accessions, and at the end of the year the force numbered 29.

ALLOTMENTS.

The appropriation for gaging streams 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.

An appropriation of $150,000 for examination of lands under the stock-raising homestead law enacted December 29, 1916, was included

in the sundry civil act approved June 12, 1917, to be immediately available.

The appropriation for gaging streams for the fiscal year was allotted as follows:

Allotments of appropriation for gaging streams (investigation of water resources), 1916–17.

Administrative expenses of the Survey		$12,454
Administrative expenses of the branch		7,100
Computations and reports		17,500
Inspection		1,000
Stream gaging:		
New England States	$4,500	
New York	2,500	
Virginia and Maryland	600	
South Atlantic and Gulf States	4,500	
Texas	4,000	
Ohio Valley	8,000	
Upper Mississippi Valley States	6,500	
Colorado, Wyoming, and New Mexico	7,500	
Montana	4,000	
Utah	4,000	
Nevada	2,500	
Idaho	4,000	
Oregon	4,000	
Washington	4,000	
California	4,000	
Arizona	3,500	
Hawaii	4,500	
		72,600
Investigation of ground waters, including quality of waters		21,200
Land classification board		11,000
Water-power investigations		7,000
Contingent		146
		$150,000

Of the total appropriation, 62 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		$175
Arizona		4,040
California:		
State engineer	$8,280	
State water commission	6,835	
City of San Francisco	4,380	
		19,495

Colorado		$530
Connecticut		770
Hawaii		16,000
Illinois		2,580
Iowa		500
Kansas		1,000
Kentucky		420
Maine		5,640
Massachusetts		2,370
Minnesota		2,470
Mississippi		550
Montana		2,760
Nevada		1,980
New York:		
State engineer	$1,500	
Conservation commission	9,835	
		11,335
North Dakota		300
Oregon		5,700
Texas		10,295
Utah		5,180
Vermont		1,245
Washington		6,230
Wisconsin		5,970
Wyoming		4,895

The work done under cooperative agreements with the States has been restricted to studies of stream flow except in California, Connecticut, Arizona, Montana, and Hawaii.

In California investigations of ground waters were continued in San Jacinto, Salinas, and Santa Clara valleys and in San Diego County, and measurements of depth to ground-water level were made in the southern part of the State.

The report on ground water in Sacramento Valley, work on which has been in progress for several years, was practically completed, and the report on the San Jacinto and Temecula basins and a special report on floods in southern California in January and February, 1916 (Water-Supply Paper 426), were submitted for publication.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii measurements of streams were supplemented by measurements of precipitation and studies of the loss of water in irrigation canals.

A compilation of stream-flow records in Massachusetts, which was in press at the beginning of the fiscal year, was issued as Water-Supply Paper 415, and a similar compilation of stream-flow records in Vermont is in press as Water-Supply Paper 424.

Investigations of ground water in Arizona were continued as in previous years in cooperation with the Agricultural Experiment Station, analyses of water being made at the experiment station.

An investigation of ground waters in Montana, begun in 1916 in cooperation with the State engineer, who collected well records throughout the State, and with the State Board of Health and Montana State College, at the chemical laboratory of which analyses of water were made, was also continued.

Reclamation Service.—The measurement of streams that are to furnish water to reclamation projects under construction has been continued in cooperation with the United States Reclamation Service. The field work is done by Survey engineers who are employed in the locality, and actual cost is repaid by the Reclamation Service through transfer of funds.

The Survey also continued to assist the Reclamation Service in an investigation undertaken to obtain a basis for the equitable distribution of the waters of Milk and St. Mary rivers—a work carried on under cooperative agreement with the Canadian Department of the Interior.

Office of Indian Affairs.—In accordance with authorizations by the Office of Indian Affairs, stream gaging was continued on the following Indian reservations: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Quinault, Rosebud, Standing Rock, Warm Springs, and Western Shoshone.

National Park Service.—Streams in the Yosemite, Glacier, and Yellowstone national parks were measured during the year at stations maintained in cooperation with the National Park Service.

War Department.—Stream measurements made in connection with studies of flood control and navigation in the Ohio River basin have been continued in cooperation with the Corps of Engineers, United States Army.

Reports on both surface and ground waters available for use at cantonments and other sites of military importance were prepared and submitted to the War Department.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, in cooperation with the Forest Service, was continued.

City of San Francisco.—In connection with the proposed storage of the water of Tuolumne River in Hetch Hetchy Valley as a water supply for the city of San Francisco, measurement of that stream was continued in cooperation with the city government.

City of San Diego.—An investigation of the ground water in the part of San Diego County lying west of the divide was nearly completed. In this work the San Diego city government cooperated.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprise 25 reports and 5 separate chapters. Titles and brief summaries of these publications are given on pages 26–30. At the

end of the year 22 other reports were in press and 8 manuscripts were awaiting editorial examination.

GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained gaging stations for measuring discharge of streams in 41 States and in Hawaii and Alaska. The relatively large amount of work now in progress is, however, possible only because of extensive cooperation with States and other Federal organizations. Twenty-four cooperating States (including Hawaii) have contributed more than $110,000 for work in these States, and the Indian Office, Engineer Corps, Reclamation Service, and Forest Service have also cooperated largely in the study of flow of particular streams. The cooperating States include, besides many of the northern and eastern States, all the States in the Great Basin and on the Pacific slope and nearly all those in the Rocky Mountain and western Gulf groups, where water is necessary for irrigating agricultural lands.

Ground-water investigations have been made in 14 States and in Alaska, and five water-supply papers containing the results of such investigations have been published during the year.

Many investigations of ground water or quality of water were under way at the end of the year, but lack of funds prevents an enlargement of the work commensurate with the importance of the subject.

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 are generally incorporated in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers. In includes also special investigations of conditions affecting stream flow and the utilization of streams. In carrying on the work the United States is divided into 17 districts, including Hawaii. One of these districts (Kansas) was established during the year. The following list shows the location of the districts and district offices and gives the names of the engineers:

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: W. E. Hall, Federal Building, Atlanta, Ga.

Ohio River: A. H. Horton, Washington, D. C.

Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffices, Old Capitol Building, St. Paul, Minn.; Federal Building, Chicago, Ill.

Kansas: R. C. Rice, Federal Building, Topeka, Kans.

Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.

Rocky Mountain: Robert Follansbee, New Post Office Building, Denver, Colo.

Great Basin: C. C. Jacob, Federal Building, Salt Lake City, Utah.

Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.

Washington: G. L. Parker, Federal Building, Tacoma, Wash.

Oregon: F. F. Henshaw, Couch Building, Portland, Oreg.

California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.

Arizona: C. E. Ellsworth, Fleming Building, Phoenix, Ariz.

Texas: G. A. Gray, Old Post Office Building, Austin, Tex.

Hawaii: G. K. Larrison, Kapiolani Building, Honolulu, Hawaii.

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 1,178 gaging stations were being maintained, including 92 in Hawaii. During the year 259 stations were discontinued and 144 stations established. In addition records ready for publication were received for about 150 stations from other Government bureaus and private persons. During the year 7,769 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or individuals.

Gaging stations and cooperating parties for the year ended June 30, 1917.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Service.	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	.....	.....	6	.....
Arizona	....	1	....	6	2	....	....	18	....	2	5	24	3	2	266	61
California	....	....	29	2	....	2	6	151	23	42	104	151	21	17	1,207	379
Colorado	4	3	20	....	....	1	....	14	....	6	1	47	6	6	244	6
Connecticut	....	....	....	....	....	....	....	.....	....	1	.....	1	.....	1	11	.....
Florida	....	....	....	....	....	....	....	.....	....	.....	.....	.....	.....	.....	.....	11
Georgia	2	....	....	....	....	4	....	.....	....	18	2	22	4	3	53	9
Idaho	2	18	2	15	....	1	....	6	....	9	7	46	11	35	323	50
Illinois	....	....	....	....	1	1	....	25	....	1	2	26	3	1	93	1
Indiana	....	....	....	....	....	....	....	.....	....	1	.....	1	.....	1	.....	.....
Iowa	....	....	....	....	....	3	....	14	....	.....	3	14	1	1	42	1
Kansas	....	....	....	....	....	....	....	3	....	.....	.....	3	3	.....	4	.....
Kentucky	....	....	....	....	....	....	....	5	....	.....	.....	5	.....	.....	20	1
Maine	....	....	....	....	....	....	....	16	....	2	2	16	.....	.....	115	.....
Maryland	3	....	....	....	....	....	....	.....	....	.....	.....	3	.....	.....	19	.....
Massachusetts	....	....	....	....	....	....	....	17	....	1	1	17	.....	.....	143	2
Michigan	....	....	....	....	....	....	....	.....	1	1	.....	2	.....	.....	.....	.....
Minnesota	....	....	....	....	1	2	....	29	....	1	4	29	2	3	147	1

Gaging stations and cooperating parties for the year ended June 30, 1917—Continued.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Service.	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.
Montana	8	35	14	7	....	1	....	23	....	1	1	88	8	30	445	10
Nevada	....	2	....	3	....	1	....	34	....	12	18	34	3	11	118	22
New Hampshire	....	....	....	....	....	....	....	....	....	6	.....	6	2	.....	20	2
New Jersey	1	....	....	....	....	....	....	....	....	....	.....	1	.....	.....	1	.....
New Mexico	1	....	....	....	....	....	....	....	....	3	.....	4	.....	3	20	.....
New York	....	....	....	....	1	4	....	48	1	18	24	48	7	10	431	16
North Carolina	1	....	....	....	....	1	....	....	....	3	.....	5	.....	4	21	.....
North Dakota	....	....	....	1	....	....	....	5	....	....	.....	6	.....	.....	30	.....
Ohio	1	....	....	....	2	....	....	....	....	....	.....	3	.....	3	2	.....
Oklahoma	....	4	....	....	....	....	....	....	....	....	.....	4	.....	.....	2	.....
Oregon	....	4	3	9	....	2	1	15	18	54	.....	106	25	38	286	81
Rhode Island	....	....	....	....	....	....	....	....	....	....	.....	.....	.....	1	4	.....
South Carolina	....	....	....	....	....	....	1	....	....	....	.....	1	.....	.....	3	.....
South Dakota	....	....	....	4	....	....	....	....	....	1	.....	5	.....	.....	29	2
Tennessee	....	....	....	....	....	2	....	....	....	6	.....	8	1	1	40	4
Texas	....	1	....	....	....	4	....	39	4	2	11	39	7	1	367	16
Utah	....	2	....	5	....	....	....	118	....	89	96	118	17	23	881	122
Vermont	....	....	....	....	....	....	....	9	....	4	4	9	.....	.....	37	2
Virginia	2	....	....	....	....	1	....	....	....	2	.....	5	.....	5	25	1
Washington	3	1	8	13	....	....	1	7	2	30	1	64	6	3	360	63
West Virginia	8	....	....	....	6	1	....	....	....	2	.....	17	.....	25	52	2
Wisconsin	....	....	....	2	2	....	....	45	1	11	16	45	4	3	229	5
Wyoming	....	5	2	....	....	1	3	49	....	1	3	58	3	13	220	5
Hawaii	....	....	....	....	2	....	....	92	....	45	47	92	7	15	542	45
	36	76	78	67	18	32	12	786	50	375	352	1,178	144	259	6,849	920

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 through annual conference of the engineers the work in the several districts is further standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, 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; since 1914 the reports for the twelfth division have been published as three papers.

