DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

THIRTY-NINTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR

ENDED JUNE 30

1918

WASHINGTON

GOVERNMENT PRINTING OFFICE

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THIRTY-NINTH 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 1917–18 comprised items amounting to $1,750,520. The plan of operations as approved by the Secretary of the Interior contemplated surveys and investigations in the United States and Alaska designed mainly to obtain information or to encourage activities essential to the rapid and successful prosecution of the war. The results of the work are reported in detail in the following pages.

SPECIAL WAR ACTIVITIES.

Type of contributions.—Every activity of the Geological Survey that could possibly contribute to the prosecution of the war has been so directed. The personnel, the records, and the methods which represent the products of many years of scientific activity are all being utilized, past experience being thus translated into present service. The special training given to the Survey engineers has made them available for effective service both overseas and in this country; the large amount of technical data collected through the years has been found to possess a present value not anticipated; and the official machinery organized for scientific investigation of the subjects within the Survey's province has also been utilized in the more intensive inquiries required, as each industrial or military need has arisen. The increase in the Survey's representation in the Army from 61 men who had held appointments of the Secretary at the beginning of the year to 322 at the end necessarily involved a serious reduction in the man power available for other contributions to war work. Yet it is believed that both in variety of scope and in volume of results the war activities under direction of the United States Geological Survey were more important during the closing months of this year than ever before.

These special investigations of the year may be broadly classified as related either to war materials or to military surveys. To the study of raw materials both the geologic branch and the water-

resources branch have contributed; in the field collection of military data the topographic branch has taken the largest part, but the field men of the other two branches have cooperated.

Raw materials.—The speeding up of American industry has created new demands for mineral raw materials, and some of the demands were intensified by enforced dependence on domestic resources. The materials which have thus assumed greater importance in the industrial world have been called "war minerals," and the field search for new occurrences of war minerals, the prompt examination of newly reported deposits, and the field estimates of the reserves thus made available have constituted a large part of the duties of the geologists of the Survey. In the effort to meet the urgent demand for essential minerals the Survey geologists have visited not only the mining districts of the United States but also deposits of potash and nitrate and chrome and manganese in Central and South America and the West Indies.

The geologic work connected with the mineral fuels has been concentrated on the search for oil pools to stimulate increased production. Close cooperation with the Fuel Administration has made all the geologic data obtained quickly available for use in directing new drilling.

The result of the statistical survey of the United States mineral industry, with its inventory of resources, has still further departed from the customary annual statement provided for by the specific appropriation. To meet the regular needs of the War Industries, Shipping, and War Trade boards and the Fuel and Railroad administrations, as well as special inquiries of the General Staff of the Army, the Ordnance bureaus of the Army and Navy, and the Tariff Commission increased attention has been given to quarterly, monthly, and weekly reports of mineral production. Even daily reports on coal shipments are compiled, and in the support of the Survey's coal statistical work the Fuel Administration has largely cooperated.

As a further contribution to the problem of meeting the Nation's fuel requirements, the hydraulic engineers of the Survey are engaged in a country-wide survey of the power situation to determine where water power can be substituted for steam-generated power or where coal can be saved by interconnecting electric plants or systems.

The increasing demand for the facts regarding the mineral raw materials led the Geological Survey to take the initiative in organizing a joint information board as a clearing house for interbureau inquiries regarding mineral products, thus making the Survey's store of information, as well as that of the other bureaus and boards, more quickly and fully available for all the Government organizations, new and old. All the interested official bodies have membership in this cooperative board, in which a representative of the War Industries

Board, Mr. Pope Yeatman, is chairman, and a Survey geologist, Mr. E. S. Bastin, is executive secretary.

Connected with both the field examinations and the statistical work is the preparation of special reports for the Capital Issues Committee. These reports cover both mineral properties and power and water systems seeking authority for new development or enlargement, and most of them have embodied data collected in former years in the course of the regular investigations made by the Survey's geologic and hydrologic engineers.

Still another natural extension of these investigations of natural resources has been the study of the mineral and power resources of the world, in response to the growing recognition of the fact that it is not sufficient to know simply what America possesses.

Military surveys.—Since March 26, 1917, the regular topographic work by the Survey engineers has been confined to the general military surveys along the United States borders in accordance with the program set forth by the General Staff. More and more, however, it has become necessary that the engineer reserve officers not recalled from the Geological Survey for overseas service should make special surveys of sites for munition plants, testing grounds, artillery ranges, airplane and balloon fields, cantonments, and other military reservations. In connection with these special surveys and the regular topographic work the Geological Survey has served as a training school for other engineer reserve officers detailed for instruction in field methods preparatory to service overseas.

In addition to the topographic surveys of a military character there has been an increased amount of confidential military data collected in the field by the Survey geologists and hydraulic engineers. Much of this has been contributed in connection with the progressive military work, but more detailed data have been collected to answer specific inquiries as to water supply, structural materials, and oil and gas available at sites for camps, aviation fields, and munition plants. The special examinations of surface and underground water supplies have increased in number and included both qualitative and quantitative studies, as well as investigations of problems of sewage disposal.

Military maps.—The contribution of the Survey's map engraving and printing plant has not been limited to the reproduction of the surveys executed by the topographic engineers but has included the reprinting of hydrographic and British Admiralty charts in large numbers for the Navy Department and various military maps of French and Belgian areas for the War Department. Motor-truck route maps and airplane route maps have also been compiled and printed for the use of the Army, as well as special charts and maps for use at instruction camps. An interesting use of this specially

equipped printing plant has been the regular issue of camouflage charts for the Navy. The regular geologic-map work has given place during the period of the war to these exigency calls for color printing for military purposes.

Results.—The distribution among the various branches of the military departments and the war boards of the service represented by these activities is shown in the accompanying diagram (Pl. I), as well as on the more detailed charts illustrating the reports of the geologic, topographic, and water-resources branches (Pls. II–IV). Yet these charts are simply diagrammatic and express only in part the results of the year's activities. Every member of the organization, clerical no less than technical, has met the call for larger service. The service of the engineer officers in France and the other Survey representatives in uniform has been largely the extension simply of the same type of technical work in the United States, and this fact has given point to all the official work. The realization that immediate use was being made of all the data collected by the Survey investigators has strengthened the desire for practical accuracy, and the war work of the scientists has undoubtedly stimulated the tendency toward seeking quantitative rather than merely qualitative results. The war has given science a larger opportunity to be useful.

War honors.—The following general order furnishes evidence of the value of the special service rendered overseas by the topographic engineers contributed by the Geological Survey.

HEADQUARTERS RAILWAY ARTILLERY RESERVE, A. E. F.,
France, May 18, 1918.

Memorandum
No. 1.

The following is published for the information of all concerned:

"EIGHTH ARMY ARTILLERY STAFF, No. 2916,
"*Headquarters, May 11, 1918.*

"Order No. 24.

"Colonel Rebourseau, Acting Artillery Commander, Eighth Army, cites in Army Artillery Orders:

"Lieutenant Kostka Mudd, C. E., U. S. R., Group 8-inch howitzers, American Howitzer Regiment,

"Orienteur officer of a group of 8-inch howitzers, displayed a most praiseworthy devotion to duty. On two separate occasions executed difficult topographic operations under heavy bombardment. Seriously wounded while engaged in this duty.

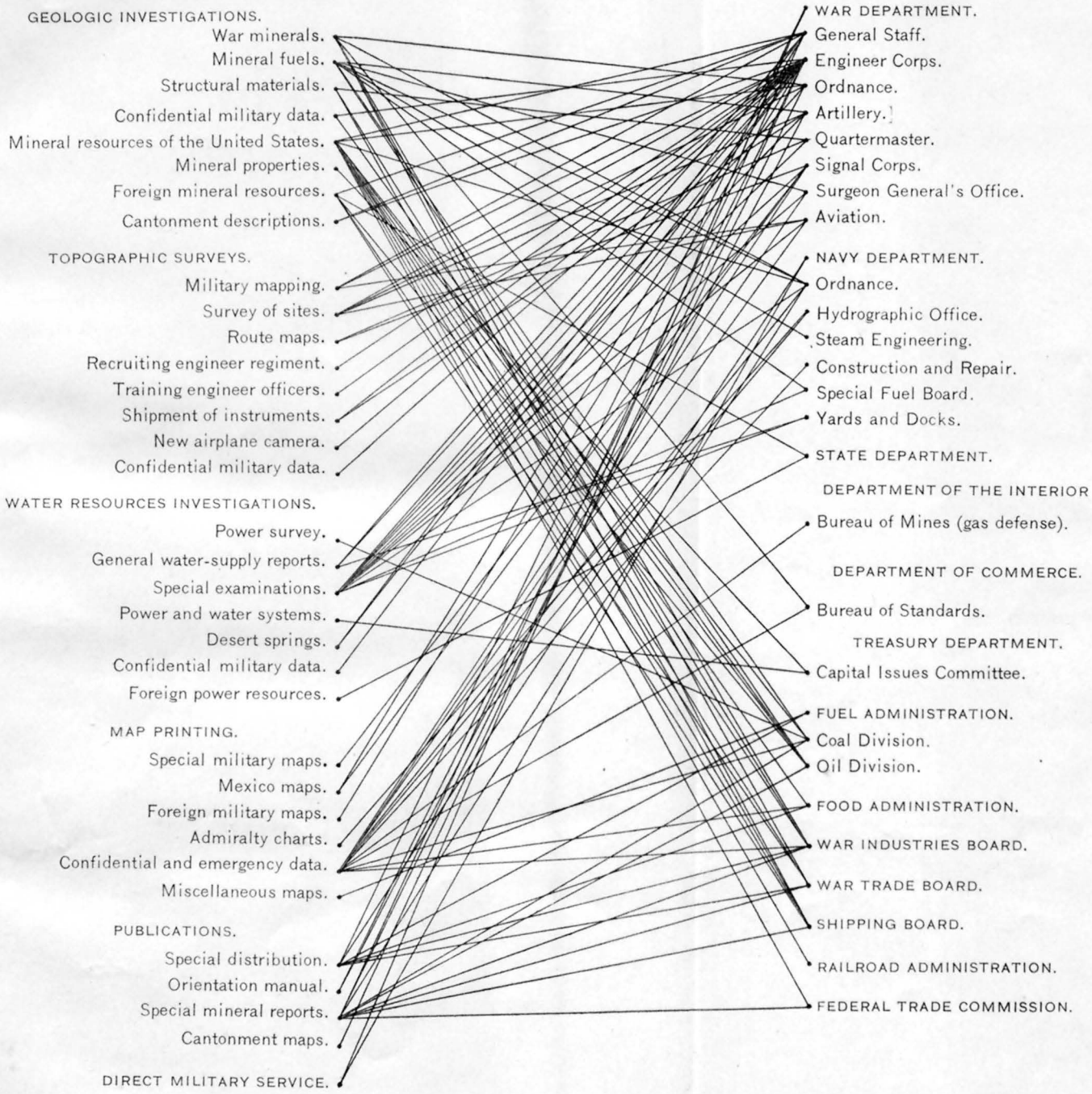
"Colonel Acting Artillery Commander, Eighth Army.
"(Signed) REBOURSEAU."

(2749)

By command of Brigadier General COE:

J. F. HOWELL,
Colonel, General Staff Corps, Chief of Staff.

Official:
J. H. COCHRAN,
Captain Coast Artillery Corps, Adjutant.



CONTRIBUTIONS TO WAR SERVICE BY THE UNITED STATES GEOLOGICAL SURVEY.

GROVE KARL GILBERT.

The coming of large opportunity for special service as outlined in the preceding pages gives added force to any tribute to those who have fitted the Survey organization for effective work. Grove Karl Gilbert was one of the original members of the Survey and retained the position of geologist until his death on May 1, 1918. By reason of his earlier connection with two of the earlier Federal surveys, the Wheeler and Powell surveys, and his continuous service of 39 years with the present organization, Mr. Gilbert had perhaps the largest opportunity to influence the working geologists in the Federal service, and that he so fully improved that opportunity was due to his exceptional talent for scientific leadership. His first work under the present Survey, the Lake Bonneville monograph, still retains its place as the premier among the more than 1,300 scientific and technical volumes of the United States Geological Survey. To those who had the privilege of reading Monograph I while they were beginners in geology there came an inspiration for thorough observation of geologic facts and clear analysis of geologic processes that remains linked with the name of G. K. Gilbert, but doubly fortunate were the smaller number of students who sat under the teaching of this scholarly investigator, who saw the truth so clearly. Happily, Mr. Gilbert's influence upon geologists was extended to the scores of members of the Survey's scientific staff who successively were associated with him in official life, and the closer that association the more enthusiastic was the recognition of helpful stimulus received.

The combination of keen mind and kind heart granted to Mr. Gilbert in so generous measure made him a leader in scientific thought, whose share in making and fixing the standards of the United States Geological Survey can not be overestimated. At this time, when the organization to which he devoted the best part of his life is making its largest contribution of usefulness to the Nation, full credit must be given to Mr. Gilbert and the other pioneers in scientific public service. Among his many contributions to geologic science, Mr. Gilbert's last, the professional paper on the mining-débris problem in the Sierra Nevada, was characterized by the same thoroughness of treatment which gave both value and charm to the Bonneville monograph. Throughout the period between Mr. Gilbert's first study of the Great Basin region and the completion of his Sierra Nevada investigation his outlook upon his science was so broad as to bring every type of data to bear upon the problem in hand, and his purpose was everywhere evident to determine quantitatively as many factors as possible. Mr. Gilbert was a geologist who won the respect of the engineer, and his influence was unconsciously exerted in giving to his science that degree of accuracy which can state results in figures as well as in adjectives. Pure science as given to the world by Grove Karl Gilbert was useful science.

WORK OF THE YEAR.

PUBLICATIONS.

The publications of the year numbered 229 and consisted of 1 annual report, 6 professional papers, 11 separates from 3 professional papers, 14 bulletins, 48 separates from 6 bulletins, 17 water-supply papers, 2 separates from 1 water-supply paper, 1 annual report on mineral resources in two parts, 61 separates from 2 annual reports on mineral resources, 1 new geologic folio and 1 folio in the octavo edition, 1 list of publications, 1 circular listing geologic folios available, 1 advance statement on copper in 1917, 2 index-map circulars, 1 book entitled "Manual for the Artillery Orientation Officer," 48 press bulletins, and 12 monthly lists of new publications. The total number of pages in these publications was 14,913. Brief notices of the publications in the regular series are given below:

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. 1917. 176 pages, 2 plates.

A detailed account of the work of the Geological Survey during the fiscal year 1917, including reports from each branch, division, and section, abstracts of the publications of the year, and maps showing areas covered by geologic and topographic surveys. Under the heading "Special features" the Director discusses the war work of the Survey, emphasizing the use made of results already at hand as the product of years of field and office investigation; the concentration of present geologic field work on the essential mineral resources, especially those of which the domestic supply falls short of current demands; and the notable contributions made by the Survey to the conduct of the war through the diversion of practically all the activities of the topographic branch to the urgent needs of the War Department for military surveys, the printing of a large number of maps and charts for the War and Navy Departments in the Survey's plant, and the commissioning in the Engineer Officers' Reserve Corps of a group of 69 specially trained Survey engineers, two of whom were appointed on Gen. Pershing's staff. During the year the Survey moved to the new Interior Department Building the completion of which marked 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 and the large accumulation of scientific records. Nearly one-third of the building is occupied by the Survey.

PROFESSIONAL PAPER 93. Geology of the Navajo country; a reconnaissance of parts of Arizona, New Mexico, and Utah, by H. E. Gregory. 1917. 161 pages, 34 plates, 3 text figures.

The region described as the Navajo country lies mainly in northeastern Arizona, between Puerco, Little Colorado, Colorado, and San Juan rivers and the one hundred and eighth meridian, and contains over 25,000 square miles. Of this area more than 22,000 square miles is included within six Indian reservations, which form the largest area of undeveloped Indian land in the United States. The Atchison, Topeka & Santa Fe Railway extends along the southern margin of this region, but most of the region is difficult of access, roads and trails are few, water is scanty and generally poor, and food for animals is scarce. The white population is very small and consists of widely scattered Government officials, traders, and missionaries. The Indians number over 32,000 and are none too friendly. Geologic work in such a country is necessarily reconnaissance; some of

it, in fact, is exploratory. As the region is arid, the primary object of the investigation was to obtain information concerning the water supply. The results of this phase of the work have been set forth in Water-Supply Paper 380, noticed in the Thirty-eighth Annual Report. So far as the demands of the main problem permitted, geologic mapping was done and the most significant geologic features were noted. This phase of the work is reported in Professional Paper 93. It is believed that in view of the limits imposed by the nature of the work the geologic map accompanying this paper represents fairly well the areal geology of the Navajo country and that the text presents the essential facts in its geologic history. Stratigraphy received the most attention and is discussed in greatest detail; igneous rocks, structure, physiography, and economic geology are treated somewhat less fully. An appendix gives a list of geographic names in the Navajo country, with the authority, significance, and origin, compiled from the best available sources, as well as the author's own observations. The paper is illustrated by numerous views of striking or significant geologic features and both topographic and geologic maps.

PROFESSIONAL PAPER 96. The geology and ore deposits of Ely, Nev., by A. C. Spencer. 1917. 189 pages, 15 plates, 4 text figures.

This paper is not only a monographic study of the most productive copper district in Nevada but the first report to be issued by the United States Geological Survey to describe adequately some of the great deposits of disseminated ore which during the last few years have contributed so largely to the copper output of the country. The chemistry of ore deposition and enrichment is discussed more thoroughly and closely in this report than it commonly is in a geologic monograph, and because of the author's wide field experience and of the many suggestions that he makes for future experimental investigations this part of the report should be of especial value. The general geologic features of the district are clearly set forth, and the ore deposits are described with the completeness of detail that is characteristic of the Survey's reports on mining districts. The descriptions of the mines and prospects are illustrated by numerous maps and sections, and the paper contains also topographic and geologic maps of the district and views of some of its principal features.

PROFESSIONAL PAPER 98. Shorter contributions to general geology, 1916; David White, chief geologist. 1917. 395 pages, 102 plates, 46 text figures.

Contains 22 papers by 20 authors. These papers, which had previously been published separately, have been noticed in the Thirty-seventh and Thirty-eighth annual reports.

PROFESSIONAL PAPER 99. Chemical analyses of igneous rocks published from 1884 to 1913, inclusive, with a critical discussion of the character and use of analyses (a revision and expansion of Professional Paper 14), by H. S. Washington. 1917. 1,201 pages, 3 text figures.

This paper contains 8,602 analyses of igneous rocks, collected by a very extensive, systematic, and thorough search of the literature. Among them are included practically all those given in Professional Paper 14 (published in 1903 and now out of print), which embraced 2,881 analyses. The progress made in this branch of geology is shown not only by the greatly increased number of analyses but by their better quality and greater fullness. In discussing the character of rock analyses the author mentions the tendency, even among petrographers, to accept without question the results of an analysis—to assume that the analyst, like the proverbial king, can do no wrong. This assumption applies, of course, not to the personal good faith of the analyst but to the analytical methods he employs. Comparatively few petrographers seem to recognize the difficulties and uncertainties of analytical work. A consequence of this unquestioning confidence is that such work is likely to be intrusted to a student in chemistry who has had no

experience in quantitative rock analysis and does not appreciate its complexities and difficulties. Dr. Washington urges that the ability to make an accurate and complete chemical analysis of an igneous rock should form an essential part of the training and equipment of every petrographer and sets forth criteria by which analyses may be judged. The analyses included in this volume have been rated according to these criteria in five classes, described as excellent, good, fair, poor, and bad. Those of the first three classes, called superior analyses, are considered worthy of use in petrologic discussions; those of the other two classes are of little or no use. Of the 8,602 analyses included in this collection over 6,500 are classified as superior. The norms of the superior analyses of fresh rocks, numbering nearly 5,000, have all been recalculated, and these analyses are arranged according to the quantitative system of classification, an outline of which is given as one of the appendixes. Several indexes facilitate reference to the analyses. To the petrographer this volume should be useful in many ways. It includes practically all the analyses of igneous rocks that have been published during the 30 years ending with 1913, so arranged that they may be readily studied and compared. The references that accompany the analyses constitute an extensive bibliography of the science of petrography.

PROFESSIONAL PAPER 100–B. The coal fields of Ohio, by J. A. Bownocker, with a computation of the original coal content of the fields by F. R. Clark. 1917. Pp. 35–96, Pls. II–IX, figs. 4–49.

Part of Professional Paper 100, The coal fields of the United States. The volume of which this paper forms the second part to be published is planned to give information concerning the quantity, quality, and geographic distribution of the coal still in the ground in this country and available for future use. As Part A was a general introduction to the volume, this paper is the first of the series covering the separate States or groups of States. It was prepared by the State geologist and describes the coal beds in detail, with numerous maps and both tabular and graphic sections, shows the composition of the coals by a large number of analyses, and discusses the uses to which Ohio coals are put. The computations of the original coal content of the several fields indicate a total of 87,638,000,000 tons, of which 86,552,000,000 tons remains available.

PROFESSIONAL PAPER 101. Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico; papers by W. T. Lee and F. H. Knowlton. 1917. 450 pages, 103 plates, 16 text figures.

The primary object of the studies whose results are set forth in these papers was to determine the geologic relations in the Raton Mesa region, a highly dissected plateau lying just east of the Rocky Mountains and extending across the boundary between Colorado and New Mexico. This region is a geologic unit but comprises two coal fields, one in each State. The coal occurs in two formations, separated by an unconformity, and the questions whose answers were sought in these studies are whether or not the coal-bearing formations are widely separated in time and with what formations they are to be correlated. Mr. Lee concludes that the lower formation is Upper Cretaceous and the upper formation is Eocene and that the unconformity represents post-Cretaceous erosion. As his conclusions differ radically from those held by some other geologists, he states briefly the fundamental principles that have governed him in placing the Cretaceous-Tertiary boundary. The principle is generally accepted that the uplift in western America which drained the continent and culminated in the formation of the mountains marks the division of time between Cretaceous and Tertiary, but there is no general agreement in applying this principle. Mr. Lee believes that the first of a series of movements that followed a long period of quiescence and ushered in a succession of crustal disturbances like those of the Tertiary is more significant in delimiting periods of geologic time than the greatest movement of the series,

and therefore that the lowest well-marked unconformity above rocks of undoubted Cretaceous age in the Rocky Mountain region—the unconformity here described—should constitute the line of separation between Cretaceous and Tertiary. The paper discusses the general geology, describes the local features in detail, with sections, maps, and views, and sets forth the correlation of the formations with those of other regions. The coal-bearing formations contain great numbers of fossil plants, of which some afford a means of correlation with the formations of other fields and others are new to science. These plants are described and illustrated by Mr. Knowlton.

PROFESSIONAL PAPER 105. Hydraulic-mining débris in the Sierra Nevada, by G. K. Gilbert. 1917. 154 pages, 34 plates, 33 text figures.

The protest and litigation resulting from the conflict of interest between the hydraulic miners of the Sierra Nevada and the valley farmers whose alluvial lands were being buried and ruined by mine tailings washed down by floods from the mountains culminated in 1884 in a series of injunctions whereby the miners were restrained from casting their tailings into the streams. In 1893 a permanent board, known as the California Débris Commission, was appointed with authority to regulate hydraulic mining in such a way as to prevent any injury to the navigable waters of Sacramento and San Joaquin rivers. Under licenses granted by this commission a small amount of hydraulic mining was carried on, but the experience of the first 10 years seemed to demonstrate that the great deposits of auriferous gravel, whose average gold content is small, could not be exploited at a profit under such restrictions. In 1904 the California Miners' Association addressed a memorial to the President requesting him to instruct the United States Geological Survey to make a study of those portions of the Sacramento and San Joaquin valleys affected by the detritus from torrential streams. This study was undertaken, and the present report deals largely with the geologic and physiographic aspects of the subject. The phase of the study covered by a laboratory investigation of the laws of transportation of detritus by running water had already been treated in Professional Paper 86, by the same author. Professional Paper 105 gives a historical outline of the development and restriction of hydraulic mining in California, a discussion of the physical features of the northern part of the great interior valley of the State, a summary of the evidence indicating subsidence of the land, an account of the changes in the condition of rivers and bays from artificial causes, including some changes not attributable to mining, data on the quantity and distribution of detritus, a report of studies on Yuba River, where retaining works had been erected, an analysis of the relation of the movement of débris to the Golden Gate bar, and suggestions for future handling of this problem. The author's studies show that the depth of water on the bar outside the Golden Gate, a matter of prime importance to the port of San Francisco, depends chiefly on the supply of sand brought to the bar and the velocity of the tidal currents by which it is distributed. The sand brought to the head of Suisun Bay by Sacramento and San Joaquin rivers is not believed to reach the bar in any appreciable quantity, but the tidal scour through the Golden Gate is reduced by deposits on shoals in the bays and by encroachments on the area of the bays through the reclamation of bordering marsh lands and other causes. Every acre of reclaimed tide marsh implies a fractional reduction of the tidal current in the Golden Gate. The question whether the community should make a large addition to its permanent agricultural wealth at the cost of a small permanent injury to its great harbor is a question of relative values. The stress which caused the restriction of hydraulic mining no longer exists. By means of suitable works for the control of floods in the valley rivers mining might be partly resumed without prejudice to any valley interest except navigation. The important interest which now dictates that débris should be controlled is that

of the commerce which traverses the Golden Gate. Possibilities for resumption of mining on a large scale, with storage of débris, lie in cooperation with irrigation and electric-power development for the control of Sierra streams. This paper is abundantly illustrated with views of features showing different phases of the subject, diagrams, and maps.

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

PROFESSIONAL PAPER 108–F. A fossil flora from the Frontier formation of southwestern Wyoming, by F. H. Knowlton. 1917. Pp. 73–107, Pls. XXVII–XXXIX.

This paper deals with a small but important fossil flora from the vicinity of Cumberland, Lincoln County, Wyo. The plants were discovered by Frémont in 1843, were described and figured by Hall in 1845, and then remained in obscurity and practically lost for more than 40 years. A part of the collection was found in 1887 in the National Museum, covered with dust and without adequate labels. Attempts to determine the locality from which they came by means of Frémont's account were unsatisfactory, but finally the discovery of identical material near Cumberland removed the doubt. They were referred tentatively by Hall to the Jurassic but are now known to be of Colorado age (Cretaceous).

PROFESSIONAL PAPER 108–G. Orbitoid Foraminifera of the genus *Orthophragmina* from Georgia and Florida; papers by C. W. Cooke and J. A. Cushman. 1917. Pp. 109–124, Pls. XL–XLIV, figs. 19–20.

Mr. Cooke discusses the stratigraphic and faunal associates of the species described by Mr. Cushman, in order to make evident the value of these species in the investigation of problems of geologic correlation.

PROFESSIONAL PAPER 108–H. The Pliocene history of northern and central Mississippi, by E. W. Shaw. 1918. Pp. 125–163, Pls. XLV–LX, figs. 21–25.

The record of Pliocene time in northern and central Mississippi is generally assumed to be scant or lacking, but recent work on the later Tertiary and Quaternary geology of the Mississippi embayment has brought to light a large mass of data bearing on the Pliocene history of this region, and the object of this paper is to present some of these data and point out their apparent significance. The author concludes that at the beginning of the Pliocene epoch the surface of Mississippi was smoother than it is to-day, that this surface of low relief persisted through perhaps a third or a half of the epoch, and that it was then uplifted intermittently, during four principal stages, to a maximum amount of 200 feet. This part of the State was at the beginning of Pliocene time at least 100 feet above the highest hills remaining to-day, and much of it was lowered by erosion more than 200 feet in the Pliocene epoch. The paper is profusely illustrated with views of surficial features, maps, and sections.

PROFESSIONAL PAPER 108–I. Stratigraphy in southwestern Maine and southeastern New Hampshire, by F. J. Katz. 1917. Pp. 165–177, Pl. LXI, fig. 26.

Describes the geologic formations in an area of about 1,500 square miles lying mostly between Portland, Me., and Portsmouth, N. H., a part of the New England coastal lowland whose rock surface is abundantly mantled with glacial drift and over broad areas deeply buried under outwash deposits of late Pleistocene age.

PROFESSIONAL PAPER 108–J. The Flaxville gravel and its relation to other terrace gravels of the northern Great Plains, by A. J. Collier and W. T. Thom, jr. 1918. Pp. 179–184, Pls. LXII–LXV, fig. 27.

Describes a terrace deposit of Miocene or early Pliocene age, occurring at intervals south of the international boundary for 175 miles westward from the vicinity of Flaxville, Mont., and shows its relation to Canadian deposits of Oligocene age a short distance north of the boundary. This deposit is composed largely of pebbles from the Rocky Mountains, to the west, and contains numerous fossil bones, which have been found at 25 widely separated localities.

PROFESSIONAL PAPER 108-K. The Helderberg limestone of central Pennsylvania, by J. B. Reeside, jr. 1917. Pp. 185-225, figs. 28-30.

Presents the results of a study of certain formations which have been examined in Maryland, New Jersey, and New York and described with more or less detail but concerning whose occurrence in the intervening area in Pennsylvania little exact information has been available. Gives a number of local sections in great detail.

PROFESSIONAL PAPER 108-L. Stratigraphy of the Hanna Basin, Wyo., by C. F. Bowen. 1918. Pp. 227-235, Pl. LXVI, fig. 31.

Describes an area in Carbon County, Wyo., that has attracted the attention of geologists since the days of the territorial surveys under King, Hayden, and Powell. Gives evidence to show that what had previously been regarded as a single formation consists of two formations separated by a marked unconformity and offers some suggestions as to the source of the material in the more than 20,000 feet of continental deposits in this area.

This pamphlet contains a title-page, table of contents, and index for the use of those who may wish to bind the separate parts of Professional Paper 108.

Parts of Professional Paper 120, Shorter contributions to general geology, 1918, as follows:

PROFESSIONAL PAPER 120-A. New determinations of carbon dioxide in water of the Gulf of Mexico, by R. C. Wells. 1918. Pp. 1-16, fig. 1.

Although the carbon dioxide in sea water is the subject of an extensive literature, recent advances in geochemistry have brought out new relations that require further determinations in order to show the connection, if any exists, between the history, temperature, and geographic location of the water, the life it contains, and its saturation with calcium and magnesium compounds. This paper gives the results of determinations on water from the Gulf of Mexico, which is essentially similar to that of the open ocean.

PROFESSIONAL PAPER 120-C. Deposits of Claiborne and Jackson age in Georgia, by C. W. Cooke and H. K. Shearer. 1918. Pp. 41-81, Pl. VII, figs. 7-9.

Information obtained in field work during the last few years in the Coastal Plain of Georgia throws light on certain previously unsolved problems of stratigraphy and considerably alters some former correlations. This paper presents the new evidence regarding the age and correlation of the Eocene formations of Georgia and gives revised descriptions of the deposits of Claiborne and Jackson age.

PROFESSIONAL PAPER 120-E. Two lamprophyre dikes near Santaquin and Mount Nebo, Utah, by G. F. Loughlin. 1918. Pp. 101-109, fig. 13.

No description of lamprophyre dikes in Utah has heretofore been published, and this paper is presented as a contribution to the petrology of the State. The two dikes described are on the west slope of the Wasatch Mountains.

BULLETIN 597. Geology of Massachusetts and Rhode Island, by B. K. Emerson. 1917. 289 pages, 10 plates, 2 text figures.

In preparing this treatise and the accompanying geologic map the author endeavored to use all the material available. A large part of the area is described from the results of his own studies, which began in 1871. The State of Massachusetts presents a perfect illustrative section across the Appalachian Mountain system in an area where it culminates in variety and complexity, about midway in its great sweep from Newfoundland to Alabama. This area lies just south of the region where the great folds of this mountain system were compressed against the Adirondacks, by forces thrusting from the east, in a zone where the ancient unfolded rocks of New York form the foreland. The broad topographic divisions of the State, which have been marked out by erosion, are also the broad geologic divisions. These are the limestone valley of the Housatonic; the upland of

eastern Berkshire County, largely granite; the sandstone valley of the Connecticut; the central upland, or Worcester County plateau, made up of granite and schist; the slope descending eastward from the central upland, underlain by a great complex of stratified and igneous rocks; and the Coastal Plain, including Cape Cod Peninsula and the islands to the south. The illustrations of this report include views of rock specimens and of models showing restorations of the great Triassic reptiles whose footprints have been found in the Connecticut Valley and a detailed geologic map of the two States.

BULLETIN 641. Contributions to economic geology (short papers and preliminary reports), 1916, Part II, Mineral fuels; David White, G. H. Ashley, and M. R. Campbell, geologists in charge. 1917. 333 pages, 25 plates, 36 text figures.

Contains 12 papers of the classes indicated in the subtitle, by 11 authors. These papers were published separately in advance and have been noticed in the Thirty-seventh and Thirty-eighth annual reports.

BULLETIN 647. The Bull Mountain coal field, Musselshell and Yellowstone counties, Mont., by L. H. Woolsey, R. W. Richards, and C. T. Lupton; compiled and edited by E. R. Lloyd. 1917. 218 pages, 36 plates, 2 text figures.

The Bull Mountain coal field, which lies somewhat southeast of the center of Montana, about 25 miles north of Billings, came into prominence in 1906–7, soon after the construction of the Pacific coast extension of the Chicago, Milwaukee & St. Paul Railway, which passes through the northern part of the field. The coal is a subbituminous coal of high grade, the beds are in general situated favorably for mining and can be reached by short spurs from the railway, and sufficient water and timber are to be had near by. All the conditions in the field give promise that the growth of the coal-mining industry here will be steady and persistent. The Survey has already published preliminary reports on the salient geologic and economic features of the field, and the present report describes the field and the coal beds in greater detail and gives some additional information. The description is arranged by townships, and each township description is accompanied by a map showing the topography and economic geology, including sections of the coal beds. A general geologic map of the whole field is also given, and the report contains several views showing geologic features of interest.

BULLETIN 651. Spirit leveling in Ohio, 1898 to 1916, inclusive; R. B. Marshall, chief geographer. 1917. 456 pages, 2 plates.

Gives the results of all spirit leveling done by the Geological Survey in Ohio to the end of 1916. Primary or precise leveling has now been extended over the entire State, and every county has several bench marks well distributed within its area. These bench marks are shown on a map of Ohio included in the bulletin. The highest point in the State is said to be Campbell Hill, in Logan County, 1,550 feet above sea level.

BULLETIN 654. Spirit leveling in Nevada, 1897 to 1916, inclusive; R. B. Marshall, chief geographer. 1917. 91 pages, 1 plate.

Gives the results of all spirit leveling done by the Geological Survey in Nevada to the end of 1916. The elevations recorded range from 470 feet on Colorado River in Clark County to 13,145 feet on East Peak, in the White Mountains, in Esmeralda County.

BULLETIN 655. The Lake Clark-central Kuskokwim region, Alaska, by P. S. Smith. 1917. 162 pages, 12 plates, 6 text figures.

The lower part of the Kuskokwim Valley was explored by the Russians in the first half of the eighteenth century, and the upper part was explored by the United States Geological Survey in 1898. In 1909 the Iliamna region, southeast of the Kuskokwim, was covered by an extensive geologic and topographic reconnaissance survey. The exploration of the region between Lake Clark and Kuskokwim River, whose results are set forth in this report, was planned to tie

together these earlier surveys. It traversed a field that was almost unknown except through the reports of a few prospectors and fur hunters, and therefore its results replace a nearly complete blank in our knowledge of the geography and geology of Alaska. During this exploration 4,800 square miles of previously unsurveyed country was mapped, the positions of certain previously known features were determined with greater precision, data were obtained concerning the geologic and physiographic character and history of this region, and some notes were made about the flora, fauna, climate, and population. Few mines or prospects are being developed in this region, but the report gives a sketch of the mineral resources and a summary of the general conditions that prevail at the mining camps in adjacent regions. The principal metalliferous deposits are those of gold and quicksilver, but other minerals occur in minor amounts. The report is well illustrated with views of the region and contains topographic and geologic maps.

BULLETIN 656. Anticlines in the southern part of the Big Horn Basin, Wyo.; a preliminary report on the occurrence of oil, by D. F. Hewett and C. T. Lupton. 1917. 192 pages, 32 plates, 12 text figures.

Gives information regarding 50 domes and anticlines, gathered during geologic examinations made for the purpose of classifying the lands in the Big Horn Basin according to their content of oil or other minerals. At the time of publication 11 of these anticlines had already proved to be productive of oil, though some of them had not been drilled sufficiently to indicate their commercial value. The surface indications suggest that at least half of the anticlines described in this paper constitute some of the most promising undeveloped oil territory in Wyoming. The Big Horn Basin seems to be destined to furnish a large contribution to the Nation's supply of high-grade oil. The paper contains numerous structure-contour maps, and each anticline is described in detail.

BULLETIN 658. Geologic structure in the Cushing oil and gas field, Okla., and its relation to the oil, gas, and water, by C. H. Beal. 1917. 64 pages, 11 plates, 4 text figures.

Sets forth some interesting facts that are thought to be related to the accumulation of oil and natural gas, disclosed on analysis of a large amount of information collected by a petroleum technologist of the Bureau of Mines in connection with the supervision of "oil and gas mining operations on allotted lands leased by members of the Five Civilized Tribes" authorized by the act of August 1, 1914. The Cushing field is the most productive light-oil field in the world and embraces nearly 35 square miles of productive territory, in which have been drilled about 2,500 wells ranging in depth from about 1,200 to nearly 3,000 feet. Until other fields have been similarly studied and more facts become available only tentative hypotheses can be advanced to account for the phenomena observed. It is hoped that this paper will stimulate such studies, so that ultimately a large body of facts may be obtained to throw light on the laws governing the accumulation of oil and gas. The paper contains several structure maps.