In addition to the progress reports, special reports on various hydraulic subjects have been completed for publication during the year.

The following table shows the division into drainage areas and gives numbers of water-supply papers containing results of stream measurements for 1899–1917:

Numbers of water-supply papers containing results of stream measurements, 1899–1917.

Year.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
												North Pacific slope basins.		
	North Atlantic slope (St. John River to York River).	South Atlantic and eastern Gulf of Mexico (James River to the Mississippi).	Ohio River.	St. Lawrence River and Great Lakes.	Hudson Bay and upper Mississippi River.	Missouri River.	Lower Mississippi River.	Western Gulf of Mexico.	Colorado River.	Great Basin.	Pacific slope in California.	Pacific slope in Washington and upper Columbia River.	Snake River basin.	Lower Columbia River and Pacific slope in Oregon.
1899 [a]	35	[b] 35, 36	36	36	36	[c] 36, 37	37	37	[d] 37, 38	38, [e] 39	38, [f] 39	38	38	38
1900 [g]	47, [h] 48	48	48, [i] 49	49	49	49, [j] 50	50	50	50	51	51	51	51	51
1901	65, 75	65, 75	65, 75	65, 75	[k] 65, 66, 75	66, 75	[k] 65, 66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75	66, 75
1902	82	[b] 82, 83	83	[l] 82, 83	[k] 83, 85	84	[k] 83, 84	84	85	85	85	85	85	85
1903	97	[b] 97, 98	98	97	[k] 98, 99, [m] 100	99	[k] 98, 99	99	100	100	100	100	100	100
1904	[n] 124, [o] 125, [p] 126	[p] 126, 127	128	129	[k] 128, 130	130, [q] 131	[k] 128, 131	132	133	133, [r] 134	134	135	135	135
1905	[n] 165, [o] 166, [p] 167	[p] 167, 168	169	170	171	172	[k] 179, 173	174	175, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906	[n] 201, [o] 202 [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911	301	302	303	304	305	306	307	308	309	310	311	312	312	312
1912	321	322	323	324	325	326	327	328	329	330	331	332–A	332–B	332–C
1913	351	352	353	354	355	356	357	358	359	360	361	362–A	362–B	362–C
1914	381	382	383	384	385	386	387	388	389	390	391	392	393	394
1915	401	402	403	404	405	406	407	408	409	410	411	412	413	414
1916	431	432	433	434	435	436	437	438	439	440	441	442	443	444
1917	451	452	453	454	455	456	457	458	459	460	461	462	463	464

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Estimates for 1899 in Twenty-first Annual Report, Part IV.
[b] James River only.
[c] Gallatin River.
[d] Green and Gunnison rivers and Grand River above junction with Gunnison.
[e] Mohave River only.
[f] Kings and Kern rivers and south Pacific slope basins.
[g] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52. Estimates for 1900 in Twenty-second Annual Report, Part IV.
[h] Wissahickon and Schuylkill rivers to James River.
[i] Scioto River.
[j] Loup and Platte rivers near Columbus, Nebr., and all tributaries below junction with Platte.
[k] Tributaries of Mississippi from east.
[l] Lake Ontario and tributaries to St. Lawrence River proper.
[m] Hudson Bay only.
[n] New England rivers only.
[o] Hudson River to Delaware River, inclusive.
[p] Susquehanna River to Yadkin River, inclusive.
[q] Platte and Kansas rivers.
[r] Great Basin in California except Truckee and Carson river basins.
[s] Below junction with Gila.
[t] Rogue, Umpqua, and Siletz rivers only.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The work of the division of ground waters comprises investigations of the occurrence and quality of waters below the surface of the ground and of methods of recovering and utilizing such waters. Most of the work has been done in the arid and semiarid States of the West, where interest in irrigation with ground water is great and where prospects for considerable increase in areas thus irrigated are favorable.

Nearly 40 investigations of ground water or quality of water (including the reports in press) were in progress in the course of the year, covering areas in Alaska, Arizona, California, Connecticut, Mississippi, Montana, Nebraska, Nevada, New Mexico, South Carolina, South Dakota, Texas, Utah, Washington, and Wyoming. Of these investigations six were conducted in cooperation with the geologic branch of this Survey, one was made for the War Department, one for the Department of Justice, one for the United States Indian Office, and 19 were made in cooperation with State organizations, including two geological and natural history surveys, two departments of engineering, two experiment stations, one agricultural college, and one board of health.

During the year the division suffered a severe loss in the death of R. B. Dole, whose thorough and extensive work on the quality of the natural waters of the United States during his 14 years of service on the Geological Survey constitutes an eminent contribution to science and a production of great economic value to the entire country. The comprehensive paper which he was preparing on the chemical composition of the surface waters of the United States remains unfinished, but it is to be completed by other workers and eventually to be published as a professional paper. A. A. Chambers has been placed in charge of the investigations of the quality of water.

In connection with preparations for war a comprehensive digest of information relating to the water supplies available for use at military camps near the border of the United States, except the Canadian border, was prepared in cooperation with the section of Coastal Plain investigations of the geologic branch and was submitted to the War Department.

A bibliography of the publications of the United States Geological Survey relating to ground water, with brief abstracts, detailed index, and map, was prepared by O. E. Meinzer and is to be published as a water-supply paper. Work was also begun by Mr. Meinzer on a comprehensive treatise on ground water and on an elaborate report on the geology and water resources of the desert valleys of the western United States.

A paper entitled "The divining rod, a history of water witching, with a bibliography," by A. J. Ellis, was published as Water-Supply Paper 416. The chapter on the production of mineral waters for the annual volume, Mineral Resources of the United States, also was prepared by Mr. Ellis.

The analytical work in connection with studies of oceanography, begun in a previous year, was continued by A. A. Chambers. A brief report was prepared by Mr. Chambers on the mineral waters of the United States as compared with those formerly imported from Europe. A paper on the classification of springs was prepared by Kirk Bryan and will be published as part of the "Contributions to hydrology."

As in previous years the maps and manuscripts for geologic folios were reviewed so far as they relate to ground water.

Meetings of the Ground-Water Club for professional study and discussion were held biweekly during the winter and spring.

WORK BY STATES.

Alaska.—The report on the mineral springs of Alaska, by G. A. Waring, with a chapter on the quality of the water by R. B. Dole and A. A. Chambers, was submitted for publication as Water-Supply Paper 418. Analyses of Alaska surface waters have also been made by Mr. Chambers, and a report on these is in preparation.

Arizona.—The report on "The Navajo country, a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah," by H. E. Gregory, was published as Water-Supply Paper 380. A brief report on ground water in an area west of Little Colorado River is being prepared by Prof. Gregory. Both reports are based on investigations made in previous years through financial cooperation by the Office of Indian Affairs.

A report by A. T. Schwennesen on the artesian and other ground waters in San Simon Valley, with special reference to their use for irrigation, was published as Water-Supply Paper 425–A. A comprehensive report on ground water in San Bernardino and San Simon valleys and in Gila Valley above San Carlos is being prepared. Through cooperation with the Arizona Agricultural Experiment Station the water analyses in connection with these investigations were made by A. E. Vinson, of the experiment station staff.

Near the end of the fiscal year plans were made for a comprehensive survey of desert watering places and conditions affecting the occurrence of ground water in that part of Arizona lying west of Tucson and south of Phoenix and Parker. Kirk Bryan and C. P. Ross were assigned to this project.

California.—The report on ground water in the San Jacinto and Temecula basins, Cal., was completed by G. A. Waring and is to be published as a water-supply paper.

A detailed report on the ground water in the part of San Diego County lying west of the divide, by A. J. Ellis and C. H. Lee, was nearly completed. The analytical work for this investigation was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

Some work was done on the final report on Sacramento Valley by Kirk Bryan, but the completion of this paper was delayed through the author's duties in connection with Yale University.

A report on ground water in the Morgan Hill area of Santa Clara Valley, by W. O. Clark, was completed and published as Water-Supply Paper 400–E. The final report on the entire Santa Clara Valley was nearly completed by the end of the fiscal year.

Brief investigations of ground water in Mohave Valley and in Ivanpah, Mesquite, and Pahrump valleys were made by G. A. Waring, who practically completed his reports on all these valleys. The analytical work in connection with these investigations was done by S. C. Dinsmore.

An investigation of Salinas Valley was begun by W. O. Clark, and at the end of the fiscal year most of the field work in this area was completed.

Near the end of the year plans were made for a detailed survey of desert watering places and ground-water resources of parts of southeastern California, including Imperial Valley, Colorado Desert, Mohave Desert, and Death Valley. Field work in this region was assigned to D. G. Thompson and J. S. Brown.

Since 1900 measurements of depth to 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 relation 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 is withdrawn in large quantities by evaporation and transpiration. As in the preceding year, these measurements were made by F. C. Ebert.

All the ground-water work in California is done in financial cooperation with the State department of engineering.

Connecticut.—Observations in connection with an investigation of the relations between precipitation, ground-water storage, evaporation, run-off, and quality of water in the Pomperaug Valley, begun in July, 1913, by A. J. Ellis, were continued during the year, and some work was done in compiling the results.

Reports, which will be published as water-supply papers, were also practically completed for the Meriden area, the Southington-Granby area, the Glastonbury area, the Norwalk area, and the Suffield area. The Meriden report is by G. A. Waring; the others by H. S. Palmer. A total of 127 samples of water from the Meriden and Southington-Granby areas were analyzed by Messrs. Dinsmore and Chambers.

All the work in Connecticut was done in cooperation with the State Geological and Natural History Survey and was supervised by H. E. Gregory.

Mississippi.—The investigation of ground water in Mississippi, which was begun in a previous year, was continued in cooperation with the section of Coastal Plain investigations of the geologic branch. (See p. 64.)

A chapter on the water in the Eocene formations was prepared by Mr. Waring, and considerable work was done on a study of the quality of water in the State by Mr. Chambers.

Montana.—The investigation of ground water in Montana, begun in August, 1915, was continued by A. J. Ellis, who nearly completed a report on the entire area south of Yellowstone River. This investigation is carried on in cooperation with State organizations. The chemical analyses are made at the laboratory of the State board of health and the Montana State College, under the supervision of W. M. Cobleigh, director of the laboratory, and records of wells are collected throughout the State by A. W. Mahon, State engineer, in cooperation with W. A. Lamb, district engineer of the United States Geological Survey.

A report by O. E. Meinzer on artesian water in Little Bitterroot Valley, with special reference to its use for irrigation, was published as Water-Supply Paper 400–B. The report contains 10 analyses, made in the laboratory of the State board of health and Montana State College, of water from this valley.