BULLETIN 659. Cannel coal in the United States, by G. H. Ashley. 1918. 127 pages, 8 plates, 27 text figures.

Cannel coal is essentially a rock formed by the solidification and partial oxidation of water-laid deposits consisting mainly of plant spores, pollen grains, and remains of low orders of water plants and animals. It differs from bituminous coal, which is derived from woody or peaty material grown in place. About 60 years ago cannel coal was the principal source of oil in the United States, but the discovery of rock oil naturally knocked the bottom out of the "coal-oil" industry. The recent rapid growth in the demand for hydrocarbons and their products has brought about a renewed interest in cannel coal, which is one of the richest substances in hydrocarbons known. The availability of these hydrocarbons for the

chemical industry is yet to be proved but the increasing number of inquiries for information concerning cannel coal have led to the preparation of this report. The author has compiled a large number of facts about cannel coal from many sources and gives the results of his own observations on some of the deposits. Many analyses, including some of English and Scotch cannels, are given, and the properties, composition, origin, mode of occurrence, and uses of cannel coal are discussed. The known deposits in this country are described in detail. The book contains numerous maps and sections, together with views showing the character of the coal.

Parts of Bulletin 660, Contributions to economic geology, 1917, Part I, as follows:

BULLETIN 660–B. Notes on the greensand deposits of the eastern United States, by G. H. Ashley; Methods of analysis of greensand, by W. B. Hicks and R. K. Bailey. 1917. Pp. 27–58, Pl. II, fig. 1.

The shortage of potash resulting from the shutting off of the foreign supply has led to a vigorous search for possible new sources in this country. Among the mineral deposits that contain potash are the greensands of the Eastern States, which underlie hundreds if not thousands of square miles within reach of the steam shovel. The object of Mr. Ashley's paper is to place before chemical engineers and others succinct information as to the location and extent of easily accessible deposits in the Eastern States and as to their content of potash. The deposits discussed lie in New Jersey, Delaware, Maryland, Virginia, North Carolina, Tennessee, and Arkansas, and those in New Jersey and Delaware were found to be the best and most available, their potash content ranging from 3.50 to 7.15 per cent. These deposits are abundant, and the practical question is one of profitable exploitation.

The second paper discusses discrepancies shown in analyses of greensand made by different methods and describes the method used by the Geological Survey, which is much shorter than any other known method and is believed to be sufficiently accurate for commercial work.

BULLETIN 660–C. Manganese deposits of the Caddo Gap and De Queen quadrangles, Ark., by H. D. Miser. 1917. Pp. 59–122, Pl. III, figs. 2–13.

The high prices offered for manganese ores on account of the war demand have stimulated interest in the manganese deposits of west-central Arkansas, which had previously been little exploited. Recent developments, which began in 1916, have been confined almost entirely to the area discussed in this paper. The author gives an outline of the geology of the area and describes the ore deposits and the mines and prospects in detail. He concludes that some of these deposits that might now be worked at a profit will not pay to work after the price of ore again becomes normal. The paper contains a geologic map and numerous sections and diagrams showing the mode of occurrence of the ore.

BULLETIN 660–D. Tin resources of the Kings Mountain district, North Carolina and South Carolina, by Arthur Keith and D. B. Sterrett. 1917. Pp. 123–146, Pl. IV.

Describes a tin belt that lies along or near the Southern Railway between Bessemer City, N. C., and Gaffney, S. C. No known tin deposit in this belt is more than 3 miles from a railroad. Considerable work has been done on the tin-bearing veins in this area but not enough to indicate conclusively whether they are of commercial value. The paper discusses the general geology of the area and describes the mines and prospects.

BULLETIN 660–E. Louisiana clays, including results of tests made in the laboratory of the Bureau of Standards at Pittsburgh, by G. C. Matson. 1917. Pp. 147–158, Pl. V, figs. 14–15.

Describes samples of clay obtained from the principal geologic formations of Louisiana at a number of localities. The samples were collected to determine

the possibilities of obtaining clays suitable for the manufacture of brick, terra cotta, tile, and other building materials, for which the demand is gradually increasing. The paper contains a map showing the distribution of clay-bearing formations in Louisiana, diagrams of well sections, and a table giving the results of the tests.

BULLETIN 660–F. Ore deposits of the northwestern part of the Garnet Range, Mont., by J. T. Pardee. 1918. Pp. 159–239, Pls. VI–IX, figs. 16–25.

The area described in this paper lies in western Montana, about 30 miles southeast of Missoula. It has yielded between $6,000,000 and $10,000,000 in placer gold and about $1,500,000 in gold, besides considerable copper, lead, and silver, from lodes. Most of the mines show no evidence of being exhausted, and new discoveries are looked for throughout the area. The paper consists of an outline of the geography, physiography, and geology and a detailed description of the ore deposits and the mines and prospects. It is illustrated by geologic maps and sections showing veins and workings.

BULLETIN 660–G. The Dunkleberg mining district, Granite County, Mont., by J. T. Pardee. 1917. Pp. 241–247, Pl. X, fig. 16.

Describes a small district in western Montana about 50 miles northwest of Butte. Lode mining has been carried on intermittently in this district during the last 30 years, and the total production is estimated at $200,000 in silver and lead.

BULLETIN 660–H. The antimonial silver-lead veins of the Arabia district, Nev., by Adolph Knopf. 1918. Pp. 249–255.

The Arabia district, in Humboldt County, Nev., was an active mining camp in the late sixties but has been idle till recently. The present high prices of lead, antimony, and silver have stimulated renewed activity in this district, and this paper is a sketch of the ore deposits and the mines and prospects. The author concludes that it is not unreasonable to expect that rich secondary antimonial silver sulphides will be found at depths greater than those reached by the present workings and that the district merits deeper exploration than has yet been attempted.

BULLETIN 660–I. Strontianite deposits near Barstow, Cal., by Adolph Knopf. 1918. Pp. 257–270, Pl. XI.

Strontium is used principally in the form of strontium hydrate in a process for the recovery of sugar from the large amounts of molasses that are unavoidably produced during the manufacture of beet sugar. This process is used in several foreign countries. Strontium is also used in signal lights and in fireworks to give a brilliant red color to the flame. Of the two commercial sources of strontium the carbonate, strontianite, is the more valuable, though much less common than the sulphate, celestite. War conditions have stimulated the search for new deposits, and strontianite was found near Barstow, San Bernardino County, Cal., in 1915. This paper describes not only the California deposits but the chief commercially productive strontium deposits of Europe, in England, Sicily, and Germany. The permanence of the industry in this country is thought to depend on the adoption of the strontia process by American beet-sugar refineries; and this, in turn, probably depends on the assurance of a regular supply of strontium hydrate at a reasonable price.

BULLETIN 660–J. Possibilities for manganese ore on certain undeveloped tracts in Shenandoah Valley, Va., by D. F. Hewett, G. W. Stose, F. J. Katz, and H. D. Miser. 1918. Pp. 271–296, figs. 26–33.

This report aims to present briefly the results of field work in a part of Virginia where many manganese deposits are known. The examination was directed toward the discovery of areas likely to contain manganese, with the aid of data gathered in a study of the geologic relations of known deposits. Northwestern Virginia has long been the source of much of the manganese ore mined in the

United States. The deposits lie along the east side of the Shenandoah Valley, at the foot of the Blue Ridge, and this examination covered a narrow belt about 85 miles long, at the center of which is the most productive mine in this area—the Crimora. Six undeveloped tracts are recommended as presenting features favorable for the accumulation of deposits of manganese and manganiferous iron ores, and the paper contains sketch maps showing the location of each tract and the general geology in its vicinity. The field work was done in cooperation with the Virginia Geological Survey, which will publish a more detailed report.

This pamphlet contains a title-page, table of contents, introduction, and index (pp. i–viii, 297–304) for the use of those who may wish to bind the separate chapters of Bulletin 660.

Parts of Bulletin 661, Contributions to economic geology, 1917, Part II, as follows:

BULLETIN 661–B. Structure of the northern part of the Bristow quadrangle, Creek County, Okla., with reference to petroleum and natural gas, by A. E. Fath. 1917. Pp. 69–99, Pls. III–VI, figs. 14–18.

Describes a part of the Bristow quadrangle, in Creek County, northeastern Oklahoma, within which, although it is bordered by some of the most productive oil fields of the State, only a few gas wells had been drilled and a very small quantity of oil had been found. The area described contains several anticlines, a few of which appear to be well worth prospecting with the drill. The paper contains a map showing topography and geologic structure, a number of well records, and descriptions of localities where the structure is favorable or unfavorable for the accumulation of oil.

BULLETIN 661–C. The De Soto-Red River oil and gas field, La., by G. C. Matson and O. B. Hopkins. 1917. Pp. 101–140, Pls. VII–X, figs. 19–21.

Describes an oil and gas field in northwestern Louisiana, 30 miles southeast of Shreveport and 45 miles south of the Caddo oil and gas field. Gas was discovered in the De Soto Parish in 1912, and oil a year later. The first oil well in Red River Parish was drilled in 1914. The total production of the field has probably been over 12,000,000 barrels. The report contains a map showing the structure, numerous well logs, and a table of analyses of oil from this and neighboring fields.

BULLETIN 661–D. The Irvine oil field, Estill County, Ky., by E. W. Shaw. 1917. Pp. 141–191, Pls. XI–XV, figs. 22–28.

Describes an oil field which has received little publicity but which in November, 1916, was producing about 5,000 barrels a day, or more than all the other oil fields in Kentucky combined. The oil-bearing rock lies near the surface in the valley bottoms, and drilling is inexpensive, but the country is rough and transportation of machinery and supplies to the wells is difficult. The output has been limited by insufficient facilities for marketing, and the wells have not been forced to their full capacity. This report gives a full discussion of the geology of the field and includes sections on the structure and the character and origin of the oil, statistics and diagrams showing the production, and suggestions for prospecting. Structure and sketch maps and views of structural features are included in the illustrations.

BULLETIN 661–E. The Bowdoin dome, Mont., a possible reservoir of oil and gas, by A. J. Collier. 1917. Pp. 193–209, Pl. XVI, fig. 29.

The discovery of a small flow of gas, favorable geologic structure, and the presence within moderate depth of strata that might be sources of petroleum are suggested as warranting a test of the area near Bowdoin, in northeastern Montana, about 40 miles south of the Canadian boundary. The author describes the geology of the area and gives a structure map.

BULLETIN 661–F. The Corsicana oil and gas field, Tex., by G. C. Matson and O. B. Hopkins. 1917. Pp. 211–252, Pls. XVII–XXI, figs. 30–32.

The Corsicana oil and gas field, in Navarro County, Tex., embraces a number of productive pools covering in the aggregate about 50 square miles, within an area that measures 20 miles from north to south by 10 miles from east to west. Although this field has been productive for more than 20 years, little has been written concerning the geology of the field and the structural conditions under which the pools of oil and gas have accumulated. The purpose of this report is to give a more complete account than has yet been printed of the history, production, and geology of the field, with especial reference to the structure and the age and relations of the oil sands. Information obtained from the study of this field should be applicable to other areas in the same general region where the geologic conditions are similar. Although the field has already been extensively drilled, a few suggestions are made for future development. The illustrations comprise structure and geologic maps and diagrams showing well records and production.

BULLETIN 661–G. The Palestine salt dome, Anderson County, Tex.; The Brenham salt dome, Washington and Austin counties, Tex.; papers by O. B. Hopkins. 1917. Pp. 253–280, Pls. XXII–XXV.

These papers describe two small salt domes in which interest has been aroused because of the discovery of tarry oil in water wells a few miles from each dome. Salt was produced from the Palestine dome before 1890, and the industry has recently been revived. No evidence of oil has been found there, and the geologic conditions suggest that no large amount remains, even if it ever accumulated, The author points out the area where the conditions are most favorable for oil. if any is present in this dome. In the Brenham dome one well drilled in 1915 obtained a small quantity of oil, and 13 others had been drilled by April, 1917, but the results were discouraging. The study of the area failed to throw much light on the probable presence and location of oil in the dome, but the paper presents the information at hand, which may be of value to anyone who continues drilling in this area.

BULLETIN 661–H. Oil and gas possibilities of the Hatchetigbee anticline, Ala., by O. B. Hopkins. 1917. Pp. 281–313, Pls. XXVI–XXIX.

One of the first deep wells drilled for oil in the Gulf Coastal Plain was put down in 1884–85 at Bladon Springs, Ala., near the crest of the Hatchetigbee anticline. At that time the anticlinal theory of oil and gas accumulation was being much discussed, but the reasons that led to the selection of this site are not known. A little gas was found in this well, but no further work was done here until after the discovery of oil at Beaumont, Tex., in 1901. In the next four or five years six deep wells were drilled in this area, but all were poorly located with reference to the structure. Interest in the area has been revived recently, and this report presents the results of a geologic examination by the Survey. A number of areas in which the structure is favorable for the accumulation of oil and gas were found. The report contains a geologic map and sections, views of fossils, and well logs.

BULLETIN 661–I. Phosphatic oil shales near Dell and Dillon, Beaverhead County, Mont., by C. F. Bowen. 1918. Pp. 315–320, fig. 33.

A report on oil shale at two localities in southwestern Montana. The shale occurs at about the same geologic horizon as the phosphate deposits of this general region. Laboratory tests have shown that the phosphate is not driven off by distillation, and the fact that the shale yields oil on distillation and yet retains a notable quantity of phosphate in the ash presents to the technologist a problem whose solution may be economically as valuable as it is scientifically interesting.

This pamphlet contains a title-page, table of contents, introduction, and index (pp. i–viii, 321–328) for the complete volume of Bulletin 661, for the use of those who wish to bind the separate chapters.

Parts of Bulletin 662, Mineral resources of Alaska, report on progress of investigations in 1916, as indicated below. The annual report on Alaskan investigations is issued first in the form of advance chapters. This report is the thirteenth of the series and contains 15 papers by 11 authors, arranged on the same plan as in previous volumes. In the papers dealing with the economic geology of certain districts special emphasis is laid on the conclusions having immediate interest to the miner. The papers listed below comprise all to be included in the volume for 1916, but the volume itself had not yet been issued June 30, 1918.

BULLETIN 662–A. Preface; Administrative report; The Alaskan mining industry in 1916, by A. H. Brooks. 1917. Pp. 1–62, i–xi, Pls. I–IV.

BULLETIN 662–B. Mining developments in the Ketchikan and Wrangell mining districts, by Theodore Chapin; Lode mining in the Juneau gold belt, by H. M. Eakin; Gold placer mining in the Porcupine district, by H. M. Eakin; Water-power investigations in southeastern Alaska, by G. H. Canfield. 1917. Pp. 63–154, Pls. V–IX, fig. 1.

BULLETIN 662–C. Mining in the lower Copper River basin, by F. H. Moffit; Mining on Prince William Sound, by B. L. Johnson; Copper deposits of the Latouche and Knight Island districts, Prince William Sound, by B. L. Johnson. 1917. Pp. 155–220, Pls. X–XII, figs. 2–4.

BULLETIN 662–D. The gold placers of the Tolovana district, by J. B. Mertie, jr. 1917. Pp. 221–277, Pls. XIII–XIV, figs. 5–6.

BULLETIN 662–E. Mineral resources of the Kantishna region, by S. R. Capps. 1917. Pp. 279–331, Pl. XV, fig. 7.

BULLETIN 662–F. Gold placers of the Anvik-Andreafski region, by G. L. Harrington. 1917. Pp. 333–349, Pl. XVI.

BULLETIN 662–G. Lode deposits near the Nenana coal field, by R. M. Overbeck; Gold placers near the Nenana coal field, by A. G. Maddren. 1917. Pp 351–402, Pl. XVII.

BULLETIN 662–H. Lode mining in the Fairbanks district, by J. B. Mertie, jr. 1917. Pp. 403–424, Pl. XVIII, fig. 8.

BULLETIN 662–I. Lode mining and prospecting on Seward Peninsula; Placer mining on Seward Peninsula, by J. B. Mertie, jr. 1917. Pp. 425–458.

BULLETIN 663. The structural and ornamental stones of Minnesota, by Oliver Bowles. 1918. 225 pages, 21 plates, 27 text figures.

Gives a summary of the history of the stone industry in Minnesota, describes the rocks of the State and their constituent minerals, and presents an outline of the geologic history. The main body of the report consists of detailed descriptions of the quarries, their products, mode of operation, equipment, ownership, and means of transportation. As a guide for prospective operators undeveloped outcrops are also described. The first stone quarry in Minnesota was opened in 1820 to obtain limestone for use in building part of old Fort Snelling. At present the building and ornamental stones produced in the State, though far less valuable than the iron ores, rank second in value in Minnesota's mineral output. The paper contains numerous illustrations showing features of the stones, including several reproducing the stones in their natural colors, as well as notable structures in which these stones have been used.

This bulletin is to be followed by similar ones covering other States, to be prepared by the Survey in cooperation with the Bureau of Mines, the Bureau of Standards, and the geological surveys of the States interested.

BULLETIN 665. Bibliography of North American geology for 1916, with subject index, by J. M. Nickles. 1917. 172 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 1916. The book is indexed and contains lists of chemical analyses reported and of minerals, rocks, and geologic formations described.

Parts of Bulletin 666, Our mineral supplies, as follows:

BULLETIN 666–Q. Copper, by B. S. Butler. 1917. 4 pages, 1 plate.

BULLETIN 666–R. Limestone and lime, by G. F. Loughlin. 1917. 6 pages.

BULLETIN 666–S. Portland cement, by E. F. Burchard. 1917. 5 pages, 1 text figure.

BULLETIN 666–U. The rarer metals, by F. L. Hess. 1917. 13 pages.

BULLETIN 666–V. Iron, by E. F. Burchard. 1917. 12 pages, 1 text figure.

BULLETIN 666–X. Mica, monazite, and lithium minerals, by W. T. Schaller. 1917. 6 pages.

BULLETIN 666–Y. Zinc, by C. E. Siebenthal. 1917. 4 pages.

BULLETIN 666–Z. Nitrates, by H. S. Gale. 1917. 4 pages.

BULLETIN 666–AA. Lead, by C. E. Siebenthal. 1917. 3 pages.

BULLETIN 666–BB. Magnesite, by H. S. Gale. 1917. 3 pages.

BULLETIN 666–CC. Fluorspar, by E. F. Burchard. 1917. 8 pages, 1 text figure.

BULLETIN 666–DD. Petroleum, by J. D. Northrop. 1917. 13 pages, 1 text figure.

BULLETIN 666–EE. Manganiferous iron ores, by E. C. Harder. 1917. 13 pages.

BULLETIN 667. The Cosna-Nowitna region, Alaska, by H. M. Eakin. 1918. 54 pages, 8 plates, 3 text figures.

Gives results of a study of a previously unexplored region in central Alaska that promised both to furnish a feasible route of travel for pack trains and to yield information on the character of the bedrock. The region is fairly accessible, is well timbered, and includes much fertile land similar to that near Fairbanks. It has produced no mineral wealth, but some of the geologic formations are similar to those which are gold bearing in neighboring districts, and workable placers may possibly be found in this region. The author points out the most favorable places to search for such deposits. The report contains topographic and geologic maps and other illustrations.

BULLETIN 670. The Salt Creek oil field, Wyo., by C. H. Wegemann. 1918. 52 pages, 7 plates, 2 text figures.

Describes the Salt Creek oil field, which produces daily 10,000 barrels of high-grade paraffin oil and is one of the largest proved fields in Wyoming. This field includes an area of about 7 square miles lying 40 miles due north of Caspar. The author describes also two adjacent pools—the Shannon pool, where the first oil obtained in this region was found, in 1889, and the Teapot dome, which has not yet been thoroughly tested. The report contains maps of the Salt Creek and Shannon fields and estimates of future production.

BULLETIN 675. The upper Chitina Valley, Alaska, by F. H. Moffit, with a description of the igneous rocks by R. M. Overbeck. 1918. 82 pages, 13 plates, 2 text figures.

Presents the results of a recent survey of the Chitina Valley. Although this report deals largely with the more purely scientific aspects of the geologic problems offered by this region, the solution of these problems has a definite economic value. The copper-bearing rocks that contain valuable deposits in the lower part of the Chitina Valley occur also in the upper part, and the formations from which the Nizina placers have derived their gold are present in this region. No mineral deposits of proved value have yet been exploited in this part of the valley, but so far little prospecting has been done here. The report contains topographic and geologic maps and illustrations showing features of geologic interest.

Parts of Bulletin 690, Contributions to economic geology, 1918, Part I, as follows:

BULLETIN 690–A. Zinc carbonate and related copper carbonate ores at Ophir, Utah, by G. F. Loughlin. 1917. Pp. 1–14, figs. 1–4.

The zinc carbonate ore of the Ophir district, of which shipments were first made in 1913, presents some very interesting features. These are discussed in this paper, which forms a contribution to the literature on the genesis of oxidized zinc ores.

BULLETIN 690–B. Gravel deposits of the Caddo Gap and De Queen quadrangles, Ark., by H. D. Miser and A. H. Purdue. 1918. Pp. 15–29, Pls. I–III, figs. 5–6.

Interest in possible American sources of flint pebbles or substitutes for them to be used in tube mills has been aroused since the beginning of the war, owing to the partial interruption of imports of flint pebbles from Denmark and France, which formerly supplied most of the pebbles used in this country. This report describes the gravels in the area covered and discusses the possibility of their use in tube mills. The gravels consist largely of novaculite, a rock as hard as quartz though somewhat less resistant to abrasion. The paper contains a map of the area and an illustration showing characteristic pebbles.

BULLETIN 690–C. A geologic reconnaissance of the Uinta Mountains, northern Utah, with special reference to phosphate, by A. R. Schultz. 1918. Pp. 31–94, Pls. IV–V, fig. 7.

Describes the practically unknown phosphate deposits that occur in the Uinta Mountains, in northern Utah, in the same formation as in the neighboring and better-known phosphate fields of Idaho, Montana, Utah, and Wyoming. The reconnaissance examination on which the paper is based showed that about 225,000 acres in this region may tentatively be regarded as containing valuable deposits of phosphate. These lands have been included in the phosphate reserve approved May 11, 1915. The paper contains maps showing the location of the deposits.

BULLETIN 690–E. Manganese at Butte, Mont. by J. T. Pardee. 1918. Pp. 111–130.

Describes the manganiferous gangue of the silver-zinc lodes at Butte, which was formerly regarded merely as waste rock but which under the present high prices is a possible source of considerable manganese. The amount of this material is very large, but only a small part of that in the oxidized zone, in the outcrops and the upper parts of the lodes, meets present trade requirements. This reserve of material containing 40 per cent or more of manganese, is estimated at 2,600 tons. In addition, however, there is about 132,000 tons of material averaging 24 per cent of manganese. The unoxidized material that contains 15 per cent or more of manganese and lies within depths ordinarily reached in mining amounts to millions of tons, and whether it can be utilized as a source of manganese is a problem of metallurgy rather than of mining.

Parts of Bulletin 691, Contributions to economic geology, 1918, Part II, as follows:

BULLETIN 691–A. The structure of parts of the central Great Plains, by N. H. Darton. 1918. Pp. 1–26, Pls. I–IV, figs. 1–18.

Although oil has been found at only a few localities in the central Great Plains region, there are in this region many favorable structural features, such as domes and anticlines, and a presentation of all available facts as to structural conditions in the region was believed to be warranted by the prevailing great interest in the possibility of the occurrence of oil and gas. The paper contains a map showing the structure of the region by underground contours, also numerous diagrams and sections, and points out the most favorable places for testing with the drill.

BULLETIN 691–B. Oil shale of the Uinta Basin, northeastern Utah, and Results of dry distillation of miscellaneous shale samples; papers by D. E. Winchester. 1918. Pp. 27–55, Pls. V–XII, fig. 19.

Gives results of an investigation of the zone of oil shale along the south side of the Uinta Basin, in which the shale was found to be of minable thickness and as rich as those mined in Scotland, if not richer. On the north side of the basin the shale is concealed beneath younger rocks, but it is estimated from the available evidence that the portion of the basin that lies in Utah contains sufficient shale to produce 42,800,000,000 barrels of shale oil, with perhaps 500,000,000 tons of ammonium sulphate as a by-product. The shale must be mined like coal and then crushed and distilled in huge retorts, giving off crude shale oil, ammonia, and fuel gas as the valuable products. Over 80 samples distilled in a field apparatus gave yields ranging from 1 to 90 gallons of oil to the ton of shale. The author gives a diagram illustrating processes of manufacture in the Scottish mineral-oil industry.

BULLETIN 691–C. Geologic structure of the northwestern part of the Pawhuska quadrangle, Okla., by K. C. Heald. 1918. Pp. 57–100, Pls. XIII–XV, figs. 20–30.

Describes those geologic features of a part of the Pawhuska quadrangle, in Osage County, Okla., that bear on the occurrence, discovery, and development of commercial quantities of oil or gas. The rocks that crop out in the area are shown in a generalized stratigraphic section, but the characteristics and extent of certain beds that are of value in mapping the structure of the area are described fully. Both regional and local structure are shown on the structure map that accompanies the paper. The two producing fields are in widely separated parts of the area; in the intervening territory not even a trace of oil or gas has yet been found. The author gives a list of localities in the unproved area where the conditions are most favorable for test drilling.

BULLETIN 691–H. Geology and oil prospects of the Salinas Valley-Parkfield area, Cal., by W. A. English. 1918. Pp. 219–250, Pls. XXVII–XXVIII, figs. 35–36.

Describes an area in the southern Coast Ranges of California, extending from the country west of Salinas River eastward to the crest of the Diablo Range. East of this range is San Joaquin Valley, along whose west edge lie the largest productive oil fields of the State. No productive wells have been drilled in the area examined, and by far the larger part of it offers little encouragement for wildcat drilling, but certain localities appear to be well worth testing. These localities are described in detail, with reasons for the author's conclusions. The paper contains geologic maps of the area and a sketch of conditions in adjacent productive fields.

WATER-SUPPLY PAPER 389. Surface water supply of the United States, 1914, Part IX Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, E. A. Porter, C. C. Jacob, and G. A. Gray, district engineers. 1917. 198+xxxiii pages, 2 plates.

WATER-SUPPLY PAPER 390. Surface water supply of the United States, 1914, 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. 1917. 306+xxxiii 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 1915. Data for gaging stations are given under the following heads: Location, Drainage area, Records available, Gage, Discharge measurements, Channel and control, Extremes of discharge, Ice, Diversions, Regulation, 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 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 400. Contributions to the hydrology of the United States, 1916; N. C. Grover, chief hydraulic engineer. 1917. 108 pages, 7 plates, 11 text figures.

Contains the following papers, previously issued as advance chapters:

The people's interest in water-power resources, by G. O. Smith.

Artesian water for irrigation in Little Bitterroot Valley, Mont., by O. E. Meinzer.

The measurement of silt-laden streams, by R. C. Pierce.

Accuracy of stream-flow data, by N. C. Grover and J. C. Hoyt.

Ground water for irrigation in the Morgan Hill area, Cal., by W. O. Clark.

WATER-SUPPLY PAPER 401. Surface water supply of the United States, 1915, Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. H. Pierce, C. C. Covert, and G. C. Stevens, district engineers. 1917. 155+xxxvi pages, 2 plates.

WATER-SUPPLY PAPER 403. Surface water supply of the United States, 1915, Part III, Ohio River basin; N. C. Grover, chief hydraulic engineer; A. H. Horton and W. E. Hall, district engineers. 1917. 175+xxxiv pages, 2 plates.

WATER-SUPPLY PAPER 404. Surface water supply of the United States, 1915, Part IV, St. Lawrence River basin; N. C. Grover, chief hydraulic engineer; W. G. Hoyt, A. H. Horton, C. C. Covert, and C. H. Pierce, district engineers. 1917. 122+xxxi pages, 2 plates.

WATER-SUPPLY PAPER 406. Surface water supply of the United States, 1915, Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb and Robert Follansbee, district engineers. 1917. 281+xli pages, 2 plates.

WATER-SUPPLY PAPER 408. Surface water supply of the United States, 1915, Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. A. Gray, W. E. Hall, and Robert Follansbee, district engineers. 1917. 111+xxvi pages, 2 plates.

Similar to the reports for 1914 noticed above.

WATER-SUPPLY PAPER 418. Mineral springs of Alaska, by G. A. Waring, with a chapter on the chemical character of some surface waters of Alaska, by R. B. Dole and A. A. Chambers. 1917. 114 pages, 9 plates, 16 text figures.

Hot springs are widely distributed in Alaska, but they were only slightly used by the natives before the coming of the white man. Since the Russian occupation, however, they have been gradually coming into use, and a number of bathing establishments have been constructed at some of the more accessible springs. A demand has arisen for more accurate information about the qualities of the thermal waters, and to meet this demand Mr. Waring undertook the investigation whose results are here set forth. Besides his own observations he compiled all available information about mineral springs in Alaska, and the paper contains data concerning 109 springs. Samples of stream waters were analyzed, and the results, though meager, constitute the only published information so far available to show the composition of surface waters in subpolar regions, where the conditions of erosion and ground-water circulation are very different from those in more temperate regions. The book contains maps and views of some of the springs.

WATER-SUPPLY PAPER 424. Surface waters of Vermont, by C. H. Pierce. 1917. 218 pages, 14 plates, 2 text figures.

From the days of the earliest settlement the rivers of Vermont have figured largely in her growth and development, and now there is hardly a town in the State which is not dependent in some way on power derived from falling water. How the waters of Vermont can be best used to serve the interests of her citizens is a vital question. Fortunately pure water is abundant, but before construction of a power plant is undertaken it is necessary to have data showing the power available and whether the run-off, on which the effective power will depend, will be so distributed throughout the year as to correspond to the requirements

of the market. The Geological Survey has established 25 gaging stations on streams in Vermont, and this paper gives all records collected at these stations and all other available records of river discharge collected in Vermont or on the borders. The illustrations include a map of the State, three maps showing river profiles, and views of gaging stations and power plants. At the end of the volume is given a gazetteer of streams, lakes, and ponds in Vermont.

Parts of Water-Supply Paper 425, contributions to the hydrology of the United States, 1917, as follows:

WATER-SUPPLY PAPER 425–B. Ground water for irrigation in Lodgepole Valley, Wyoming and Nebraska, by O. E. Meinzer. 1917. Pp. 37–69, Pls. IV–VI, fig. 3.

Contains results of a brief field investigation of the drainage basin of Lodgepole Creek, a long, narrow belt between the much larger basins of the North Platte and South Platte. The investigation was made in response to repeated requests from residents of the valley who are interested in projects for extending irrigation by pumping shallow ground water or by discovering artesian water. The paper contains data on cost of pumping for irrigation, by H. C. Diesem, of the United States Department of Agriculture.

WATER-SUPPLY PAPER 425–C. Hydraulic conversion tables and convenient equivalents. 1917. Pp. 71–94.

Gives many tables and equivalents of practical use to hydraulic engineers.

WATER-SUPPLY PAPER 426. Southern California floods of January, 1916, by H. D. McGlashan and F. C. Ebert. 1918. 80 pages, 17 plates.

The rains that swept southern California in January, 1916, converted the streams into torrents that overran their banks and devastated large areas of the most fertile land in the State. The floods wrought widespread ruin throughout the region that extends southward from Santa Clara River to the Mexican boundary and westward from the north-south ranges of San Bernardino and Santa Clara counties to the ocean. A record of the magnitude of such a flood and a study of the damage done and of previous floods are of value not only in efforts to solve the general problem of flood prevention but also in planning the complete utilization of the water resources of a region. In San Diego County, especially, where the losses were very heavy, a number of feasible reservoir sites have not been developed because the expense is apparently not yet warranted by the demand for their utilization for water supply alone. A detailed study may show, however, that the value of these sites as reservoirs for flood protection is sufficient to justify the county in assuming part of the cost of construction or assessing it against the properties to be protected. A fundamental requirement for this study is a knowledge of precipitation and stream flow, such as that presented in the records given in this paper. The records of precipitation were collected at 156 stations and those of stream flow at 38 stations. The paper is illustrated by numerous views showing flood damage and contains a map of the area.

WATER-SUPPLY PAPER 430. Surface water supply of Hawaii, July 1, 1913, to June 30, 1915; N. C. Grover, chief hydraulic engineer; G. K. Larrison, district engineer. 1917. 329 pages.

Similar in scope to Water-Supply Papers 389 and 390, noticed on pages 27–28.

WATER-SUPPLY PAPER 431. Surface water supply of the United States, 1916, Part I, North Atlantic slope drainage basins; N. C. Grover, chief hydraulic engineer; C. C. Covert, C. H. Pierce, and G. C. Stevens, district engineers. 1918. 175 + xxxvi pages, 2 plates.

WATER-SUPPLY PAPER 434. Surface water supply of the United States, 1916, Part IV, St. Lawrence River basin; N. C. Grover, chief hydraulic engineer; W. G. Hoyt, A. H. Horton, C. C. Covert, and C. H. Pierce, district engineers. 1917. 130 + xxxii pages, 2 plates.

WATER-SUPPLY PAPER 437. Surface water supply of the United States, 1916, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, district engineer. 1918. 49 + xxxii pages, 2 plates.

WATER-SUPPLY PAPER 438. Surface water supply of the United States, 1916, Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. A. Gray and Robert Follansbee, district engineers. 1917. 106 + xxvi pages, 2 plates.

WATER-SUPPLY PAPER 445. Surface water supply of Hawaii, July 1, 1915, to June 30, 1916; N. C. Grover, chief hydraulic engineer; G. K. Larrison, district engineer. 1917. 224 pages.

Similar in scope to Water-Supply Papers 389 and 390, noticed on pages 27–28.

MINERAL RESOURCES OF THE UNITED STATES, 1915. 1917. Part I, Metals; H. D. McCaskey, geologist in charge; iv + 99a + 1,000 pages, 3 plates, 7 text figures. Part II, Nonmetals; E. F. Burchard, geologist in charge; vi + 1,084 pages, 7 plates, 36 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. Contains an insert showing production of coal in the United States, 1807–1915. Issued first, as received, in 66 advance chapters, each covering a single mineral product or group of allied products.

MINERAL RESOURCES OF THE UNITED STATES, 1916. Fifty-five advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1917. Six advance chapters.

GEOLOGIC FOLIO 207. Deming, N. Mex., by N. H. Darton. 1917. 15 folio pages of text, 3 maps, 1 structure-section sheet, 9 plates, 11 text figures.

Description and maps of the Deming quadrangle, covering about 1,009 square miles in Luna County, N. Mex.

TOPOGRAPHIC AND OTHER MAPS as follows:

Agua Fria, Tex.[1]
Arbuckle, Cal.
Arena, Cal.
Atwater, Cal.
Avery, Idaho-Mont.
Bainbridge, Ohio.
Barwise School, Tex.
Battle Creek, Mich.[1]
Belfast, Maine.
Belvidere, Ill.[1]
Birds Landing, Cal.
Bladen, Ga.[1]
Brainerd, Minn.
Brownfield, Ill.-Ky.
Buck Hill, Tex.[1]
Burkburnett, Tex.-Okla.
Camel Mountain, N. Mex.[1]
Camp Dix, N. J.-Pa.[2]
Camp Sherman, Ohio.[3]
Chesaning, Mich.
Christmas, Ariz.
Clara, Tex.-Okla.
Columbus, N. Mex.[1]
Compton Landing, Cal.
Coulterville, Ill.
Cowen, W. Va.
Cranes Flat, Idaho.
Del Norte, Colo.
Dover, N. H.-Maine.[4]
Eminence, Mo.
Fairfield, Utah.
Galesburg, Mich.[1]
Gantts Quarry, Ala.
Garrison, Ohio.[5]
Gustine, Cal.
Hamilton, Ohio.[6]
Hermanas, N. Mex.[1]
Higginsport, Ohio.[5]
Hillsboro, Ohio.
Hillsboro, Oreg.-Wash.
Hilo, Hawaii.
Idaho (State, 1:500,000).[7]
Jordan Gap, Tex.[1]
Kings, Ill.[1]
Kirkland, Ill.[1]
Knobnöster, Mo.
Koehler, N. Mex.
Lamoure, N. Dak.[8]
Lawtey, Fla.[1]
Leonidas, Mich.[1]
Logan Creek, Cal.[5]
Lower Matanuska Valley, Alaska.
Macclenny, Fla.-Ga.[1]
Matewan, W. Va.-Ky.-Va.[9]
Millsboro, Del.[1]
Moira, N. Y.
Moorcroft, Wyo.
Morattio, Va.[1]
Morgan Hill, Cal.
Mount Riley, N. Mex.[1]
Naugatuck, Ky.-W. Va.[9]
Neshkoro, Wis.
New Effington, S. Dak.-N. Dak.

[1] Photolithograph in colors.
[2] Covers Bordentown quadrangle and parts of Whiting, Cassville, and Pemberton quadrangles.
[3] Covers Roxabell and Chillicothe quadrangles.
[4] Resurvey.
[5] Preliminary edition showing part of quadrangle.
[6] New and enlarged edition covering Hamilton quadrangle and part of Harrison quadrangle.
[7] Photolithograph.
[8] New edition.
[9] Sheet completed; part engraved in 1912.