Nebraska.—A report on the ground-water supplies available for irrigation in Lodgepole Valley, Nebr., was prepared by O. E. Meinzer and submitted for publication as Water-Supply Paper 425–B. This paper includes also a section on the cost of pumping for irrigation in western Nebraska, by H. C. Diesem, of the Office of Public Roads and Rural Engineering, Department of Agriculture.

Nevada.—The final report on ground water in Big Smoky, Clayton, and Alkali Spring valleys, by O. E. Meinzer, was published as Water-Supply Paper 423. The water-level measurements begun in 1913 were continued during the year by F. J. Jones.

The investigation of ground water on the Truckee-Carson irrigation project, to determine the cause of the rise of the water levels in

Big Soda and Little Soda lakes, by C. H. Lee and W. O. Clark, was completed, and a report thereon was submitted to the Department of Justice.

An investigation of the ground-water resources of Reese River valley and an adjacent part of Humboldt River valley was made by G. A. Waring, who prepared a report on the area to be published as a part of Water-Supply Paper 425. The area examined by Mr. Waring in Ivanpah, Mesquite, and Pahrump valleys also lies in part in the State of Nevada. Water analyses for both areas were made for the Geological Survey by S. C. Dinsmore at Reno, Nev.

New Mexico.—A report on ground water in the Animas, Playas, Hachita, and San Luis basins, in Grant County, N. Mex., completed by A. T. Schwennesen in the preceding fiscal year, is to be issued as Water-Supply Paper 422. Analyses of water samples and of the water-soluble contents of soil samples from these basins were made by R. F. Hare through cooperation with the New Mexico Agricultural Experiment Station.

The Navajo country, which was investigated by H. E. Gregory, and San Simon Valley, which was investigated by A. T. Schwennesen, lie partly in New Mexico but more largely in Arizona. Reports on both areas were published during the fiscal year.

An investigation to determine the changes produced in the artesian basin in Pecos Valley through developments since 1906, when a preliminary report on the geology and underground waters of the Roswell artesian area by C. A. Fisher (Water-Supply Paper 158) was published, and to devise means for ascertaining and preventing the underground losses of artesian water was made by O. E. Meinzer, who spent about ten days in the field and submitted a manuscript report to the land-classification board.

South Carolina.—Near the end of the fiscal year a survey of the ground-water resources of the Coastal Plain province of South Carolina (see p. 74) was begun in cooperation with the section of Coastal Plain investigations of the geologic branch. Water samples collected in connection with this investigation are being sent to the new water laboratory of the Geological Survey to be analyzed under the direction of Mr. Chambers.

South Dakota.—A report on artesian water in the vicinity of the Black Hills, S. Dak., prepared in the preceding fiscal year by N. H. Darton, is still awaiting publication. This report is a revision of earlier reports on the area by Mr. Darton and includes much new material.

Texas.—The work in Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch. Work was continued in the part of the Texas Coastal Plain not covered

by Water-Supply Paper 335 (Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen), and a comprehensive paper on this area is being prepared.

Utah.—A rapid examination of parts of western Utah was made by G. A. Waring for the purpose of obtaining information for the classification of lands under the enlarged-homestead act. A manuscript report was submitted by Mr. Waring to the land-classification board.

Washington.—Ground-water conditions in Quincy Valley, Wash., including the Moses Lake region, were investigated in the fall of 1916 by A. T. Schwennesen, who prepared a report on the area which will be published as Water-Supply Paper 425–E. This investigation is important because of the need for water to irrigate orchard lands. Twenty samples of water from the area were analyzed by S. C. Dinsmore.

Wyoming.—A report on ground water for irrigation in Lodgepole Valley, which lies partly in Wyoming and partly in Nebraska, was prepared by O. E. Meinzer and is now in press as Water-Supply Paper 425–B.

DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization was continued during the year essentially as described in previous annual reports, except that the force was increased by the transfer from the Salt Lake office of W. E. Dickinson. E. C. La Rue, to whom Mr. Dickinson was assigned as an assistant, and E. C. Murphy, hydraulic engineer, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. Mr. La Rue completed his report on enlarged-homestead petitions near Utah Lake and in the last part of August established headquarters at Portland, Oreg., from which he engaged in office and field examination of lands that will revert to the United States from the grant to the California-Oregon Railroad Co. In connection with this work, Mr. La Rue has submitted a report on the Rogue River basin and begun the preparation of reports on the basins of Willamette and Big Sandy rivers and coast streams. These reports are being prepared for the purpose of determining the value of streams on the railroad-grant lands for the development of power.

Mr. Murphy completed his report on water-power sites in New Mexico and then began an investigation of enlarged-homestead petitions in Montana. During the year he examined lands in the basins of Teton, Marias, Missouri, Sun, Dearborn, and Boulder rivers, and Whitetail and Clancy creeks, along Musselshell River, in the Musselshell irrigation district, in the basin of American Fork, on the Winnett irrigation project, and on the Flat Willow project.

Reports containing the results of work of the division of water utilization published during the year include Water-Supply Papers 395, 396, 417, 419, 420, and 421. Titles and brief summaries of these publications are given on pages 28 and 30.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The funds for the administration of the stock-raising homestead law became available June 12 on the approval of the sundry civil appropriation act, which also provided specifically for the cost of classifying enlarged-homestead lands, an expense that had previously been borne by the general appropriation for investigations of water resources. E. C. Murphy, hydraulic engineer, who had been examining enlarged-homestead lands in Montana, was immediately assigned to field work in Montana under the new law and was still engaged in that work at the end of the fiscal year.

In anticipation of the urgent necessity for a large number of men for field service in classifying lands under the new law, the Civil Service Commission had given a special examination and established a small list of eligibles. Work on the organization of field parties was in progress June 30, but no field work had been done.

LAND-CLASSIFICATION BOARD.

ORGANIZATION AND PERSONNEL.

The land-classification board consists of a division of mineral classification, the work of which pertains to lands valuable for coal, oil, phosphate, and various other minerals, and a division of hydrographic classification, the work of which pertains to irrigation, dry farming, stock raising, and water power. Technical men from other branches of the Survey act in consultation on matters involving important classification. The organization and personnel for the year were as follows:

Chief of branch: W. C. Mendenhall, geologist.

Secretary of the board: Elsie Patterson.

Division of mineral classification: A. R. Schultz, geologist; E. R. Lloyd and E. H. Finch, associate geologists; W. B. Emery, R. W. Howell, and H. S. Palmer, assistant geologists; Howard Clark, junior topographer.

Division of hydrographic classification: Herman Stabler, hydraulic engineer; W. B. Heroy, geologist; R. W. Davenport and R. M. Davis, assistant engineers; W. N. White, assistant classifier; J. F. Deeds, J. G. Mathers, and M. A. Sanchez, junior engineers; C. E. Nordeen, junior topographer.

The permanent force of the board at the end of the year included 6 geologists, 8 engineers, 4 draftsmen, and 24 employees in other grades, a total of 42 persons. There were 15 additions to and 10 separations from the force during the year.

FUNDS.

The allotments from the different appropriations amounted for the year 1917 to $57,120 and were distributed among the general appropriations as follows:

Geologic surveys	$29,720
Topographic and forest surveys	11,500
Gaging streams	11,000
Salaries of scientific assistants and skilled labor	4,900
	57,120

SUMMARY OF WORK OF CLASSIFICATION.

During the year 1,321,989 acres of lands were classified as to their coal character. Of this amount 951,540 acres were classified as non-coal land and 370,449 as coal land. Coal-land withdrawals during the year amounted to 553,233 acres, and coal-land restorations to 1,635,446 acres. The area withdrawn for classification as to coal at the close of the year was 44,853,741 acres.

New withdrawals of probable oil lands amounting to 903,791 acres were made during the year, and areas aggregating 176,311 acres were restored because examination determined that the lands were not favorable for the accumulation of oil. The result of the year's work, therefore, has been an increase of the area of oil reserves from 5,621,160 to 6,348,640 acres. Indian lands to the amount of 42,097 acres were classified as oil lands.

The classification of 2,530,309 acres of land as mineral land because they contain shales from which, it is believed, great quantities of petroleum and by-products may be distilled brings the total area of lands so classified up to 3,992,036 acres. Naval reserves of such oil-shale land aggregating 132,024 acres were established during the year.

Phosphate reserves were decreased by 80 acres during the year, the area withdrawn on June 30, 1917, being 2,506,398 acres.

During the year the Secretary, on the recommendation of the Geological Survey, designated 13,133,851 acres of land as nonirrigable under the enlarged-homestead acts. The designations of 112,807 acres, which were found to have been erroneously designated, were canceled, the result being a net increase in this classification of lands of a little more than 13,000,000 acres during the year. At the end of the year 275,633,861 acres were classified as being not susceptible of irrigation. The number of petitions for such designation available for action during the year was 16,077, of which 8,868 were acted upon; 7,209 were awaiting action at the end of the year.

Withdrawals of lands believed to be available for power sites aggregated 156,353 acres, and restorations of lands previously with-

drawn but found to be without value for power amounted to 79,908 acres. The increase of outstanding withdrawals from 2,352,652 to 2,429,097 acres was the net result of these actions. In pursuance of the enabling act 764,438 acres in Arizona and 201,000 acres in New Mexico were designated as valuable for water power, and 31,765 acres of Oregon & California Railroad grant lands in Oregon were classified as power-site lands.

During the year areas amounting to 11,934 acres were withdrawn as public water reserves and 3,498 acres were eliminated from such reserves. The net increase in lands withdrawn as public watering places was from 193,272 to 201,708 acres.

CORRESPONDENCE.

During the year 25,721 letters were referred to the land-classification board. In addition, some 4,900 copies of correspondence from various bureaus were sent to the board for its information and files. This material is made up largely of copies of General Land Office letters to registers and receivers of local land offices, of reports made by agents of the General Land Office, and of copies of departmental decisions. In the same period 15,362 letters, reports, acknowledgments, and notifications were prepared in the board. For the working days of the year these figures show a daily average of about 85 for the incoming and 51 for the outgoing mail.

PUBLICATIONS.

Bulletin 623, entitled "Petroleum withdrawals and restorations affecting the public domain," was made available to the public in June, 1916. The demand for this report was so large that the entire edition was exhausted in less than four months, and a reprint was ordered in October, 1916. At the same time an appendix to the first edition of this bulletin was printed, covering all the oil withdrawals and restorations made from January 15 to September 30, 1916. A copy of this appendix was mailed to each person who had received a copy of Bulletin 623. The reprint of this bulletin, which includes the appendix, gives true copies of all petroleum withdrawals and restorations, contains chapters on the purpose and history of withdrawals, oil-land law, and orders and correspondence, and is illustrated by nine State maps showing all lands included in withdrawals on September 30, 1916. Additional withdrawals and restorations have been made in some of the States since that date, and lists have been published in Press Bulletin 321 and in a multigraphed circular. It is planned to make future similar actions available to the public in the same manner and by the issue of revised reprints or appendixes to Bulletin 623.

COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey, by 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 Land Office, was continued along the same lines as in 1915–16. The Survey received during the year 3,067 requests from the General Land Office for information as to the mineral character or the relation to water supply of public lands sought, and it furnished such information in 3,651 cases. It also received for consideration 1,372 reports of field examinations by the General Land Office and acted on 1,314 reports of this character.

At the beginning of the year more than 2,000 cases involving the mineral character of lands were pending, and at the end of the year the number was about 500 less. The cases acted upon involving both mineral character and water resources also outnumber the cases received, and the pending cases of this class at the end of the year were about 700 less in number than at the beginning. The total number of cases covered by the cooperative agreement with the General Land Office pending at the end of the year is 1,585, approximately 500 less than at the beginning of the year. Of the pending cases, 486 are concerned only with the mineral character of the land, 24 only with the water resources, and 1,075 with both mineral character and water resources.

During the year numerous applications for classification of lands included in withdrawals were received. A number of requests were sent to the Survey for the reclassification of lands as to mineral or power-site possibilities, and a large number of applications of other types were referred for consideration and report. These are considered in more detail in the sections on hydrographic and mineral classifications.

The following table shows the year's record in the several classes of cooperative cases, including those discussed above and including also requests for the designation of lands under the enlarged-homestead and stock-raising homestead acts and other miscellaneous cases:

General summary of cooperative cases, fiscal year 1916–17.

Class.	Pending July 1, 1916.	Received.	Disposed of.	Pending June 30, 1917.	Gain or loss.
Mineral character only:					
General Land Office requests for information	90	425	455	60	+ 30
General Land Office field-service reports	199	949	722	426	− 227
Applications for classification as to mineral	18	76	56	38	− 20
	307	1,450	1,233	524	− 217
Water resources only:					
General Land Office requests for information	30	22	46	6	+ 24
General Land Office field-service reports	20	24	26	18	+ 2
Cases in national forests	1	24	19	6	− 5
Applications for reclassification as to water resources	12	78	72	18	− 6
Applications for rights of way	98	321	347	72	+ 26
Lists under Carey Act	1	4	5	0	+ 1
Desert-land proofs under irrigation projects	51	87	72	66	− 15
Petitions under enlarged-homestead acts	7,038	9,039	8,868	7,209	− 171
Applications under stock-raising homestead act	1	3,036	34	3,002	−3,002
	7,251	12,635	9,489	10,397	−3,146
Mineral character and water resources:					
General Land Office requests for information	1,465	2,513	2,997	981	+ 484
General Land Office field service reports	194	292	413	73	+ 121
General Land Office requests for information as to water resources, accompanied by field-service reports as to mineral character	67	107	153	21	+ 46
Indian Office requests for information	20	33	45	8	+ 12
	1,746	2,945	3,608	1,083	+ 663
Grand total	9,304	17,030	14,330	12,004	−2,700

MINERAL CLASSIFICATION.

COAL.

Regulations.—The only change that has been made in the regulations governing the classification and valuation of coal lands since their adoption in 1913 occurs in the last part of paragraph 2, which was revoked by a decision of Secretary Lane on February 16, 1915 (43 L. D., 520), 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 2½ or 10 acres. Administration under these regulations has proved the soundness of the principles underlying them, and they furnish what is believed to be a just and reasonable standard for the disposition of public land underlain by coal of any quality or thickness.

Withdrawals and restorations.—The total area of coal-land withdrawals made during the year was 553,233 acres, approximately 84,000 acres less than last year. These withdrawals for the most part affect lands in Arizona not previously known to contain coal and land in Montana within the former Fort Peck Indian Reservation, which had been previously classified as coal land at the minimum price but which were withdrawn pending legislation and later in the year restored to entry at the former coal values. In New Mexico

certain coal lands within the Navajo Indian Reservation that have been reconveyed by the Atchison, Topeka & Santa Fe Railway Co. to the United States Government were withdrawn pending examination and appraisal. Coal lands not hitherto known have been discovered in Arizona, New Mexico, Montana, and Washington and have been withdrawn by Executive order pending detailed examination. Like other recent years, the year has shown a substantial decrease in the area of land included in outstanding withdrawals of coal lands, because, although over 500,000 acres of land has been withdrawn during the year, a much larger area, more than 1,635,000 acres, has been restored as rapidly as field work and classifications have been completed, and the restorations thus effected during the year exceed the withdrawals by more than 1,000,000 acres.

Coal withdrawals and restorations, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Arizona	118,718	67,197	43,970	141,945
California	17,643	.....	.....	17,643
Colorado	4,622,749	.....	119,332	4,503,417
Idaho	338,452	.....	.....	338,452
Montana	11,131,717	464,780	683,928	10,912,569
Nevada	83,833	.....	.....	83,833
New Mexico	5,709,760	20,616	126,482	5,603,894
North Dakota	14,857,342	.....	200,887	14,656,455
Oregon	4,361	.....	.....	4,361
Utah	5,426,730	.....	100,474	5,326,256
Washington	847,255	640	20,702	827,193
Wyoming	2,777,394	.....	339,671	2,437,723
	45,935,954	553,233	1,635,446	44,853,741

Classification.—Examinations made for coal-land classification have resulted in eliminating from withdrawal large areas of noncoal land in Montana, Wyoming, North Dakota, New Mexico, and Colorado and smaller areas in other States, thus continuing the policy of examining and eliminating from withdrawal as rapidly as possible areas of doubtful coal value. In Arizona certain lands within Indian reservations included in former coal withdrawals were restored in order to clear the records.

During the fiscal year more than 370,000 acres have been classified as coal land and more than 951,000 acres as noncoal land, a total classification of 1,321,989 acres. This is considerably less than the results of either of the preceding two years and far below those attained annually prior to that time. The decrease in classified areas within the last three years is due partly to the elimination of the larger noncoal areas from withdrawal and the consequent restriction of field examinations to a detailed study of known coal fields and

partly to a decrease in allotments for coal-land examination on account of increased demands for the examination of other mineral deposits.

In the first of the following tables the classifications made during the year are summarized by States. In the same table the classifications are divided into two groups—reclassifications, which constitute a revision of previous classifications, and new classifications, which comprise the classification of withdrawn areas or areas not previously considered. The sum of these two groups is the total classification. The net increase or decrease in total areas classified in any State, as shown in the last two columns, is obtained directly from the other columns of the table.

Lands classified as coal and noncoal land, fiscal year 1916–17, in acres.

State.	Total classification.			Reclassification.		New classification.		Net increase or decrease in areas classified.	
	Coal.	Noncoal.	Total.	Previous noncoal, now coal.	Previous coal, now noncoal.	Coal.	Noncoal.	Coal.	Noncoal.
Colorado	71,501	105,110	176,611	.....	57,599	71,501	47,511	+ 13,902	+105,110
Montana	73,994	231,742	305,736	52,939	12,807	21,055	218,935	+ 61,187	+178,803
New Mexico	14,109	181,561	195,670	1,962	67,226	12,147	114,335	− 53,117	+179,599
North Dakota	201,427	70	201,497	540	70	200,887	.....	+201,357	− 470
Oregon	.....	40	40	.....	40	.....	.....	− 40	+ 40
Utah	8,938	72,758	81,696	.....	30	8,938	72,728	+ 8,908	+ 72,758
Washington	320	20,228	20,548	.....	.....	320	20,228	+ 320	+ 20,228
Wyoming	160	340,031	340,191	.....	520	160	339,511	− 360	+340,031
	370,449	951,540	1,321,989	55,441	138,292	315,008	813,248	+232,157	+896,099

Classifications of coal and noncoal land, June 30, 1917, in acres.

State.	Classification outstanding July 1, 1916.		Net result of classification, 1916–17.		Classification outstanding June 30, 1917.		
	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	228,502	.....	.....	8,720	228,502	237,222
Colorado	3,348,564	9,250,638	+ 13,902	+105,110	3,362,466	9,355,748	12,718,214
Idaho	2,113	7,936,925	.....	.....	2,113	7,936,925	7,939,038
Montana	5,560,135	21,580,236	+ 61,187	+178,803	5,621,322	21,759,039	27,380,361
Nevada	5,880	2,428	.....	.....	5,880	2,428	8,308
New Mexico	728,214	3,554,103	− 53,117	+179,599	675,097	3,733,702	4,408,799
North Dakota	2,174,635	3,181,325	+201,357	− 470	2,375,992	3,180,855	5,556,847
Oregon	17,164	1,062,055	− 40	+ 40	17,124	1,062,095	1,079,219
South Dakota	250,123	6,956,108	.....	.....	250,123	6,956,108	7,206,231
Utah	1,066,663	3,234,333	+ 8,908	+ 72,758	1,075,571	3,307,091	4,382,662
Washington	148,940	1,562,308	− [a] 320	+ 20,228	148,620	1,582,536	1,731,156
Wyoming	7,623,325	14,941,289	− 360	+340,031	7,622,965	15,281,320	22,904,285
	20,995,191	73,602,780	231,517	+896,099	21,226,708	74,498,879	95,725,587

[a] 640 acres not priced, rewithdrawn; 320 acres coal priced; net, −320 acres.

Area and valuation of coal lands June 30, 1917.

State.	Appraised coal land July 1, 1916.	Coal land appraised 1916–17.		Net result of appraisals, 1916–17.	Total appraised coal land outstanding June 30, 1917.	Total valuation of appraised coal land outstanding June 30, 1917.	Average value per acre.
		Total coal land appraised.	Coal land reclassified as noncoal land and rewithdrawn.				
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*		
Arkansas	60,715	.....	.....	.....	60,715	$1,473,762	$24.20
California	7,720	.....	.....	.....	7,720	585,086	75.70
Colorado	2,863,585	71,501	57,599	+ 13,902	2,877,487	195,091,022	67.80
Idaho	2,113	.....	.....	.....	2,113	51,824	24.50
Montana	5,445,592	73,994	12,807	+ 61,187	5,506,779	129,698,998	23.60
Nevada	5,880	.....	.....	.....	5,880	117,600	20.00
New Mexico	710,262	14,109	67,226	− 53,117	657,145	15,682,664	23.90
North Dakota	2,174,635	201,427	70	+201,357	2,375,992	37,623,645	15.80
Oregon	6,915	.....	40	− 40	6,875	121,651	17.70
South Dakota	250,123	.....	.....	.....	250,123	2,758,587	11.00
Utah	1,048,542	8,938	30	+ 8,908	1,057,450	44,325,419	41.90
Washington	740	320	.....	+ 320	1,060	22,400	21.10
Wyoming	7,448,456	160	520	− 360	7,448,096	385,436,687	51.70
	20,025,278	370,449	138,292	232,157	20,257,435	812,989,345	39.90

Applications for classification as to coal.—During the present year the Survey received 44 applications for classification; 37 of these were requests for classification as coal land and 7 as noncoal land. There were also pending at the beginning of the year 12 applications for coal classification and 3 for noncoal. Of the total 59 received and pending cases, 15 were approved—12 as coal and 3 as noncoal—and 13 disapproved—9 as coal and 4 as noncoal. At the end of the year there were pending 31 requests for classification, of which 28 were for coal and 3 for noncoal.