Newman, Cal.
Noria, N. Mex.[1]
Oahu, Hawaii.
Oneonta, N. Y.
Otway, Ohio.
Paintsville, Ky.
Pasco, Wash.
Passadumkeag, Maine.
Pelican Rapids, Minn.
Piketon, Ohio.
Planada, Cal.
Prestonsburg, Ky.
Princeton, Cal.
Prosser, Wash.
Regina, Ky.-Va.[2]
Reserve, N. Mex.
Rochester, Vt.
Rockford, Ill.-Wis.[1]
Russell, N. Y.
Salem, Oreg.
San Simon, Ariz.-N. Mex.
Sardinia, Ohio.
Sites, Cal.[3]
Stevinson, Cal.
Superior, Wis.-Minn.
Tappahannock, Va.[1]
Tascotal Mesa, Tex.[1]
Toano, Va.[1]
Union City, Mich.[1]
United States (showing oil and gas fields in 1916).
Uniontown, Ky.-Ind.
Vicksburg, Miss.-La.
Wallula, Wash.
Webster Springs, W. Va.[4]
White Rock, S. Dak.-Minn.-N. Dak.
Williams, Cal.
Winton, Cal.
Wisconsin (State, 1:1,000,000).[5]
Wolfskill, Cal.

GEOLOGIC BRANCH.

SCOPE AND ORGANIZATION OF WORK.

Primarily the work of the geologic branch includes "the examination of the geological structure, mineral resources, and products of the national domain" and "the preparation of a geological map of the United States." Its operations extend to every region of the country and to nearly every field of geology; it has both fostered scientific geologic research and taken a leading part in the development of the mineral resources of the country through its field investigations of the mineral deposits and its accounting of the minerals produced. During later years it has become a national bureau of public information on geologic matters relating not only to all parts of the United States and Alaska but to other countries as well.

The geologic branch is under the immediate charge of the chief geologist, David White, and is organized in four divisions, as follows: (1) Division of geology, in charge of the chief geologist until May 15, when on account of the growing administrative demands due to the war the immediate charge of the division was placed in the hands of Sidney Paige, geologist; (2) division of Alaskan mineral resources, in charge of George C. Martin during the absence of Maj. A. H. Brooks in France; (3) division of mineral resources, H. D. McCaskey, geologist in charge; and (4) division of chemical and physical research, G. F. Becker, geologist in charge. The work of each of these divisions is described in the following pages.

PUBLICATIONS OF THE BRANCH.

The publications of the fiscal year 1918 prepared wholly or partly in the geologic branch embrace 6 professional papers, 11 bulletins, etc., 120 chapters of reports to be published later as annual volumes,

[1] Photolithograph in colors.
[2] Sheet completed; part engraved in 1915.
[3] Preliminary edition showing part of quadrangle.
[4] New and enlarged edition covering Webster Springs quadrangle and part of Mingo quadrangle.
[5] Photolithograph.

and 1 geologic folio. Titles and brief abstracts of these publications are given on pages 12–30. Besides the official publications 42 papers were, with the permission of the Director, published by scientific societies or elsewhere in scientific and technical journals. Six reports based on work done in cooperation with State geological surveys have been transmitted to the States for publication.

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The scientific force of the division of geology at the beginning of the year consisted of 69 geologists, 21 associate geologists, 23 assistant geologists, 7 junior geologists, and 14 geologic aids. During the year four members of the scientific staff resigned to take positions in private life at higher salaries; one member died; one was transferred to another bureau; six entered the Army; eight new members were appointed; and one was transferred from another division. The total number of geologists of various grades on the divisional staff at the end of the year was 131, a net loss of 3.

The organization of the division remained the same as the previous year, except that the increasing urgency of war work and the rapidly changing character of the demands made upon the Survey resulted in temporary redistribution of activities quite out of accord with the formal organization. Thus the work of the two sections of Areal geology was practically suspended; the Coastal Plain investigations were confined essentially to areas having special military importance; the geologic work on metalliferous deposits was limited to the ores of the war metals; coal-field examinations were made only where needed by the Navy Department and the Fuel Administration or in localities where immediate development was desired; work of nonmetals, notably salines, has for several years been on a war basis; oil and gas field investigations were confined to areas of greatest promise of new oil reserves or to the relief of the fuel situation; and the preparation of geologic folios was discontinued to enable the map-printing plant of the Survey to devote all its energies to war work.

The committee on geologic names examined 77 manuscripts, comprising 13,600 pages and involving about 1,975 geologic names.

The physiographic committee supervised the preparation of descriptions of various Army camps of which topographic maps are available and continued the preparation of the geographic handbooks of (1) Virginia, West Virginia, Maryland, and Delaware and (2) the New England States, begun last year.

FINANCIAL STATEMENT.

The total funds available for the geologic work of the Survey for the fiscal year 1918 were as follows:

Geologic surveys	$350,000
Statutory salaries	13,700
Search for potash deposits (part of the appropriation for chemical and physical researches)	19,410
	383,110

The expenditures, classified by projects, were approximately as follows:

Iron and steel alloy metals	$50,317
Platinum, mercury, copper, and other metals	26,479
Potash, nitrates, and other salts	25,496
Phosphates, cements, and other nonmetalliferous deposits	11,828
Oil and gas	77,705
Coal	21,440
Examinations of Army and Navy training camps, stations, and surroundings	5,468
Collection of geologic information of military importance	6,195
Geographic manuals	10,760
Compilation of information concerning foreign mineral resources	10,185
Areal investigations	9,391
Glacial and Coastal Plain investigations	7,900
Paleontologic investigations	13,398
Geologic-map editing	271
Special structural studies of Great Basin region	2,479
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	85,798
	365,110
Land-classification board	18,000
	383,110

COOPERATION WITH OTHER GOVERNMENTAL AND STATE AGENCIES.

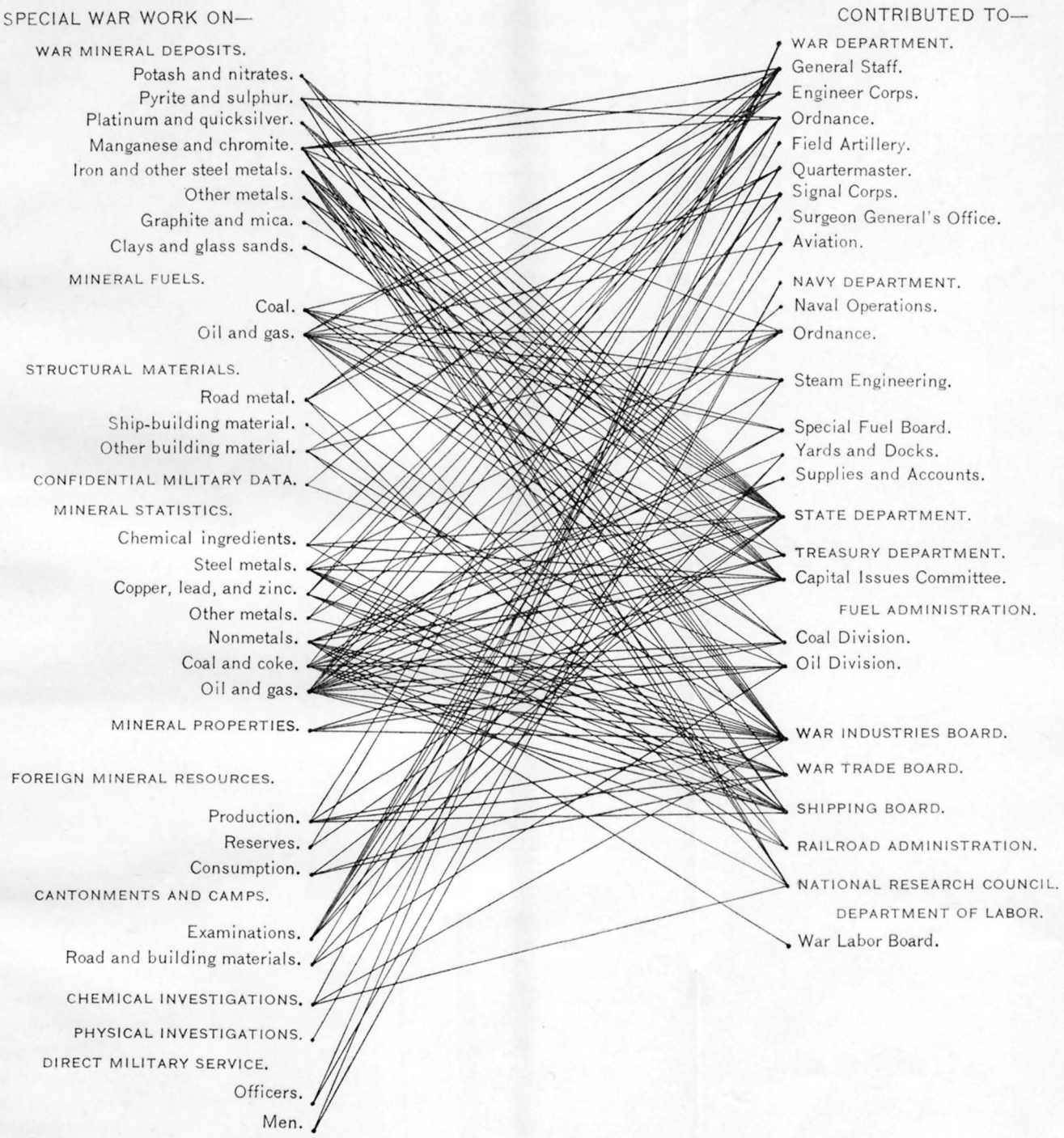
The widened scope of operations due to the special and highly diverse demands presented to the Survey by the war boards and other departments of the Government has led to corresponding expansion in cooperative response. The range in governmental activities to which the Survey has been called to make geologic contributions and the groups which have taken part in this work are roughly indicated in the accompanying diagram (Pl. II). To recite the list of subjects and the nature of the investigations would take too much space here, however interesting such a review might be to the reader. Most of the projects are specifically mentioned in the detailed account of the work in the different States.

Besides cooperating in the investigation of special war problems the Survey has cooperated in work either distinctly essential to the war industries or required by the programs of other organizations both Federal and in the States. The metallographic study of ores was continued in cooperation with the Bureau of Mines and later jointly placed at the service of the Ordnance Department of the War Department. The Bureau of Standards, the Bureau of Mines, and the Office of Public Roads have cooperated in the investigation and testing of building stones, clays, and road materials, and the Coast and Geodetic Survey in the determination of gravity at stations selected by the Survey with reference both to isostasy and the detection of mineral deposits of economic importance. Numerous field examinations have been made for the Department of Justice, the War Department, the Navy Department, the Bureau of Mines, the Bureau of Standards, the General Land Office, the Office of the Supervising Architect of the Treasury Department, the Forest Service, and the Office of Indian Affairs. The Indian Office has cooperated with the Survey in the study of the oil lands in the Osage Reservation in Oklahoma. Through the division of geology the Survey has cooperated informally with the Smithsonian Institution, the Weather Bureau, the Bureau of Lighthouses, the Bureau of Fisheries, and the research laboratories of the Carnegie Institution. Assistance has been given to the geologic departments of a number of universities and colleges.

In strictly geologic investigations or paleontologic studies the Survey has cooperated, through the division of geology, with 27 States—Alabama, California, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Virginia, and Wisconsin. Informal cooperation exists between the Survey and all the States having geological surveys.

GENERAL FEATURES OF THE WORK OF THE YEAR.

As stated in the report for last year, the resources of the Survey both in geologists and in funds have been concentrated mainly on the discovery, estimation, and development of domestic deposits of minerals for which the United States was, on its entrance into the great war, more or less fully dependent upon overseas importation. Secondarily the efforts of the geologic branch were devoted to increasing the production of those minerals, not imported, which must be brought forth in far greater amounts than ever before in this country to supply the war necessities of the Allies and to maintain both our military efficiency and our industrial vitality. Deposits of war minerals, not only developed deposits but those that were merely reported or rumored, were hunted down, examined, and inventoried



CONTRIBUTIONS TO WAR SERVICE BY THE GEOLOGIC BRANCH.

qualitatively and quantitatively, and notes were made as to their capacity under favorable conditions for production. Through press notices, "Contributions to economic geology," articles in the technical journals and publications of technical societies, and memoranda submitted to the different war boards and other governmental agencies concerned with the production of war minerals the data thus gained, together with the information as to the areas deserving testing and development, have been brought to the attention of the public, while at the same time, through the more frequent reports (weekly for some important mineral products) of the division of mineral resources, the Government and the public have been kept informed of the progress of this development as expressed in authentic reports of production by grades and in the best forecasts obtainable.

By way of illustration it may be noted that in the field of iron and steel alloy ores alone deposits were examined at 1,580 localities by 21 geologists in 23 States, Cuba, Porto Rico, and Santo Domingo.

As already noted, the principal object of this work was to provide adequate domestic supplies of these mineral commodities, making the United States independent should importations be forcibly terminated by submarine successes and releasing ships from transporting ores and other minerals from distant sources so that they might carry soldiers and munitions. In this work of military reinforcement and preparedness the Survey enjoyed the cooperation of the Bureau of Mines, which also gave special attention to the mining, milling, and metallurgic problems involved in the extraction and utilization of our domestic ores, and of the Shipping, War Industries, and War Trade boards, which were able to give the prospective producer assurance of his market. Without this cooperation success would have been impossible.

In the development of the domestic supplies of some of the most essential war minerals the results of this campaign have been successful almost beyond expectation. Although when this country entered the war we supplied but 4 per cent of the estimated amount of high-grade manganese ore we needed, over 800,000 tons a year, our domestic supply is now nearly 35 per cent and, with the large reserves of low-grade ore which are being used more widely, can readily be made entirely sufficient for our needs. Pyrite and sulphur are now produced from domestic sources in amounts sufficient to supply the enormously increased number of plants required for munitions, chemicals, and fertilizers, and the supplies are approximately adjusted to the consumption of the plants in operation.

Assiduous effort in discovering deposits of chromite and in encouraging the development of both the new and the producing deposits, coupled with a governmentally fostered conservation in the use of

chrome refractory and other materials, has shown that under conditions favoring domestic production the country may be made nearly independent. Partly through the better utilization of the domestic flake and partly through the stabilization of production, domestic graphite has replaced 20 per cent of the imported graphite in the manufacture of crucibles, the most indispensable large use of the mineral, and the country is able to eliminate importations of overseas graphite for other purposes. Sheet mica sufficient to satisfy all but the most exacting needs is known to be present in the United States, though on account of American methods of mining and preparation the product is not acceptable to makers of radio equipment and magnetos. A supply of magnesite in abundant amounts and of qualities to meet every essential use has been demonstrated, and the use of sintered dolomite as a substitute for calcined magnesite has proved successful. High-grade clays, satisfactorily replacing imported clays for the manufacture of electrical porcelain, graphite crucibles, and other indispensable uses, with the possible exception of coating paper, are either being produced or are in the way of being developed. Glass sand of the extreme purity necessary for making high-grade optical glass has, after long search, been located in large quantities in this country; glass pots suitable for its manufacture are produced from the domestic materials, and the United States is now able to furnish satisfactory lenses for its optical instruments.

The search for nitrates, the most indispensable of our war minerals, has not yet been successful. Extensive exploration and sampling of the many reported natural deposits of nitrates, including the caliches of southwestern California, have revealed no supply of this essential constituent of explosives and important ingredient of fertilizers. The continued investigation of brines and buried saliferous deposits, coincident with the search for potash, has been equally fruitless. No nitrate deposit has yet been located that is sufficiently rich and extensive to pay the cost of its development and treatment on a commercial scale, notwithstanding the prevailing very high prices. The examinations are nevertheless of distinct public value, both in checking wasteful and fruitless speculation and investment and in keeping well informed those who are charged with the responsibility of procuring or producing the needed war supplies. The search, which has been made in cooperation with the Nitrate Division of the Ordnance Department of the War Department, has been extended to Guatemala.

The situation in respect to potash is somewhat better and is improving, the rate of production during the first six months of 1918 having been equal to nearly 25 per cent of the normal consumption. By force of circumstances the country is now essentially independent of foreign importations, though at an undetermined cost in the fer-

tility of the soil. Searles Lake, in California, the alkali lakes in western Nebraska, and the alunite deposits of Utah, all of which were examined with favorable recommendations in earlier reports by the Geological Survey, are now our principal sources of supply. From these, as well as from various by-product recoveries, larger and increasing supplies are expected in the last half of 1918 and in 1919, as is detailed in the current chapter on potash in Mineral Resources for 1917.

Hardly less necessary than the effort to develop domestic supplies of the war minerals formerly imported has been the struggle to make the production of petroleum in the United States meet the ever-increasing consumption in this country while better fulfilling our obligations to assist in supplying our allies. The enormous increase in the use of gasoline for warfare in the air, on the sea, and on land, as well as for our essential industrial activities, including vastly increasing motor freight transportation, can be met in part only by the development of processes for greater recovery of gasoline from the crude oils produced. It is too much to hope that the progress of the last few years in this development can be continued at the necessary rate. The effort to increase the production of crude oil must be carried to the farthest limit if the reserve now in storage is not soon to be exhausted. The curtailment of unessential consumption, though palliative, will not do away with the dangerous situation. Unless a great increase can be made in importations, which will require more ships, the most effective remedy and the only one that will avoid hardship and lowered industrial efficiency is an increase in the production of crude petroleum in this country through the discovery and development of new oil reserves. Geologic exploration in promising regions is one of the most practicable and certain steps toward this object. Accordingly, the Geological Survey has concentrated the activities of its oil and gas geologists on the search for anticlines and domes in those regions of the country, such as the Osage Indian Reservation, in Oklahoma, where geologic conditions favorable to the occurrence of oil are known to exist and where the discovery of such a structural feature is likely to lead to the discovery of an oil or gas pool. The results of these structural examinations, many of which have been conducted in cooperation with State surveys, are, at the earliest possible moment, contributed in an informal way to the public for the immediate guidance of the driller to those points where oil may be developed with the least hazard of waste in money, time, labor, equipment, and opportunity through drilling the less promising or even absolutely unfavorable areas. The loss of capital, the waste of opportunity, and the unprofitable employment of strictly limited supplies of drilling materials and of labor that are involved in random drilling, which with com-

petent geologic advice might all be diverted to areas of reasonably favorable geologic structure, constitute an economic loss not only to the operators but to the public.

The investigation, with mapping, of the deposits of oil shale in the West, begun by the Geological Survey in 1913 largely as a measure of preparedness, has yielded a volume of information as to the distribution, richness, character, composition, and possibilities of these shales, which is now proving invaluable in the foundation of a new industry that is sooner or later to be of very great economic importance to the country. The many experimental plants now in operation or under construction for producing oil from these shales for commercial use should soon demonstrate whether, as was expected, the moment has already arrived when the production of shale oil will not only regulate the price of gasoline but will assure an almost unlimited supply of that essential fuel. Conservative estimates of the quantity of crude oil that may be recovered from beds of shale 3 feet or more in thickness and capable of yielding 25 gallons or more of oil to the ton of shale (some beds will yield as high as 70 gallons) indicate that the shales of northwestern Colorado and northeastern Utah alone can produce over 10 times as much oil as has been recovered from oil wells in the United States since the first commercial oil well was drilled in Pennsylvania in 1859. What the full possibilities of these shales may be in the way of by-products other than gasoline remains to be seen. It is not impossible that new products or preparations yet to be discovered in the experimental laboratory may be of signal importance to the country and may radically affect the commercial success of the industry. The tests already made indicate that the shales will furnish material for dyes, fertilizers, rubber substitutes, paving materials, drugs, and lubricants.

Little progress has been made in the regional mapping of coal fields or in the classification of large areas of coal or oil lands. The coal-field geologists have furnished data to the Fuel Administration and to the other branches of the Government concerning highly diverse geologic problems affecting the coal supply, besides examining coal lands in the West where mines were to be opened in order to enlarge the output.

Other war demands, which have occupied the attention of geologists best qualified to meet them, have included the examination of camp and station sites for the Army and Navy with reference to drainage, water supplies, building and road materials; the location of oil and gas reserves for the Army and Navy; the acquisition and compilation of geologic and physiographic information of military importance for reports to the Army engineers; and the examination of mineral deposits concerning which geologic advice has been desired by other bureaus and departments. A fuller account of these activi-

ties, which are typically cooperative, is given in the record of the work in the several States.

Less distinctly military in purpose are the popular descriptions of the geographic features in the regions surrounding the principal Army cantonments and their origin and history. These descriptions, printed on the backs of the topographic maps of the regions in which the camps are located, are designed to interest the soldier and, through an attractive and clear explanation of the geographic features of the regions, to create in him a greater interest in and a better understanding of analogous features that he may see in other parts of the country or of the world. Of like nature are two geographic manuals covering the New England and Virginian regions, the publication of which has been delayed by the interruption of the work of the contributors through their assignment to field investigation of deposits of war minerals and by an increase in the elaboration and care in the descriptions.

In geology there is no political boundary. Geologic formations extend beneath frontiers and fortresses, and ores and other useful minerals are deposited in like manner from continent to continent. Accordingly, in anticipation that the Geological Survey would be called upon for information regarding the mineral deposits and production of countries other than our own, several of its specialists in the study of the different kinds of mineral deposits began in December, as a preparedness measure, the compilation of such data. The results of this work more than fulfilled the expectations, and the demands for the information have been so numerous and urgent as to require that the work be placed in the hands of a carefully chosen committee, each member of which is a specialist in his subject. Under the direction of this committee the compilation is now going forward in a comprehensive and thorough manner. In furnishing such information to the various war organizations the geologic branch is only more fully performing its work as the American bureau of information regarding the geology and mineral resources of the world.

Of field examinations and expenditures, other than those relating to war minerals, there have been practically none in the division of geology. Field studies in areal, glacial, and historical geology have been suspended except in several minor investigations, the cost of which has been defrayed by cooperating State surveys to whose plans the work was necessary. Some of the sections of the division of geology have been reduced to administrative skeletons or even to merely nominal existence in order that the combined strength of the division might be utilized in the work that proved most necessary. Accordingly, in the office only a very meager amount of interim progress has been made in the preparation of a relatively small number of reports, though at the same time the scientific organization is ready

to resume its normal activities when peace comes. Geologists of national reputation, distinguished as specialists in so-called scientific branches of geology, have thrown themselves unreservedly, with splendid emulation and with thought only how our Nation's great cause can be furthered, into such of the waiting tasks as they might be able to do best. Several chiefs of sections have themselves served in war work under chiefs of other sections. In the close teamwork between divisions the divisional boundaries have often been lost sight of. This is especially true of the joint work of the division of geology and mineral resources, between which the mutual cooperation of geologists in supplying information and assistance has been most complete. The same spirit and practicality of helpfulness have prevailed also in the divisions of Alaskan mineral resources and chemical and physical researches.

Although the more strictly scientific work of the geologic branch involving field examinations is practically suspended during the war, many scientific data relating to the problems under study are gathered as the strictly economic work proceeds. In fact, economic work of the highest order is not performed by geologists who do not keenly observe accessory and related criteria that appear at first to be purely scientific.

Some progress has been made in the thorough observation of temperatures in deep wells by new methods, more precise than those hitherto in use. Also a beginning has been made in a most profitable study of oil field waters and of the petrologic and chemical composition of the oil sands, with reference to changes in the water content and the results of underground evaporation by expanding gases.

It is to be regretted that the exigencies of war have made it necessary for the Coast and Geodetic Survey, which, in cooperation with the Geological Survey, was engaged in observations of gravity in different parts of the country, to suspend this work for a time, for it is expected that the results of these tests may prove to have very important applications to the solution of some economic problems, including the location of mineral deposits of certain types.

Another feature of the year that is to be regretted is the slow progress in the publication of Survey manuscripts submitted to the Public Printer. Even the economic reports most urgently needed by the public have, in general, been issued only after unusual delays.

The work of the division is more fully described in the following accounts of the geologic investigations of the Survey in the several States and Territories. It has extended to every State.

WORK OF THE DIVISION, BY STATES.

ALABAMA.

A report on the underground water resources in the vicinity of the proposed aviation camp at Tuscaloosa, Ala., by T. W. Vaughan, was submitted to the Signal Corps, United States Army, and the geographic features of the region including Camp McClellan, near Anniston, were examined and a popular description prepared for publication on the back of the topographic map of the vicinity by F. E. Matthes, who submitted geologic data as to the water supplies and building materials in the area. A geologic map of the Anniston quadrangle with cross section, prepared by Charles Butts, also was transmitted to the commanding officer of the camp.

Manganese deposits in Murphrees Valley, near Walnut Grove, were examined by G. W. Stose, and mica deposits in eastern Alabama were studied by W. T. Schaller.

A report on the commercial marbles of the southern Appalachian region, prepared in cooperation with the geological surveys of Tennessee, Alabama, and Georgia, has been completed by T. Nelson Dale, and a report on the correlation of the deposits of Jackson and Vicksburg age in Mississippi and Alabama, by C. Wythe Cooke, has been published outside the Survey.

ARIZONA.

A report on the geology and copper deposits of the Ray and Miami districts, Ariz., was completed by F. L. Ransome and has been submitted for publication as Professional Paper 115.

The tungsten and molybdenum deposits of the Hualpai Mountains, tungsten and manganese deposits near Globe, tungsten (scheelite) deposits in the Old Hat district, near Oracle, vanadium deposits near Dripping Springs, Christmas, and Winkelman, and molybdenum (wulfenite) deposits near Tucson and at Shultz (Mammoth district) were examined by F. L. Hess.

A brief paper on the recently discovered quicksilver deposits in the Phoenix Mountains has been submitted for publication in the "Contributions to economic geology, 1918" (Bulletin 690–D), by F. C. Schrader, who also completed a report, for the Office of Indian Affairs, on the geology and mineral deposits of the Gila River Indian Reservation.

Tungsten deposits in the vicinity of Nogales, Bisbee, Fort Huachuca, Dragoon, and Kingman and in the Hillside and Tip Top districts were examined by E. S. Larsen. Manganese deposits in the Patagonia and Ash Peak districts, in Mohave County near Williams and Santa Maria rivers, and at Tucson, Bouse, Wickenburg, Aguila, Winkelman, and Mammoth were examined by E. L. Jones, jr., and those at Bisbee and Tombstone by F. L. Ransome.

A report entitled "Geology of the Navajo country—a reconnaissance of parts of Arizona, New Mexico, and Utah," by H. E. Gregory, has been issued as Professional Paper 93.

Volcanic cinder cones near Ash Fork and Nevin, on the Santa Fe Railway, were examined by G. F. Loughlin in the search for vesicular lava suitable for an aggregate in concrete for ship construction.

ARKANSAS.

A report on the ground-water conditions of the site for the proposed aviation camp at Lonoke, Ark., by T. W. Vaughan, was submitted to the Signal Corps, United States Army, and a reconnaissance of the geology and physiography of the Little Rock quadrangle was made by L. W. Stephenson and H. D. Miser for use in a popular description to be printed on the back of the topographic map of the Little Rock quadrangle, which includes the Camp Pike military cantonment.

At the request of the Department of Justice, an investigation of the recent geologic history of certain "sunken lands" in northeastern Arkansas was made by E. W. Shaw. Mr. Shaw has in preparation a paper on lakes in northwestern Arkansas.

At the request of the United States Forest Service, the Arkansas National Forest, including portions of Garland, Saline, Perry, Yell, Montgomery, Polk, Pike, and Howard counties, and the Ozark National Forest, including portions of Johnson, Pope, Newton, Searcy, and Van Buren counties, were examined by A. C. Spencer, H. D. Miser, F. J. Katz, and Charles Butts, who reported on the erosional conditions and run-off.

The geology of the Batesville region was mapped and the manganese deposits were examined, with estimation of the ore reserves, by H. D. Miser. A report by Mr. Miser on the manganese deposits of the Caddo Gap and De Queen quadrangles has been issued as Bulletin 660–C.

The asphalt deposits and oil prospects in Pike and Sevier counties are discussed in a report by H. D. Miser and the late A. H. Purdue, published as Bulletin 691–J. They also contributed a paper on the gravel deposits of the Caddo Gap and De Queen quadrangles, printed as Bulletin 690–B.

The study of the Morrow fauna has occupied a portion of the office time of G. H. Girty.

A report, by G. H. Ashley, on greensand deposits, with special reference to their availability as a source of potash, was published in Bulletin 660–B.

CALIFORNIA.

The search for platinum in the serpentine region and the examination of the platiniferous deposits in northern California were continued by L. M. Prindle, who was for a time associated with H. G.

Ferguson. This work was conducted in cooperation with the State Mining Bureau. The areas examined included East Fork, Hay Fork, and Post Creek, in the southern part of Trinity County, and the South Fork of Trinity River.

Most of the developed chromite deposits in the State were visited by J. S. Diller in the summer of 1917 with a view to determining their size and their prospective output during the last half of 1917 and 1918. In June, 1918, field investigations were resumed in greater detail so as to include all the known or reported deposits in the State, the work being conducted under agreement by Prof. G. D. Louderback, of the State Council of Defense, and by Mr. Diller, in cooperation with the State Mining Bureau and the United States Bureau of Mines. This work, which is now in progress, includes the inventory of the available chromite resources, as well as the estimation of the prospective production of the mines. Under similar cooperative auspices the manganese deposits of the greater part of the State are now under examination, those in the eastern parts of San Bernardino, Riverside, and Imperial counties by E. L. Jones, jr.

The quicksilver deposits, both developed and undeveloped, were examined by F. L. Ransome, with special reference to their probable and possible production during 1918.

An investigation, with extensive sampling as a basis for commercial estimates of their value, of nitrate occurrences, with the necessary accessory study of the geologic structure, stratigraphy, and physiography, was carried out in several districts in the lower valley of Amargosa River, at the south end of Death Valley. The districts covered are the Saratoga Niter Hills, Confidence Hills, Owl Springs; the so-called Round Mountain and Valley beds; the Zabriskie basin including lake-bed deposits near Zabriskie, Shoshone, Tecopa, Resting Springs, and Tule Springs; and the so-called Upper Canyon and Lower Canyon beds, near Amargosa River south of Tecopa. The so-called Pilot niter field, at the south end of Slate Range, in Panamint Valley, was also examined. This work was done in cooperation with the Nitrates Division of the Ordnance Department of the War Department, under the general supervision of Hoyt S. Gale, by parties in charge of L. F. Noble, G. R. Mansfield, F. C. Calkins, and Theodore Chapin. Investigations will be continued by L. F. Noble with special reference to the origin of the caliche nitrates already examined and with a view to studying the possibility of the occurrence of nitrate in the bedded Tertiary deposits of the region.

A number of reported potash deposits, including those in the vicinity of Ash Meadows and in Deep Springs Valley, and the developments that have recently taken place about Owens Lake were examined by Mr. Gale.

Tungsten deposits near Victorville, Atolia, and Woody, in the Greenhorn Mountains, and at Grass Valley were examined by Frank L. Hess. Others near Bishop and Big Pine, in the south end of the Sierra Nevada, near Atolia, and in eastern San Bernardino County were studied by E. S. Larsen, jr. Mr. Larsen also examined molybdenum deposits in northern California, in Tulare County, and near the head of Death Valley and a celestite deposit west of Brawley, in Imperial County.

A detailed examination with mapping of the prospective oil territory of the Camulos quadrangle was made by W. S. W. Kew, assisted by J. P. Buwalda and C. M. Wagner. A report by Mr. Kew on the "Structure and oil resources of the Simi Valley" has been submitted for publication in "Contributions to economic geology, 1918" (Bulletin 691–M).

A report on the oil-field waters of the Sunset-Midway field has been prepared by G. S. Rogers to accompany a professional paper on the geology of that field submitted for publication by R. W. Pack. Available information regarding the geology of the Whittier-Fullerton oil field has been compiled by W. A. English in preparation for the detailed study of the region.

A report by W. A. English on the "Geology and oil prospects of the Salinas Valley-Parkfield area" has been printed as Bulletin 691–H. A brief discussion of the oil prospects in California has been submitted by W. B. Emery in a report on prospective oil fields in the public-land States.

A report on the strontianite deposits near Barstow, by Adolph Knopf, has been published as Bulletin 660–I, and a paper on "An andalusite mass in the pre-Cambrian of the Inyo Range" has been submitted by Mr. Knopf for unofficial publication.

The magnesite deposits of the State were examined by R. W. Stone, and his conclusions are contained in the report on magnesite in the current volume of Mineral Resources.

A report on "Hydraulic-mining débris in the Sierra Nevada," presenting the results of an exhaustive study, by the late G. K. Gilbert, of the detritus problems of the Sacramento basin and San Francisco Bay, was issued as Professional Paper 105.

Office work in the study of the Tertiary invertebrates of the coast formations and on a report on the Cretaceous invertebrates of the State was performed respectively by W. H. Dall and T. W. Stanton.

COLORADO.

The known or reported manganese deposits near Placerville, Salida, Wellsville, Moffatt, Iola, and Klondyke, Colo., were examined by E. L. Jones, jr., and those near Leadville and Red Cliff by J. B. Umpleby. The principal conclusions reached have been given to the

press or contributed to technical journals. Molybdenum deposits in the Iron Springs district also were examined by Mr. Jones.

Some further study of the Boulder tungsten field was made by Frank L. Hess, who also made a hasty estimate of the quality of tailings from the Cripple Creek gold district. Some of these tailings contain a considerable percentage of potash combined with silica and alumina, and interest has been shown in the possibility of separating the potash. Later in the year Mr. Hess examined the large molybdenite deposits at Climax, Summit County.

In continuance of the oil-shale investigations in this State, a reconnaissance examination with mapping of 22 townships northwest of De Beque was completed by D. E. Winchester, who in June revisited the region for the purpose of noting the mining operations and procuring samples of less weathered material for testing. The mapping of the oil shales in the region north of the Grand River valley in the De Beque district is completed, and the report is now in preparation.

Coal lands near Mount Harris, Routt County, were examined to procure data for classification by Mr. Winchester, and lands south of Mancos, in Montezuma County, by A. J. Collier. A short report on the Mancos area has been submitted by Mr. Collier for publication in "Contributions to economic geology, 1918" (Bulletin 691–K).

Some examinations and compilation of office data relating to the structural features favorable to oil and gas in the Axial and Monument Butte quadrangles were made by E. T. Hancock for purposes of classification, and inspections of structure and the results of drilling at several points north of Denver were made by W. T. Lee. The broad structural features of eastern Colorado are described, with reference to their possibilities of containing oil, in a paper by N. H. Darton, published as Bulletin 691–A. A paper on the "Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico," by W. T. Lee and F. H. Knowlton, has been issued as Professional Paper 101.

The monograph on the Leadville district, long in preparation, was so nearly completed as to be submitted by the late Capt. J. D. Irving on his departure for France. A chapter on the oxidized zinc ores, written by G. F. Loughlin for inclusion in this monograph, is being published in advance as Bulletin 681.

In the office the description of the flora of the Denver formation, by F. H. Knowlton, has gone forward, and the Cretaceous invertebrates have received some attention by T. W. Stanton. A description of the Zion Canyon National Monument was prepared by W. T. Lee for publication by the National Park Service.

Some progress was made in the compilation of the materials for the San Juan report by Whitman Cross and E. S. Larsen, prior to the

detachment of both geologists on investigations of war minerals. A report on the "Geology and ore deposits of the Creede district," by W. H. Emmons and E. S. Larsen, was submitted for publication in "Contributions to economic geology," and a paper on the "Geology of the Creede mining district" has been prepared by Mr. Larsen for unofficial publication.

CONNECTICUT.

In order to facilitate the completion of the geologic mapping in progress in cooperation with the Connecticut Geological and Natural History Survey, under the direction of H. E. Gregory, a conference was held with Prof. Gregory by W. C. Alden with reference to the Pleistocene deposits of the Granby, Hartford, Meriden, Middletown, New Haven, Guilford, and Saybrook quadrangles, which have been under examination for folio publication. The geographic features of the State are to be treated by Arthur Keith in a handbook on the geography of New England.

The large quartz deposit at Lantern Hill, North Stonington, was examined by G. F. Loughlin in cooperation with the Carnegie Geophysical Laboratory to determine its suitability for the manufacture of optical glass.

An economic study of the limestone and dolomites of western Connecticut and Massachusetts has been begun by T. Nelson Dale. Manuscript of a bulletin on the granites of New England, bringing up to date in one volume the information heretofore distributed among several bulletins, has been practically completed by Mr. Dale.

DELAWARE.

A description of the geographic features of Delaware was written by L. W. Stephenson as a part of a geographic handbook to cover the States of Delaware, Maryland, Virginia, and West Virginia.

The results of sampling and tests of the marls for potash are given in a paper entitled "Notes on the greensand deposits of the Eastern United States," by G. H. Ashley, published as Bulletin 660–B.

FLORIDA.

At the request of the construction quartermaster of the gunnery station to be established south of Miami, Fla., an oral report was made by T. W. Vaughan on the ground-water conditions in the vicinity of Miami.

The rutile-bearing sand on the coast near Pablo Beach was examined by F. L. Hess in cooperation with the Bureau of Mines. A conference on the deposits was held with E. H. Sellards, State geologist.

After informally contributing to the State geologist the principal results of the structural investigations relating to oil and gas in the

region between Marianna and Lake City and between Lake City and Tampa and in the vicinities of Kissimmee, Melbourne, and Titusville, made in June and July in cooperation with the State Geological Survey, O. B. Hopkins spent some time in the office preparation of a report thereon, until the pressure for field examinations in the Mid-Continent field and Texas necessitated his detail to those regions.

Office work on the description of the Mollusca from the Alum Bluff formation was continued during part of the year by Julia Gardner, until her departure for France, and the study of the fauna of the Nashua marl was advanced by W. C. Mansfield, who for most of the year assisted in the compilation of the statistics of production and distribution of coal and in the field mapping of military geologic features. A report on the Foraminifera of the genus *Orthophragmina*, by J. A. Cushman and C. Wythe Cooke, has been issued as Professional Paper 108–G.

A description of the physiographic features of the Interlachen quadrangle was written by T. W. Vaughan.

GEORGIA.