OIL.

Withdrawals and restorations.—The examination and withdrawal of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California, Wyoming, and Montana. The examinations were made for the purpose of reducing the outstanding oil withdrawals in so far as the data indicated that the withdrawn lands were not valuable for oil and of adding new areas to the oil reserves wherever the data indicated the presence of oil. These examinations resulted in eliminating from withdrawal 176,311 acres of nonoil land and added to the withdrawals 903,791 acres of prospective oil land, a net increase of 727,480 acres for the year.

In California more than 104,000 acres in the Salinas Valley, principally in Monterey County but in part in San Luis Obispo County, was restored to entry, field examination by the Survey having shown these lands to be barren of oil. Field work in the Salinas Valley also resulted in the restoration of a little more than 12,000 acres of

land in Monterey County withdrawn a year ago because it was believed to be favorable for oil accumulation but later found to be almost entirely private land. A restoration of 4,695 acres in Orange and Los Angeles counties was made as a result of the decision rendered by the Supreme Court in the Burke case (224 U. S., 669).

In Wyoming an area of a little less than 38,000 acres in the Big Horn Basin was restored to entry during the year, and about 904,000 acres in Wyoming were included in withdrawals. Approximately 10,000 acres of land in the Big Horn Basin has been withdrawn on the basis of detailed field examination and office work. Approximately 27,000 acres were withdrawn in the Hanna Basin, in southern Wyoming, and the remainder of the withdrawn area of about 133,000 acres lies in the Big Muddy and Lost Soldier fields and in the vicinity of Powder River station.

The discovery of oil in the fall of 1915 near the Wyoming-Montana line made it advisable to withdraw certain favorable areas in the northern part of the Big Horn Basin previously known to the Survey but not included in an oil withdrawal. Part of the area so withdrawn was examined, and the examination resulted in restoring more than 37,600 acres of withdrawn land in this part of the State.

The keen interest manifested in the possible occurrence of oil in Montana about a year ago, after the discovery of oil in Elk Basin, near the Montana-Wyoming State line, caused the Survey to recommend the withdrawal of all areas of favorable structure known in this part of the State, in continuance of the departmental policy of holding prospective oil lands until appropriate legislation for their disposition can be enacted. Some of the withdrawn land in this part of Montana was examined by the Survey and found to be barren of oil, and more than 29,900 acres in southern Montana was restored to entry. Other areas in the State, the largest of which was that of the Malta or Bowdoin dome, in the upper Milk River valley, were withdrawn.

Oil withdrawals and restorations, fiscal year 1916–17, in acres.

	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
	Acres.	*Acres.*	*Acres.*	*Acres.*
Arizona	230,400			230,400
California	1,365,947		108,718	1,257,229
Colorado	87,474			87,474
Louisiana	467,030			467,030
Montana	641,622	734,432	29,949	1,346,105
North Dakota	84,874			84,894
Utah	1,952,326			1,952,326
Wyoming	791,467	169,359	37,644	923,182
	5,621,160	903,791	176,311	6,348,640

Oil-shale withdrawals.—Of special interest during the year was the creation of two naval oil-shale reserves, one of 45,440 acres in Colorado and one of 86,584 acres in Utah. Lands included within these reserves are not subject to agricultural or mineral entry and in that respect differ from the classified oil-shale land.

Classification.—Most of the lands examined and included in oil withdrawals have not definitely been classified as oil lands, and no classification of oil lands outside of Indian reservations was made during the fiscal year. The lands on which oil is known or believed to be present in commercial quantities have been included in oil withdrawals pending further detailed examinations, in order to determine the mineral character of these lands and to hold the lands until legislation providing for their disposition is enacted. Lands included in oil withdrawals may therefore be considered tentatively as oil lands, although they have not, with the exception of some of the land in California, been so classified. In addition to the classifications that are reported as withdrawals and restorations in the preceding table, a direct classification as oil land of 42,097 acres in the Blackfeet Indian Reservation, Mont., has been made. Examinations of lands in such reservations are frequently made for the information of the Office of Indian Affairs in its administration of Indian lands. Mineral classification of certain oil lands within the Northern Pacific land grant have been reported to the Commissioner of the General Land Office, but these lands are a part of the outstanding oil reserves and are included in the table given above.

The classification of oil-shale land in Utah was continued in 1916, and large areas have been added to the classified mineral lands. Field examination by the Survey during the four seasons of 1913–1916 has shown that the potentiality of the oil shale of this region as a source of petroleum is enormous. There is also locked up in these shales a vast amount of nitrogen which can be recovered as a by-product in the refining of the shale and used in the manufacture of fertilizers, explosives, etc.

Classification of oil-shale land, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916, (mineral).	Classified during fiscal year.		Outstanding June 30, 1917.	
		Mineral.	Non-mineral.	Mineral.	Non-mineral.
Colorado	893,418	2,600	.....	896,018	.....
Utah	112,950	2,527,709	[a] 4,744	2,635,915	4,744
Wyoming	460,103	.....	.....	460,103	.....
	1,466,471	2,530,309	4,744	3,992,036	4,744

[a] Reclassification of area previously classified as mineral land.

Applications for classification.—During the year the Survey received 27 applications for classification of withdrawn oil lands as nonoil land. At the beginning of the year there were also pending three applications for classification as to oil, making a total for the year of 30 cases. Six of these were approved and the lands were restored to entry; 18 were disapproved for the reason that the lands were included in an outstanding oil reserve and the data on file indicate that the lands are valuable for deposits of oil, or because no detailed information is available to the Survey to prove that they are nonoil land, and the data submitted by the applicants were rejected because the evidence submitted did not show that the land is nonoil land and could not be used as a basis for nonoil classification. At the end of the year there remained pending six applications.

PHOSPHATE.

Regulations.—There has been no change in the procedure affecting the classification of phosphate lands. Under the regulations defining phosphate lands, adopted by the Survey in 1912 to guide its recommendations for withdrawal and restoration, lands underlain by deposits containing less than 30 per cent of tricalcium phosphate are considered nonmineral lands. Phosphate beds that are from 1 foot to 6 feet or more in thickness and contain 70 per cent or more of tricalcium phosphate are held to depths ranging from zero along the outcrop to the maximum of 5,000 feet in direct ratio to the variation of the thickness of the bed from 1 to 6 feet. For beds containing less than 70 per cent of tricalcium phosphate the depth limit varies from zero to the depth of a 70 per cent bed of any given thickness in direct ratio to the variation in tricalcium phosphate content from 30 to 70 per cent.

Withdrawals and restorations.—During the year, as in previous years, field examination has been made to obtain information regarding the phosphate character of public lands in order that the nonphosphate areas might be eliminated from the phosphate reserves and newly discovered phosphate areas might be included. Phosphate work was carried on in Idaho, Montana, Utah, and Wyoming, but the results of these investigations were not assembled by the end of the year, and no action has been taken. As a result of the work new withdrawals and restorations will be made as soon as the field work is compiled and the data made available. No withdrawals have been made during the year, and only one restoration, including 80 acres in Florida, has been approved.

Phosphate withdrawals and restorations, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Florida	119,817	80	119,737
Idaho	966,377	.....	966,377
Montana	119,227	.....	119,227
Utah	302,465	.....	302,465
Wyoming	998,592	.....	998,592
	2,506,478	80	2,506,398

Classifications.—Indian lands, such as those included in the Fort Hall Indian Reservation, Idaho, and in the Shoshone or Wind River Indian Reservation, Wyo., are not public lands, and therefore such lands can not be withdrawn. Examinations of lands in such reservations are frequently made for the information of the Office of Indian Affairs in its administration of them. If these examinations are made for the purpose of determining whether or not the lands contain phosphate, the results are transmitted not as withdrawals or restorations but as classifications either as phosphate or nonphosphate lands. Mineral classifications of certain phosphate lands within the Northern Pacific land grant have been reported to the Commissioner of the General Land Office, but these lands are a part of the outstanding phosphate reserves and are included in the table given above.

In addition, therefore, to the classifications that are reported as withdrawals and restorations in the preceding table, direct classifications of lands in the Fort Hall Indian Reservation, Idaho, and the Wind River Indian Reservation, Wyo., have been made as indicated in the following table:

Phosphate classifications of Indian lands outstanding June 30, 1917, in acres.

State.	Phosphate land.	Nonphosphate land.
Idaho	4,080	17,440
Wyoming	20,576	85,515
	24,656	102,955

Applications for classification.—During the fiscal year the Survey received five applications for classification of withdrawn lands as nonphosphate land. Two of these were approved and the lands restored to entry; two were disapproved because the data on file indicate that the lands are valuable for deposits of phosphate or because no detailed information is available to the Survey, and the evidence submitted by the applicants was not sufficiently definite to be used as

a basis for a nonphosphate classification; and one remained pending at the end of the year.

POTASH.

Field work in search of commercial deposits of potash was continued by the geologic branch of the Survey during the fiscal year, but no new areas were found on the public lands. No new areas were withdrawn, and no changes were made in the two existing potash reserves in California, Searles Lake, and Panamint Valley, aggregating 91,207 acres, or in the potash reserve of 39,422 acres at Columbus Marsh, Nev.

METALLIFEROUS LANDS.

The act of February 26, 1895 (28 Stat., 683), made provision for classifying the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho with respect to their mineral or nonmineral character, 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 has been continued during subsequent years, and field examination of all lands thus far listed to the Survey for examination and report has been completed and the classification furnished to the Commissioner of the General Land Office.

Lands in Northern Pacific Railroad grant in Idaho and Montana classified, fiscal years 1911–1917, in acres.

State.	Classification.	1911	1912	1913	1914	1915	1916	1917	Total.
Idaho	Mineral	45,645	19,444	1,000	.....	.....	.....	.....	65,789
	Nonmineral	90,712	53,055	1,200	.....	.....	478	.....	145,445
		136,357	72,199	2,200	.....	.....	478	.....	211,234
Montana	Mineral	130,386	1,134	19,800	480	6,629	.....	.....	158,429
	Nonmineral	21,802	83,981	65,570	7,696	7,911	2,229	160	189,349
		152,188	85,115	85,370	8,176	14,540	2,229	160	347,778
Idaho and Montana	Mineral	176,031	20,278	20,800	480	6,629	.....	.....	224,218
	Nonmineral	112,514	137,036	66,770	7,696	7,911	2,707	160	334,794
		288,545	157,314	87,570	8,176	14,540	2,707	160	559,012

In addition to the above work a supplemental report was furnished to the Secretary of the Interior covering certain manganese areas examined by the Survey in 1915. The entire area included in the Gila Indian Reservation, Ariz., was examined as to the mineral character of the lands in the reservation, but a report has not yet been

furnished to the Commissioner of Indian Affairs, as the chemical work on the mineral specimens collected in the field has not been completed.