A preliminary examination of the manganese deposits in the vicinity of Cartersville, Ga., was made in August by F. C. Schrader, but the detailed mapping and examination of the entire Cartersville region was undertaken in June by Laurence LaForge, and the investigation of the mineral prospects was undertaken by representatives of the State Geological Survey, with which this work (not yet completed) is done in cooperation. Deposits of high-grade mica in northern Georgia were examined by W. T. Schaller.

A report on the commercial marbles of the southern Appalachian region, prepared in cooperation with the geological surveys of Alabama, Georgia, and Tennessee, by T. Nelson Dale, has been completed.

A report on the ground-water conditions in the vicinity of Grayson and the water supply for an aviation camp site at Americus, by T. W. Vaughan, was made to the Signal Corps, United States Army, and information on the water supply for a chemical plant at Brunswick was furnished by L. W. Stephenson. The general geographic and geologic features of the country including Camp Gordon were reviewed by F. E. Matthes for popular description on the back of the topographic map of the camp and environment, in cooperation with the State.

Preparation of a report on the geologic structure in the Fitzgerald district and along Chattahoochee River in southern Georgia, examined at the request of the State Geological Survey, was, after communication of the principal conclusions to the press, suspended for the remainder of the year on account of the imperative necessity for field examinations in other more promising regions.

A report on "Deposits of Claiborne and Jackson age in Georgia," by C. Wythe Cooke and H. K. Shearer, has been published as Professional Paper 120–C, and a report by J. A. Cushman and Mr. Cooke on the "Orbitoid Foraminifera of the genus *Orthophragmina* from Georgia and Florida" as Professional Paper 108–G. Some progress in the office description of the fossils from the Alum Bluff formation in the State was made by Julia Gardner prior to her departure to France with the Red Cross.

IDAHO.

A portion of July was spent by J. B. Umpleby in the compilation of material in preparation of the report by him and E. L. Jones, jr., on the ore deposits of Idaho.

G. R. Mansfield has been engaged in the investigation and classification of lands in several of the coal basins of eastern Idaho where applicants desired to open coal mines.

The manuscript describing the Hailey quadrangle by L. G. Westgate is practically completed. A stratigraphic chapter for this report was completed by E. S. Kirk, and collections of fossil invertebrates and plants have been examined for information of the field geologists by T. W. Stanton and F. H. Knowlton. Some office attention has been given by G. H. Girty to the invertebrates from the Lower Triassic of the State.

Deposits of cobalt and nickel in the Blackbird district were examined by F. L. Hess, and tungsten deposits near Carroll were examined by E. S. Larsen, jr.

ILLINOIS.

Conforming to the plans of the Illinois State Geological Survey, which bore the field expenditures of the cooperative investigations, the study of the stratigraphy and economic geology of the Equality and Shawneetown quadrangles, in which the structure is complicated by much faulting, was continued by Charles Butts. The faunas of some of the Mississippi formations were reviewed in the office by G. H. Girty. Early Silurian invertebrates of southern Illinois and southeastern Missouri were examined by E. O. Ulrich in connection with work carried on in cooperation with the State of Missouri.

With the object of gathering information as to the possibilities of increasing the production of petroleum in the State, brief examinations of the Illinois oil fields were made by the geologists of the State in cooperation with this Survey, in the course of which E. W. Shaw visited some of the areas. A paper on "A new area of Carboniferous rocks with some coal in the north end of the Gulf embayment" was transmitted by Mr. Shaw for outside publication. A cooperative report by Stuart Weller and Charles Butts on the geology of Hardin County is now in preparation.

The geographic and more interesting geologic features in the region about Camp Grant have been reviewed and described in popular form by R. D. Salisbury for publication on the back of the Camp Grant topographic map. This work is contributed through the cooperation of the State.

INDIANA.

A report on the ground-water conditions of the site for the proposed aviation camp at Evansville, Ind., was made by T. Wayland Vaughan, and a brief inspection of the oil fields of the State was made by E. W. Shaw, with particular respect to the extension of the amount of undrilled "inside" territory. Conforming with the request of the Treasury Department and the Indiana Limestone Quarrymen's Association, work for a report on the character and grading of the Bedford limestone has been undertaken by G. F. Loughlin but has been suspended because of the war.

IOWA.

The geographic and geologic features in the vicinity of Camp Dodge, Iowa, were examined by James H. Lees, assistant State geologist, representing the cooperating State Survey, for a popular description of the country about the camp, by Mr. Lees and W. C. Alden, to be printed on the back of the Camp Dodge topographic map.

A report on "Evidence of Iowan stage of glaciation," by W. C. Alden, based on investigations conducted in cooperation with the State Geological Survey, has been published by the State.

For the purpose of establishing correlations essential to the completion of the reports on southwestern Minnesota, in accordance with the cooperative arrangement with the State Geological Survey, a reexamination of the drift in a portion of northwestern Iowa was made in October by Frank Leverett in conference with Profs. T. C. and R. T. Chamberlin.

KANSAS.

At the request of the Kansas State geologist a detailed cooperative examination was made by A. E. Fath of the Eldorado field and surrounding country, embracing a large part of Butler County, the work including reconnaissance inspections in the Augusta, Fox-Bush, and Weaver oil fields. The Otto field, in Cowley County, was examined by Mr. Fath at the request of the Bureau of Mines, to which a report thereon was immediately transmitted. A brief visit to the region embracing Eldorado was made by the chief geologist.

Some data on the possibilities of developing oil and gas in western Kansas are contained in a paper by N. H. Darton on "The structure of parts on the central Great Plains," printed as Bulletin 691–A.

KENTUCKY.

A popular description, educational in scope and purpose, of the region about Camp Taylor, Ky., embracing Louisville, was prepared by Charles Butts for publication on the back of the Camp Taylor topographic map.

A paper on the description and correlation of the post-Mississippian formations of western Kentucky by Charles Butts, based on studies made in cooperation at the request of the State Geological Survey, was transmitted to that organization for publication. This paper was accompanied by a paper on the stratigraphy of the Chester group by E. O. Ulrich.

An outline of the petroleum geology of Kentucky was prepared by E. W. Shaw, and some office work on the Carboniferous faunas concerned in the interstate cooperative investigations was done by G. H. Girty.

A description of the geologic structure and oil and gas prospects in the region of Irvine, by Mr. Shaw, has been issued as Bulletin 661–D. A report by Mr. Shaw and K. F. Mather on the "Oil fields of Allen County, Ky.," is in press as Bulletin 688.

The cannel coals of the State are described by G. H. Ashley in Bulletin 659, on "Cannel coal in the United States."

LOUISIANA.

At the request of the city of New Orleans an examination of the structural criteria and of the records of drilling in Terrebonne Parish, La., was made by E. W. Shaw, who submitted a brief preliminary report to the city commissioner of public utilities. Fossils from one of the gas wells in Terrebonne Parish were examined by C. Wythe Cooke, who determined that rocks of Tertiary age were upfolded in the region. Pleistocene invertebrates collected by the field geologists were examined by W. H. Dall.

Certain oil lands near Sour Lake, whose title is in dispute, were at the request of the Department of Justice reviewed by Frank Leverett with reference to their recent geologic history. The results of the work were immediately reported to that department.

The salt and oil domes in the new Iberia field were examined by G. S. Rogers in the course of an extended study of the salt domes of the Coastal Plain.

A description with maps of the De Soto-Red River oil and gas field, by G. C. Matson and O. B. Hopkins, is published as Bulletin 661–C, and a report by Mr. Matson on Louisiana clays, including the results of tests made in the laboratory of the Bureau of Standards at Pittsburgh, as Bulletin 660–E.

MAINE.

Pyrite deposits in the vicinity of Katahdin Iron Works and at other points in Maine were examined by E. S. Bastin and A. C. Spencer in connection with a review of the raw materials available for producing sulphuric acid in the United States.

The necessary field examinations were made and the greater part of the text for a descriptive report on the geographic features of the State was prepared by Arthur Keith for use in a geographic manual of the New England States.

A report on the "Stratigraphy in southwestern Maine and southeastern New Hampshire," by F. J. Katz, has been issued as Professional Paper 108–I.

A bulletin on the granites of New England, bringing up to date in one volume the information heretofore distributed among several bulletins, has been practically completed by T. Nelson Dale.

MARYLAND.

A description of the geographic and more interesting geologic features in the region embracing Camp Meade, Md., is, through the cordial cooperation of the Maryland Geological Survey, being prepared by E. W. Berry, for printing on the back of the topographic map of the area.

The chromite deposits in and about the Line Pit mine, in Cecil County, were examined by Miss E. F. Bliss.

A report on the potable water supply in the lower part of the Patuxent estuary was prepared for use of the Navy Department by the section of Coastal Plain investigations in cooperation with the State Geological Survey.

The greensand deposits are described by G. H. Ashley, with special reference to their availability as a source of potash, in Bulletin 660–B.

Descriptions of the physical features of the Coastal Plain and of the Allegheny regions of the State have been prepared by L. W. Stephenson and M. R. Campbell, respectively, and examinations of the Piedmont Plateau and the valley region have been made by Laurence LaForge and G. W. Stose, to obtain material for use in the preparation of a geographic manual covering the States of Maryland, Delaware, West Virginia, and Virginia.

MASSACHUSETTS.

Information regarding the road materials of Massachusetts has been compiled by Laurence LaForge and B. K. Emerson for use of the Council of National Defense.

Descriptions of granites in Massachusetts are included in an economic bulletin on the granites of New England, the manuscript of which has been practically completed by T. Nelson Dale; and an

economic study of the limestones and dolomites of western Massachusetts and Connecticut has been begun by Mr. Dale.

A preliminary report by B. K. Emerson on the "Geology of Massachusetts and Rhode Island" has been issued as Bulletin 597.

Tertiary invertebrates collected in connection with the Coastal Plain investigations were examined by W. H. Dall.

The physical features of the State are described by Arthur Keith in a manual on the geography of New England, now in preparation.

MICHIGAN.

In connection with the preparation of his report on the Pleistocene of the Lake Superior region Frank Leverett examined the drift in the Elsie and Perrinton quadrangles, Mich. The results of this study were used also for Mr. Leverett's report on the Pleistocene deposits of Minnesota, investigated in cooperation with the Minnesota Geological Survey.

A report on the geography and geology of the country including Camp Custer, near Battle Creek, was prepared by Mr. Leverett in cooperation with the State Geological Survey for publication by the State. A shorter and more popular educational description of the area was written by Mr. Leverett for printing on the back of the topographic map of the region.

The description of the fauna of the Marshall group has received some office attention from G. H. Girty.

MINNESOTA.

A preliminary report on the Cuyuna iron-ore district, Minn., was prepared by E. C. Harder and submitted for publication by the Minnesota Geological Survey, with which the work was done in cooperation. A paper on the manganiferous iron ores of the Cuyuna district, prepared by Mr. Harder, was published in the Bulletin of the American Institute of Mining Engineers for September, 1917. Mr. Harder also made some progress in the preparation of his final report on the Cuyuna district.

The description of the Pleistocene deposits of Minnesota, based on field investigations carried on in cooperation with the State Geological Survey, was nearly completed by Frank Leverett. Office study based on cooperative field investigations was carried on by Frank Leverett in the preparation of his report on the "Surface formations and agricultural conditions of southern Minnesota." This report is designed for publication by the State.

"Structural and ornamental stones of Minnesota," a report by Oliver Bowles, based on cooperative work by the State Geological Survey, has been published as Bulletin 663.

MISSISSIPPI.

A report on the ground-water conditions in the vicinity of Jackson, Miss., by T. Wayland Vaughan, was submitted to the Signal Corps. A manuscript on the ground-water resources of the Cretaceous deposits of the State, based on investigations carried on in cooperation with the State Geological Survey, is in preparation by L. W. Stephenson. The water supply for an aviation camp site at West Point was the subject of a report by Mr. Stephenson, and the ground-water prospects in the vicinity of Camp Shelby were examined by Mr. Stephenson for the War Department.

A paper on the correlation of the deposits of Jackson and Vicksburg age in Mississippi and Alabama, by C. Wythe Cooke, has been published outside the Survey, and a report entitled "Deposits of Claiborne and Jackson age in Georgia," by Mr. Cooke and H. K. Shearer, has been issued as Professional Paper 120–C.

A report on the "Pliocene history of central and northern Mississippi," by E. W. Shaw, has been published as Professional Paper 108–H.

MISSOURI.

The faunas of southeastern Missouri received both field and office attention from E. O. Ulrich, through the cooperation of the State Bureau of Mines and Economic Geology, which bore the cost of the field investigations.

A portion of the year was devoted by G. H. Girty to the study of the fossil invertebrates of the Joplin district.

MONTANA.

The manganese ore deposits in the vicinity of Butte and in the Madison and Jefferson valleys, Mont., were examined by J. T. Pardee, and those in the Philipsburg district by J. B. Umpleby, with a view to ascertaining the capacity of the region to contribute to the domestic supply of manganese in 1917 and 1918. A paper on "Manganese ore at Butte," by Mr. Pardee, has been issued as Bulletin 690–E, and reports on "Ore deposits of the northwestern part of the Garnet Range, Mont.," and on "The Dunkleberg district, Granite County, Mont.," by Mr. Pardee, have been published in Bulletin 660, parts F and G, respectively.

Tungsten (scheelite) deposits in the Crevice and Sheepeater districts near Jardine, hübnerite deposits near Butte, and molybdenite deposits near Butte and in the Tobacco Root Mountains, 23 miles south of Jefferson Island, were examined by Frank L. Hess.

The structure and oil and gas possibilities of the Huntley field, an area lying north of the Crow Indian Reservation and southeast of

Billings, were examined by E. T. Hancock and a report with map recording the results has been submitted for publication in the "Contributions to economic geology."

Portions of Teton County were examined in reconnaissance or in detail by Eugene Stebinger, with special reference to oil and gas. A paper on the "Geology of the Birch Creek-Sun River region, Mont.," has been submitted by Mr. Stebinger and is now in press as Bulletin 691–E.

A report by C. F. Bowen on "Anticlines in parts of the Musselshell Valley" is in press as Bulletin 691–F, and another on the "Geology and oil and gas prospects of the Lake Basin field," west of Billings, by E. T. Hancock, has been issued as Bulletin 691–D. A description of the Elk Basin oil field, by C. J. Hares, has been prepared for publication. Papers entitled "The Bowdoin dome, Montana, a possible reservoir of oil and gas," by A. J. Collier, and "Phosphatic oil shales near Dell and Dillon, Beaverhead County, Mont.," by C. F. Bowen, were published as parts E and I, respectively, of Bulletin 661.

The graphite deposits at Dillon were examined by H. G. Ferguson, and the Devonian oil shales near Freeport were sampled by E. T. Hancock for distillation tests.

A report on the coal fields of Montana, by A. J. Collier and E. R. Lloyd, has been somewhat advanced by Mr. Collier, who has also in preparation a report on the Scobey lignite field. Mr. Collier's paper on the geology of northeastern Montana (Professional Paper 120–B) is in press.

Cretaceous invertebrates from the State have been under descriptive investigation by T. W. Stanton and fossil plants by F. H. Knowlton. A report by D. Dale Condit on the "Relations of the late Paleozoic and early Mesozoic formations of southwestern Montana and adjacent parts of Wyoming" has been submitted for publication in the "Shorter contributions to general geology, 1918" (Professional Paper 120–F).

A preliminary report on the Pleistocene of northeastern Montana and northwestern North Dakota, in preparation by W. C. Alden, was early in the year interrupted for more urgent work connected with war interests. A paper by A. J. Collier and W. T. Thom, jr., on "The Flaxville gravel and its relation to other terrace gravels of the northern Great Plains," has been issued as Professional Paper 108–J. The classification of the coal lands in the northeastern part of the Crow Indian Reservation was completed by A. J. Collier, assisted by Chester K. Wentworth. The report on "The Bull Mountain coal field, Musselshell and Yellowstone counties, Mont.," by L. H. Woolsey, R. W. Richards, and C. T. Lupton, has been issued as Bulletin 647.

NEBRASKA.

Several of the alkali lakes and the potash-recovery plants in western Nebraska were briefly examined by H. S. Gale.

The oil prospects in the western part of the State are tentatively discussed by N. H. Darton in "The structure of parts of the central Great Plains," published as Bulletin 691–A.

Tertiary and Pleistocene invertebrates from the State were examined by W. H. Dall.

NEVADA.

The quicksilver deposits at Ivanhoe Springs, in the Ione district, and at a number of other localities in Nevada, were examined by F. L. Ransome as a part of a quantitative and qualitative estimation of the quicksilver resources of the United States.

Manganese ore deposits near Pioche were examined in the autumn of 1917 by J. B. Umpleby, and the results were published both officially and unofficially. In the spring of 1918 J. T. Pardee examined the manganese ore deposits of White Pine County, including the Ely and Siegel districts, and the results of his work have been published in a press bulletin. A thorough inventory of the manganese deposits, either known or reported, in the State was begun in June, 1918, by E. L. Jones, jr., and J. C. Jones, in cooperation with the Bureau of Mines and the State University.

The sulphur, alum, and alunite deposits near the town of Sulphur were examined by E. S. Larsen, jr., who submitted notes with special reference to the possible availability of the alunite deposit as a source of potash. A brief examination of the reported deposit of potash discovered north of Lovelocks was made by F. L. Hess.

Tungsten deposits were examined by Mr. Hess and Mr. Larsen, either together or separately, at or near Tungstonia, Golconda, Ellsworth, Imlay, Mill City, Shoshone (Minerva district), Baker (Snake Creek, South Lexington Canyon), Osceola, Sacramento Pass, and numerous localities reached from Lovelocks, at Toulon, Toy, Round Mountain, and Spanish Springs, in the "Lava Beds" west of Seven Troughs, and in the Nightingale Mountains. Most of these are contact-metamorphic deposits now making a considerable aggregate production. Mr. Larsen examined a molybdenite deposit north of Golconda. The deposits were examined with the object of determining the amounts and grades of ore obtainable for use under war conditions.

A report on "The antimonial silver-lead veins of the Arabia district, Nev.," by Adolph Knopf, was published as Bulletin 660–H. Another report by Mr. Knopf on the geology and ore deposits of the Rochester district, in preparation, has been suspended for more urgent investigations.

A report on "The geology and ore deposits of Ely, Nev.," by A. C. Spencer, has been printed as Professional Paper 96, and a report on the genesis of the Tonopah ores, by E. S. Bastin and F. B. Laney, is now in press as Professional Paper 104.

NEW HAMPSHIRE.

The surficial features of New Hampshire are described by Arthur Keith in the geographic manual on New England, now nearing completion.

A report by F. J. Katz on "Stratigraphy in southwestern Maine and southeastern New Hampshire" has been published as Professional Paper 108–I.

Descriptions of New Hampshire granites are included in an economic bulletin on the granites of New England by T. Nelson Dale, the manuscript of which is practically completed.

NEW JERSEY.

The geographic and salient geologic features in the vicinity of Camp Dix, near Wrightstown, N. J., were examined in cooperation by H. B. Kümmel, State geologist, and E. W. Shaw, with the object of jointly preparing a popular description of the region to be printed on the back of the topographic map of the camp.

The composition of the greensands of the southern part of the State and their availability as a source of potash are set forth in a paper by G. H. Ashley, printed as Bulletin 660–B.

NEW MEXICO.

The examination of the "Red Beds" and the gypsum and saline deposits of New Mexico, with the object of determining the geologic history of the region and the horizons at which potash may be present, was continued by N. H. Darton, who is engaged in the preparation of a report on the stratigraphy and structure of the "Red Beds" region of the Southwest with special reference to the possibilities of the presence of potash. A brief investigation of the reported discovery of potash deposits near Tucumcari was made by R. K. Bailey, and an examination of springs reported to contain notable proportions of potash coming from the "Red Beds" near Grant was made by Mr. Darton.

Sulphur deposits in the vicinity of Jemez Springs were examined and reported on by G. R. Mansfield.

The classification of the lands in the northeastern portion of the San Juan Basin, with reference to oil and coal, was continued by J. B. Reeside, jr., and Harvey Bassler. After Mr. Reeside's entrance on military duty Mr. Bassler continued the work until the end of the field season.

Manganese deposits near Silver City were examined by J. B. Umpleby, and those near Magdalena, Fierro, Rincon, Hillsboro, and Lake Valley by E. L. Jones, jr. Tungsten deposits at White Oaks, near Rinconada (Copper Mountain or Picuris district), and near Gage, and iron deposits near White Oaks were examined by F. L. Hess.

Several volcanic cinder cones were examined by G. F. Loughlin, assisted by C. E. Barglebaugh and H. D. Pallister, for the Emergency Fleet Corporation, in search of porous rock suitable for a lightweight aggregate in concrete for ship construction.

"The geology of the Navajo country—a reconnaissance of parts of Arizona, New Mexico, and Utah," by H. E. Gregory, has been issued as Professional Paper 93.

The Cretaceous invertebrates from several parts of the State received office attention from T. W. Stanton. Papers on the "Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico," by W. T. Lee and F. H. Knowlton, are printed in Professional Paper 101. The text and maps for the Raton-Brilliant folio have been submitted by Mr. Lee.

Some progress was made by Sidney Paige in the report on the Tyrone district, and the geology of the Deming quadrangle is mapped and described in detail by Mr. Darton in Folio 207.

NEW YORK.

The physiographic features of the areas embracing Camp Upton and Camp Mills, N. Y., were examined by W. C. Alden, who prepared popular educational descriptions of the geographic features and their origin for printing on the backs of the topographic maps covering these areas. Geologic data of military value for Long Island were compiled and mapped by Mr. Alden.

Manganese deposits at Annandale were examined by D. F. Hewett. Some office time was given by E. O. Ulrich to the study of the fossils from the Chazy formations in the northern part of the State.

NORTH CAROLINA.

Manganese deposits in the Hot Springs region, N. C., were examined by F. C. Schrader. At the request of the State Geological Survey, the limestones and marls of the Coastal Plain were studied in the field by J. A. Cushman and E. W. Berry, with sampling for analyses and economic tests. A report by Mr. Cushman and Mr. Berry is now in preparation for publication by the State, with which the work was done in cooperation. Fossils collected by Mr. Cushman were identified by C. W. Cooke.

A paper on the tin deposits of the Kings Mountain region, by Arthur Keith and D. B. Sterrett, has been published as Bulletin

660–D, and a report, by G. H. Ashley, on greensand deposits in the State, with special reference to their availability as a source of potash, was published in Bulletin 660–B. Mica deposits in the Piedmont region were examined by W. T. Schaller.

Descriptions of the marbles of North Carolina are included in a report on the commercial marbles of the southern Appalachian region, which has been completed by T. Nelson Dale.

A number of clay-bearing localities in the State were examined by Heinrich Ries, in connection with the preparation of a general report by him on the high-grade clays of the United States which may be used in substitution for imported clays.

Information on a proposed artillery cantonment was contributed to the Chief of Field Artillery by T. W. Vaughan, who made field examinations with Lieut. Col. E. P. King, jr., particularly between Fayetteville and Hamlet.

NORTH DAKOTA.

In cooperation with the North Dakota Geological Survey the lignite-bearing areas of the Ray quadrangle were examined and the lands classified by A. J. Collier, assisted by C. G. Wentworth. The Nesson anticline, which offers possibilities of oil in a part of Williams County, has been described by Mr. Collier in a short report now being printed as Bulletin 691–G.

The fossil shells collected by the field geologists in the Lance formation and the plants from the Eocene have been examined by T. W. Stanton and F. H. Knowlton, respectively, for the purpose of assisting in the correlation of the geologic formations.

The manuscript for a folio by H. A. Hard on the Edgeley and Lamoure quadrangles was critically reviewed by W. C. Alden.

OHIO.

The geographic and geologic features of the vicinity of Camp Sherman, near Chillicothe, Ohio, were examined by M. R. Campbell and Frank Leverett, the information being for the use of the State geologist, Prof. J. A. Bownocker, and Mr. Campbell, respectively, in the preparation of popular descriptions of the physical features of the region and their origin. The material compiled by Mr. Campbell has been published in the form of a popular educational text on the back of the topographic map of Camp Sherman.

A special report on the oil and gas resources of the Woodsfield quadrangle, in preparation by D. D. Condit and R. V. A. Mills, will deal particularly with the lack of parallelism between the Berea sand and the exposed Pennsylvanian formations and the relatively close adherence of the Berea oil pools to the domes and anticlines actually in the Berea itself. This work has been delayed by the transfer of

Mr. Mills to the Bureau of Mines and the detail of Mr. Condit to more urgent war work.

A summary report with maps on "The coal fields of Ohio," prepared through the cooperation of the State Geological Survey by J. A. Bownocker, State geologist, has been issued as Professional Paper 100–B.

Manuscripts on the clay and the oil resources of the Wellsville quadrangle have been prepared by James H. Hance.

OKLAHOMA.

In view of the prospective leasing for oil of the lands in the Osage Reservation, Okla., and the great importance of this territory by reason of the general productivity of its numerous anticlines and domes, the high grade of the oil, and the availability of refining and transportation facilities, as many as practicable of the oil and gas geologists were assigned to studies of the structure in Osage County. Thirteen townships in the west half of the county have been examined by C. F. Bowen, assisted by G. E. Dorsey; on the "east side" the work begun by K. C. Heald two years ago was continued throughout the year, during which he was joined by F. R. Clark, D. E. Winchester, W. B. Emery, E. R. Lloyd, R. V. A. Mills, W. S. W. Kew, E. M. Spieker, K. F. Mather, G. B. Richardson, O. B. Hopkins, Sidney Powers, W. A. English, J. P. Buwalda, H. M. Robinson, M. I. Goldman, C. S. Ross, and P. V. Roundy. The field investigations of the Pawhuska quadrangle were completed in June, and work was begun on the preparation of a series of papers describing and mapping the geologic structure by townships, the papers to be issued as rapidly as possible for the guidance of prospective lessees of these lands, which are being placed upon the market in large aggregate acreages. These papers will form parts of Bulletin 686. The description and map of several townships in the northwest quarter of the Pawhuska quadrangle, by Mr. Heald, have been issued as Bulletin 691–C.

Press notices bringing to the attention of the public certain anticlines and domes in Pontotoc and Hughes counties have been based on the work done by H. M. Robinson in cooperation with the Office of Indian Affairs and the Superintendent of the Five Civilized Tribes. Further examinations in southern Oklahoma were made by Mr. Robinson in June. This work included the additional study of the Preston anticline, in the Denison and Tishomingo quadrangles, on which Mr. Hopkins and Mr. Powers had been engaged earlier in the winter. This anticline is described, with small-scale map, in a general report on the stratigraphy, structure, and areal geology of parts of northern Texas and southern Oklahoma, based on field examinations made by Messrs. Stephenson, Hopkins, and Powers, which is now in process of publication as Professional Paper 120–H.

Detailed structural examinations in a part of the west half of the Hominy quadrangle were made under agreement by Robert H. Wood, whose work was, however, interrupted by other demands.

At the request of the Commanding Officer of the Department of the Southwest, an examination of the structure and oil and gas possibilities of the Fort Sill military reservation was begun. While the geologist, Sidney Powers, was engaged in this examination in June, he was called into military service, leaving the work unfinished.

To bring up to date the information regarding the progress of developments in the south half of the Bristow quadrangle, A. E. Fath reviewed that area in May. Several collections of Carboniferous fossils, sent into the office by field geologists, were examined by G. H. Girty.

A report on "Geologic structure in the Cushing oil and gas field, Okla., and its relation to the oil, gas, and water," by Carl H. Beal, courteously contributed in cooperation by the Bureau of Mines, has been published as Bulletin 658.

The manganese and iron ore deposits near Bromide and Sulphur were examined in October by D. F. Hewett in company with representatives of the Oklahoma Geological Survey.

OREGON.

The deposits of antimony, molybdenum, and tungsten in the vicinity of Baker City, La Grande, Huntington, Weatherby, North Powder, St. Joseph, and Lostine, Oreg., were examined by E. S. Larsen, jr., who also examined deposits of the rare minerals in other areas.

In the course of the Survey's investigations of the platinum resources of the country, the platinum-bearing placers and the serpentine regions of Oregon were studied by L. M. Prindle and H. G. Ferguson. Manganese deposits near Pleasant Valley were investigated by J. T. Pardee.

A number of chromite localities of southwestern and eastern Oregon were visited by J. S. Diller in connection with the estimation of the possible chromite output for 1917 and 1918.

Certain of the quicksilver deposits of the State were investigated by F. L. Ransome in November.

Collections of Cretaceous and Carboniferous fossils gathered by the field geologists were determined in the office by T. W. Stanton and G. H. Girty, respectively.

The nitrate claims prospected near Vale and the several reported deposits in the vicinity of Bend were examined by H. S. Gale, who also inspected several locations in Yamhill County and vicinity, where small amounts of natural gas have been developed. The exploration near Vale was the basis of an article on the origin of nitrates con-

tributed by Mr. Gale to the Mining and Scientific Press for November 13, 1917.

PENNSYLVANIA.

The field investigation of the areal and structural geology of the Zelienople quadrangle, Pa., was finished early in the season by G. B. Richardson, who also completed the mapping, with special reference to the structure and gas resources, of the southern half of the New Kensington quadrangle, before the pressure for examinations in the Osage Reservation, Okla., called Mr. Richardson to that region.

A geologic section of Blair and Huntingdon counties, accompanied by a descriptive text, was prepared and published by Charles Butts in the June issue of the American Journal of Science.

The abandoned chromite mines and the chromite-bearing serpentines of southeastern Pennsylvania have been examined by Miss E. F. Bliss. The results of this study have been contributed to the press and in more detailed form to the different interested Governmental war-mineral agencies.

The text and maps for the Bellefonte folio have been submitted to the Survey by Prof. E. S. Moore, the work having been done under an agreement of a previous year. The Huntingdon-Hollidaysburg folio has been submitted by Charles Butts to the chief of section.

A paper on "The Helderberg limestone of central Pennsylvania," by J. B. Reeside, jr., is printed as Professional Paper 108–K. The cannel coals of the State are described, with analyses, by G. H. Ashley, in Bulletin 659.

RHODE ISLAND.

The results of a reconnaissance survey of the general geology of Rhode Island, by B. K. Emerson, are given with a map in Bulletin 597, "Geology of Massachusetts and Rhode Island." The physical features of the State are described in a manual on the geography of New England, now in preparation by Arthur Keith.

Descriptions of Rhode Island granites are included in an economic bulletin on the granites of New England, manuscript of which has been practically completed by T. Nelson Dale.

SOUTH CAROLINA.

The counties included in the Coastal Plain in South Carolina were examined with special reference to the mapping and description of geologic data of military importance and interest by C. Wythe Cooke, who during the last half of the year contributed reports on the military geology and geography of a number of the counties for transmission to the engineers of the War Department. The reconnaissance was made with mapping on the scale of 1: 500,000.

At the request of the War Department a report on the possibilities of obtaining a water supply from wells at Fort Moultrie was prepared by members of the Coastal Plain section for transmission to the War Department, and a report on the water resources of Camp Jackson was prepared by Mr. Cooke for the engineer officer in charge.

The tin deposits of the State are described in a report by Arthur Keith and D. B. Sterrett, on "Tin resources of the Kings Mountain district, North Carolina and South Carolina," printed as Bulletin 660–D. Mica deposits in the western part of the State were examined by W. T. Schaller.

SOUTH DAKOTA.

The general structural features and the oil and gas possibilities of the southwestern part of South Dakota are discussed by N. H. Darton in a report on "The structure of parts of the central Great Plains," printed as Bulletin 691–A.

TENNESSEE.

In accordance with a cooperative agreement with the Tennessee Geological Survey, a detailed examination of the physiography and structure of the manganese ore-bearing areas of eastern Tennessee was begun by G. W. Stose and F. C. Schrader, the general geology being in the hands of Mr. Stose and the investigation, with qualitative and quantitative estimation, of the manganese ores being carried on by Mr. Schrader. A progress report on the area now covered is now ready for submission to the State Survey for publication. A small area near Sevierville containing carbonates of manganese was examined by Arthur Keith and G. W. Stose in March.

Manganese deposits in the Del Rio district were examined and sampled by F. C. Schrader in August.

A report on the coal resources of the Crossville quadrangle was revised by Charles Butts for publication by the State.

A report on the commercial marbles of the southern Appalachian region, prepared in cooperation with the geological surveys of Tennessee, Alabama, and Georgia by T. Nelson Dale, has been completed. Mr. Dale also contributed the economic part of a bulletin on the marbles of eastern Tennessee which is to be published by the State Geological Survey.

Some progress was made in the preparation of the report on the geology and mineral resources of the Waynesboro quadrangle by H. D. Miser. A report on the structure of the Waynesboro quadrangle, with special reference to oil and gas, of which the late A. H. Purdue, State geologist, was joint author, was completed by Mr. Miser and has been published by the State Survey in "The resources of Tennessee."

An outline of the petroleum geology of Tennessee is in preparation by E. W. Shaw.

The results of the examination of some of the greensands of western Tennessee, to show their potash content, are given in a paper by G. H. Ashley, printed as Bulletin 660–B.

Early Paleozoic fossils, which were sent to the office by the field geologists, were determined by E. O. Ulrich.

TEXAS.

The search for potash at Cliffside, 6 miles northwest of Amarillo, Tex., was continued during the early part of the summer until the well, at a depth of over 1,700 feet, had passed the horizon of the supposed potash salts without encountering potash of commercial value. The capacity of the rig having been reached and the available funds expended, boring was discontinued in October.

The field sampling and testing of the salts and brines encountered in boring wells in the "Red Beds" of western Oklahoma, northern Texas, and eastern New Mexico, sampled through the cordial cooperation of the companies, was continued by R. K. Bailey.

The quicksilver deposits of the Terlingua district were examined in March by F. L. Ransome, and the manganese ore deposits near Shumla were investigated, sampled, and estimated by J. B. Umpleby.

The general structure and the coals of the Santo Tomas coal fields in Webb County were examined by G. H. Ashley, whose report thereon is published as Bulletin 691–I.

The investigation of the salt domes of the Coastal Plain, including studies of the origin and differentiation of the salt, sulphur, oil, gas, and water and of the geologic structure, were continued by G. S. Rogers until late in the winter, when he was detailed to other investigations of greater military importance. A paper on the origin of the salt domes of Texas and Louisiana was contributed by Mr. Rogers for publication in the proceedings of the American Institute of Mining Engineers. Oil indications and reported structure at a number of points in Smith, Wood, and Delta counties were examined during the winter by O. B. Hopkins and Sidney Powers.

Sulphur deposits were examined with the estimation of reserves by P. S. Smith and W. O. Hotchkiss in October in cooperation with the engineers of the Bureau of Mines.

In December the study of a part of northeastern Texas bordering on Red River was resumed by L. W. Stephenson for the purpose of completing a manuscript on the stratigraphy and structure and on the correlation of the formations in that part of northeastern Texas. In this work Mr. Stephenson was joined for a time by O. B. Hopkins and Sidney Powers, who gave special attention to mapping the structure and investigating the oil possibilities of Fannin, Hunt, and

Grayson counties. Mr. Stephenson's report on the area is in press as Professional Paper 120–H. Fossils from the Hueco and Bend formations and from the Eocene have been examined in the office by G. H. Girty and C. W. Cooke, respectively.

Papers on the Corsicana oil and gas field, by G. C. Matson and O. B. Hopkins, and the Palestine and Brenham salt domes, by Mr. Hopkins, have been issued as parts F and G of Bulletin 661.

Information regarding the water supply for an aviation camp site at San Leon was furnished by T. W. Vaughan, who also furnished the Signal Corps general information on the ground-water conditions about San Antonio. Information on water supply at Leon Springs was supplied to the constructing quartermaster at that place.

Material for the description of the geographic features and their origin in and about Camp Travis was gathered by L. W. Stephenson for printing on the back of the San Antonio topographic map.

Physiographic descriptions of the Brackett, Nueces, and Rock Springs quadrangles were prepared by T. W. Vaughan for use in teaching soldiers the interpretation of topographic maps.

UTAH.

An examination of the structure and oil possibilities of the Green River Desert south of the Denver & Rio Grande Railroad, north of San Rafael River and east of San Rafael Reef, was made, with classification of the land, by W. B. Emery, assisted during the early part of the field season by H. S. Palmer. Later the work was continued until the close of the season by Harvey Bassler, who made a special examination of coal lands in Salina Canyon, where there was a desire to open new coal lands. The office work in preparing reports on the Salina Canyon area was done by Eugene Stebinger.

A specimen of tungstenite, a new tungsten sulphide, from Alta, was identified by R. C. Wells and described in an unofficial paper by him and B. S. Butler. Later E. S. Larsen examined the deposit. Other tungsten (scheelite) deposits 17 miles north of Lucin, near Emigrant Spring, Box Elder County, and near Gold Hill and on Trout Creek, Tooele County, were examined by F. L. Hess. A new type of molybdenum deposit in which ilsemannite impregnates sandstone and which occurs near Ouray was examined by Mr. Hess.

Manganese ores of Grand, Utah, Tooele, and Juab counties were studied by J. T. Pardee in May, and press notices containing the results were prepared for immediate publication.

The detailed field study of the geology and ore deposits of the Cottonwood and American Fork districts by B. S. Butler and F. C. Calkins was suspended near the end of the field season of 1917, on account of the urgent need for the services of these geologists in war-mineral work of more pressing importance.

Professional Paper 111, on the ore deposits of Utah, by B. S. Butler and G. F. Loughlin, is in press.

Supplementary office work was done on the reports on the Tintic and Ophir districts by G. F. Loughlin. The Tintic report has been submitted for publication as Professional Paper 107, and the report on "Zinc carbonate and related copper carbonate ores at Ophir, Utah," has been issued as Bulletin 690–A. Mr. Loughlin also completed and submitted a paper on "Two lamprophyre dikes near Santaquin and Mount Nebo, Utah," which was published as Professional Paper 120–E.

The preparation of an economic report on the Sunnyside-Wellington district and of a short report on the Farnham anticline, in Carbon County, by F. R. Clark, was interrupted in order that Mr. Clark might participate in the oil mapping of the Osage Reservation, Okla.

Several potash plants near Great Salt Lake were visited by H. S. Gale, and a brief review of the recent developments for the production of potash from the various alunite properties about Marysvale was made by V. C. Heikes, and a report thereon filed.

Collections of fossils from the Carboniferous and Lower Triassic were studied by G. H. Girty, and from the Jurassic by T. W. Stanton.

"Geology of the Navajo country—a reconnaissance of parts of Arizona, New Mexico, and Utah," by H. E. Gregory, has been published as Professional Paper 93.

The deposits of oil shale in the Uinta Basin, northeastern Utah, and at several other localities in the State are described by D. E. Winchester in Bulletin 691–B.

A brief report on the Lost Creek coal field, Morgan County, Utah, by F. R. Clark, is in press as Bulletin 691–L. A paper on the Green River Desert section was transmitted by W. B. Emery for unofficial publication.

A paper giving the results of "A geologic reconnaissance of the Uinta Mountains, northern Utah, with special reference to phosphate," by A. R. Schultz, is contained in Bulletin 660–C.

VERMONT.

The physical features of Vermont are described by Arthur Keith in a geographic manual of New England now nearing completion.

Descriptions of Vermont granites are included in the bulletin on the granites of New England, the manuscript of which has been practically completed by T. Nelson Dale.

VIRGINIA.

The areal and structural study of the Shady limestone and its contiguous formations through the manganiferous region of the Valley of Virginia was completed by G. W. Stose, F. J. Katz, and H. D.

Miser. A short report by Messrs. Stose, Miser, Katz, and D. F. Hewett on the "Possibilities for manganese on certain undeveloped tracts in the Shenandoah Valley" has been published as Bulletin 660–J. A more extended report with detailed descriptions and maps of the belt has been prepared for transmission for publication by the State Geological Survey, with which this work was done in cooperation.

A reconnaissance examination of the manganese ore deposits in Bland County was made in June by G. W. Stose in association with E. G. Spilsbury, of the Bureau of Mines.

A report, by G. H. Ashley, on greensand deposits, with special reference to their availability as a source of potash, was published in Bulletin 660–B.

The economic map of Buchanan County was completed by Henry Hinds and T. K. Harnsberger for transmission to the State and is now in process of engraving. The preparation of the descriptive text has been delayed by the resignation of Mr. Harnsberger and the absence of Mr. Hinds, but it is practically complete. This work also was done in cooperation with the State Geological Survey, by which the results are to be published.

Descriptions of marbles in Virginia are included in a report on the commercial marbles of the southern Appalachian region, which has been completed, by T. Nelson Dale.

An examination of the ground waters in the vicinity of Yorktown was made by T. W. Vaughan, and a report on the water supply was transmitted to the Chief of Yards and Docks, Navy Department, by whom the investigation was requested. Mr. Vaughan also furnished to the Signal Corps information on the ground water conditions near Mount Vernon. The water supply for the aviation camp at Langley Field was examined by L. W. Stephenson. In compliance with a request from the Construction Quartermaster of the War Department, a memorandum on the probability of developing an adequate water supply for Camp Lee was prepared by Mr. Vaughan. Sand and gravels in the vicinity of Camp Humphreys were examined and similarly reported on by N. H. Darton. Data on water supply at Hampton Roads were furnished to the Pig Point Depot and the United States Navy; and information on ground water was furnished the Signal Corps.

The geographic features of the region including Langley Field, near Hampton, have been examined and a description of their origin was submitted by L. W. Stephenson for publication on the back of the Hampton topographic map.

The Piedmont Plateau of this State has been examined by Laurence LaForge, the geographic features of the valley region by G. W. Stose, and the Allegheny region by M. R. Campbell, for description in a

geographic manual of the Virginian region. The chapter on the Coastal Plain province of the State has been written by L. W. Stephenson.

The country about Camp Lee was visited by M. R. Campbell and L. W. Stephenson in company with A. W. Giles, of the State Geological Survey, by whom a description of the geographic features of the area and their origin was prepared in cooperation for publication as a pamphlet by the Geological Survey of Virginia.

A report on the tin deposits near Cash Creek was prepared by H. G. Ferguson and has been published by the Virginia Geological Survey.

Pleistocene plants and early Paleozoic invertebrates have been examined by F. H. Knowlton and E. O. Ulrich, respectively.

Corundum deposits near Whittles were examined and sampled for testing by F. J. Katz. The results are given in the report on abrasives in the current Mineral Resources volume. The field investigation was made in cooperation with the State geologist, T. L. Watson. The rutile deposits at Arrington have been examined by F. L. Hess.

The physical and general geologic features of the Urbanna quadrangle and the surrounding region were examined in the later part of May and in June by W. T. Lee, W. C. Mansfield, and R. D. Mesler, with particular attention to the acquisition of information of military importance.

WASHINGTON.

Manganese deposits near Anacortes, Omak, and in the Olympic Mountains; arsenic deposits near Mineral; chromite on Cypress Island; tungsten near Bumping Lake; molybdenum in the Cascade district; strontium near La Conner; epsomite near Ironville; diatomaceous earth near Quincy; and platinum near Riverside, Quillayute, Anacortes, and Yacolt, Wash., were examined by J. T. Pardee. A press bulletin was issued on the manganese deposits in the Olympic region.

Tungsten ore in the vicinity of Blue Grouse Mountain, Cathedral Peak, and Silver City were examined by F. L. Hess.

The magnesite deposits of Stephens County were examined by R. W. Stone, and the results were communicated promptly to the press and published in the annual report on magnesite in Mineral Resources.

Coal lands near Fairfax and Mineral were examined for classification in order that parties desiring immediately to open coal mines might proceed to increase the coal production of the State.

A notice descriptive of the salines in Okanogan County examined by J. T. Pardee was communicated to the press.

WEST VIRGINIA.

A study of the stratigraphy and coals of the Abram Creek-Stony River basin, W. Va., was made by G. H. Ashley to procure data needed by the Fuel Administration. A report with maps describing the region is in preparation for issue in "Contributions to economic geology."

In response to the request of the Navy Department, a large number of coal mines in the New River and Pocahontas fields and in the Potomac basin were sampled by G. H. Ashley, W. T. Lee, E. W. Shaw, E. T. Hancock, and Eugene Stebinger, in cooperation with the Bureau of Mines.

At the request of the Navy Department, the natural-gas resources in portions of Boone and Kanawha counties were examined by E. W. Shaw for the purpose of advising that department as to the acquisition of gas territory as a source of fuel for the armor and projectile plants being built near Charleston. In this work this Survey enjoyed the cordial cooperation and advice of the State geologist, I. C. White.

Information as to the coal resources of several regions in the southern part of the State was furnished by G. H. Ashley and David White for the use of various governmental agencies. The cannel coals of the State are described by Mr. Ashley in a paper on "Cannel coal in the United States," printed as Bulletin 659.

A paper on glass sand near Berkeley Springs, by R. W. Stone, has been published outside the Survey. A brief paper on the Cabin Creek oil field is in preparation by E. W. Shaw.

WISCONSIN.

A report on the "Pleistocene geology of southeastern Wisconsin," by W. C. Alden, with an introduction by T. C. Chamberlin, has been published as Professional Paper 106.

A portion of northern Wisconsin has been under investigation for description in a report by Frank Leverett on the glacial history of the Lake Superior region.

Physiographic descriptions of the Ripon and Neshkoro quadrangles have been prepared and transmitted by W. C. Alden for publication, and a description of the physical features of The Dells quadrangle has been prepared by Mr. Alden.

To furnish correlations needed by the State geologist, field investigations of the stratigraphy and fossils of the Ordovician and Silurian formations were made by E. O. Ulrich, the field expenditures being borne by the cooperating State. The faunas of the Mayville dolomite and other Niagaran formations have been studied in the office by Mr. Ulrich.

WYOMING.

Over 50 anticlines, many of which contain oil, are described by D. F. Hewett and C. T. Lupton in a report on "Anticlines in the southern part of the Big Horn Basin, Wyo.," which has been issued as Bulletin 656. "The Salt Creek oil field, Wyo.," by C. H. Wegemann, a much more detailed description than that earlier published, has been issued as Bulletin 670. The oil possibilities of the extreme eastern part of the State are broadly treated by N. H. Darton in Bulletin 691–A, "The structure of parts of the central Great Plains."

A brief reconnaissance of the structure along the southwest front of the Black Hills uplift from Upton to Ardmore was made by E. T. Hancock, and the principal conclusions were issued to the press. This reconnaissance is preliminary to detailed studies of the region.

A manganese deposit near Marshall was examined by E. L. Jones, jr., and chromite and asbestos deposits at a number of localities by J. S. Diller.

A description of "A fossil flora from the Frontier formation of southwestern Wyoming," by F. H. Knowlton, is given in Professional Paper 108–F.

Cretaceous fossils forwarded by the field geologists to the office have been under examination by T. W. Stanton, and a monographic report on the Jurassic ammonites was submitted by J. B. Reeside, jr., prior to his entry on military service. Vertebrate fossils from this State are described by T. D. A. Cockerell in a paper on "Some American Cretaceous fish scales," to be published as Professional Paper 120–I.

A report on the "Relations of the late Paleozoic and early Mesozoic formations of southwestern Montana and adjacent parts of Wyoming," by D. Dale Condit, is in press as Professional Paper 120–F, and a paper by Eliot Blackwelder on "New geological formations in western Wyoming" has been published outside the Survey. The "Stratigraphy of the Hanna Basin, Wyo.," is described by C. F. Bowen in Professional Paper 108–L.

CANAL ZONE.

Reports on the geology, paleontology, and physiography of the Canal Zone, now in course of publication as Bulletin 103 of the United States National Museum, received some attention in the office by T. W. Vaughan, under whose direction the materials on the geologic history of the Canal Zone, Central America, and the West Indies have been gathered in cooperation with other governmental bureaus and scientific institutions.

WEST INDIES, CENTRAL AMERICA, AND SOUTH AMERICA.

The chrome and manganese ore deposits of Cuba were examined by E. F. Burchard in cooperation with Albert Burch, of the Bureau of Mines, between February 18 and April 29. Estimates of the probable output of these ores from Cuba in 1918 and 1919 and of reserve tonnage were made, and the results were promptly communicated to the bureaus concerned and to the War Department, the Shipping Board, and the War Industries Board through the Joint Information Board. A press bulletin on the situation with respect to these ores in Cuba has been prepared by Mr. Burchard.

A paper on the "Cenozoic history of Central America and the West Indies," summarizing the results of geologic, paleontologic, and physiographic explorations in that part of the hemisphere, under supervision of T. W. Vaughan, was prepared by him for unofficial publication.

Information as to the water resources of St. Thomas, Virgin Islands, was supplied by Mr. Vaughan for the use of the insular government.

As in previous years, the paleontologic specialists of the Survey have been called on by the National Museum and by other scientific institutions of this or other governments to examine and report on fossils in order to determine the geologic formations. The fossil Foraminifera from various West Indian localities received attention from J. A. Cushman, who completed a monographic account of all collections then available, the work being done at no cost to the Survey. Pleistocene fossils from Panama, Mexico, and Uruguay have been examined by W. H. Dall, who also reported on Tertiary shells from Uruguay. Mr. Dall has also studied Oligocene fossils from Venezuela. Cretaceous fossils from Guatemala were examined by T. W. Stanton.

During June investigations of deposits of minerals of war importance were carried on by H. G. Ferguson in the Dominican Republic and by Max Roesler in Porto Rico.

Hoyt S. Gale was detailed for two months under the Office of the Chief of Engineers of the War Department for the investigation of the occurrence and manufacture of potassium nitrate in Guatemala. A special report on this subject was submitted to the War Department and a copy was deposited in the library of the Survey.

A summary of the results of an investigation of potash deposits in the Pintados Salar, in the nitrate fields of northern Chile, was contributed by Mr. Gale to the Engineering and Mining Journal of April 13, 1918.

CANADA.

Mesozoic and Tertiary plants forwarded to the Survey from western Canada were examined by F. H. Knowlton. Pleistocene and Tertiary invertebrates from Alberta were similarly examined by W. H. Dall, and Cretaceous invertebrates by T. W. Stanton. Carboniferous fossils from the Mackenzie Valley were studied by G. H. Girty.

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, the work during the year has been concentrated chiefly upon special investigations of the materials that are in special demand during the war, such as platinum, tin, chromite, tungsten, nickel, sulphur, copper, and fuels. Areal geologic surveys were restricted to work in the region tributary to the Government railroad and to the completion of projects already under way.

PERSONNEL.

On July 1, 1917, the personnel of the division consisted of 1 acting geologist in charge, 9 geologists, 1 topographic engineer, 1 hydraulic engineer, 3 clerks, and 1 draftsman on annual salaries, 1 field assistant, and 7 camp hands and recorders. On June 30, 1918, the personnel included 1 acting geologist in charge, 7 geologists, 1 topographic engineer, 1 hydraulic engineer, and 3 clerks on annual salaries and 3 geologists on per diem salaries. The field force also included 10 temporary field employees.

The following members of the division of Alaskan mineral resources now hold commissions and are engaged in active military service:

Alfred H. Brooks, major, Engineer Officers' Reserve Corps.
J. W. Bagley, major, Engineer Officers' Reserve Corps.
E. M. Aten, captain, Quartermaster Department.
C. E. Giffin, captain, Engineer Officers' Reserve Corps.
G. L. Harrington, first lieutenant.

FIELD WORK DURING THE SEASON OF 1917.

Areas covered and allotments.—Eleven parties were engaged in Alaska surveys and investigations during 1917. Nine of the parties were engaged in geologic surveys, one in topographic surveys, and one in stream gaging. The areas covered by reconnaissance geologic surveys on a scale of 1 : 250,000 (4 miles to an inch) amount to 1,750 square miles; by detailed geologic surveys on a scale of 1 : 62,500 (1 mile to an inch), 275 square miles. Much of the time of the geologists was devoted to the investigation of special problems relating to the occurrence of mineral deposits, the results of which can not be expressed in terms of area. About 1,050 square

miles was covered by reconnaissance topographic surveys on a scale of 1:250,000 (4 miles to an inch). In cooperation with the Forest Service, stream gaging was continued in southeastern Alaska.

The following tables show the allotments, including both field and office work, of the total appropriation of $100,000 for the fiscal year 1918, classified by regions, by kinds of surveys, and by kinds of expenditures. In addition to these funds, a balance of about $6,000 from last year's appropriation was expended in equipping parties for the season's field work. In the first table the general office expenses are apportioned to the several allotments, account being taken of variations in character of work. The results are expressed in round numbers. Salaries of the permanent staff are included up to the end of the fiscal year 1918, but expenses other than these include only the cost of field and office work during 1917. The "general investigations" include, with other things, the cost of collecting mineral statistics, of office work relating to the field investigations of previous seasons, and of investigations under the direct administration of the geologic branch. A balance of about $37,300 is available for equipping the field parties in 1918.

Approximate general distribution of appropriations for Alaska investigations, 1917–18.

Southeastern Alaska	$20,300
Prince William Sound, Copper River, and Controller Bay	10,300
Cook Inlet and Susitna Basin	7,600
Southwestern Alaska	3,900
Yukon basin	5,500
Seward Peninsula	1,900
General investigations	13,200
To be allotted to field work, 1918	37,300
	100,000

Approximate allotments to different kinds of surveys and investigations, 1917–18.

Reconnaissance geologic surveys	$9,100
Detailed geologic surveys	3,400
Special geologic investigations	17,500
Reconnaissance topographic surveys	4,000
Investigations of water resources	5,400
Collection of mineral statistics	1,600
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation	21,700
To be allotted to field work, 1918	37,300
	100,000

Allotments for salaries and field expenses, 1917–18.

Scientific and technical salaries	$24,964
Field expenses	18,536
Clerical and administrative salaries and miscellaneous expenses	19,200
To be allotted to field work, 1918	37,300
	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. In 1917 seven parties were engaged in such investigations.

Progress of surveys in Alaska, 1898–1917.

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[a]					Investigations of water resources.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Measurements of stream volume.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189	9,500	.....	.....	12,840	2,070	.....	.....	....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	95	.....	....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	....	14	286
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	....	81	703
1910	90,000	.....	8,635	321	.....	13,815	36	.....	....	69	429
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	....	68	309
1912	90,000	.....	2,000	525	.....	.....	298	.....	....	69	381
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	....	.....	.....
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	.....
1917	100,000	.....	1,750	275	.....	1,050	.....	.....	....	19	.....
	1,561,189	73,200	101,285	5,507	51,680	148,030	3,731	453	74	.....	.....
Percentage of total area of Alaska	.....	12.48	17.27	0.94	8.81	25.24	0.64	.....	....	.....	.....

[a] The Coast and Geodetic and International Boundary surveys 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.—G. C. Martin, acting geologist in charge, was engaged in office work till August 1, when he started for Alaska. Two days were spent in Juneau, collecting data on mining developments. The time from August 15 to 21 was spent in the Katalla oil field. The time from August 26 to September 6 was devoted to a field conference with the engineer in charge of the Government coal mines in the Matanuska Valley. A brief visit was then made to the Nenana coal field. He returned to Washington on October 11.

During Mr. Martin's absence in Alaska, F. H. Moffit was acting geologist in charge and devoted considerable time to executive work. Since June 11, 1917, most of Mr. Moffit's time has been given to assisting Maj. Bagley in his investigations of airplane mapping, and since November he has devoted himself exclusively to that work.

E. M. Aten continued as office assistant to the acting geologist in charge and assisted in the collection of statistics of production of precious metals in Alaska until July 13, when he went into the military service as captain in the Quartermaster Department, U. S. R. After that date Miss L. M. Graves took up Mr. Aten's administrative duties, and T. R. Burch assisted in the collection and compilation of the mineral statistics.

A systematic investigation of the heavy placer minerals of Alaska was begun by G. L. Harrington and J. B. Mertie, jr., during the year. This work has already yielded results of considerable value. Platinum was found in concentrates from Aloric River, in the Kuskokwim Delta, and also from Marshall. Tin ore (cassiterite) was found in concentrates from Yentna River in such amount as to indicate that it possibly occurs in commercial quantities. Cassiterite was also found in small quantities in concentrates from Boob Creek, in the Tolstoi district; from Willow Creek, near Nome; and from Riglagalik River, in the Kuskokwim Delta. Scheelite was determined in a number of concentrates from the vicinity of Nome and from Bonanza Creek, at the base of Seward Peninsula. These localities are not new but are important as indicating that the mineral may occur in sufficient amount to be a valuable by-product of placer mining. Scheelite was also found at a new locality on Jack Wade Creek.

Theodore Chapin was detailed to work for the division of geology from December 19, 1917, to April 17, 1918. S. R. Capps and A. G. Maddren have been detailed to work for the division of geology since February 23 and June 4, respectively.

Southeastern Alaska.—Studies of the ore deposits and mining developments in the Ketchikan district were continued by Theodore Chapin, who devoted the time from July 10 to 20 and from September 25 to November 4 to this work. Especial attention was given to the copper deposits.

An investigation of the reported occurrence of platinum at Lituya Bay was made by J. B. Mertie, jr., in July. Mr. Mertie also investigated the iron ores of southeastern Alaska in October.

A reconnaissance of the geology and mineral deposits of the Sitka district, with especial reference to the nickel-bearing copper ore on the west side of Chichagof Island, was made by R. M. Overbeck.

The investigation of the water resources of southeastern Alaska, begun in 1915 under a cooperative agreement with the Forest Service, was continued. G. H. Canfield, who had charge of this work, main-

tained 17 automatic gages throughout the year. In addition to these gages 3 others were installed in cooperation with individuals and corporations. This work could not have been carried on without the cordial cooperation of the Forest Service, many members of which have given substantial aid. Particular acknowledgment should be made to W. G. Weigle, special agent at Ketchikan, and to Leonard Lundgren, district engineer at Portland, Oreg.

A study of the Paleozoic rocks of southeastern Alaska was assigned to Edwin Kirk. He left Washington July 1 and remained in the field until the later part of September, studying the stratigraphy and making large collections of fossils from various localities in southeastern Alaska.

Prince William Sound and Copper River region.—B. L. Johnson continued his investigations of mining developments in the Prince William Sound region and the eastern part of Kenai Peninsula and made a detailed survey of part of the Jack Bay district. Mr. Johnson devoted the time from July 14 to October 19 to this work.

The reconnaissance topographic survey of the Prince William Sound region, begun several years ago, was extended eastward by D. C. Witherspoon. The season's work covered 1,000 square miles, including the eastern shore line of Prince William Sound from Fidalgo Bay to the entrance of Orca Inlet, which was mapped on a scale of 1 : 250,000. In addition, Mr. Witherspoon surveyed the eastern end of Hawkins Island.

A brief investigation of the reported nickel ore in the Copper River Valley was made by R. M. Overbeck, who devoted a few days in August to this work.

Cook Inlet, Susitna region, and southwestern Alaska.—The progress of construction of the Government railroad in Alaska created a demand for information on the geology and mineral resources of the region tributary to it. S. R. Capps was charged with the investigation of an area tributary to the railroad in the upper Susitna Valley. Between July 1 and September 7 he made geologic reconnaissance surveys covering an area of more than 1,500 miles on a scale of 1:250,000 and also investigated the copper and gold lodes of the western Talkeetna Mountains and of the Willow Creek district.

Investigations of the platinum deposits of the Yentna district and of the chromite deposits of lower Cook Inlet were made by Mr. Mertie.

The sulphur deposits on Makushin and Akun islands and near Stepovak Bay were investigated by A. G. Maddren. Mr. Maddren also made a brief visit to the beach placers on the west side of Kodiak Island. His field work extended from July 21 to September 22.

Yukon region.—The work in the Yukon region included especial investigations of the tungsten, tin, and platinum deposits of the Fairbanks, Hot Springs, and Ruby districts by Theodore Chapin, a

special investigation of platinum deposits in the Tolstoi district by G. L. Harrington, and an examination of the coal along the main line of the railroad west of Nenana River by G. C. Martin. No areal surveys were undertaken.

Seward Peninsula.—Work on Seward Peninsula included investigations by G. L. Harrington of the gold and platinum placers of the Candle and Koyuk districts, of the placer and lode tin and the graphite of the Yukon district and Imuruk Basin, and of the general mining developments. No areal surveys were made.

FIELD WORK FOR THE SEASON OF 1918.

Field work was begun before the end of the fiscal year (during May and June) by seven parties, as indicated below. D. C. Witherspoon began a topographic reconnaissance survey (scale 1:250,000) of the region adjacent to the Government railroad between Talkeetna River and Broad Pass. G. H. Canfield is continuing the investigation of the water powers of southeastern Alaska in cooperation with the Forest Service. R. M. Overbeck began a geologic reconnaissance survey of the Tolovana placer district. Edwin Kirk was detailed from the division of geology for a geologic reconnaissance survey of parts of Chichagof and Admiralty islands. George H. Girty was also detailed from the division of geology for special investigations of the Carboniferous rocks of southeastern Alaska and Yukon River. Edward Steidtmann, of the University of Wisconsin, and S. R. Cathcart, of Yale University, have been engaged to investigate the tin deposits of the York region. A. C. Gill, of Cornell University, has been engaged to investigate the chromite deposits of Cook Inlet. All these surveys and investigations will continue into the fiscal year 1918–19.

ALASKA OFFICE.

A branch office of the Geological Survey, in charge of Theodore Chapin as resident geologist, has been opened at Anchorage, and this will be his general headquarters throughout the year. It will be his purpose to do everything possible to aid the mining industry in the region tributary to the Government railroad. The plans not only contemplate close cooperation with those in charge of the operation of the Government coal mines, in the Matanuska Valley, but have the additional purpose of keeping the Geological Survey in touch with all local developments in mining and prospecting and of furnishing whatever aid may be possible by giving information, advice, and publications to those engaged in mining and prospecting.

COLLECTION OF STATISTICS.

The collection of statistics of production of metals in Alaska, begun by the Alaska division in 1905, was continued as usual. Preliminary estimates of mineral production for 1917 were published on January 1, 1918.

PUBLICATIONS.

During the year the Survey published three bulletins (Nos. 655, 667, and 675) and one water-supply paper (No. 418) relating to Alaska. Four topographic maps (lower Matanuska Valley, by R. H. Sargent, scale 1:62,500, contour interval 50 feet; Pl. I, Bulletin 655; Pl. I, Bulletin 667; and Pl. II, Bulletin 675) were published during the year.

Four bulletins (Nos. 662, 664, 668, and 683), two professional papers (Nos. 109 and 120–D), and eight topographic maps (Juneau and vicinity, by D. C. Witherspoon, scale 1:24,000, contour interval 50 feet; Pl. I, Bulletin 668; Pls. I and II, Bulletin 683; and Pls. I, III, IV, and V, Professional Paper 109) were in press at the end of the year.

Manuscripts of the following reports are completed:

The marble resources of southeastern Alaska, by E. F. Burchard (Bulletin 682).
The Kantishna region, Alaska, by S. R. Capps.
The Porcupine district, by H. M. Eakin.

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 Ketchikan district, by Theodore Chapin.
The geology of Latouche Island, by B. L. Johnson.
A geologic reconnaissance in the northern part of the Yukon-Tanana region, Alaska, by Eliot Blackwelder.
The western Talkeetna Mountains, by S. R. Capps.

Office work on the maps listed below has been completed:

Kotsina-Kuskulana district, by D. C. Witherspoon; scale, 1:62,500; contour interval, 100 feet.
Lower Kuskokwim region, by A. G. Maddren; scale, 1:500,000; contour interval, 400 feet.
Ruby district, by C. E. Giffin and R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

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.
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.
Fidalgo-Gravina district, by D. C. Witherspoon; scale, 1:250,000; contour interval, 200 feet.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The scientific force of the division of chemical and physical research, in charge of G. F. Becker, geologist, consists of 1 geologist, 8 chemists, and 2 physicists. Though not formally organized as such, the division consists in effect of two sections, the work in chemistry being in charge of George Steiger, chief chemist, and that in physics being under the immediate supervision of C. E. Van Orstrand. The investigations of the division were considerably retarded during the year through conditions incident to the move into the new building.

The work in chemistry includes primarily the tests necessary to the determination of rocks, ores, and minerals collected by or received at the Survey; qualitative and quantitative determinations of specimens and samples collected by the geologists; and researches relating to the various problems in geology on which the Geological Survey is engaged. During the year 1,014 quantitative analyses and 1,133 qualitative tests of rocks, minerals, and waters were made, principally on samples of ores and commercially valuable minerals. Analyses of a great many samples containing nitrates or potash were made by W. B. Hicks, R. K. Bailey, and Roy Backus. Mr. Backus is an additional chemist detailed, in cooperation, from the Ordnance Department of the War Department. Mr. Bailey spent the greater part of the year in studying and testing for potash or nitrates the well drillings and brines from a number of wells in progress of sinking in western Oklahoma and eastern New Mexico. Routine analyses of oil-field waters in Louisiana and Texas were made by Chase Palmer, who also made scientific analyses of marble samples, chiefly from Tennessee and Alabama, for use in a general geologic report on the marbles of the southern Appalachian region. Several elaborate analyses of native alloys of the platinum metals from Alaska were made by R. C. Wells. Many analyses of ores of chromium, platinum, manganese, and sulphur were also made in this division.

The war problems associated with mineralogy, such as the discovery of new deposits and means of increasing the production of high-grade sheet mica or the development of supplies of zircon, have occupied much of the time of W. T. Schaller, who has compiled the annual statistical reports on production of precious stones and mica. Some progress has been made by Mr. Schaller on several manuscripts, and a number of mineralogic studies of essentially scientific character have occupied some of his time when he was not engaged in the compilation of information for various governmental agencies.

Isotopic lead has been described by F. W. Clarke, in the Proceedings of the National Academy of Sciences, and a paper on the "Inorganic constituents of two small crustacea," by Mr. Clarke and Benedict Salkover, has been published in the Journal of the Washington Academy of Sciences. Mr. Clarke's work in calculations of atomic weights is being extended. He also has in preparation a new edition of "The data of geochemistry."

Work on the problems of physical chemistry, in charge of R. C. Wells, has been largely suspended on account of the pressure for analyses indirectly connected with war investigations. However, the study of the origin of certain oil-field waters as related to the presence of gases has been continued in cooperation with R. V. A. Mills in the division of geology. A joint manuscript entitled "The evaporation and concentration of waters associated with petroleum and natural gas" has been submitted for publication as a professional paper. A report on "New determinations of carbon dioxide in water of the Gulf of Mexico," by Mr. Wells, has been issued as Professional Paper 120–A. An important new mineral, tungstenite or bisulphide of tungsten, discovered in a specimen of ore from the Emma mine, Salt Lake County, Utah, has been described in a joint paper by Mr. Wells and B. S. Butler, contributed to the Journal of the Washington Academy of Sciences. Another paper by Mr. Wells, "Extraction of potassium salts from the Pintados Salar, Tarapacá, Chile," was published in the Engineering and Mining Journal. Mr. Wells has also had charge of the preparation of the report on the production of sodium salts in the United States during 1917.

Experimental tests in the extraction of potash from greensands were witnessed and reported by W. B. Hicks, who, in conjunction with H. S. Gale, compiled the annual report on the production of potash in the United States. A paper on this subject was contributed by Mr. Hicks for publication in the Manufacturers Record. A report on the part played by fluorine in sericitization, based on investigations made by George Steiger, chief chemist, and Sidney Paige, has been transmitted for unofficial publication, and another by Mr. Steiger and E. S. Larsen, jr., on "Griffithite, nontronite, and alunogen," has been prepared for publication.

Researches in capillarity and heat conduction and an investigation of the part played by voids and interstitial spaces in the rocks have occupied the greater part of the attention of the geologist in charge, who was able to devote some time also to the theory of the formation of salt domes.

Observations of deep temperatures were made by C. E. Van Orstrand at several localities in West Virginia and Texas, those in West Virginia in cooperation with the State Geological Survey. By means of a specially constructed apparatus, Mr. Van Orstrand was

able to observe the temperatures with greater accuracy than has ever before been possible. A preliminary report entitled "Apparatus for the measurement of temperatures in deep wells and temperature determinations in some deep wells in Pennsylvania and West Virginia" has been published by the Geological Survey of West Virginia. With the assistance of A. F. Melcher, Mr. Van Orstrand has made an extended tabulation and discussion of deep earth temperatures of the globe. Another paper by Mr. Van Orstrand, "Tables of the exponential function of the circular sine and cosine to radian argument," is ready for publication.

DIVISION OF MINERAL RESOURCES.

The division of mineral resources, in charge of H. D. McCaskey, geologist, embraces 32 geologists and engineer specialists in charge of the different mineral subjects, and a highly trained clerical and statistical staff of 43. For the more efficient accomplishment of the work branch offices are maintained in Denver, Salt Lake City, and San Francisco, with organization as described on page 87.

During the year this division has been the main source of information for the governmental war boards and other agencies that required data on the mineral production of the United States, its statistics, conditions, and prospects. The demands made upon it by the organizations responsible for the war mineral supplies and the war industries of the United States have increased enormously in scope as well as in number. Statistics of production have been gathered and compiled quarterly, monthly, weekly, and even daily, for some of the war minerals. Questionnaires revised to include new particulars needed by some war board have followed quickly other questionnaires that were themselves more comprehensive and searching than the preceding ones. Data of new classes have been gathered, and reports and statements in great numbers have been prepared to meet the special requirements of nearly every agency touching the mineral interests of the country. An idea of the scope of the work and of the calls made on the division may be gained by an inspection of Plate II.

A very important part of the work of the division this year has been the encouragement which has been given to producers of war minerals; buyers have been put into touch with miners, local metallurgic and mining troubles have been brought to the attention of the Bureau of Mines or other appropriate Government organizations, and help has been extended in procuring cars, fuel, and supplies for the operators.

The accomplishment of this task has been a test both of the experience of the Survey, covering 38 years of preparation of annual reports of production, and of the personnel, and it would not have been possible without the most complete cooperation of the other

divisions of the geologic branch. The wisdom of the policy adopted by the Survey 15 years ago in assigning the preparation of these reports to geologists familiar with the deposits in the ground and with mining conditions has been especially evident this year, when it has been necessary to supplement the statements as to production and the progress of the industries by reports of the reserves in the ground and of their possible yield within certain periods. The great store of information collected by the Survey geologists during many years regarding the occurrence, distribution, and conditions of production of ores and minerals of different kinds in all parts of the United States is now proving to be of the greatest value not only to the Survey but to all other agencies in solving the mineral problems of the war.

By way of illustration, the specialists are called upon by the Shipping Board for estimates of the quantity of all war minerals that will probably be produced in the United States in the next 12 months and that must be transported by rail and by coastwise vessels in the calendar year, and for statements as to the need of importing certain minerals and estimates of the quantity required; or they are asked to advise the Capital Issues Committee of the Federal Reserve Board in regard to requests for permission to raise capital on mining property, and to give opinions about undeveloped deposits of war minerals that might profitably be developed to meet needs arising through present demands; or, again, they may advise the General Staff as to Allied and enemy mineral supplies, their location, extent, and utilization.

The successful campaign of the Shipping Board to save tonnage by decreasing mineral imports, through which 1,000,000 tons of shipping was released for military purposes, was based on the work of this division of the Survey.

Preliminary estimates of output in 1917 were issued in the form of special press bulletins in December, 1917, and during the early months of 1918, with reviews of conditions that prevailed during the year 1917, on the following subjects: Abrasives; aluminum and aluminum salts; arsenic; bauxite and bauxite abrasives; bromine; Portland cement; chromite; clay; copper; feldspar; gold and silver; granite paving industry; graphite; gypsum; iron ore; lead; lead and zinc pigments; lime; Indiana oolitic limestone; limestone and marble industry at Carthage, Mo.; lithium minerals; lithographic stone; magnesium; manganese; metal mine production in California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Texas, Utah, and Washington; mineral production in Alaska; mica; petroleum; oil fields east of Mississippi River; consumption of fuel oil by railroads; phosphate rock; platinum; potash; quicksilver; salt; strontium; sulphur and sulphuric acid; zinc; and zirconium.

The final figures (advance statement) of copper produced in 1917 have also been published.

As the necessity for adjusting importations, export licensing, allocations of shipping, etc., to the progress of domestic mineral production became more obvious, closer and more intimate action developed between this division and the War Trade, War Industries, and Shipping boards. To systematize and coordinate more fully the exchange of information, an informal joint committee was in December, 1917, arranged to act as a clearing house between this division and the above-named war boards, all of which were represented in its membership and Edson S. Bastin was designated chairman. The weekly, monthly, and quarterly statistical data on mineral production, stocks, commitments, etc., compiled in the division of mineral resources by the survey specialists were distributed to interested Governmental organizations by the cooperative committee, and these data, together with statistics of imports and exports were compiled by the committee in special forms, both graphic and tabular, for similar distribution. Occasional assistance was contributed by the division of planning and statistics of the Shipping Board in the special compilation of import and export statistics obtained from the Bureau of Foreign and Domestic Commerce.

In connection with the work of the cooperative committee it became apparent that some agency was needed to coordinate various mineral investigations conducted independently by several Government bureaus and boards, to provide a broader channel for the exchange of information, and to eliminate duplication of effort. Therefore, at the suggestion of the Geological Survey, through a call from the Secretary of the Interior, representatives of the different departments together with representatives of the Geological Survey, Bureau of Mines, statistical division of the War Industries Board, bureau of research of the War Trade Board, and committee on mineral imports and exports of the Shipping Board met on February 12, 1918, for discussion and to outline an organization. On February 14, in response to invitations sent out by the temporary chairman, the Director of the Survey, representatives of twenty bureaus and divisions of the war boards organized the Joint Information Board on Minerals and Derivatives. Pope Yeatman, in charge of the section of nonferrous metals of the War Industries Board, was made chairman, and Edson S. Bastin, of the division of mineral resources of the Geological Survey, executive secretary. The activities of the board have included meetings for the presentation of information concerning minerals of war importance and the discussion of administrative problems connected with the procuring of the necessary supplies of these minerals, the

receipt of official inquiries relating to mineral information and the proper routing of such inquiries and the replies thereto, and the scrutiny of mineral questionnaires to be sent out by member organizations with a view to avoiding duplication. Files have been maintained containing much of the mineral information prepared in response to war requests, and a card index has been built up listing nearly all the mineral activities of the Government. There have been 13 meetings of the board up to June 30. Mimeographed copies of minutes of these meetings, recording fully the information presented, have been distributed to members of the board. Among the subjects covered were the following: Chrome ores and chrome alloys; manganese ores, manganese metallurgy, and manganese alloys; sulphur, pyrite, sulphuric acid; graphite; tin; asphalt and bitumen; tungsten, molybdenum, vanadium, and ferroalloys; clays; mica; quicksilver; fertilizers; also activities of various bureaus on minerals. Owing to changes in executive organizations and to changes in personnel within them, the board as now constituted is composed of 41 members, representing 36 divisions and bureaus in the following Government organizations: War, Navy, Agricultural, Commerce, Interior, Treasury, and State departments; War Industries, War Trade, and Shipping boards; Food, Fuel, and Railroad administrations; National Museum; Tariff Commission; Federal Trade Commission, and National Research Council. To meet the increase of secretarial work F. J. Katz, of the division of mineral resources, was assigned as assistant secretary.