Withdrawals.—No new areas were withdrawn and no change was made in the mineral-land withdrawal of 8,507 acres in Arizona.

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

Withdrawals and restorations.—The classification of the public lands with relation to their value in connection with water-power development 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., 855, 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1916, the area included in outstanding withdrawals was 2,352,652 acres. During the year 156,353 acres additional were withdrawn, and 79,908 acres previously included in power-site reserves were restored to the public domain. On June 30, 1917, the total area withdrawn in connection with water power was 2,429,097.

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Alabama	120	.....	.....	120
Alaska	69,300	.....	.....	69,300
Arkansas	22,354	.....	.....	22,354
Arizona	335,791	27,173	62,640	300,324
California	256,090	8,323	407	264,006
Colorado	273,670	3,124	290	276,504
Idaho	260,745	2,987	1,238	262,494
Michigan	1,240	.....	.....	1,240
Minnesota	12,309	.....	.....	12,309
Montana	171,891	536	8,130	164,297
Nevada	26,153	1,208	.....	27,361
Nebraska	761	.....	.....	761
New Mexico	13,577	49,705	680	62,602
Oregon	261,676	56,406	764	317,318
Utah	451,217	760	4,553	447,424
Washington	108,593	5,427	240	113,780
Wyoming	87,165	704	966	86,903
	2,352,652	156,353	79,908	2,429,097

Water-power designations.—The act of June 20, 1910 (36 Stat., 557), enabling Arizona and New Mexico to enter the Union as States, reserved to the United States all lands actually or prospectively valuable for power sites so far as ascertained and designated by the Secretary of the Interior within five years after the proclamation of the President declaring admission of the new States. The five-year period terminated February 14, 1917, for Arizona and January 6, 1917, for New Mexico. No designations were made prior to the cur-

rent fiscal year, though investigations and surveys preliminary to designation had been in progress for several field seasons. Prior to the expiration of the five-year period referred to, however, designations were made covering all lands in the two States believed to be actually or prospectively valuable for power sites, the areas being 764,438 acres in Arizona and 201,000 acres in New Mexico. Such of these lands as were not otherwise withdrawn were also included in power-site reserves under appropriate acts of Congress.

The act of June 9, 1916 (39 Stat., 218), revesting in the United States title to lands held by the Oregon & California Railroad Co., provides for the classification as "power-site lands" of the revested lands found to be chiefly valuable for water-power sites. During the fiscal year 31,765 acres of power-site lands in Oregon were classified under this act, and such of them as were not otherwise withdrawn were included in power-site reserves under appropriate acts of Congress.

Applications for reclassification.—At the beginning of the fiscal year 12 applications for the reclassification of lands included in power-site reserves were awaiting action, and during the year 78 were received, making a total of 90 cases. Action was taken on 72 cases, leaving 18 pending at the end of the year.

Right of way applications.—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1235, 1253), 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 related to the development of water power. Such applications, when received in proper form at the General Land Office, are 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, and a report is made to the Secretary of the Interior on the circumstances in the case. This agreement, after execution by the applicant and issuance of the permit by the Secretary of the Interior, defines the conditions under which the power is to be developed, the tenure of the site, and the provisions for the protection of the public interest as regards distribution of output, rates, and service.

During the year favorable reports were rendered on 14 applications for permit under the act of February 15, 1901, involving the development of 4,223 continuous horsepower and the construction of 194 miles of transmission lines. Favorable reports were also ren-

dered on five applications for grants under the act of March 4, 1911, for right of way for 49 miles of transmission line.

In pursuance of the Secretary's instructions of August 24, 1916, 26 permittees under the act of February 15, 1901, and grantees under the act of March 4, 1911, were called on for reports of their operations during the calendar year 1916. The reports received show that public lands under permit or grant from the Secretary of the Interior were used during the year for the generation or transmission of about 1,200,000,000 kilowatt-hours of electric energy, the equivalent of 156,000 continuous horsepower.

In addition to applications for rights of way for hydroelectric development, a large number of applications 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, respectively, 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 for irrigation uses, under the act of March 3, 1891 (26 Stat., 1095), 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.

Applications for rights of way, fiscal year 1916–17.

Class.	Pending July 1, 1916.	Received 1916–17.	Acted on 1916–17.	Pending June 30, 1917.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 990), etc....	28	69	77	20
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), and May 11, 1898 (30 Stat., 404), etc.....	24	119	127	16
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.....	33	25	29	29
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), May 11, 1898 (30 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.....	13	108	114	7
Total number of applications for original consideration...	98	321	347	72
Additional applications for reconsideration.....	36	22	37	21

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. There was no change in the status of such withdrawals during the fiscal year. The following table shows the area of such withdrawals outstanding:

Reservoir sites outstanding June 30, 1917.

	Acres.
Arizona	23,040
Montana	9,080
North Dakota	1,569
Oregon	10,619
Washington	35,943
	80,251

Carey Act segregations.—During the year four 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. One such list was pending report on July 1, 1916. Reports on all these lists had been submitted before the end of the year, and supplemental reports on five 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 information 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 87 such cases were received, and 51 were carried over from the preceding year. Of these 138 cases 72 were reported on and 66 were pending June 30, 1917. Supplemental reports were rendered on 10 cases.

ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), June 13, 1912 (37 Stat., 132), March 3, 1915 (38 Stat., 953), and March 4, 1915 (38 Stat., 1162), was continued during the year. These acts are now applicable to 14 States. As a result of the investigations of surface and underground water conditions, designations during the fiscal year have added a large area of land to that previously classified.

Enlarged-homestead designations, fiscal year 1916–17, in acres.

State.	Outstanding July 1, 1916.	Designations 1916–17.	Cancellations 1916–17.	Outstanding June 30, 1917.
Arizona	25,125,355	213,692	.....	25,339,047
California	4,875,197	2,337,251	.....	7,212,448
Colorado	26,026,922	947,321	13,750	26,960,493
Idaho:				
Sections 1–5 only	9,754,609	290,901	2,833	10,042,677
Section 6	124,828	2,873	2,792	124,909
	9,879,437	293,774	5,625	10,167,586
Kansas	372,684	95,455	.....	468,139
Montana	48,502,807	1,018,116	678	49,520,245
Nevada	46,305,197	.....	3,445	46,301,752
New Mexico	25,468,032	3,299,319	18,895	28,748,456
North Dakota	9,560,710	1,934,493	.....	11,495,203
Oregon	17,874,712	122,082	.....	17,996,794
South Dakota	14,426,192	1,059,797	.....	15,485,989
Utah:				
Sections 1–5 only	7,150,736	374,376	38,790	7,486,322
Section 6	1,274,124	68,173	8,928	1,333,369
	8,424,860	442,549	47,718	8,819,691
Washington	5,196,302	250,842	.....	5,447,144
Wyoming	20,574,410	1,119,160	22,696	21,670,874
	262,612,817	13,133,851	112,807	275,633,861

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 sections 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho only, 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 had already been submitted on the original entry.

A seventh section was added to the enlarged-homestead act of February 19, 1909, by the act of July 3, 1916 (39 Stat., 344), which permits an additional entry for land not contiguous to that originally entered after submission of final proof on the original entry. Under this section residence is required on the additional entry in conformity with the homestead laws except where the additional entry

lies within 20 miles of the original homestead and the prospective entryman still owns and resides upon his original homestead, in which case no residence upon the additional entry will be required. The act applied to all States affected by the general provisions of the enlarged-homestead act except Idaho, but by the act of September 5, 1916 (39 Stat., 724), the act of June 17, 1910, extending the provisions of the enlarged-homestead act to Idaho, was amended by adding thereto a section 7 identical with that added to the 1909 act on July 3, 1916.

Noncontiguous entries under section 6 of the enlarged-homestead act are not permitted under these acts.

The enlarged-homestead acts of February 19, 1909, and June 17, 1910, were further amended by the act of February 20, 1917 (39 Stat., 925), which provides that a homesteader who has received patent to an area of less than a quarter of a section may make entry and obtain title under these two homestead acts, "for such an area of public land as will, when one-half of such area is added to the area of the lands to which he has already obtained title, not exceed one quarter section." Under this act additional entries can be allowed in the cases mentioned without the necessity of the land in the original homestead being designated as subject to entry under the enlarged-homestead act.

Under the act of February 20, 1917 (Public 340), any person who prior to the passage of the act entered under the homestead laws lands included in a ceded Indian reservation and paid therefor a price equivalent to or greater than $4 an acre is entitled to the benefits of the homestead law as if such entry had not been made. The privileges of this act extend only to persons who have submitted final proof on the land previously entered and paid the entire purchase price therefor. Any such person may enter land under the enlarged-homestead act where the proposed additional entry only has been designated as subject to such entry and without the necessity of the ceded Indian lands in the original homestead being designated.

Designations under the enlarged-homestead acts 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. The passage of the act of March 4, 1915 (38 Stat., 1162), which provides that a preference right of entry in the event of designation can be procured by filing an application at the local land office of the district in which the lands are situated, has led to a very large increase in the number of applications received.

Action on petitions under the enlarged-homestead acts, fiscal year 1916–17.

	Pending July 1, 1916.	Received 1916–17.	Action taken, 1916–17.					Pending June 30, 1917.	Cases reconsidered.
			All designated.	Part designated.	Refused.	Recalled.	Total.		
Arizona	112	102	57	10	46	1	114	100	1
California	619	774	945	9	25	27	1,006	387	18
Colorado	997	1,358	984	26	85	37	1,132	1,223	42
Idaho	1,064	656	302	11	20	129	462	1,258	39
Kansas	13	430	401	3	3	1	408	35	17
Montana	1,055	1,664	1,392	79	331	39	1,841	878	252
Nevada	43	14	.....	.....	2	.....	2	55	.....
New Mexico	948	1,104	992	18	151	61	1,222	830	17
North Dakota	78	417	261	12	22	9	304	191	15
Oregon	156	397	32	4	.....	17	53	500	3
South Dakota	445	720	657	36	49	8	750	415	29
Utah	845	338	326	12	149	48	535	648	15
Washington	114	230	115	2	7	.....	124	220	4
Wyoming	549	835	759	22	123	11	915	469	32
	7,038	9,039	7,223	244	1,013	388	8,868	7,209	484

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations on June 30, 1917, has been printed.

STOCK-RAISING HOMESTEADS.

The stock-raising homestead law, approved December 29, 1916 (39 Stat., 862), authorizes the Secretary of the Interior to designate unreserved public lands in any of the public-land States, but not in Alaska, as "stock-raising lands."

The lands to be designated are those whose surface is chiefly valuable for grazing and raising forage crops, which do not contain merchantable timber, are not susceptible of irrigation from any known source of water supply, and are of such character that 640 acres is reasonably required to support a family. The classification of these lands will be made by the Survey on the basis of data now available or to be collected by field parties.