Typical of additional statistical work undertaken by the division to meet war demands have been the inquiries relating to coal, copper, lead and zinc, and manganese.

Early in the year the Survey began the publication of weekly statements, prepared by C. E. Lesher, assisted by W. T. Thom, jr., of the production of bituminous coal and the factors in each district that are limiting production and shipment. At the request of the committee on coal production of the Council of National Defense, on October 17, the coal and coke statistical work of the division was coordinated with the statistical section of the United States Fuel Administration under a cooperative agreement between the Survey and the Fuel Administration, and the publication of weekly figures has been continued in charge of Mr. Lesher.

In addition to preparing the usual annual and semiannual reports on copper B. S. Butler began early in the year, at the request of the Council of National Defense, to collect by telegraph weekly statistics of the production of refined copper, stocks of refined copper, and sales of copper and distribute them to the war boards. Later Mr. Butler began the collection of monthly statistics of production and stocks of blister copper and monthly reports from the principal copper mines showing production and cause for any shortage of production.

At the request of the War Industries Board weekly telegraphic reports of smelter production, stocks, and commitments by classes of lead and zinc were obtained and compiled by C. E. Siebenthal. From these reports a weekly statement of the production and stocks of spelter by grades is made up and issued to the press and the industry; also, for the War Industries Board, a monthly statement of lead production and stocks of all classes and partial products is obtained by mail. Quarterly reports of lead and zinc production are also prepared by Mr. Siebenthal and published by the Survey, as well as the usual annual reports on lead, zinc, and cadmium.

During 1917 the importance of manganese in the war program and the difficulty of obtaining ships for imports created the demand for accurate, timely, and regular information concerning production from domestic deposits. Beginning in June, 1917, the annual canvass among manganese producers was supplemented by a quarterly inquiry, and since March, 1918, by monthly inquiry, under the supervision of D. F. Hewett. These inquiries have shown a steady increase in the rate of production of all grades of ore, as well as in the number of producers. This speeding up of manganese production may be mentioned as illustrating the increased activity in mining; although only 26,997 tons of high-grade manganese ore was produced in 1916, 28,345 tons was produced in the first half of 1917, 70,225 tons in 9 months, and 114,216 tons in 12 months, and reports from producers for the first quarter of 1918 show an output of 39,068 tons, with a prospect of 195,000 tons for the entire year. The lower grades show similar increases. Equally gratifying, as showing the interest in production, is the increase in the number of shippers of high-grade ore, from only 55 in 1916 to 133 in 1917. The number of manganese property owners to whom it has been necessary to send inquiries has increased from about 150 in 1916 to 1,200 in June, 1918.

The tremendous demand for cut steel in such forms as shells, large and small guns, and other metal articles used in the war has caused a great increase in the demand for information about tungsten, making it necessary for the Survey to collect much more information about deposits, ores, and their destinations and uses than heretofore, and this has been obtained by F. L. Hess, together with much additional information on the other ferroalloy metals, molybdenum, nickel, cobalt, vanadium, titanium, and zirconium. The national interest in molybdenum has been greater than ever before, and at the same time reliable data concerning uses and markets have been difficult to obtain, owing to the fact that control of consumption rests in a few hands and to the apparent mystery made of the uses. The demand for information about nickel has also been very large, owing to its general use in good steels other than tool steels, and closer touch has been kept with the industry than ever before.

Many deposits of tungsten and molybdenum were examined during the year, and hearings of the Tariff Commission concerning tungsten were attended at Denver on June 17, by Mr. Hess. Like tungsten and nickel, vanadium has become standard in many of the best steels, and naturally the inquiries for vanadium and for information about vanadium deposits have increased largely. Special uses for titanium have made it necessary to do a considerable amount of work upon the subject, and there has also been some inquiry for the other alloy metals, particularly cobalt.

In addition to the regular annual and semiannual reports on mineral production by the division of mineral resources, based on correspondence with approximately 110,000 mineral producers, the following investigations have been undertaken, largely for the information of Government organizations as a contribution to war work: Semiannual production of emery, corundum, and artificial abrasives, by F. J. Katz; weekly production and stocks of primary aluminum, and monthly production, stocks, and commitments of secondary aluminum (recovered scrap, etc.), by J. M. Hill; monthly production, stocks, and commitments of antimony metal, and weekly production of antimonial lead, by E. S. Bastin; monthly production and stocks of asphalt and bitumen, including petroleum tars, by J. D. Northrop; quarterly production and stocks of bromine, by R. W. Stone; monthly production, shipments, and stocks of chromite, by J. M. Hill; monthly mine output from principal copper mines, monthly production from copper smelters, monthly and weekly production and stocks of copper refineries, and weekly reports of copper-selling agents, by B. S. Butler; monthly and quarterly shipments and stocks of graphite, by H. G. Ferguson; weekly production, stocks, and commitments and monthly production and stocks from lead refineries, including antimonial lead, by C. E. Siebenthal; quarterly production and shipments of manganese ores by grades, and monthly shipments, beginning April, 1918, by D. F. Hewett; monthly production, stocks, and commitments of nickel, by F. L. Hess; monthly shipments, deliveries, and stocks of crude petroleum, by J. D. Northrop; monthly production, shipments, and stocks of pyrite, by P. S. Smith; quarterly production and stocks of quicksilver, by F. L. Ransome; monthly production, shipments, and stocks of sulphur, by P. S. Smith; quarterly production of tungsten ores, by F. L. Hess; and quarterly production and stocks, weekly production, stocks, and commitments of zinc smelters, by C. E. Siebenthal.

Work on Bulletin 666, "Our mineral supplies," was completed, with the exception of the last chapter and the introduction, by the mineral-resources specialists during the year, and the delay in completion was due only to the constant press of more urgent demands.

In addition to the many studies and reports for publication or for special war or industrial purposes, the members of the division have been called into innumerable conferences with other Government officials and representatives of the mineral industries on questions of national and even international importance. They have also served the public at large in the field and in the office by conference and by correspondence.

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 1917. The 17 States that cooperated were Alabama, Florida, Georgia, Illinois, Iowa, Maryland, Michigan, Minnesota, Missouri, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. By this cooperation duplication by various organizations of a considerable amount of work is obviated, uniform and authoritative statistics are presented, and the producers are saved the annoyance of preparing several sets of statistical returns for the same purpose.

On June 30, 1918, the manuscripts of 22 chapters for the report for 1917 had been completed and transmitted to the printer. The reports on the several mineral products are prepared by the following persons:

Authors of chapters in Mineral Resources.

Author.	Subject.
E. S. Bastin	Antimony.
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).
M. 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).
A. J. Ellis	Mineral waters.
H. G. Ferguson	Graphite.
H. S. Gale	Borax (with C. G. Yale); nitrates; potash (with W. B. Hicks).
C. N. Gerry	Gold, silver, copper, lead, and zinc in Idaho and Washington (mine 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	Cobalt, molybdenum, nickel, tantalum, tungsten, titanium, vanadium, uranium.
D. F. Hewett	Manganese and manganiferous ores.
W. B. Hicks	Potash salts (with H. S. Gale).
J. M. Hill	Aluminum and bauxite; barytes; 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).
Adolph Knopf	Tin.
C. E. Lesher	Coal; fuel briquetting; the manufacture of coke; artificial gas.
G. F. Loughlin	Lime; slate; stone.
H. D. McCaskey	Gold and silver (general report) (with J. P. Dunlop); mineral products of the United States (summary report) (with M. B. Clark).
G. C. Martin	Gold, silver, and copper in Alaska.
Jefferson Middleton	Clay-working industries; fuller's earth; sand-lime brick.
J. D. Northrop	Asphalt and bituminous rock; natural gas; petroleum.
C. C. Osbon	Peat.
F. L. Ransome	Quicksilver.
C. E. Siebenthal	Lead, zinc, and cadmium (general report).
W. T. Schaller	Gems and precious stones; mica.
P. S. Smith	Sulphur, sulphuric acid, and pyrite.
R. W. Stone	Gypsum, magnesite (with C. G. Yale); magnesium; phosphate rock; sand and gravel; salt, bromine, and calcium chloride.
J. B. Umpleby	Arsenic, bismuth, selenium, and tellurium.
R. C. Wells	Sodium salts.
C. G. Yale	Borax (with H. S. Gale); magnesite (with R. W. Stone): gold, silver, copper, lead, and zinc in California and Oregon (mines report).

H. D. McCaskey, geologist in charge of the division, continued also in charge of the metals section and of the three offices of the division in the Western States; and G. F. Loughlin was designated and served throughout the year as geologist in charge of the nonmetals section of the division, succeeding E. F. Burchard.

The offices of the division at Denver, Salt Lake City, and San Francisco are under the 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, 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 fact that so many members have been selected for overseas duty has made necessary the temporary reorganization of the topographic branch. Since March 26, 1917, when military mapping was begun for the War Department, 110 members of this branch have received commissions in the Engineer Officers' Reserve Corps, ranging from second lieutenant to major; 66 of this number are either in France or have been selected for overseas duty and 7 are reporting direct to the Chief of Engineers.

The present assignments are as follows:

Chief geographer, Maj. R. B. Marshall.

Southeastern, northeastern, central, southern, and eastern departments, Maj. W. H. Herron and Maj. T. G. Gerdine, geographers, in charge.

Western department, G. R. Davis, geographer, in charge.

Inspectors of topography, Maj. W. M. Beaman, topographic engineer, in charge; Maj. A. M. Walker, topographic engineer, Capt. L. S. Leopold, topographer.

CIVILIAN PERSONNEL.

The civilian technical corps of the topographic branch was increased during the year by the reinstatement of 1 assistant topographer, the appointment of 7 new junior topographers and 22 draftsmen, the transfer of 3 draftsmen, and the temporary detail of 2 drafts-

men from other branches. In addition to this, 2 geologists and 2 topographic engineers were transferred to this branch from other divisions for the period of the war. The technical force was reduced by the transfer of 1 draftsman, the resignation of 1 draftsman, 1 geologist, 1 assistant topographer, and 4 junior topographers, and the enlistment of 1 assistant topographer, 5 junior topographers, and 2 draftsmen. With those changes the corps now includes 5 geographers, 14 topographic engineers, 7 topographers, 13 assistant topographers, 10 junior topographers, and 33 draftsmen—a total of 82. In addition, 132 technical field assistants were employed during the whole or a part of the fiscal year. To assist with the military mapping 57 Engineer Reserve officers ranging in rank from second lieutenant to captain were detailed from the War Department to the topographic branch, and of this number 30 have been returned to the War Department. Two topographers, 3 junior topographers, and 1 clerk are on furlough. The clerical force comprises 15 clerks of various grades.

MILITARY PERSONNEL.

The following members of the topographic branch received commissions in the Engineer Officers' Reserve Corps prior to June 30, 1918:

Maj. J. W. Bagley.
Maj. W. M. Beaman.
Maj. C. H. Birdseye.
Maj. R. H. Chapman.
Maj. C. E. Cooke.
Maj. T. G. Gerdine.
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. C. G. Anderson.
Capt. R. W. Berry.
Capt. Basil Duke.
Capt. A. T. Fowler.
Capt. C. E. Giffin.
Capt. E. G. Hamilton.
Capt. Duncan Hannegan.
Capt. J. P. Harrison.
Capt. A. F. Hassan.
Capt. R. M. Herrington (in cavalry, U. S. A.).
Capt. H. H. Hodgeson.
Capt. E. I. Ireland.
Capt. B. A. Jenkins.
Capt. C. B. Kendall.
Capt. L. L. Lee.
Capt. L. S. Leopold.
Capt. H. L. McDonald.
Capt. Frederick McLaughlin.
Capt. E. L. McNair.
Capt. W. L. Miller.
Capt. C. L. Nelson.
Capt. Albert Pike.
Capt. C. L. Sadler.
Capt. A. B. Searle.
Capt. J. G. Staack.
Capt. William Stranahan.
Capt. W. O. Tufts.
First Lieut. J. E. Blackburn.
First Lieut. A. O. Burkland.
First Lieut. G. C. Douglas.
First Lieut. J. R. Eakin.
First Lieut. R. T. Evans.
First Lieut. J. C. Fales.
First Lieut. C. R. Fisher.
First Lieut. S. P. Floore.
First Lieut. C. C. Gardner.
First Lieut. L. B. Glasgow.
First Lieut. E. L. Hain.
First Lieut. Charles Hartmann.
First Lieut. F. W. Hughes.

First Lieut. R. A. Kiger.
First Lieut. A. P. Meade, jr.
First Lieut. T. H. Moncure.
First Lieut. W. H. S. Morey.
First Lieut. Kostka Mudd.
First Lieut. O. H. Nelson.
First Lieut. A. J. Ogle.
First Lieut. S. T. Penick.
First Lieut. Roscoe Reeves.
First Lieut. R. H. Reineck.
First Lieut. T. F. Slaughter.
First Lieut. C. H. Semper.
First Lieut. D. H. Watson.
First Lieut. J. H. Wilson.
Second Lieut. N. E. Ballmer.
Second Lieut. W. C. F. Bastian.
Second Lieut. S. H. Birdseye.
Second Lieut. D. S. Birkett.
Second Lieut. E. W. Bowler.
Second Lieut. E. C. Burt.
Second Lieut. W. G. Carson.
Second Lieut. Howard Clark.
Second Lieut. R. G. Clinite.
Second Lieut. F. W. Crisp.
Second Lieut. F. A. Danforth.
Second Lieut. C. H. Davey.
Second Lieut. C. A. Ecklund.
Second Lieut. W. S. Gehres.
Second Lieut. C. C. Holder.
Second Lieut. A. J. Kavanagh.
Second Lieut. J. B. Leavitt.
Second Lieut. P. W. McMillen.
Second Lieut. J. B. Metcalfe, jr.
Second Lieut. R. R. Monbeck.
Second Lieut. Bishop Moorhead.
Second Lieut. A. L. Opdycke.
Second Lieut. S. L. Parker.
Second Lieut. T. P. Pendleton.
Second Lieut. J. M. Rawls.
Second Lieut. L. B. Roberts.
Second Lieut. M. A. Roudabush.
Second Lieut. C. W. Rowell.
Second Lieut. R. C. Seitz.
Second Lieut. H. E. Simmons.
Second Lieut. R. B. Steele.
Second Lieut. C. A. Stonesifer.
Second Lieut. O. G. Taylor.
Second Lieut. K. W. Trimble.
Second Lieut. W. B. Upton, jr
Second Lieut. C. W. Wardle.
Second Lieut. R. F. Wilcoxon.
Second Lieut. R. M. Wilson.
Second Lieut. B. H. Yoakum.

TRAINING SCHOOL FOR TOPOGRAPHERS.

On July 1, 1917, a training school for topographers was established in the vicinity of Washington for the purpose of training a force of field assistants sent here by engineering colleges throughout the country to acquire training in the rudiments of topographic engineering. About 75 candidates reported during the summer for training and were instructed for nearly a month each, after which they were distributed to topographic parties all over the country. On account of the operation of the selective draft, however, most of them enlisted in the Twenty-fifth and Twenty-ninth Engineers, and it has been found impracticable to reopen the school during the summer of 1918.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 103 published maps, a photolithographic reprint of Crelle's Tables, and two bulletins (Nos. 651 and 654) giving results of spirit leveling in Nevada and Ohio. Bulletin 650, "Geographic tables and formulas," was reprinted with additions and corrections. Page proof has been reviewed for Bulletins 671, 672, 673, and 674, on spirit leveling in New York, Illinois, Kentucky, and Washington, respectively.

A translation from the French of the "Manual for the artillery orientation officer," containing a report of conferences held in the Army centers of instruction from November, 1916, to February, 1917, was made in collaboration with the United States Coast and Geodetic Survey and the Army War College.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1918 were:

Topographic surveys	$350,000
Surveying national forests	75,000
Statutory salaries	9,200
Special funds for military mapping (contributed by War Department)	500,000
Aviation photography	65,000
	999,200

COOPERATION.

Cooperation has been maintained in six States, which contributed the following amounts, with the understanding that they were to be used on military surveys:

California	$14,000
Illinois	7,000
Maine	5,000
Michigan	15,000
Virginia	4,500
Washington	10,500
	56,000

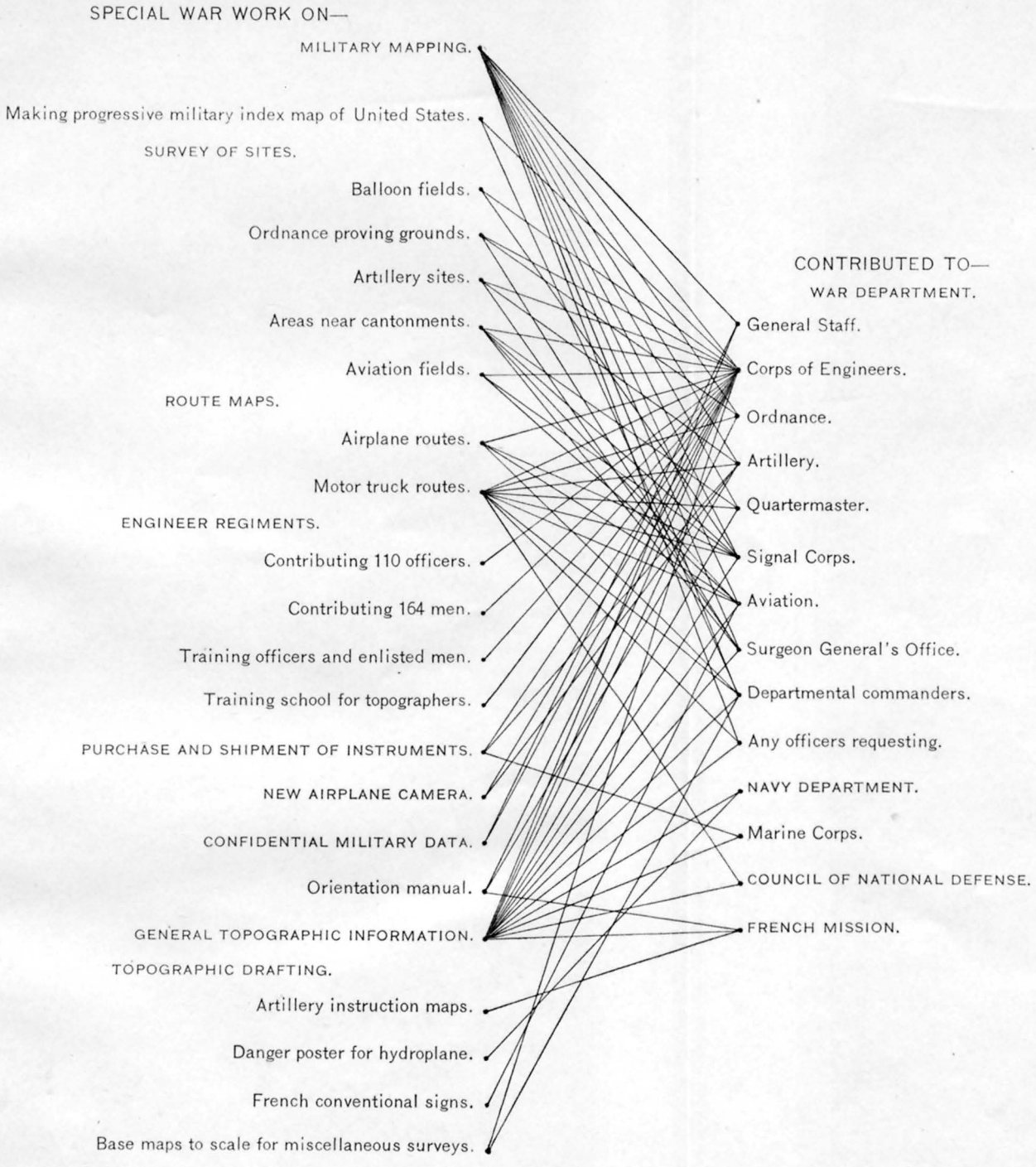
SUMMARY OF RESULTS.

Practically all the funds available for topographic mapping were allotted to areas selected by the War Department for special military surveys, and the sums contributed by the States for cooperation were done so with the understanding that they were to be used on these military surveys. The mapping of this class accomplished during the fiscal year amounted to 22,579 square miles, and detailed results are given by States in the reports of the several departments.

The contribution of this branch to war service is shown in Plate III.

As shown in the following tables, the total new area mapped was 21,955 square miles, making the total area surveyed to date in the United States 1,279,890 square miles, or 42.2 per cent of the entire country. In addition, 476 square miles of resurvey were completed, making the total area of surveys during the year 22,431 square miles.

In connection with these surveys, 7,945 linear miles of primary and precise levels were run, making 273,956 miles of primary and precise levels run since the authorization of this work by Congress in 1896.



CONTRIBUTIONS TO WAR SERVICE BY THE TOPOGRAPHIC BRANCH.

In the course of this work 2,204 permanent bench marks were established.

Triangulation stations to the number of 58 were occupied, and 58 were permanently marked. Primary-traverse lines aggregating 7,676 miles were run, in connection with which 884 permanent marks were set.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1917, to June 30, 1918.

	New area mapped July 1, 1917, to June 30, 1918.	Total area mapped to June 30, 1918.	Percentage of total area of State mapped to June 30, 1918.
	Square miles.	*Square miles.*	
Alabama	.....	19,192	37
Arizona	.....	70,136	62
Arkansas	.....	21,494	40
California	2,890	122,508	77
Colorado	.....	50,980	49
Connecticut	.....	4,965	100
Delaware	310	2,370	100
District of Columbia	.....	70	100
Florida	1,361	4,716	7
Georgia	2,600	21,507	36
Idaho	.....	28,196	33
Illinois	849	16,795	29
Indiana	.....	3,609	10
Iowa	.....	11,916	21
Kansas	.....	64,159	78
Kentucky	.....	18,094	45
Louisiana	.....	8,366	17
Maine	144	10,119	30
Maryland	12	12,327	100
Massachusetts	.....	8,266	100
Michigan	887	9,085	15
Minnesota	.....	7,354	9
Mississippi	.....	2,126	4
Missouri	.....	36,913	53
Montana	.....	58,511	40
Nebraska	300	27,117	35
Nevada	.....	51,141	46
New Hampshire	644	4,123	44
New Jersey	.....	8,224	100
New Mexico	2,539	42,588	34
New York	.....	44,663	91
North Carolina	159	18,549	35
North Dakota	.....	9,814	14
Ohio	.....	41,040	100
Oklahoma	.....	39,908	57
Oregon	58	24,720	26
Pennsylvania	.....	25,136	56
Rhode Island	.....	1,248	100
South Carolina	3,706	9,346	30
South Dakota	.....	19,032	25
Tennessee	.....	21,283	50
Texas	2,408	73,384	28
Utah	.....	69,025	82
Vermont	.....	4,473	47
Virginia	2,350	34,334	80
Washington	729	30,054	43
West Virginia	.....	24,170	100
Wisconsin	9	12,701	23
Wyoming	.....	30,043	31
Total United States	21,955	1,279,890	42.2
Hawaii	.....	1,393	.....

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, F. J. McMaugh, Oscar Jones, B. H. Yoakum, S. G. Lunde, G. T. Hawkins, C. F. Urquhart, E. C. Bebb, H. S. Senseney, E. L. McNair, Jacob Lenovitz, G. W. Hodgkins, R. H. Blain, C. R. Wingate, jr., Samuel Goldstein, D. T. McNair, A. W. Phelps, Harold Dewhirst, and W. E. Trimble, under the immediate supervision of E. M. Douglas, geographer. 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, geographer, was engaged during the year in revising relief maps of the United States, in preparing relief maps of Ohio, southern California, aviation route from San Diego to Los Angeles, Pecatonica Flats (for use of Camp Grant cantonment), and the Balkan Peninsula; a poster for the Aviation Section, United States Navy; color schemes for use in aviation photography; and a chart showing contour construction for railroad cuts and fills, for the drafting division.

INSPECTION OF TOPOGRAPHIC MAPPING.

W. M. Beaman, assisted by L. S. Leopold, spent the entire year in the office in general supervision of the preparation of all results of military surveys for engraving, photolithography, or other reproduction. A. M. Walker assisted in this work from July to September, when he was selected for foreign service.

AERIAL PHOTOGRAPHIC SURVEYS.

Maj. J. W. Bagley, assisted by F. H. Moffit and for a part of the time by J. B. Mertie, was engaged during the year in designing and constructing photographic cameras to be used in connection with airplanes for making maps. This work was done under the direction of the Chief of Engineers, United States Army, and the Director of the Geological Survey. Sixteen engineer officers, most of whom are now at different aviation fields in this country, were trained in the use of these instruments, and about 40 enlisted men assisted them in mapping areas, which include among others the airplane mail route from Washington to New York and the airplane route from Washington to Langley Field, Va. Investigation of the problems arising in the use of the cameras is still in progress.

DRAFTING.

The compilation of the United States portion of the international map of the world, under the immediate supervision of A. F. Hassan, was discontinued in order that the drafting force might be utilized in drafting the military topographic maps for photolithographic reproduction. During the year the force was increased from 8 to 33 draftsmen.

In addition to 76 topographic maps which were completed during the year, 15 maps of motor-truck routes, 7 maps of air routes, and 4 French battle maps were prepared. Ten artillery-instruction diagrams, one sheet of British and French conventional signs, one drawing of the Lewis machine gun, and one drawing of an airplane camera were also prepared.

NORTHEASTERN DEPARTMENT.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Maine and New Hampshire. This work comprised the completion of the survey of 4 quadrangles and the resurvey of a portion of 1 quadrangle, in addition to which 3 quadrangles were partly surveyed. The total new area mapped was 788 square miles, for publication on the scale of 1:62,500, and the area resurveyed was 40 square miles, for publication on the same scale. In connection with this work 194 miles of primary levels were run and 45 permanent bench marks were established.

Topographic surveys in northeastern department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of 1:62,500.		Total area surveyed.	Primary levels.	
		New.	Resurvey.		Distance run.	Bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Maine	20	144	40	184	100	24
New Hampshire	20	644	.....	644	94	21
	.....	788	40	828	194	45

Maine.—For the continuation of cooperative topographic surveys in Maine the Public Utilities Commission allotted $5,000 and the United States Geological Survey allotted an equal amount, the amount necessary to complete the surveys being paid from Federal funds. The survey of the Cutler and Machias quadrangles, in Washington County, was completed, and that of the Columbia Falls quadrangle, in Washington County, was begun by W. H. Griffin, A. P. Meade, and J. F. McBeth, the total area mapped being 144 square

miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas S. R. Archer ran 100 miles of primary levels and established 24 permanent bench marks.

Maine–New Hampshire.—The resurvey of the York quadrangle, in York County, Maine, and Rockingham and Strafford counties, N. H., was continued by J. H. Wheat and G. W. Guerdrum, the total area resurveyed being 40 square miles, all in Maine, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

New Hampshire.—The survey of the Alton and Mount Pawtuckaway quadrangles, in Rockingham, Strafford, and Belknap counties, N. H., was completed by Robert Muldrow, Hersey Munroe, A. T. Fowler, A. L. Opdycke, L. B. Roberts, A. J. Kavanagh, and P. W. McMillen, and that of the Gilmanton quadrangle, in Merrimack and Belknap counties, was continued by C. E. Cooke, A. C. Roberts, J. B. Metcalfe, and E. L. Bemis. The survey of the Suncook quadrangle, in Merrimack, Rockingham, and Hillsboro counties, was begun by Hersey Munroe and A. J. Kavanagh. The total area mapped was 644 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas C. H. Semper ran 94 miles of primary levels and established 21 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Cutler and Machias, Me.

Progress in the drafting of additional sheets was made as follows: York, Maine–N. H., 90 per cent; Alton, N. H., 90 per cent; Gilmanton N. H., 80 per cent; Mount Pawtuckaway, N. H., 60 per cent.

Primary-level circuits were adjusted for the following quadrangles: Columbia Falls and Machias, Maine; Alton, Gilmanton, Mount Pawtuckaway, and Suncook, N. H.

Preliminary geographic positions were computed for the following quadrangles: Alton, Gilmanton, and Suncook, N. H.

EASTERN DEPARTMENT.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Delaware, Maryland, and Virginia. This work included the completion of the survey of 15 quadrangles and of the resurvey of 2 quadrangles, in addition to which 10 quadrangles and 1 special area were partly surveyed and 1 special area was completed. In addition to this work, the map of an area covering 227 square miles in Virginia was revised. The total new area mapped was 2,672 square miles, 2,660 square miles for publication on the scale of 1:62,500, and 12 square miles on the scale of 1:4,800. The area resurveyed was 376 square miles for publication on the scale of 1:62,500, 26 square miles

for publication on the scale of 1:10,000, and 34 square miles for publication on the scale of 1:20,000, making a total of 436 square miles resurveyed. In connection with this work 1,571 miles of primary levels were run, 626 permanent bench marks were established, 1,242 miles of primary traverse were run, and 315 permanent marks were set.

Topographic surveys in eastern department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of—					Total area surveyed	Primary levels.		Primary traverse.	
		1:62,500		1:4,800 (new).	1:10,000 (resurvey).	1:20,000 (resurvey).		Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	Resurvey.								
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Delaware	10	310	.....	.....	.....	.....	310	.....	.....	.....	.....
Maryland	3, 10	.....	16	12	.....	.....	28	106	218	76	138
Virginia	5, 10, 20 1 meter 5 meters	2,350	360	.....	26	34	2,770	1,465	408	1,166	177
	.....	2,660	376	12	26	34	3,108	1,571	626	1,242	315

Delaware.—The survey of the Cape Henlopen, Cedar Creek, and Rehoboth quadrangles, in Kent and Sussex counties, Del., was completed by C. E. Cooke, W. H. Griffin, A. B. Searle, A. P. Meade, jr., J. F. McBeth, S. P. Floore, R. A. Kiger, F. W. Crisp, and S. H. Birdseye, the total area mapped being 310 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Delaware–Maryland.—The resurvey of the Maryland portion of the Harrington quadrangle, in Caroline County, was completed by A. B. Searle, the area mapped being 16 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Maryland.—The survey of the Gunpowder Neck filling plant, in Harford County, Md., was begun by J. G. Staack, C. E. Cooke, Fred McLaughlin, A. B. Searle, W. J. Lloyd, L. S. Leopold, K. W. Trimble, Pearson Chapman, J. H. Wilke, R. M. Herrington, S. H. Birdseye, C. A. Stonesifer, C. C. Holder, T. P. Pendleton, and J. L. Lewis, the total area mapped being 12 square miles, for publication on the scale of 1:4,800. For the control of this area S. H. Birdseye and H. S. Senseney ran 106 miles of primary levels and established 218 permanent bench marks, and C. F. Urquhart ran 76 miles of primary traverse and set 138 permanent marks.

Virginia.—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted $4,500 and the United States Geological Survey an equal amount, the amount necessary to complete the surveys being paid from Federal funds. The survey of the New Kent, Doswell, King William, Disputanta, Smithfield,

Charles City, Aylett, Toano, Tappahannock, and Surry quadrangles, in King and Queen, King William, New Kent, Essex, Middlesex, Caroline, Hanover, Prince George, Sussex, Surry, Henrico, Charles City, James City, Richmond, Westmoreland, Nansemond, and Isle of Wight counties, was completed, and that of the Homeville, Jarratt, McKenney, Ivor, and Lawrenceville quadrangles, in Isle of Wight, Brunswick, Nottoway, Dinwiddie, Surry, Sussex, Southampton, and Greenesville counties, was begun by A. T. Fowler, Fred McLaughlin, Duncan Hannegan, J. I. Gayetty, F. W. Hughes, C. H. Davey, C. S. Wells, J. M. Whitman, W. K. McKinley, J. H. Wilke, W. J. Lloyd, Olinus Smith, W. H. S. Morey, P. W. McMillen, U. S. Grant, E. I. Ireland, T. F. Slaughter, E. M. Levy, Basil Duke, R. W. Burchard, J. E. Blackburn, E. M. Bandli, H. A. Bean, C. D. S. Clarkson, J. J. Charters, H. E. Simmons, H. L. McDonald, J. J. Phelan, Bishop Moorhead, E. E. Harris, H. J. Gilkey, C. B. Holmes, R. L. Harrison, and C. M. Madden, the total area mapped being 1,819 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. The resurvey of the Cape Henry and Newport News quadrangles, in Princess Anne, Norfolk, Elizabeth City, Warwick, and Nansemond counties, was completed by R. H. Sargent, H. M. Eakin, Mark Noble, H. C. O. Clarke, B. W. Brown, R. C. Seitz, A. J. Kavanagh, T. F. Murphy, Hersey Munroe, and E. V. Perkinson, the area resurveyed being 360 square miles, for publication on the scale of 1:62,500. In addition to this work J. I. Gayetty revised the map of the Disputanta quadrangle, the area covered being 227 square miles. For the control of these areas E. E. Harris, S. R. Archer, C. R. French, H. J. Switzer, S. L. Parker, and A. C. Schilling ran 826 miles of primary levels and established 213 permanent bench marks, and J. J. Charters, J. C. Fales, R. L. Bennett, A. C. Schilling, H. J. Switzer, J. J. Phelan, and F. J. McMaugh ran 628 miles of primary traverse and set 72 permanent marks.

In addition to this work the resurvey of the Mulberry Island special area (which covers a portion of the Yorktown quadrangle), in Warwick County, was completed by H. C. O. Clarke, E. V. Perkinson, C. D. S. Clarkson, H. E. Simmons, J. L. Lewis, A. L. Ackers, A. J. Kavanagh, R. W. Burchard, B. W. Brown, R. L. Harrison, Bishop Moorhead, A. B. Searle, E. M. Bandli, F. L. Whaley, J. M. Whitman, Cornelius Schnurr, J. J. Charters, and W. R. Chenoweth, the total area resurveyed being 60 square miles, 26 square miles for publication on the scale of 1:10,000 and 34 square miles for publication on the scale of 1:20,000. For the control of this special area E. E. Harris, S. L. Parker, A. C. Schilling, and R. B. Steele ran 152 miles of primary levels and established 81 permanent bench marks, and J. J. Charters, J. C. Fales, and J. J. Phelan ran 107 miles of primary traverse and set 67 permanent marks.

Virginia-North Carolina.—The survey of the Suffolk quadrangle, in Nansemond County, Va., and Gates County, N. C., was completed and that of the Elwood, Emporia, White Plains, Arringdale, and Boykins quadrangles, in Southampton, Greenesville, Sussex, Nansemond, Isle of Wight, and Brunswick counties, Va., and Hertford, Gates, Northampton, Warren, and Halifax counties, N. C., was begun by Fred McLaughlin, A. L. Ackers, C. E. Bardsley, W. R. Chenoweth, M. J. Gleissner, R. F. Wilcoxon, G. C. Douglas, C. F. Merten, E. L. Marek, G. B. Davidson, R. W. Berry, Cornelius Schnurr, J. M. Whitman, Duncan Hannegan, F. L. Whaley, and A. C. Schilling, the total area mapped being 690 square miles, of which area 531 square miles lies in Virginia and 159 square miles in North Carolina. For the control of these areas E. E. Harris, J. C. Fales, C. R. French, and R. B. Steele ran 487 miles of primary levels and established 114 permanent bench marks, and H. J. Switzer, J. J. Phelan, J. C. Fales, and R. L. Bennett ran 431 miles of primary traverse and set 38 permanent marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Cape Henlopen, Cedar Creek, Harrington, Millsboro, and Rehoboth, Del.; vicinity of Edgewood, Gunpowder Neck Canal Creek, Gunpowder Neck Cantonment Site, Md.; Aylett, Charles City, Disputanta, Doswell, New Kent, Surry, Tappahannock, and Toano, Va.

Progress in the drafting of additional sheets was made as follows: Gunpowder Neck, Md., 35 per cent; King William, Va., 90 per cent; Newport News, Va., 25 per cent; Mulberry Island, Va., 1:10,000, 10 per cent; Mulberry Island, Va., 1:20,000, 35 per cent.

Primary-level circuits were adjusted for the following quadrangles: Cape Henlopen, Cedar Creek, Harrington, Millsboro, and Rehoboth, Del.; Aylett, Arringdale, Boydton, Boykins, Cape Henry, Doswell, Elwood, Emporia, Homeville, Ivor, Jarratt, King William, Lawrenceville, McKenney, New Kent, Newport News, Smithfield, South Hill, Suffolk, Tappahannock, and Yorktown, Va.

Geographic positions were computed for the following quadrangles: Gunpowder Neck, Md.; Arringdale, Boykins, Cape Henry, Elwood, Emporia, Homeville, Isle of Wight, Ivor, Jarratt, Lawrenceville, McKenney, Newport News, Smithfield, South Hill, Suffolk, White Plains, Williamsburg, and Yorktown, Va.

SOUTHEASTERN DEPARTMENT.

FIELD WORK.

Summary.—During the year topographic mapping was carried on in Florida, Georgia, North Carolina, and South Carolina. This work included the completion of the survey of 35 quadrangles, in addition

to which 20 quadrangles were partly surveyed. The total new area mapped was 7,826 square miles, 7,010 for publication on the scale of 1:62,500 and 816 square miles for publication on the scale of 1:21,120. In connection with this work 3,509 miles of primary levels and 423 miles of precise levels were run and 1,000 permanent bench marks established.

Primary traverse was carried on by six parties in Georgia, North Carolina, and South Carolina, 4,697 miles being run and 346 marks being set. This work made control available in 98 quadrangles.

Topographic surveys in southeastern department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of—		Total area surveyed.	Levels.			Primary traverse.	
		1:62,500 (new).	1:21,120 (new).		Primary.	Precise.	Bench marks.	Distance run.	Permanent marks.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Miles.*	*Miles.*		*Miles.*	
Florida	10	1,361	.....	1,361	223	.....	27	.....	.....
Georgia	10	2,600	.....	2,600	1,616	274	485	2,167	154
North Carolina	10	159	.....	159	.....	.....	.....	44	3
South Carolina	5,10,20	2,890	816	3,706	1,670	149	488	2,486	189
	.....	7,010	816	7,826	3,509	423	1,000	4,697	346

Florida.—The survey of the Palm Valley, Orange Park, Middleburg, Mayport, Jacksonville, Hilliard, and Cambon quadrangles, in Nassau, Duval, St. Johns, and Clay counties, Fla., was completed by J. H. Jennings, W. L. Miller, Fred Graff, jr., Gilbert Young, Horace Raynor, M. A. Roudabush, C. W. Wardle, J. B. Leavitt, W. S. Gehres, C. L. Sadler, O. G. Taylor, R. M. Herrington, C. W. Stump, jr., G. R. Richardson, R. L. Harrison, J. C. Hilliard, C. W. Goodlove, and H. R. Kilmer, the total area mapped being 927 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. For the control of the Hilliard quadrangle S. L. Parker ran 120 miles of primary levels and established 13 permanent marks.

Florida–Georgia.—The survey of the Kingsland, Folkston, Boulogne, St. Marys, Fernandina, Moniac, and Macclenny quadrangles, in Nassau and Baker counties, Fla., and Camden, Charlton, and Ware counties, Ga., was completed by R. L. Harrison, J. A. Duck, F. W. Farnsworth, E. J. Essick, C. W. Stump, jr., C. W. Goodlove, H. R. Kilmer, R. M. Herrington, J. C. Hilliard, R. B. Turner, E. S. Huntley, Horace Roberts, F. L. Shalibo, Montague Blundon, G. F. Brockman, William Soaper, jr., C. L. Sadler, and O. G. Taylor, the total area mapped being 1,175 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. For the control of these areas R. G. Clinite ran 146 miles of primary levels and established 24 permanent marks.

Georgia.—The survey of the Nahunta, Jesup, Hinesville, and Cumberland Island quadrangles, in Camden, Pierce, Glynn, Wayne, and Liberty counties, Ga., was completed and that of the Millen, Stellaville, Spread, Register, Brooklet, Glennville, Daisy, Rocky Ford, Dearing, Appling, Hephzibah, Sylvania, and Egypt quadrangles, in Richmond, Columbia, Burke, Screven, Bulloch, Effingham, Jenkins, Jefferson, Warren, McDuffie, Glascock, Emanuel, Liberty, Tattnall, and Bryan counties, was begun by C. W. Goodlove, E. J. Essick, J. A. Duck, J. H. Jennings, J. M. Rawls, W. F. Hicks, Albert Pike, L. L. Lee, Gilbert Young, James Dolan, R. L. Harrison, A. L. Opdycke, W. L. Miller, T. F. Slaughter, Olinus Smith, F. W. Hughes, W. D. Lewis, C. L. Sadler, M. A. Roudabush, W. C. F. Bastian, E. K. Nelson, F. W. Look, C. C. Gardner, G. F. Brockman, R. D. Cummins, C. W. Rowell, W. C. Perkins, Horace Roberts, J. W. Lewis, W. W. Keeler, J. F. McCook, W. H. Griffin, A. P. Meade, jr., J. F. McBeth, R. L. McCammon, and S. T. Penick, the total area mapped being 1,649 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 Bascom, Meldrim, Pembroke, Wadley, and Rosier quadrangles L. F. Biggs, D. S. Birkett, S. R. Archer, R. F. Creson, jr., C. H. Semper, H. P. Kilby, R. G. Clinite, and H. S. Senseney ran 1,353 miles of primary levels and established 385 permanent bench marks and C. H. Semper ran 195 miles of precise levels. In addition to this, for the control of these areas and that of the Macon, Gordon, Meriwether, Hazelhurst, Elliott, Altamaha, Davisboro, Sandersville, Dublin, Warthen, Gibson, Vidalia, Swainsboro, Sparta, Cobbtown, Milledgeville, Reidsville, Warrenton, Stillmore, Garfield, Dates, and Wrightsville quadrangles, E. L. McNair, Oscar Jones, and G. T. Hawkins ran 1,936 miles of primary traverse and set 142 permanent marks.

North Carolina.—(See Virginia-North Carolina.)

South Carolina.—The survey of the Yemassee, Green Pond, Walterboro, Edisto Island, Cottageville, Cummings, Varnville, Olar, and Pineland quadrangles, and the west half of the Ravenels and Wadmela Island quadrangles, in Hampton, Colleton, Barnwell, Bamburg, Beaufort, Charleston, and Dorchester counties, S. C., was completed, and that of the Montmorenci, Talatha, and Allendale quadrangles, in Aiken, Edgefield, and Barnwell counties, was begun by C. E. Cooke, Gilbert Young, R. B. Turner, F. E. Smith, J. H. Wilke, Harry Aid, W. S. Beames, W. G. Sloan, Robert Muldrow, W. H. S. Morey, Montague Blundon, E. S. Huntley, C. W. Goodlove, H. R. Kilmer, C. W. Wardle, Horace Roberts, H. D. Clement, C. E. Crook, David Adams, E. V. Holloway, C. C. Shepard, F. W. Farnsworth, G. F. Brockman, C. B. Moore, W. K. McKinley, E. J. Francis, W. H. Griffin, A. P. Meade, jr., J. F. McBeth, R. L. McCammon, W. L. Miller, W. J. Nolte, J. M. Rawls, G. H. Guerdrum, and T. F. Slaughter,

the total area mapped being 2,638 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. In addition to this, the survey of the Sewee Bay, Capers Island, Bulls Island, Fort Moultrie, Melgrove, Charleston, James Island, Birdkey, Legareville, Kiawah Island, Ladson, Stono, and Wando 7½-minute quadrangles, in Charleston and Berkeley counties, was completed by J. H. Jennings, W. K. Wood, Angus MacManus, Fred Graff, jr., W. B. Upton, jr., C. B. Childs, J. J. Murphy, E. B. Hill, C. L. Wade, J. F. McCook, James Dolan, C. W. Stump, jr., E. H. Stelle, R. D. Cummin, and J. C. Hilliard, the total area surveyed being 816 square miles, for publication on the scale of 1 : 21,120, with a contour interval of 5 feet. For the control of these areas and of the Chicora, Lodge, Bamberg, Talatha, Santee, Georgetown, Waverly Mills, St. George, Bonneau, Kingstree, Okatie, Moncks Corner, Awensdaw, Trio, Ridgeville, Summerville, and Fort Fremont quadrangles H. S. Senseney, C. W. Stump, jr., H. L. Hudson, F. L. Shalibo, R. G. Clinite, D. S. Birkett, H. D. Clement, C. H. Semper, and P. W. McMillen ran 1,433 miles of primary levels and established 403 permanent bench marks and C. H. Semper ran 107 miles of precise levels.

In addition to this, for the control of these areas and of the Scranton, Kingstree, Branchville, Lodge, Ridgeville, Bowman, Bamberg, Williston, Woodford, Seivern, Edmund, Lexington, Batesburg, and Edgefield quadrangles, E. L. McNair, R. F. Creson, jr., B. H. Yoakum, H. S. Senseney, and Oscar Jones ran 2,178 miles of primary traverse and set 166 permanent marks.

Georgia-South Carolina.—The survey of the Shirley quadrangle, in Hampton County, S. C., and Effingham and Screven counties, Ga., was completed, and that of the Greens Cut, Peeples, Augusta, and Warrenville quadrangles, in Aiken and Hampton counties, S. C., and Richmond, Burke, and Screven counties, Ga., was begun by Gilbert Young, C. E. Crook, David Adams, F. E. Smith, E. H. Stelle, R. B. Turner, C. L. Sadler, E. K. Nelson, B. H. Yoakum, R. A. Mafit, P. W. McMillen, Robert Muldrow, W. K. McKinley, and C. B. Moore, the total area mapped being 462 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 Robbins, Clarks Hill, Savannah, and Hardeeville quadrangles C. H. Semper, D. S. Birkett, L. F. Biggs, F. L. Shalibo, R. F. Creson, jr., and H. L. Hudson ran 457 miles of primary levels and established 175 permanent bench marks, C. H. Semper ran 121 miles of precise levels, and E. L. McNair, B. H. Yoakum, H. S. Senseney, and Oscar Jones ran 539 miles of primary traverse and set 35 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Cambon, Jacksonville, Lawtey, Mayport, Middleburg, Orange Park, and Palm Valley, Fla.; Boulogne, Fernandina, Folkston, Hilliard, Kingsland, Macclenny, and Moniac, Fla.-Ga.; Bladen, Cumberland Island, Everett City, Hinesville, Hortense, Jesup, and Nahunta, Ga.; Cottageville, Walterboro, Yemassee, and Varnville, S. C.

Progress in the drafting of additional sheets was made as follows: St. Marys, Fla.-Ga., 65 per cent; Green Pond, S. C., 20 per cent; Edisto Island, S. C., 20 per cent.

Primary-level circuits were adjusted for the following quadrangles: Cambon, Hilliard, Jacksonville, Lawtey, Middleburg, and St. Marys, Fla.; Bladen, Everett City, and Moniac, Ga.; Boulogne and Macclenny, Ga.-Fla.; Charleston, Cottageville, Edisto Island, Fort Fremont, Green Pond, Hardeeville, Okatie, Ravenels, Varnville, Walterboro, and Yemassee, S. C.

Geographic positions were computed for the following quadrangles: Ates Creek, Jacksonville, Mayport, Middleburg, Orange Park, and St. Marys, Fla.; Agricola, Appling, Bascom, Broxton, Cobbtown, Coffee, Daisy, Dates, Dearing, Davisboro, Egypt, Folkston, Garfield, Glennville, Greens Cut, Hephzibah, Meldrim, Milledgeville, Millen, Moniac, Nahunta, Offerman, Pembroke, Register, Reidsville, Rocky Ford, Rosier, Sessoms, Sandersville, Spread, Stellaville, Sylvania, Wadley, Wilcox, Winokur, and Wrightsville, Ga.; Boulogne, Fla.-Ga.; Savannah, Ga.-S. C.; Halifax and Potecasi, N. C.; Allendale, Awensdaw, Bulls Island, Bonneau, Charleston, Cottageville, Chicora, Cummings, Egypt, Georgetown, Green Pond, Johns Island, Moncks Corner, Montmorenci, Okatie, Olar, Pineland, Ravenels, Ridgeville, Santee, Summerville, Talatha, Trio, Varnville, Waverly Mills, Walterboro, Williston, and Yemassee, S. C.; Augusta, Clarks Hill, Hardeeville, Peeples, Robbins, Shirley, and Warrenville, S. C.-Ga.

CENTRAL DEPARTMENT.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Michigan, Nebraska, and Wisconsin. The work included the completion of the survey of 8 quadrangles and 1 special area. The total new area mapped was 2,045 square miles, 1,745 square miles for publication on the scale of 1:62,500, 24 square miles for publication on the scale of 1:10,000, and 276 square miles for publication on the scale of 1:20,000. In connection with this work 750 miles of primary levels were run and 188 permanent bench marks were established.

Primary traverse was carried on by three parties in Illinois, Michigan, and Nebraska and covered 2,488 square miles, 822 miles being

run and 95 permanent marks set. The result of this work was to make control available in 10 quadrangles and 1 special area.

Topographic surveys in central department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Primary levels.		Primary traverse.	
		1:62,500 (new).	1:10,000 (new).	1:20,000 (new).		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Illinois	20	849			849	261	57	241	24
Michigan	20	887			887	279	76	339	25
Nebraska	10		24	276	300	210	55	242	46
Wisconsin	20	9			9				
		1,745	24	276	2,045	750	188	822	95

Illinois.—The governor of Illinois allotted $7,000 for the continuation of cooperative topographic surveys, and the United States Geological Survey allotted an equal amount, the amount necessary to complete the surveys being paid from Federal funds. The survey of the Kings and Kirkland quadrangles, in Ogle, Winnebago, Dekalb, and Boone counties, was completed by J. G. Staack, R. H. Reineck, S. T. Penick, T. F. Slaughter, J. A. Duck, C. C. Gardner, A. L. Opdycke, C. C. Holder, and J. B. Leavitt, the total area mapped being 442 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles Fred Crisp ran 132 miles of primary traverse and set 12 permanent marks; S. L. Parker, C. C. Holder, and F. A. Danforth ran 80 miles of primary levels and established 22 permanent bench marks in the Kings quadrangle; and C. C. Gardner and H. S. Senseney ran 24 miles of primary levels and established 5 permanent marks in the Kirkland quadrangle.

Illinois-Wisconsin.—The survey of the Belvidere and Rockford quadrangles, mainly in Boone and Winnebago counties, Ill., was completed, the total area mapped being 416 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area 9 square miles is in Wisconsin. For the control of these areas Fred Crisp ran 109 miles of primary traverse and set 12 permanent marks, all in Illinois. For the control of the Rockford quadrangle C. H. Semper ran 82 miles of primary levels and established 12 permanent bench marks, and for the control of the Belvidere quadrangle C. H. Semper, H. S. Senseney, and S. L. Parker ran 75 miles of primary levels and established 18 permanent marks.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted $15,000 and the United States Geological Survey allotted an equal amount, the amount necessary to complete the surveys being paid from Federal

funds. The survey of the Battle Creek, Union City, Galesburg, and Leonidas quadrangles, in Kalamazoo, Barry, Calhoun, Branch, Eaton, and St. Joseph counties was completed by C. L. Sadler, E. I. Ireland, Duncan Hannegan, J. I. Gayetty, J. M. Whitman, S. P. Floore, Olinus Smith, F. W. Hughes, C. S. Wells, J. M. Rawls, R. A. Kiger, M. A. Roudabush, R. R. Monbeck, S. H. Birdseye, G. H. Guerdrum, F. W. Farnsworth, C. H. Davey, E. J. Essick, P. W. McMillen, W. F. Hicks, W. K. McKinley, J. C. Hilliard, and E. E. Harris, the area mapped being 887 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 Marshall and Homer quadrangles Oscar Jones and H. S. Senseney ran 339 miles of primary traverse and set 25 permanent marks. For the control of the Battle Creek, Galesburg, Leonidas, and Union City quadrangles S. L. Parker, R. R. Monbeck, C. H. Davey, A. O. Burkland, E. E. Harris, and W. S. Gehres ran 279 miles of primary levels and established 76 permanent marks.

Nebraska.—The survey of the Omaha balloon field, in Washington and Douglas counties, Nebr., was completed by C. E. Cooke, C. L. Sadler, J. G. Staack, C. C. Holder, M. A. Roudabush, S. T. Penick, R. M. Herrington, A. L. Opdycke, F. W. Hughes, J. A. Duck, Olinus Smith, C. C. Gardner, C. S. Wells, P. W. McMillen, J. W. Lewis, E. L. Goldsmith, W. D. Lewis, E. K. Nelson, F. W. Look, E. J. Francis, Percy Lyons, and W. C. F. Bastian, the area surveyed being 276 square miles for publication on the scale of 1:20,000 and 24 square miles for publication on the scale of 1:10,000, with a contour interval of 10 feet. For the control of this area Oscar Jones ran 242 miles of primary traverse and set 46 permanent marks, and H. S. Senseney S. R. Archer, S. H. Birdseye, and P. W. McMillen ran 210 miles of primary levels and established 55 permanent bench marks.

OFFICE WORK.

The drafting of the following topographic maps was completed: Kings and Kirkland, Ill.; Belvidere and Rockford, Ill.–Wis.; Battle Creek, Galesburg, Leonidas, and Union City, Mich.; Fort Omaha, 1:10,000, Nebr.

Progress in the drafting of additional sheets was made as follows: Golconda, Ky.–Ill., 85 per cent; Fort Omaha, 1:20,000, Nebr., 95 per cent.

Primary-level circuits were adjusted for the following quadrangles: Belvidere, Kings, Kirkland, and Rockford, Ill.; Battle Creek, Galesburg, Leonidas, and Union City, Mich.; Arlington, Blair, Calhoun, Elkhorn, Florence, Irvington, and Kennard, Nebr.

Geographic positions were computed for the following quadrangles: Belvidere, Kings, Kirkland, Oregon, and Rockford, Ill.; Battle Creek, Galesburg, Homer, Leonidas, Schoolcraft, Union City, and

Vermontville, Mich.; Arlington, Ascot, Blair Calhoun, Chalco, Elkhorn, Florence, Honey Creek, Irvington, Kennard, Omaha, Ralston, and Waterloo, Nebr.

SOUTHERN DEPARTMENT.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in New Mexico and Texas. The work included the completion of the survey of 24 quadrangles. The total new area mapped was 4,947 square miles, for publication on the scale of 1:62,500, with contour intervals of 10, 25, and 50 feet. In connection with this work 583 miles of primary levels were run and 174 permanent bench marks were established.

Primary triangulation was carried on by two parties in New Mexico, 25 stations being occupied and 25 marked. The tota a ea covered by this work was about 1,802 square miles. This work made control available in 22 quadrangles.

Topographic surveys in southern department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of 1:62,500 (new).	Primary levels.		Triangulation.	
			Distance run.	Bench marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. miles.*	*Miles.*			
New Mexico	10, 25	2,539	308	94	17	17
Texas	50	2,408	275	80	8	8
		4,947	583	174	25	25

New Mexico.—The survey of the Playas, Pratt, Animas Peak, Walnut Wells, Hachita, and Big Hatchet Peak quadrangles and of the New Mexico portion of the Victorio, Noria, Antelope Wells, Cienega Springs, and Dog Mountains quadrangles (lying partly in Mexico), in Grant, Dona Ana, and Luna counties, N. Mex., was completed by J. G. Staack, J. E. Blackburn, R. H. Reineck, H. L. McDonald, R. W. Burchard, C. E. Giffin, J. L. Lewis, W. R. Chenoweth, G. C. Douglas, C. C. Gardner, F. A. Danforth, E. M. Bandli, F. L. Whaley, R. F. Wilcoxon, R. B. Steele, A. C. Williams, A. L. Ackers, Bishop Moorhead, C. E. Bardsley, H. J. Gilkey, C. F. Merten, E. M. Levy, E. P. Asbury, and C. B. Holmes, the total area mapped being 2,445 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 25 feet. Of these areas, portions of the Cienega Springs, Antelope Wells, Walnut Wells, and Animas Peak quadrangles, a total area of 141 square miles, lie in the Chiricahua National Forest. For the control of these areas R. W. Burchard and R. B. Steele ran 308 miles of primary levels and established

94 permanent bench marks, and G. T. Hawkins and B. H. Yoakum occupied 17 triangulation stations, all of which they marked permanently.

New Mexico–Texas.—The survey of the New Mexico and Texas portions of the Canutillo quadrangle (lying partly in Mexico), in Dona Ana County, N. Mex., and El Paso County, Tex., was completed by C. E. Giffin, Bishop Moorhead, C. W. Wardle, H. L. McDonald, J. L. Lewis, and W. R. Chenoweth, the total area mapped being 222 square miles (128 in Texas and 94 in New Mexico), for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Texas.—The survey of the Buck Hill, Jordan Gap, Hood Spring, Santiago Peak, Nine Point Mesa, Bone Spring, Indian Wells, Bullis Gap, Dove Mountain, and Maravillas Canyon quadrangles and of the Texas portion of the Reagan Canyon and Dryden Crossing quadrangles (lying partly in Mexico), in Brewster, Presidio, and Terrell counties, Tex., was completed by Basil Duke, C. G. Anderson, B. H. Yoakum, H. E. Simmons, R. H. Reineck, R. W. Berry, H. B. Ingersoll, R. F. Wilcoxon, Gustave Peters, D. S. Birkett, R. H. Runyan, R. L. Harrison, Cornelius Schnurr, S. G. Lunde, H. H. Hodgeson, O. H. Nelson, A. O. Burkland, R. R. Monbeck, S. T. Penick, C. C. Holder, Howard Clark, G. R. Smith, and S. P. Hayes, the total area mapped being 2,280 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas D. S. Birkett ran 275 miles of primary levels and established 80 permanent bench marks, and J. R. Ellis occupied 8 triangulation stations, all of which he marked permanently.

OFFICE WORK.

The drafting of the following topographic maps was completed: Perilla, Verde River, Ariz.; Big Hatchet Peak, Camel Mountain, Dog Mountains, Hachita, Mount Riley, Noria, Victorio, and Walnut Wells, N. Mex.; Agua Fria, Bone Spring, Buck Hill, Bullis Gap, Dove Mountain, Dryden Crossing, Hood Spring, Indian Wells, Jordan Gap, Nine Point Mesa, Reagan Canyon, Santiago Peak, and Tascotal Mesa, Tex.

Progress in the drafting of additional sheets was made as follows: Oatman special, Ariz., 9 per cent; Animas Peak, N. Mex., 10 per cent; Antelope Wells, N. Mex., 85 per cent; Canutillo, N. Mex., 90 per cent; Cienega Springs, N. Mex., 95 per cent; Playas, N. Mex., 45 per cent; Pratt, N. Mex., 20 per cent; Maravillas Canyon, Tex., 70 per cent.

Primary-level circuits were adjusted for the following quadrangles: Anapra No. 2, Animas Peak, Antelope Wells, Big Hatchet Peak, Columbus, Hermanas, and Mount Riley No. 1, N. Mex.; Agua Fria,

Bullis Gap, Dove Mountain, Dryden Crossing, Indian Wells, and Santiago Mountain, Tex.

Preliminary geographic positions were computed for the following quadrangles: Animas Peak, Antelope Wells, Big Hatchet Peak, Camel Mountain, Canutillo, Cienega Springs, Columbus, Dog Mountains, Hachita, Hermanas, Mount Riley, Noria, Playas, Pratt, Victorio, and Walnut Wells, N. Mex.; Agua Fria, Bone Spring, Dove Mountain, Bullis Gap, Hood Spring, Indian Wells, Buck Hill, Jordan Gap, Santiago Peak, Dryden Crossing, Sanderson, Longfellow, and Marathon, Tex.

WESTERN DEPARTMENT.

FIELD WORK.

Summary.—During the year topographic mapping was carried on in California, Oregon, and Washington. The work included the completion of 18 quadrangles, in addition to which 13 were partly surveyed. The total new area mapped was 3,677 square miles, for publication on the scale of 1:62,500. In addition the revision of parts of two quadrangles in California, covering 114 square miles, was completed. In connection with this work 915 miles of primary levels were run and 171 permanent bench marks were established, and 922 miles of primary traverse were run, and 128 permanent marks set.

Primary triangulation was carried on by two parties in Oregon and Washington, 33 stations being occupied, all of which were marked. This work made control available in 46 quadrangles.

Topographic surveys in western department from July 1, 1917, to June 30, 1918.

State.	Contour interval.	For publication on scale of 1:62,500 (new).	Primary levels.		Primary traverse.		Triangulation stations.	
			Distance run.	Bench marks.	Distance run.	Permanent marks.	Occupied.	Marked.
	Feet.	*Sq. miles.*	*Miles.*		*Miles.*			
California	25, 50	2,890	337	48	.....	.....	.....	.....
Oregon	25, 50	58	261	54	534	60	2	4
Washington	25, 50	729	317	69	388	68	31	29
	.....	3,677	915	171	922	128	33	33

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, the amount necessary to complete the surveys being paid from Federal funds. The survey of the Adelaida, San Miguel, Bradley, Paso Robles, San Simeon, Gorda, King City, Junipero Serra, Metz, Bryson, Gilroy Hot Springs, Crewison Peak, Jamesburg, Lucia, San Benito, Gonzales, and Bonanza quadrangles, in San Luis Obispo, Monterey, Santa Clara,

Stanislaus, Merced, and San Benito counties, was completed, and that of the Hollister, Crows Landing, Pozo, and Mount Boardman quadrangles, in San Benito, Santa Clara, Monterey, Stanislaus, Merced, and San Luis Obispo counties, was begun by J. P. Harrison, C. A. Ecklund, E. P. Davis, G. M. Cunningham, L. H. Connely, R. T. Evans, C. W. Rowell, Emerson Dolliver, S. G. Lunde, C. P. McKinley, E. N. Murphy, T. S. Marlor, J. L. Lewis, E. H. Wilcox, C. D. Curry, R. A. Furrow, C. W. H. Nessler, T. P. Pendleton, R. M. Wilson, C. A. Stonesifer, K. W. Trimble, W. B. Upton, jr., N. E. Ballmer, N. A. Huth, W. G. Carson, E. G. Hamilton, William Stranahan, R. A. Hamilton, and F. C. Witt, the total area mapped being 2,890 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet. In connection with the Lucia, Gorda, and Junipero Serra quadrangles, part of the work previously done was revised to bring the entire maps up to date. The area covered by this revision was 114 square miles. Of the Gorda, Junipero Serra, Bryson, Jamesburg, and Lucia quadrangles 364 square miles lies in the Monterey National Forest, and of the San Benito quadrangle 15 square miles lies in the Pinnacles National Forest, making a total area in the national forests of 379 square miles. For the control of these areas L. F. Biggs, N. E. Ballmer, and R. C. Seitz ran 337 miles of primary levels and established 48 permanent bench marks. The War Department did not cooperate in the mapping of the following quadrangles San Miguel, Bradley, Pozo, Paso Robles, Adelaida, Crevison Peak, Gilroy Hot Springs, Hollister, Jamesburg, Point Sur, Lucia, Crows Landing, and Mount Boardman.

Oregon.—The survey of the northeast quarter of the Glenada quadrangle, the southeast quarter of the Heceta quadrangle, and the Cottage Grove quadrangle, in Lane County, Oreg., was begun by R. M. Wilson, E. G. Hamilton, N. A. Huth, and C. A. Ecklund, the area mapped being 58 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas and of the Disston, Alsea, Coos Bay, Drain, Wendling, Scottsburg, and Cape Foul Weather quadrangles, L. F. Biggs ran 261 miles of primary levels and established 54 permanent bench marks, and J. C. Fales, F. J. McMaugh and G. T. Hawkins ran 534 miles of primary traverse and set 60 permanent marks. Triangulation was carried on by G. T. Hawkins, 2 stations being occupied and 4 permanently marked. This work made control available in 21 quadrangles.

Washington.—For the continuation of cooperative topographic surveys in Washington the State Board of Geological Survey allotted $10,500 and the United States Geological Survey allotted an equal amount, the amount necessary to complete the surveys being paid from Federal funds. The mapping of the Samish Lake quadrangle, in

Whatcom and Skagit counties, was completed, and that of the Port Angeles (40 square miles of which lies in the Olympic National Forest), Port Crescent, Van Zandt, Wickersham, Pysht Lake, and Crescent Lake quadrangles, in Clallam, Whatcom, and Skagit counties, was begun by S. G. Lunde, W. C. F. Bastian, J. L. Lewis, H. M. Eakin, D. B. Duckering, K. A. Heath, J. A. Campbell, jr., K. D. Campbell, N. E. Ballmer, W. G. Carson, E. T. Walker, R. H. Sargent, R. M. Wilson, C. P. McKinley, K. W. Trimble, T. P. Pendleton, Fred Rider, T. S. Marlor, R. T. Evans, J. P. Harrison, C. D. Curry, and R. A. Furrow, the total area mapped being 729 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 L. F. Biggs and R. C. Seitz ran 317 miles of primary levels and established 69 permanent bench marks, and F. J. McMaugh, L. F. Biggs, and C. F. Urquhart ran 388 miles of primary traverse and set 68 permanent marks. Triangulation was carried on by C. F. Urquhart, 31 stations being occupied and 29 permanently marked.

OFFICE WORK.

The drafting of the following topographic maps was completed: Piedras Blancas and San Miguel, Cal.; Port Angeles and Samish Lake, Wash.

Progress in the drafting of additional sheets was made as follows: Bradley, Cal., 85 per cent; Bryson, Cal., 5 per cent; Daulton, Cal., 10 per cent; Elgin, Cal., 80 per cent; Gorda, Cal., 70 per cent; Jamesburg, Cal., 10 per cent; King City, Cal., 10 per cent; Junipero Serra, Cal., 10 per cent; Las Garzas Creek, Cal., 10 per cent; Metz, Cal., 85 per cent; No. 10, Cal., 80 per cent; San Benito, Cal., 10 per cent; San Luis Creek, Cal., 15 per cent; San Miguel, Cal., 80 per cent; San Simeon, Cal., 30 per cent; Volta, Cal., 80 per cent.

Primary-level circuits were adjusted for the following quadrangles: Adelaida, Bradley, Bryson, Cayucos, Cholame, Paso Robles, Piedras Blancas, San Simeon, and Valleton, Cal.; Alsea No. 3, Black Butte, Cottage Grove, Glenada No. 1, and Yoncalla, Oreg.; Dungeness, Lake Crescent, Port Angeles, Port Crescent, and Pysht, Wash.

Geographic positions were computed for the following quadrangles: Alsea No. 2, Alsea No. 3, Alsea No. 4, Black Butte, Coos Bay, Cottage Grove, Lowell, Glenada No. 1, Glenada No. 4, Heceta No. 1, Heceta No. 4, Mohawk, Mound, Roseburg, Scottsburg No. 2, Scottsburg No. 3, and Yoncalla, Oreg.; Crescent Lake, Dungeness, Pleasant Lake, Port Angeles, Port Crescent, Pysht, Samish Lake, Sumas, Van Zandt, and Wickersham, Wash.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The work of the water-resources branch is conducted under the supervision of N. C. Grover, chief hydraulic engineer, and is organized in six divisions:

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.
Division of ground waters, O. E. Meinzer, geologist, in charge.
Division of quality of waters, Alfred A. Chambers, assistant chemist, in charge.
Division of power resources, W. B. Heroy, geologist, in charge.
Division of water utilization, N. C. Grover, in charge.
Division of enlarged and stock-raising homesteads, N. C. Grover, in charge.

PERSONNEL.

During the year the technical force of the branch has been reduced 46, of whom 24 entered the military service and 22 resigned or were transferred, and has been increased 134 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 15 hydraulic engineers, 7 engineers, 22 assistant engineers, 20 junior engineers, 2 geologists, 3 associate geologists, 2 assistant geologists, 1 assistant chemist, 2 junior chemists, 7 classifiers, 1 land classifier, 13 assistant classifiers, and 65 junior classifiers—a total of 161. Of this number 1 hydraulic engineer is on furlough, and 1 hydraulic engineer, 1 assistant engineer, 1 engineer, and 1 junior engineer are employed occasionally.

The members of the water-resources branch named below entered the military service. The status given is that of June 30, 1918.

Kirk Bryan, 104th Engineers, 29th Division, France.
John W. Campbell, second lieutenant, Company A, 69th Engineers, Fort Myer, Va.
Harold C. Cloudman, captain; honorably discharged April 16, 1918.
George S. Cowdrey, jr., private.
Aldace H. Davison, first lieutenant, 303d Engineers, Camp Dix, N. J.
Henry J. Dean, first lieutenant, First Provincial Battalion, E. M. P., Fort Benjamin Harrison, Ind.
William E. Dickinson, second lieutenant; honorably discharged April 8, 1918.
Donald A. Dudley, corporal, Company D, 314th Engineers, France.
Joe B. Entringer, sergeant major; candidate for commission, First Unit, 2d Company, Fourth Officers' Training School, Camp Grant, Ill.
Edgar O. Francisco, first lieutenant, Company B, 602d Engineers, Camp Devens, Mass.
Eugene L. Grant, private.
Homer E. Grosbach, private, Ground School, Princeton University, N. J.
Warren E. Hall, captain, Company D, 506th Engineers, France.
Oliver W. Hartwell, first lieutenant; honorably discharged October 20, 1917.
Bernard A. Howell, second lieutenant, France.
Clarence C. Jacob, captain; honorably discharged August 15, 1917.
Reid Jerman, private.
Joseph Krauskopf, private, Company K, Sixteenth Infantry, Camp Kearney, Cal.

George K. Larrison, captain, Company I, Engineer Officers' Training Camp, Camp Lee, Va.

Otto Lauterhahn, private, G. R. S., Unit B, Quartermasters Corps, France.

George J. Lyon, captain, Interior Storage Depot, Quartermasters Corps, Schenectady, N. Y.

Lester R. McNeely, private, Base Hospital No. 35, Camp Kearney, Cal.

Paul G. Mayer, private, headquarters company, Twelfth Infantry, Camp Fremont, Cal.

Arthur H. Montford, private.

Malcolm G. Murray, private.

J. Wendell Moulton, private; honorably discharged October 12, 1917.

John R. Neale, private.

Charles H. Pierce, first lieutenant; honorably discharged April 12, 1918.

James P. Reddick, United States Navy, San Diego, Cal.

John J. Sanford, second lieutenant; honorably discharged August 7, 1917.

George H. Smalley, United States Naval Training Station, Seattle, Wash.

James E. Stewart, in training for commission; honorably discharged November 20, 1917.

Harry Thompson, captain; honorably discharged February 17, 1918.

Eugene L. Williams, second lieutenant, Engineer Officers' Reserve Corps, France.

Leon Willie, private, Camp Lewis, Wash.

Of the above, Capts. George K. Larrison and Clarence C. Jacob, First Lieuts. Henry J. Dean, Aldace H. Davison, Oliver W. Hartwell, and Charles H. Pierce, and Second Lieut. William E. Dickinson were reported in the preceding year.

The contribution of this branch to war service is shown in Plate IV.

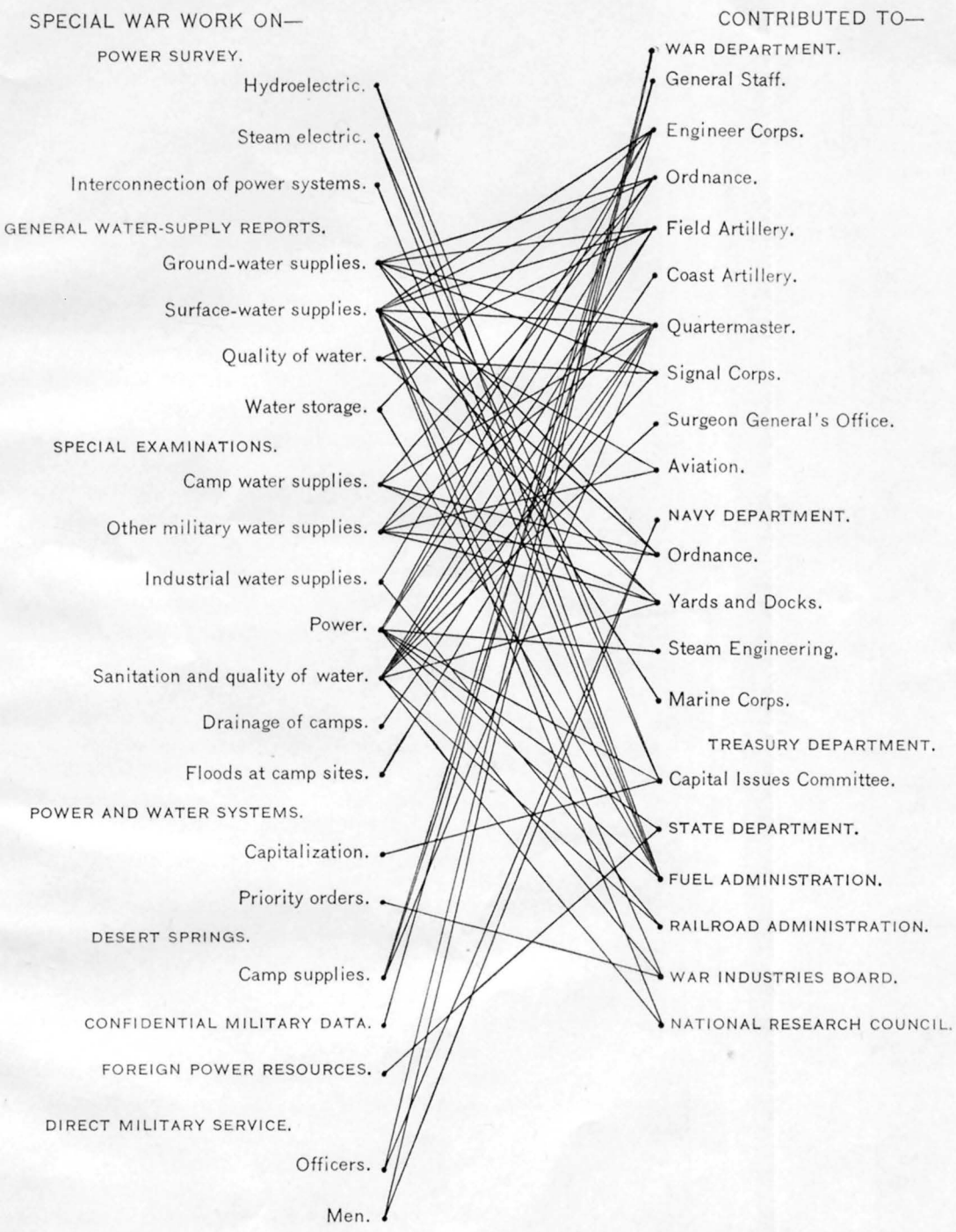
In the clerical force there were 17 separations (2 for military service) and 26 accessions, and at the end of the year the force numbered 37.

ALLOTMENTS.

The appropriation for gaging streams was $175,000, of which $25,000 might be used for drilling exploratory wells in arid regions, an increase of $25,000 over the preceding year. The cooperative funds made available by State allotments have been increased in some States and decreased in others, and these changes made 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 urgent deficiency act, approved March 28, 1918, carried an additional appropriation of $200,000 for this investigation.

An appropriation of $10,000 for discovering, improving, and marking water holes in the arid West was authorized by act approved June 12, 1917.