Before June 30 nearly 62,000 applications to enter lands under this act were received in the local land offices, involving about 24,000,000 acres. These applications were distributed by States as follows:

Applications under the stock-raising homestead law, fiscal year 1916–17.

	Number of applications.	Area in acres.		Number of applications.	Area in acres.
Arizona	1,321	559,084.91	North Dakota	700	211,553.93
California	2,567	1,042,238.04	Oklahoma	52	12,528.01
Colorado	5,767	2,205,519.37	Oregon	4,522	1,696,282.88
Idaho	4,398	1,803,447.77	South Dakota	4,182	1,409,471.54
Kansas	80	19,971.89	Utah	1,750	921,631.69
Montana	11,885	3,793,860.66	Washington	830	274,553.61
Nebraska	209	27,200.77	Wyoming	10,106	4,176,367.07
Nevada	150	78,185.47			
New Mexico	13,390	5,730,558.55		61,909	23,962,456.16

Only a small proportion of these cases were transmitted to the Survey during the year.

No appropriation was made for the administration of this law until the last month of the fiscal year, and it was therefore not possible to classify any lands under the act, as field examination will be required in a majority of the cases before classification can be made. Plans were made, however, before the funds became available, for the employment, organization, and equipping of a field force, and considerable work was also done in collecting such information as could be obtained by correspondence with the applicants.

PUBLIC WATER RESERVES.

The litigation before the department over the validity of the withdrawals for public water reserves, which has been prosecuted in the past more or less vigorously, presumably in the interest of large stock owners in various arid parts of the West, has been effectively terminated by section 10 of the stock-raising homestead act of December 29, 1916 (39 Stat., 862). Under this section the creation of public water reserves by Executive order under the act of June 25, 1910 (36 Stat., 847), is expressly recognized as being within the authority then granted to the President.

Immediately after the enactment of the stock-raising homestead law the scope of the investigations undertaken to locate lands principally valuable for stock-watering places, which control grazing privileges on public lands, was greatly enlarged. One of the first steps taken was the making of arrangements with the General Land Office whereby a large number of requests for field examinations have been made in cases covered by the cooperative agreement with that bureau. In addition to data contained in reports submitted in response to these requests, it is expected that the investigations of stock-raising homesteads being made by the Survey will yield a large amount of data during the next year, on the basis of which, it is probable, a large number of water reserves will be created.

At the present time over 900 watering places consisting of springs, creeks, and other sources of water supply have been considered and approximately 850 of these are now included in public water reserves. During the year 11,934 acres have been withdrawn and 3,498 acres have been restored, making a net increase of 8,436 acres in the area withdrawn.

Public water reserves withdrawn from entry and restored to entry, fiscal year 1916–17, in acres.

State.	Withdrawals outstanding July 1, 1916.	New withdrawals, 1916–17.	Restorations, 1916–17.	Withdrawals outstanding June 30, 1917.
Arizona	9,922	2,516	.....	12,438
California	49,846	2,788	160	52,474
Colorado	480	.....	.....	480
Idaho	6,170	1,040	.....	7,210
Montana	1,040	2,264	.....	3,304
Nevada	4,336	.....	.....	4,336
New Mexico	1,440	846	.....	2,286
Oregon	2,500	160	178	2,482
Utah	33,987	.....	160	33,827
Washington	.....	40	.....	40
Wyoming	83,551	2,280	3,000	82,831
	193,272	11,934	3,498	201,708

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 68,411 pages of manuscript were edited and prepared for printing, and proof sheets for 23,162 final printed pages were read and corrected, this work involving the handling of 5,869 galley proofs and 29,273 page proofs. Indexes were prepared for 73 publications, covering 15,139 pages. A third edition of the pamphlet "Suggestions to authors," by G. M. Wood, editor, and a pamphlet entitled "Extracts from the Style Book of the Government Printing Office," compiled by Mr. Wood, were issued during the year.

At the end of the 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 3,563, comprising 190 maps, 728 photographs prepared for reproduction, 834 diagrams and sections, 1,580 paleontologic drawings and photographs, and 231 miscellaneous illustrations. The illustrations sent to the printer were reproduced by chromolithography, photolithography, the four-color process, halftone engraving, zinc etching, wax engraving, and cuts already engraved, a total of 1,515 subjects. Proofs to the number of 2,087 were examined. Electrotypes of 57 cuts were furnished to outside applicants. At the end of the year material for illustrating 38 reports was in preparation.

DIVISION OF DISTRIBUTION.

The section of distribution, which had previously been a part of the division of book publication, was designated the division of distribution September 1, 1916, with R. C. Shelsé as chief.

Editions of 203 new books and pamphlets, 46 reprinted books and pamphlets, 5 new geologic folios, 14 new geologic maps, 86 new or revised topographic maps, 140 reprinted topographic maps, 9 new photolithographed maps, and 4 reprinted photolithographed maps, making a total of 507 publications, were received during the year. Many other special pamphlets and forms prepared for administrative use were received and distributed.

The total units of all publications received numbered 710,749 books and pamphlets, 21,753 folios, 1,732 geologic maps, 781,644 topographic maps, a grand total of 1,515,878.

The division distributed 607,101 books, 21,235 folios, and 676,526 maps, a total of 1,304,862, of which 29 books, 17,551 folios, and 475,036 maps were sold. The total amount received and deposited in the Treasury as the result of sales of publications was $35,388.79. The sales of topographic and geologic maps amounted to $33,952.84, of topographic and geologic folios to $1,383.30, and of books to $52.65. The division received and answered 104,070 letters.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

The publication of the maps and illustrations of folios continued under the direction of George W. Stose, geologist, in charge of this section.

The five folios completed this year are numbered 202 to 206. Of these the Detroit folio covers five quadrangles (Wayne, Detroit, Grosse Pointe, Romulus, and Wyandotte, Mich.), in which there are several large cities with institutions of higher education and many important industries based on natural resources, so that the folio will be of much interest to the community. Three other folios cover two quadrangles each (Eureka Springs and Harrison, Ark.; Leavenworth and Smithville, Mo.-Kans.; Colorado Springs and Manitou, Colo.). In the Colorado Springs folio are described and illustrated Colorado Springs, Manitou, the Garden of the Gods, Monument Park, and Pikes Peak, and this folio will therefore be in large demand by travelers as well as by local residents.

At the end of the fiscal year the maps and illustrations of the Deming (N. Mex.), Colchester-Macomb (Ill.), and Newell (S. Dak.) folios were completed, and the texts were well advanced. The maps of the Herman-Morris (Minn.) folio were ready to be printed and the illustrations were completed. The maps of the Elkton-Wilmington (Md.-Del.-Pa.-N. J.), Black Hills (S. Dak.), and Syracuse-Lakin (Kans.) folios were partly engraved. The Black Hills folio covers four quadrangles, and part of the same area is also represented on a larger scale in greater detail. Maps of several other folios and reports were drawn and partly prepared for publication in this sec-

tion during the year. In addition to the work on folios the maps, sections, and other illustrations for fifty Survey reports were critically reviewed by the geologist in charge of the section.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 149 topographic maps were on hand for publication, and the accessions during the year were 78, making a total of 227 maps. Of these, 2 (Lynn, Ind.-Ohio, and Seiad, Cal.) were withdrawn for additional field work, 2 (Capon Bridge and Berryville, W. Va.) were printed for office use only, 93 have been published, 111 are in process of engraving and printing, and 19 (of which 12 have been edited) have not yet been transmitted to the engraving division. Of the 95 maps published (see list, pp. 31–32) 86 are new engraved maps and 9 are photolithographs. The following statement shows the comparative status of map editing and map publication on June 30 for the last seven years:

Progress of map publication for seven years ended June 30, 1917.

	1911	1912	1913	1914	1915	1916	1917
Published during the year	86	114	101	102	107	153	95
In process of engraving and printing	56	65	89	69	87	97	111
In hand for engraving	95	102	105	114	91	52	[a]19

[a] Preparation of manuscripts from 1916 surveys delayed by war work.

The manuscripts edited during the year comprise 108 maps prepared for engraving, 3 maps for photolithography, 196 maps or sheets for the illustration of 30 Survey reports, and corrections for 227 maps about to be reprinted. The proof read comprises 84 new topographic maps, 5 maps engraved and printed under contract, and corrections to 104 old maps. The index maps for 9 circulars of the series 9–323 were revised and reprinted, 20 of the State circulars were revised and reprinted, as was also the wall index map of the United States.

The decisions of the United States Geographic Board have been grouped by States and counties, and a list in this form, without the descriptions, has been prepared for publication. A revision of Bulletin 299, Geographic dictionary of Alaska, has also been in progress and is far advanced. Six men were continuously employed in the section.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 86 topographic maps were engraved and printed; other editions were 7 photolithographed State maps and 2 photolithographed topographic maps of Willamette Valley, making a total of 95 new maps.

Corrections were engraved on the plates of 211 maps and 17 were in hand for correction. Of the 211 corrected maps, 119 were for reprint editions, 59 were in hand for printing, and 33 were corrected for other purposes. Four photolithographic State maps were corrected and reprinted and reprint editions of 21 topographic maps in hand at the beginning of the year were completed.

Of the new and reprinted maps, 239 different editions, amounting to 781,644 copies, were printed and delivered to the map room. This is a decrease of 25 editions and 146,209 copies from the preceding year.

Five new geologic folios were published, of which three were double folios and one (Detroit, Mich.) contained five sets of geologic maps. State editions of two folios, an octavo edition of one folio, and a field edition of one folio were issued during the year. Editions and partial editions amounting to 21,753 copies were printed and delivered, an increase of 913 copies over the number printed in the preceding year; 1,732 extra areal-geology sheets of the different folios were also printed.

OTHER GOVERNMENT MAP PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual reports of the governor of Alaska, the governor of Hawaii, the Commissioner General of Immigration, the Commissioner of Indian Affairs, and the Superintendent of the Coast and Geodetic Survey, Department of Commerce Special Publication 40, Department of Agriculture Bulletin 460; report of the Federal Trade Commission on the price of gasoline; soil surveys of Barbour County Ala.; Chickasaw County, Miss.; Dekalb County, Mo.; Dunklin County, Mo.; Franklin County, Fla.; Hamilton County, Ohio; Hampton County, S. C.; Latah County, Idaho; New Castle County, Del.; Richarson County, Nebr.; Schoharie County, N. Y.; Smith County, Tex.; Washington County, Nebr.; and Wells County, Ind.; Bureau of Mines Bulletin 107 and Technical Paper 155, American Ephemeris and Nautical Almanac, 1917, 1918, and 1920; Report on fertilizer industry (64th Cong., 1st sess., S. Doc. 872); Report on development of East Potomac Park (64th Cong., 1st sess., H. Doc. 1038); Geological Survey Bulletins 600, 621–B, 621–N, 621–O, 623, 629, 631, 640–J, 641–B, 641–D, 641–E 641–F, 641–J, 642–A, 642–B, 642–H, 651, 656, 657, 660–A, 660–C, 661–A, 661–C, 661–D, 661–F, 663; Professional Papers 93, 96, 97, 100–B, 101, 108–H; Water-Supply Papers 380, 395, 396, 400–E, 415, 417, 418, 419, 420, 421, 423, 424, 425–A; Mineral Resources, 1915 (chapters on coke, coal, and copper). In addition, the following separate illustrations were printed and delivered to the Government Print-

ing Office: Diagrams of two bird reservations, one elk reservation, one reservation for the use of natives of Alaska, one reservation for wireless-telegraph station, and two national monuments; maps of six national parks; for the Department of Agriculture outline maps of the United States by counties, relief maps of the United States, maps of the United States and North America (charts), map of the United States showing annual precipitation, map of India, and tick eradication map; for the Department of Commerce, candle-power scale and record sheet; for the General Land Office, protractor charts and folios of the Nenana coal fields, Alaska; for the Forest Service, fire-lookout protractor.

The following work was done for other bureaus and departments: For the General Land Office, 1,194 township plats, 579 mineral plats, 13 State maps showing homesteads, plats of 6 town sites, map of Fort Assinniboine Military Reservation, and other miscellaneous work; for the Office of Indian Affairs, 158 plats of Indian reservations, maps of 6 Indian reservations, plats of 2 town sites, certificates for Indian schools, and other miscellaneous work; for the National Park Service, 7 automobile guide maps, map showing national parks and monuments, administrative map of Rocky Mountain National Park, and other miscellaneous work; for the Forest Service, maps of 25 national forests, 15 recreation maps and fire folders, 2 atlas folios, 4 administrative maps, 9 proclamation diagrams of national forests, 1 game-reserve map, allotment-estimate forms, grazing-data chart, homestead-entry plat, map showing standing timber in the United States, index map, organization chart, and other miscellaneous work; for the War Department, 88 sheets of the Carta de la República Mexicana, map of Belgium, map of Island of Oahu, 5 Geological Survey topographic maps, map of Plattsburg training camp, and other miscellaneous work; for the Navy Department, 330 hydrographic charts and 576 British Admiralty charts.

Work was also done for the Interstate Commerce Commission, Bureau of Standards, Bureau of Mines, Reclamation Service, Bureau of Lighthouses, International Boundary Commissions, Department of Agriculture, States Relations Service, District of Columbia public schools, Weather Bureau, Eight-Hour Commission, Coast and Geodetic Survey, Chief of Engineers, United States Army, Department of Commerce, Office of Public Roads and Rural Engineering, and the commandant, Fort Myer, Va. This work for various branches of the Government amounted to about $97,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for the University of Missouri; Rider Press, New York, N. Y.; Eckert Lithographing Co., Washington, D. C.; International Committee of Young Men's Christian Associations;

Edward T. Millar Co., Columbus, Ohio; University of Idaho; State of Wyoming; Everett Press, Boston, Mass.; Atchison, Topeka & Santa Fe Railway System; International Joint Commission; and John Wiley & Sons, New York, N. Y.; and the money received in payment for the work, amounting to $553.65, was turned into the Treasury of the United States, to be credited to miscellaneous receipts. On requisition of the Government Printing Office, 218 transfer impressions were made and shipped to contracting printers. Under cooperative agreements transfer impressions were furnished without charge to the State surveys of New York, West Virginia, Illinois, and Massachusetts.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was 3,338,028, which required 9,805,217 printings. The total number of copies printed, including topographic maps and geologic folios, was 4,141,425, requiring 14,283,845 impressions.

The sales of maps and folios itemized on page 159, together with $553.65 of other miscellaneous receipts for map work, aggregated $35,889.79, so that more than one-fourth of the amount appropriated for engraving and printing the Survey maps was returned to the Treasury.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 18,255 negatives, of which 3,517 were wet, 2,477 dry, 1,351 paper, 7,959 field negatives developed, 621 lantern slides, and 2,330 were made for photolithographs; 4,435 zinc plates; 357 zinc etchings; 355 celluloids; and 45,910 prints, of which 23,666 were maps and diagrams and 22,244 were photographs for illustrations. In addition 1,766 prints were mounted and 42 lantern slides were colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Mails and files.—During the year 273,308 letters were received, an increase of 7 per cent compared with 1916. Of these letters 26,909 contained $36,753.88 remitted for Survey publications, an increase of 14 per cent in number of letters and of $4,740.96 in amount compared with 1916.

The total letter mail sent out from the Survey numbered 566,330, an increase of 30 per cent over 1916. The recording, referring, filing, and mailing of correspondence required the services of nine clerks.

Personnel records.—The roll of Secretary's appointees numbered 934 at the end of the fiscal year, 62 more than at the end of 1916. The total number of changes in the personnel was 904, which included 294

appointments, 234 separations, 339 promotions, 2 demotions, and 35 miscellaneous changes.

During the year 13,762 days of annual and 2,677 of sick leave were granted, being 59 per cent of the amount of annual leave and less than 2 per cent of the amount of sick leave permissible to grant under the law; 4,030 days of leave without pay were also granted.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to August 11. 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, 1917.[a]

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00	$2.67	$35,342.67	$34,433.66	$909.01
Salaries, scientific assistants	29,900.00	.....	29,900.00	29,482.73	417.27
Skilled laborers, etc	20,000.00	.....	20,000.00	19,969.49	30.51
Gaging streams, etc	150,000.00	36,788.93	186,788.93	186,667.39	121.54
Chemical and physical researches	40,000.00	.....	40,000.00	38,497.42	1,502.58
Preparation of illustrations	18,280.00	72.70	18,352.70	18,196.87	155.83
Mineral resources of United States	75,000.00	15.79	75,015.79	73,265.09	1,750.70
Geologic maps of United States	110,000.00	97,176.48	207,176.48	194,229.88	12,946.60
Books for the library	2,000.00	.....	2,000.00	1,708.91	291.09
Topographic surveys	350,000.00	104,373.37	454,373.37	443,598.35	10,775.02
Geologic surveys	350,000.00	9,666.90	359,666.90	351,531.73	8,135.17
Mineral resources of Alaska	100,000.00	492.48	100,492.48	93,047.41	7,445.07
Surveying national forests	75,000.00	15.30	75,015.30	74,923.97	91.33
	1,355,520.00	248,604.62	1,604,124.62	1,559,552.90	44,571.72

[a] In addition to these appropriations amounts aggregating $215,000, for Survey publications and for rent of the building occupied by the Survey, were allotted from other appropriations but not disbursed by Survey officials.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1917.

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.	Advertising and publication of notices.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery drafting, etc., supplies.
Salaries, office of the Director	$34,433.66	$34,433.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Salaries, scientific assistants	29,482.73	29,482.73	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Skilled laborers, etc	19,969.49	19,969.49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gaging streams, etc	186,667.39	140,447.76	$14,907.91	$1,080.32	$9,805.48	$114.42	$781.41	$588.98	.....	$8.40	$2,147.39	$3,200.49	$2,312.16
Chemical and physical researches	38,497.42	27,884.05	283.54	428.98	1,836.86	187.26	84.14	8.85	.....	322.39	326.30	2,018.09	352.62
Preparation of illustrations	18,196.87	17,121.01	.....	.62	.....	.....	.30	659.45	.....	.....	1.42	174.93	55.04
Mineral resources of U. S	73,265.09	67,933.69	1,500.49	83.00	1,413.19	.....	583.56	103.04	.....	.....	448.20	.34	873.83
Geologic maps of U. S	194,229.88	136,010.81	104.74	25.55	52.20	.....	84.73	3,634.36	.....	2,014.32	1,557.77	4,325.37	42,509.01
Books for the library	1,708.91	.....	.....	2.42	.....	.....	.10	.....	.....	.....	.....	.....	47.60
Topographic surveys	443,598.35	278,616.81	40,588.36	2,972.28	75,958.05	10,119.24	1,141.30	5,665.78	.....	.....	1,296.54	2,254.59	1,917.14
Geologic surveys	351,531.73	304,217.52	14,845.59	892.01	13,644.42	3,919.71	580.75	4,422.75	$0.60	.....	2,151.71	186.83	1,549.28
Mineral resources of Alaska	93,047.41	60,916.92	13,344.91	2,613.79	4,388.41	105.94	118.37	1,305.89	.....	.....	583.95	419.46	468.58
Surveying national forest	74,923.97	48,125.75	3,538.72	556.79	11,309.45	5,755.31	79.56	123.08	.....	.....	219.47	367.90	304.65
	1,559,552.90	1,165,160.20	89,114.26	8,655.76	118,408.06	20,201.88	3,454.22	16,512.18	.60	2,345.11	8,732.75	12,948.00	50,389.91

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 miscellasupplies.	Equipment (including live stock).	Structures (bench marks).	Rent.	Maintenance, operation, and repair of passenger-carrying vehicles.	Purchase of passenger-carrying vehicles.
Salaries, office of the Director	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Salaries, scientific assistants	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Skilled laborers, etc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gaging streams, etc	$255.15	$187.96	$7.89	$112.91	$10.75	$47.00	$20.38	$52.67	$7,878.09	.....	$1,202.25	$1,247.62	$250.00
Chemical and physical researches	730.11	54.67	.....	.....	.....	.....	5.39	37.25	3 821.21	.....	.....	115.71	.....
Preparation of illustrations	.....	.....	.....	.....	.....	.....	.....	.....	184.10	.....	.....	.....	.....
Mineral resources of U. S	.....	.63	1.59	.....	.....	.....	.....	.10	323.43	.....	.....	.....	.....
Geologic maps of U. S	83.62	256.74	3.96	31.00	.....	.....	.....	.....	3,535.70	.....	.....	.....	.....
Books for the library	.....	.....	.....	.....	.....	.....	.....	.....	1,658.79	.....	.....	.....	.....
Topographic surveys	1,392.50	158.55	75.75	300.79	6,210.61	897.30	2.20	233.50	5,032.42	$2,548.50	87.00	2,504.79	3,624.35
Geologic surveys	106.04	33.32	18.25	44.40	687.94	1,545.70	1.35	116.41	1,582.01	.....	.....	985.14	.....
Mineral resources of Alaska	794.91	98.85	44.16	187.24	104.16	3,219.29	39.84	27.74	4,211.00	.....	54.00	.....	.....
Surveying national forests	96.41	9.57	12.67	8.20	2,443.25	97.25	.....	22.91	1,678.76	.....	28.52	145.75	.....
	3,458.74	800.29	164.27	684.54	9,456.71	5,806.54	69.16	490.58	29,905.51	2,548.50	1,371.77	4,999.01	3,874.35

LIBRARY.

During the year the library received 9,352 books, pamphlets, and periodicals and 438 maps, a total of 9,790 publications. Current accessions were catalogued as received. Titles sent to the Library of Congress for printing numbered 589; letters received, 3,768; letters written, 1,926; books collated and bound, 1,625. The loans during the year included 5,961 books and 287 maps. This number does not include books consulted in the library by 7,491 readers.

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