CONTRIBUTIONS TO WAR SERVICE BY THE WATER-RESOURCES BRANCH.

The appropriations were allotted as follows:

For gaging streams:			
General administration:			
Direct	$10,487.50		
Denver distribution office	2,200.00		
		$12,687.50	
Editorial		1,800.00	
Branch administration		6,230.00	
Computations		16,500.00	
Reviewing manuscript		3,000.00	
Inspection		2,000.00	
			$42,217.50
Surface water:			
New England:			
Maine and Connecticut	$1,350.00		
New Hampshire	1,000.00		
Vermont	900.00		
Massachusetts	2,250.00		
		5,500.00	
New York		3,500.00	
Middle Atlantic States		600.00	
South Atlantic States		4,500.00	
Ohio River valley		8,000.00	
Upper Mississippi River:			
Illinois	$1,000.00		
Iowa	500.00		
Minnesota	2,000.00		
Wisconsin	2,500.00		
		6,000.00	
Kansas		2,500.00	
Colorado, Wyoming, and New Mexico		7,500.00	
Montana and North Dakota		4,300.00	
Great Basin:			
Utah	$4,000.00		
Nevada	2,500.00		
		6,500.00	
Idaho and Yellowstone National Park		2,800.00	
Oregon		4,000.00	
Washington		4,000.00	
California		4,000.00	
Arizona		3,500.00	
Texas		4,000.00	
Hawaii		4,500.00	
			75,700.00
Ground water			22,450.00
Well drilling, field			21,200.00
Classification of lands:			
Land-classification board		7,000.00	
Utilization, general		5,500.00	
			12,500.00
Contingent			932.50
			175,000.00

For enlarged and stock-raising homesteads:	
Field work	$275,600.00
Land-classification board	50,000.00
General administration	18,000.00
Branch administration	6,400.00
	350,000.00

Of the total appropriations, 86 per cent was allotted for work in public-land States.

COOPERATION.

States.—Cooperative funds were allotted by several States as follows:

Alabama		$170.00
Arizona		2,980.00
California:		
State engineer	$9,070.00	
State Water Commission	7,095.00	
City of San Francisco	2,455.00	
		18,620.00
Colorado		600.00
Hawaii		19,080.00
Illinois		2,675.00
Iowa:		
State Geological Survey	$500.00	
State Highway Commission	315.00	
		815.00
Kansas		2,815.00
Kentucky		250.00
Maine		3,670.00
Massachusetts		2,025.00
Montana		1,720.00
Nevada		2,765.00
New Hampshire		1,060.00
New York:		
State engineer	$2,170.00	
Conservation Commission	8,860.00	
		11,030.00
North Dakota		385.00
Oregon		6,935.00
Texas		10,965.00
Utah		8,045.00
Vermont		1,065.00
Washington		6,865.00
Wisconsin		5,055.00
Wyoming		4,450.00

The work done under cooperative agreement with the States has been restricted to studies of stream flow, except in California, Montana, and Hawaii.

In California the State cooperated in all the ground-water work. (See pp. 121–122.)

In Hawaii measurements of streams were supplemented by measurements of precipitation and studies of the loss of water in irrigation canals.

The investigation of ground waters in Montana, begun in 1916 in cooperation with the State engineer, was continued. The chemical analyses of the waters are made at the laboratory of the State Board of Health in the Montana State College.

War Department.—Many reports, based on special field investigations and office studies, were prepared and submitted to the departments and bureaus engaged in the conduct of the war.

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.

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 the 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: Menominee, La Pointe, Standing Rock, Rosebud, Pine Ridge, Crow, Yakima, Quinault, Colville, Warm Springs, Klamath, Fort Hall, Willow and Sand creeks, Gila River, Duck Valley, Uinta, and Overland Creek.

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.

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.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprise 17 reports and 2 separate chapters. Titles and brief summaries of these publications are given on pages 27–30. At the end of the year 15 reports and 3 separate chapters 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 40 States and in Hawaii and Alaska. This year, as last, the relatively large amount of work in progress has been made possible only because of extensive cooperation with States and other Federal organizations. Twenty-three cooperating States (including Hawaii) have contributed about $114,000 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 20 States, in the District of Columbia, and in Alaska.

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, but it includes also special investigations of conditions affecting stream flow and the utilization of the streams.

In carrying on the work the United States is divided into 17 districts, including Hawaii. The location of the districts and district offices and the names of the engineers in charge are given in the following list:

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.; suboffice 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, Capitol Building, Honolulu, Hawaii.

CHARACTER AND METHODS OF WORK.

Field investigations necessary to the work are made from the district offices, where the results are sufficiently analyzed to insure accuracy and completeness. At selected places, known as gaging stations, the volume of water carried by the streams is measured and records of stage and other data are collected from which the daily flow of the streams is computed. Data collected from the district offices are transmitted to Washington, where they are reviewed in the computing section and prepared for publication. By this review the records obtained in different parts of the country are brought to a uniform standard, and standardization is further effected through annual conference of the engineers.

At the end of the year 1,182 gaging stations were being maintained, including 73 in Hawaii; 268 stations were discontinued and 272 new stations established during the year. Records for about 200 additional stations were received, ready for publication, from other Government bureaus and private persons, and a number of Government and State organizations and individuals also cooperated in the maintenance of many of the regular gaging stations.

Gaging stations and cooperating parties for the year ending June 30, 1918.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	State cooperation.	Municipal cooperation.	Private persons.	Counted more than once.	Maintained at end of year.	Established during year.	Discontinued during year.	Regular gagings during year.	Miscellaneous gagings during year.
Alabama	....	....	....	....	1	....	....	3	....	1	....	5	1	1	24	5
Arizona	....	1	....	6	2	....	....	18	....	1	4	24	3	3	337	76
California	....	....	26	2	....	2	5	162	26	37	98	162	23	12	997	310
Colorado	8	2	17	....	....	1	....	17	2	5	4	48	7	6	196	3
Connecticut	....	....	....	....	....	....	....	....	....	1	....	1	....	....	4	....
Georgia	1	....	....	....	....	4	....	....	....	15	1	19	1	4	45	5
Idaho	....	40	1	14	....	1	....	....	1	6	1	62	50	34	339	55
Illinois	....	....	....	....	1	1	....	25	1	1	3	26	....	....	100	2
Indiana	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....
Iowa	....	....	....	....	....	3	....	21	....	....	3	21	7	....	46	8
Kansas	....	....	....	....	....	....	....	8	....	....	....	8	5	....	40	....
Kentucky	....	....	....	....	....	....	....	5	....	....	....	5	....	....	16	4
Maine	....	....	....	....	....	....	....	16	....	2	2	16	....	....	69	....
Maryland	3	....	....	....	....	....	....	....	....	....	....	3	....	....	8	....
Massachusetts	....	....	....	....	....	....	....	15	....	1	1	15	....	2	95	....
Michigan	....	....	....	....	....	....	....	....	1	1	....	2	....	....	....	....
Minnesota	2	....	....	....	3	2	....	1	....	....	....	8	1	22	29	....
Montana	10	51	16	7	....	....	....	20	....	1	....	105	18	1	393	31
Nevada	....	2	....	3	....	1	....	32	....	9	15	32	3	5	135	7
New Hampshire	....	....	....	....	....	....	....	3	....	7	....	10	4	....	72	9
New Jersey	1	....	....	....	....	....	....	....	....	....	....	1	....	....	1	....
New Mexico	....	....	....	....	....	....	....	....	....	....	....	....	....	4	3	....
New York	....	....	....	....	1	4	....	45	1	7	13	45	3	6	367	5
North Carolina	....	....	....	....	....	1	....	....	....	4	....	5	1	1	6	2
North Dakota	....	....	....	1	....	....	....	5	....	....	....	6	....	....	32	4
Ohio	1	....	....	....	2	....	....	....	....	....	....	3	....	....	5	2
Oklahoma	....	4	....	....	....	....	....	....	....	....	....	4	....	....	4	....
Oregon	....	4	1	12	....	2	....	11	13	44	1	86	15	35	388	83
Rhode Island	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....
South Carolina	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....
South Dakota	....	....	....	4	....	....	....	1	....	....	....	5	....	....	35	....
Tennessee	....	....	....	....	....	2	....	....	....	6	....	8	....	....	24	4
Texas	....	1	....	....	....	3	....	42	5	5	14	42	4	1	427	175
Utah	....	....	....	6	....	....	....	113	....	79	85	113	10	15	970	66
Vermont	....	....	....	....	....	....	....	9	....	4	4	9	....	....	62	....
Virginia	2	....	....	....	....	1	....	....	....	2	....	5	....	....	7	1
Washington	2	1	7	11	....	....	1	4	5	31	1	61	11	14	526	13
West Virginia	7	....	....	....	6	1	....	....	....	1	....	15	....	2	43	5
Wisconsin	....	....	....	2	2	....	....	45	....	12	16	45	3	3	178	6
Wyoming	....	37	5	....	....	1	3	43	....	6	12	83	82	57	486	16
Hawaii	....	....	....	....	....	....	....	73	2	26	28	73	20	39	427	88
	37	143	73	68	18	30	9	737	57	316	306	1,182	272	268	6,937	985

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 records 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 the numbers of water-supply papers containing results of stream measurements for 1899 to 1918:

Numbers of water-supply papers containing results of stream measurements, 1899–1918.

Year.	I North Atlantic slope (St. John River to York River).	II South Atlantic and eastern Gulf (James to the Mississippi).	III Ohio River.	IV St. Lawrence River and Great Lakes.	V Hudson Bay and upper Mississippi River.	VI Missouri River.	VII Lower Mississippi River.	VIII Western Gulf of Mexico.	IX Colorado River.	X Great Basin.	XI Pacific slope in California.	XII North Pacific slope basins.		
												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, 18
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
1918	471	472	473	474	475	476	477	478	479	480	481	482	483	484

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39. Tables of monthly discharge 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. Tables of monthly discharge 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 done by the division of ground waters in the fiscal year 1917–18 included (1) examinations and reports for the War and Navy departments on ground-water supplies for military establishments, (2) the survey of desert watering places and the erection of signs directing travelers to such watering places, and (3) exploratory drilling in the arid regions to discover water supplies for irrigation.

Shortly before the United States entered the war a comprehensive digest of information relating to water supplies available for use at military camps had been submitted to the War Department. As soon as the country entered the war a large number of problems arose in regard to water supplies for the numerous military and naval establishments that were created in different parts of the country. The War and Navy departments called on the Geological Survey for assistance in solving these problems, and work on military water supplies was given precedence over all other work in the division. Up to the end of the fiscal year information and advice were given to the War and Navy departments by this division and by the section of Coastal Plain investigations, with which there was close cooperation, in regard to ground-water supplies at about 50 localities.

The survey and marking of desert watering places was authorized by an act of Congress (S. 1351), approved August 21, 1916, which provided an appropriation of $10,000 and read as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of the Interior be and he is hereby authorized and empowered, in his discretion, in so far as the authorization made herein will permit, to discover, develop, protect, and render more accessible for the benefit of the general public springs, streams, and water holes on arid public lands of the United States; and in connection therewith to erect and maintain suitable and durable monuments and signboards at proper places and intervals along and near the accustomed lines of travel and over the general area of said desert lands, containing information and directions as to the location and nature of said springs, streams, and water holes, to the end that the same may be more readily traced and found by persons in search or need thereof; also to provide convenient and ready means, apparatus, and appliances by which water may be brought to the earth's surface at said water holes for the use of such persons; also to prepare and distribute suitable maps, reports, and general information relating to said springs, streams, and water holes and their specific location with reference to lines of travel.

A reconnaissance of conditions affecting ground water in the desert regions was carried on in connection with the survey of watering places, and a considerable part of the regular allotment for ground-water investigations was therefore used in this project in addition to the sum specifically appropriated for the survey of watering places.

The region surveyed occupies about 60,000 square miles in southern California and southwestern Arizona. In California it includes the

southern part of Death Valley and the region between this valley and the Mexican border; in Arizona it includes the region west of Tucson and Phoenix and south of Wickenburg and Parker. This region was selected because it is the driest, hottest, and least explored part of the desert region, and also because of the strategic importance of obtaining information on the water supplies along the 350 miles of national frontier that it includes. The field work was done by four parties, each of which consisted of one geologist and one non-technical assistant outfitted with an automobile and light camping equipment. The mapping was done with planetable on a scale of 1:125,000. Practically all watering places in the region were examined, about 160 samples of water were collected and shipped to the water-resources laboratory at Washington, D. C., for analysis, and a general exploration was made of the geography, geology, and ground-water conditions of the region. The maps made and the data obtained were made available to the Army engineers for incorporation in the progressive military map of the United States now in preparation. Guides with maps are being prepared for publication.

Signs directing travelers to water were erected at 167 localities in California and 138 in Arizona. The signposts are galvanized iron, 1.9 inches in outside diameter, and 12 feet long. Each post is anchored in the ground with two redwood blocks. The signs are 18-gage steel, galvanized, are white, with dark-blue letters, and are substantially bolted to the posts. They are of two sizes, 18 by 20 inches and 9 by 20 inches. Most of the larger signs, of which 470 were erected, give the names, distances, and directions to four watering places; most of the smaller signs, 165 of which were erected, give the names, distances, and directions to two watering places. The work done in this fiscal year is a part of a comprehensive plan for mapping and marking the watering places in the entire arid region lying east of the Sierra Nevada and Cascade Mountains and west of a line running approximately from eastern Oregon through Salt Lake City and Santa Fe to the mouth of Pecos River.

The exploratory drilling was undertaken as a result of an authorization by Congress for expending from the regular appropriation an amount not to exceed $25,000 for exploratory drilling in the arid regions to discover water for irrigation. The work was done in Steptoe Valley, a desert valley near Ely, Nev., where the geologic conditions indicated the existence of ground water in sufficient quantity for practical irrigation. The results obtained were favorable. Three wells were drilled, two of which obtained large supplies within 100 feet of the surface. The other well was carried to a depth of 914 feet and demonstrated the absence of deep water-bearing beds of sufficient yield to be practicable for irrigation. A careful survey was made of the entire region, and a report is to be published that will

give detailed information on the results obtained, outline the area in which ground-water conditions are favorable, and set forth the economic difficulties that may be expected in utilizing the ground water for irrigation. The abnormal conditions created by the war made it very difficult to obtain adequate equipment and competent drillers and added largely to the expense of the work. A fuller statement on these aspects of the work will be made in the forthcoming report.

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 was submitted for publication as Water-Supply Paper 427.

An outline and glossary of terms relating to ground water was prepared by Mr. Meinzer and was submitted to numerous authorities for criticism. When all the terms and definitions which it contains have been carefully considered, this outline and glossary is to be published as a water-supply paper.

A paper on the classification of springs, by Kirk Bryan, was completed by the author and submitted for publication as Water-Supply Paper 450–A.

A. J. Ellis was placed in charge of statistics on production of mineral waters for the division of mineral resources. He prepared the chapter on the production of mineral waters for the annual volume Mineral Resources of the United States for 1917.

Cooperation with the committee on physiography was continued. Mr. Meinzer continued to serve on that committee, and Mr. Ellis undertook the preparation of texts describing the geography of the La Jolla quadrangle, Cal., which includes Camp Kearney, and of the San Diego quadrangle, Cal., which includes the Point Loma military reservation and Rockwell field.

As in previous years, the investigations of ground water on the Atlantic and Gulf Coastal Plain were conducted in cooperation with the section of Coastal Plain investigations, the work being under the direct supervision of T. W. Vaughan, geologist in charge of that section.

The Ground Water Club, a semiofficial organization for professional study, held a number of meetings, most of which were devoted to discussions of the terms defined in Mr. Meinzer's glossary.

Nearly 40 investigations of ground water were in progress in the course of the year, covering areas in Alaska, Arizona, California, Connecticut, Iowa, Maryland, Mississippi, Montana, Nebraska, Nevada, New Mexico, Oklahoma, South Carolina, South Dakota, Texas, Utah, Virginia, Washington, and Wyoming. The progress of most of these investigations was notably delayed by the conditions produced by the war.

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 published as Water-Supply Paper 418. This report was prepared in cooperation with the division of Alaskan mineral resources.

Arizona.—Half of the work on desert watering places was done in Arizona. The region south of Gila River and extending from Tucson and Nogales to Yuma was covered by Kirk Bryan; the Gila Valley and the region extending north from this valley to Wickenburg and Parker was covered by C. P. Ross. Signs directing travelers to water were erected at 138 localities. By the end of the fiscal year the field work was finished and the guide and maps for the region covered by Mr. Ross was nearly finished. The office work on the region covered by Mr. Bryan was delayed by his entrance into military service soon after the completion of his field work.

A brief report on the geology and water resources of the San Carlos Indian Reservation, written in a previous year by A. T. Schwennesen, was prepared for publication as a part of the "Contributions to hydrology."

California.—Half of the work on desert watering places was done in California. The desert area in San Bernardino County was covered by D. G. Thompson, and that in Imperial County and parts of Riverside and San Diego counties by J. S. Brown. Signs directing travelers to water were erected at 167 localities, for 26 of which the posts were furnished by San Bernardino County. By the end of the fiscal year all the field work was completed and the guides and maps which are to be published were about one-half prepared.

The report on ground water in San Jacinto and Temecula basins, by G. A. Waring, is in press as Water-Supply Paper 429.

The manuscript of a report on the geology and ground-water resources of the western part of San Diego County, by A. J. Ellis and C. H. Lee, was completed and is to be published as Water-Supply Paper 446. A manuscript report on the area was furnished to the State engineer, chiefly for use in connection with problems relating to military water supplies.

A brief report on Lanfair Valley, prepared by D. G. Thompson, is to be incorporated with a report on Ivanpah, Mesquite, and Pahrump valleys, by G. A. Waring, to be published as one of the "Contributions to hydrology."

A reconnaissance of the ground-water conditions in Mohave Valley was made in the previous year by G. A. Waring, and additional field work was done in the region this year by D. G. Thompson. A report on the region is to be prepared for publication.

The reports on ground water in Sacramento Valley, by Kirk Bryan, and in Santa Clara Valley, by W. O. Clark, are nearly completed, but little progress was made with either report on account of interference by war work and other urgent work. The field work on Salinas Valley is nearly completed, but the report on that area has not yet been written.

Measurements of depth to the water level in a series of wells in southern California have been made at intervals since 1900, for the purpose of obtaining a long record 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. These measurements, as in the preceding fiscal year, 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.—No new field work was done in Connecticut during this fiscal year, but three completed reports and one unfinished report, all based on investigations made in previous years in cooperation with the State Geological and Natural History Survey, H. E. Gregory, State geologist, are awaiting publication. These reports cover the Meriden area, by G. A. Waring; the Southington-Granby area, by H. S. Palmer; the Norwalk and Suffield areas, by H. S. Palmer; and the Pomperaug Valley, by A. J. Ellis. The delay in the publication of these reports is due chiefly to the exigencies of the war.

Delaware.—A chapter on the ground-water resources of Delaware was included in a comprehensive report, entitled "The surface and underground water resources of Maryland, including Delaware and the District of Columbia," by W. B. Clark, E. B. Mathews, and E. W. Berry, and published by the Maryland Geological Survey as Special Publication, Volume X, Part II. Data for this chapter were in large part furnished by the United States Geological Survey.

District of Columbia.—Considerable information on ground water in the District of Columbia is contained in the report of the Maryland Geological Survey referred to in the preceding paragraph. This information was furnished in part by the United States Geological Survey.

Iowa.—A field examination was made of the ground-water conditions in the vicinity of Camp Dodge, near Des Moines, Iowa, by A. J. Ellis, and a manuscript report thereon was submitted to the War Department.

Maryland.—The comprehensive report on the surface and underground water resources of Maryland, mentioned above, was prepared in cooperation between the State and Federal surveys, but the greater part of the work was done by the State.

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.

Montana.—The investigation of ground water in Montana, begun in August, 1915, was continued by A. J. Ellis. 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. In the two preceding years the region south of Yellowstone River was covered by field work, and in the summer of 1917 a ground-water survey was made of Musselshell County. Reports on both regions are in preparation, and the well data for the entire State are being compiled for publication.

Nebraska.—A report on ground water for irrigation in Lodgepole Valley, Wyoming and Nebraska, by O. E. Meinzer, was published 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.—A reconnaissance of a large part of east-central Nevada was made by O. E. Meinzer and W. O. Clark, and a more detailed ground-water survey of Steptoe Valley was made by Mr. Clark and C. W. Riddell. These investigations were made in connection with the exploratory drilling in Steptoe Valley. The drilling operations were in charge of J. M. Heizer during the first part of the year and of D. H. Walker during the last part.

A report on ground water in Reese River valley and an adjacent part of Humboldt River valley, by G. A. Waring, is in press as Water-Supply Paper 425–D. The area covered in the report by Mr. Waring on Ivanpah, Mesquite, and Pahrump valleys lies in part in Nevada.

New Mexico.—The report on ground water in the Animas, Playas, Hachita, and San Luis basins, in Grant County, N. Mex., by A. T. Schwennesen, with analyses of water and soil by R. F. Hare, is in press as Water-Supply Paper 422. The analyses of water samples and of the water-soluble contents of soil samples from these basins were made through cooperation by the New Mexico Agricultural Experiment Station.

Oklahoma.—A field examination of the ground-water conditions in the vicinity of Fort Sill was made by A. J. Ellis, and a report based on this examination was submitted to the War Department.

South Carolina.—A survey of the ground-water resources of the Coastal Plain province of South Carolina was made in cooperation

with the section of Coastal Plain investigations, the work being done by C. W. Cooke, under the direction of T. W. Vaughan. Water samples collected in connection with this investigation were sent to the water-resources laboratory for analysis.

South Dakota.—The report on artesian water in the vicinity of the Black Hills, S. Dak., by N. H. Darton, is in press as Water-Supply Paper 428. 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 carried on in cooperation with the section of Coastal Plain investigations, and the field of study included the central and western parts of the Coastal Plain province.

Utah.—In the spring of 1918 a reconnaissance of the geology and water resources of a part of southeastern Utah was made by H. E. Gregory, assisted by J. H. Winchell, jr. In the fall of 1917 a brief reconnaissance of western Tooele County was made by O. E. Meinzer and W. O. Clark.

Virginia.—A number of reports that were made to the War Department on ground water in specific localities in Virginia were based in part on special field examinations. In the spring of 1918 detailed field work on ground water was begun in parts of the Coastal Plain province in connection with military mapping by the section of Coastal Plain investigations, under the direction of W. T. Lee.

Washington.—The report on ground water in Quincy Valley, Wash., by A. T. Schwennesen and O. E. Meinzer, is in press as Water-Supply Paper 425–E.

Wyoming.—The report on ground water for irrigation in Lodgepole Valley, Wyoming and Nebraska, by O. E. Meinzer, was published as Water-Supply Paper 425–B.

DIVISION OF QUALITY OF WATER.

Investigations of the quality of water formed part of the work of the ground-water division until January 2, 1918, when the quality of water division was organized. The work of this division consists largely of the analysis of surface and ground waters and the interpretation of such analyses to determine the value of the waters for domestic and industrial uses. Reports have also been made on the quality of the water supplies at camps and cantonments for the War and Navy departments.

Since the new water-resources laboratory was completed, on January 2, 1918, 208 samples of water have been analyzed and classified and calculations and classifications for about 1,500 samples analyzed elsewhere have been made for use in reports on water resources of different parts of the country. Sections on the quality of water have been critically reviewed for 14 reports, and chemical discussions have been written for two reports.

DIVISION OF POWER RESOURCES.

The division of power resources was organized for the purpose of obtaining and compiling information concerning the development of power and its utilization. The immediate occasion for its organization was an agreement with the section of power and light of the Fuel Administration by which the services of the engineers of the water-resources branch were made available for the field study of power problems. W. B. Heroy, who had been in charge of the section of hydrographic classification of the land-classification board, was transferred, on June 1, to the water-resources branch to have immediate charge of the work.

The work of the division is in part statistical and in part engineering. The statistical work consists in obtaining information concerning the installed capacity, fuel requirements, operation, and output of electrical power plants. For the purpose of making a comprehensive power survey of the country a mailing list has been established of all concerns engaged in business as electrical utilities. By the use of this list the fuel requirements of electrical utilities have been ascertained for the statistical department of the Fuel Administration. The existence of surplus power in certain locations has been ascertained, and the information has been placed in the hands of the Bureau of Ordnance and other organizations needing power for the production of war materials. Plans have also been perfected for obtaining, in cooperation with the statistical section of the Fuel Administration, weekly reports on the output of all electrical utilities. The compilation of this information will make possible a weekly review of the power production of the country, segregated between water power and fuel power.

The engineering work of the division has generally been conducted through the engineers in charge of the district offices of the water-resources branch. Several investigations have been made in areas where the production of coal has been retarded by inadequate power supply, and reports have been made suggesting the installation of additional equipment or of emergency interconnections between power stations. Possibilities for the further substitution of water power for fuel have been studied with gratifying results, and fuel economies of importance have been pointed out. The development of new water powers has been encouraged in all proper ways, and the division has assisted in obtaining licenses for the purchase of construction materials and generating equipment.

It is expected that the information obtained covering power development will be summarized in an annual publication, which will be issued as a water-supply paper. The first paper will cover the calendar year 1918.

DIVISION OF WATER UTILIZATION.

The work of the division of water utilization during the fiscal year 1917–18 was to a large extent merged with that of the division of enlarged and stock-raising homesteads by the assignment of E. C. Murphy and E. C. La Rue to investigations conducted by that division. Only occasional investigations pertaining solely to the utilization of water were undertaken.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The work of organizing field parties for the examination of lands applied for under the enlarged homestead and stock-raising homestead laws was completed as rapidly as possible in the first part of the fiscal year, funds for this work having been made available June 12, 1917. The first parties organized were assigned to work in North Dakota and South Dakota, and shortly thereafter parties were working in Montana, Colorado, Utah, Idaho, Oregon, and Wyoming. As the field season advanced and the weather became unsettled the parties were transferred from the Northern States to New Mexico, Arizona, and southern California, in which field work was carried on throughout the winter. By the middle of October about 100 classifiers of various grades were engaged in active field work, and a force of this size has been maintained with only such modifications as were made necessary by the demands for military service and of good administration. The field force consists of qualified men who make detailed examinations of the lands applied for by the public-land settlers.

Under instructions of the Secretary of the Interior, field examinations are generally confined to lands for which application has actually been made. At the end of the fiscal year field work had been practically completed in New Mexico, Arizona, southern California, southern Utah, eastern Colorado, eastern Wyoming, and North and South Dakota. Field work has also been partly completed in the Boise land district, Idaho; in the Vale, Lakeview, La Grande, Burns, and The Dalles districts, Oreg.; in the Lewistown, Glasgow, Miles City, and Havre districts, Mont.; in the Denver, Montrose, Glenwood Springs, and Durango districts, Colo.; in the Douglas, Evanston, Buffalo, and Lander districts, Wyo.; and field work was nearly completed in the State of Washington. Work in Utah and in northern California is progressing rapidly.

Field examinations of entries under the enlarged-homestead law have been made or were in progress at the end of the fiscal year in South Dakota, Montana, Colorado, New Mexico, southern California, Utah, Oregon, Idaho, and Washington.

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 at the end of 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. H. Finch and R. W. Howell, associate geologists; H. S. Palmer, assistant geologist.

Division of hydrographic classification: Herman Stabler, hydraulic engineer; R. W. Davenport, J. F. Deeds, and J. G. Mathers, assistant engineers; C. E. Nordeen, junior topographer; A. E. Aldous and G. W. Holland, classifiers; W. N. White, assistant classifier; H. C. McNamara, R. L. Filtzer, and R. O. Helland, junior classifiers.

The force at the end of the year included 36 other permanent employees and 4 temporary employees of various grades. During the year there were 33 additions to and 22 separations of employees on the permanent roll, and 31 temporary clerks not enumerated above were employed for various periods.

FUNDS.

The allotments from the different appropriations amounted for the year 1918 to $87,400, as follows:

Geologic surveys	$18,000
Topographic and forest surveys	7,500
Gaging streams	7,000
Salaries of scientific assistants and skilled labor	4,900
Enlarged and stock-raising homesteads	50,000
	87,400

SUMMARY OF WORK OF CLASSIFICATION.

During the year 9,972,256 acres of lands were classified as to their coal character. Of this amount 626,349 acres were classified as noncoal land and 9,345,907 as coal land. Coal-land withdrawals during the year amounted to only 9,369 acres, and coal-land restorations to 1,105,622 acres. The area withdrawn for classification as to coal at the end of the year was 43,757,488 acres.

New withdrawals of probable oil lands amounting to 171,247 acres were made during the year, and an area of 117 acres was 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 6,348,640 to 6,519,770 acres. Indian lands to the amount of 42,097 acres were classified as oil lands.

Phosphate reserves were increased by 217,996 acres during the year as a result of the withdrawal of 248,030 acres in Idaho and the restoration of 30,034 acres in Montana. The area withdrawn on June 30, 1918, was 2,724,394 acres.

During the year the Secretary, on the recommendation of the Geological Survey, designated 5,161,080 acres of land as nonirrigable under the enlarged-homestead acts. The designations of 445,083 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 4,600,000 acres during the year. At the end of the year 280,349,858 acres were classified as being not susceptible of irrigation. The number of petitions for such designation available for action during the year was 13,435, of which 8,020 were acted upon; 5,415 were awaiting action at the end of the year.

The first designation of stock-raising lands under the stock-raising homestead act was made on November 28, 1917, but by the end of the year 7,538,962 acres of land had been so designated as the result of field examination and office study. The number of applications for stock-raising homesteads available for action during the year was 49,033. Of these, nearly 15,000 were closed as a result of the year's work and nearly 10,000 in addition had been considered and were ready for formal action at the end of the year.

Withdrawals of lands believed to be available for power sites aggregated 137,505 acres, and restorations of lands previously withdrawn but found to be without value for power amounted to 2,230 acres. The increase of outstanding withdrawals from 2,429,097 to 2,564,372 acres was the net result of these actions, and 109,508 acres of Oregon & California Railroad grant lands in Oregon were classified as power-site lands.

During the year areas amounting to 4,756 acres were withdrawn as public water reserves and 1,830 acres were eliminated from such reserves. The net increase in lands withdrawn as public watering places was from 201,708 to 204,634 acres.

CORRESPONDENCE.

During the year 66,219 letters and petitions were received by the land-classification board. In addition, some 2,700 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 10,789 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 217 for the incoming and 35 for the outgoing mail.

PUBLICATIONS.

In 1916 a report entitled "Petroleum withdrawals and restorations affecting the public domain," containing all orders of petroleum withdrawals and restorations to September 30, 1916, was published as Bulletin 623. Since that date the President has approved a number of additional orders for withdrawals and restorations and has created two naval oil-shale reserves, and the Survey has undertaken to publish descriptive lists of the lands affected by these orders in the form of press statements. The demand for this information has been so great that the Survey's reserve stock of the two lists published prior to the current fiscal year was soon exhausted. In order to make this information readily available these two lists were republished in February, 1918, as Press Bulletin 355, and in April, 1918, a supplemental list was published as Press Bulletin 363.

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 value for mineral and water resources of lands sought under the public-land laws is made available to the department through the General Land Office was continued during the fiscal year along the same lines as in previous years. The Survey received during the year 4,106 requests from the General Land Office for information as to the mineral character or the relation to water supply of public lands sought and furnished information in 3,871 cases. It also received for consideration 1,434 reports on field examinations made by the General Land Office and acted on 1,390 reports of this character.

At the beginning of the fiscal year there were pending 1,561 cases involving the mineral character of lands. The number of mineral cases received during the fiscal year is slightly greater than that of the cases acted on, so that the pending cases at the end of the year number 479 more than at the beginning. The cases received involving both mineral character and water resources also outnumber the cases acted on, so that the pending cases of this class at the end of the fiscal year number 449 more 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 1,762, or 177 more than the number pending at the beginning of the year. Of the pending cases 232 are concerned only with the mineral character of

the land, 13 only with the water resources, and 1,517 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 classification 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 1917–18.

Class.	Pending June 30, 1917.	Received, 1917–18.	Disposed of, 1917–18.	Pending June 30, 1918.	Gain (+) or loss (−).
Mineral character only:					
General Land Office requests for information	60	108	148	20	+ 40
General Land Office field service reports	426	580	794	212	+ 214
Applications for classification as to mineral	38	158	133	63	− 25
	524	846	1,075	295	+ 229
Water resources only:					
General Land Office requests for information	6	9	14	1	+ 5
General Land Office field service reports	18	17	23	12	+ 6
Cases in national forests	6	15	17	4	+ 2
Applications for reclassification as to water resources	18	90	90	18	.....
Applications for rights of way	72	289	315	46	+ 26
Lists under Carey act	.....	6	6	.....	.....
Desert-land proofs under irrigation projects	66	58	90	34	+ 32
Petitions under enlarged-homestead acts	7,209	6,226	8,020	5,415	+ 1,794
Applications under stock-raising homestead act	3,002	46,031	14,384	34,649	−31,647
	10,397	52,741	22,959	40,179	−29,782
Mineral character and water resources:					
General Land Office requests for information	981	3,703	3,525	1,159	− 178
General Land Office field service reports	73	551	389	235	− 162
General Land Office requests for information as to water resources, accompanied by Forest Service reports as to mineral character	21	286	184	123	− 102
Indian Office requests for information	8	59	52	15	− 7
	1,083	4,599	4,150	1,532	− 449
Grand total	12,004	58,186	28,184	42,006	−30,002

MINERAL CLASSIFICATION.

COAL.

Regulations.—No changes in the coal regulations have been made; all coal valuations continue to be made under the regulations adopted in 1913, as modified on February 16, 1915 (43 L. D., 520), requiring classification to be made by quarter-quarter sections and surveyed lots.

Withdrawals and restorations.—The total area of coal land withdrawn during the year was only 9,369 acres, about 544,000 acres less

than was withdrawn last year. This area lies in New Mexico, in the Gallup coal field, and for the most part was not previously known to contain coal. A small part of the area was at one time withdrawn by the Secretary of the Interior but had not been included in a withdrawal by the President. A total of 1,105,622 acres in eight States was released from withdrawal and made available for purchase under the coal-land laws as rapidly as field work and classifications were completed. The restorations during the year therefore exceed the withdrawals by 1,096,000 acres.

Coal withdrawals and restorations, fiscal year 1917–18, in acres.

	Outstanding June 30, 1917.	New withdrawals, 1917–18.	Restorations, 1917–18.	Outstanding June 30, 1918.
Arizona	141,945			141,945
California	17,643			17,643
Colorado	4,503,417		5,041	4,498,376
Idaho	338,452		333,691	4,761
Montana	10,912,569		300,457	10,612,112
Nevada	83,833			83,833
New Mexico	5,603,894	9,369	27,019	5,586,244
North Dakota	14,656,455		423,954	14,232,501
Oregon	4,361			4,361
Utah	5,326,256		12,181	5,314,075
Washington	827,193		3,119	824,074
Wyoming	2,437,723		160	2,437,563
	44,853,741	9,369	1,105,622	43,757,488

In addition to the foregoing withdrawals and restorations under the provisions of the act of June 25, 1910 (36 Stat., 847), as amended August 24, 1912 (37 Stat., 497), 1,560 acres in the Nenana coal field, Territory of Alaska, were reserved by proclamation of the President on January 26, 1918, in accordance with the provisions of the act of October 20, 1914 (38 Stat., 741), and 238,082 acres of classified coal land in the Fort Berthold Indian Reservation, N. Dak., were restored by the Secretary on December 4, 1917.

Classification.—The work of examining and eliminating from withdrawal as rapidly as possible areas of doubtful coal value was continued during the year, although not on as large a scale as in previous years, owing to the demand for other work more directly connected with the war. These noncoal classifications have been made in Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming.

During the fiscal year 9,345,907 acres have been classified as coal land, of which 9,033,797 acres lie in North Dakota; and more than 626,000 acres were classified as noncoal. An area of 9,972,256 acres was therefore classified with respect to coal value, an increase of more than 9,600,000 acres over the area similarly classified during the preceding year.

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 classifications of withdrawn areas or areas not previously considered. The sum of classifications in these two groups represents 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.

Land classified as coal and noncoal land, fiscal year 1917–18, in acres.

State.	Total classification.			Reclassification.		New classification.		Net increase or decrease.	
	Coal.	Noncoal.	Total.	Previous noncoal now coal.	Previous coal now noncoal.	Coal.	Noncoal	Coal.	Noncoal.
Colorado	3,887	1,662	5,549	80	.....	3,807	1,662	+ 3,887	+ 1,582
Idaho	2,490	335,331	337,821	.....	.....	2,490	335,331	+ 2,490	+335,331
Montana	276,380	45,209	321,589	932	943	275,448	44,266	+ 275,437	+ 44,277
New Mexico	8,420	19,298	27,718	.....	.....	8,420	19,298	+ 8,420	+ 19,298
North Dakota	9,033,797	.....	9,033,797	333,521	.....	8,700,276	.....	+9,033,797	−333,521
Oregon	320	.....	320	.....	.....	320	.....	+ 320	.....
South Dakota	6,437	11,686	18,123	6,437	11,686	.....	.....	− 5,249	+ 5,249
Utah	12,181	.....	12,181	.....	.....	12,181	.....	+ 12,181	.....
Washington	806	2,393	3,199	80	.....	726	2,393	+ 806	+ 2,313
Wyoming	1,189	210,770	211,959	1,000	210,770	189	.....	− 209,581	+209,770
	9,345,907	626,349	9,972,256	342,050	223,399	9,003,857	402,950	+9,122,508	+284,299

NOTE.—A classification in the Nenana coal field, Alaska, not included in above totals, amounted to 52,452 acres of noncoal and 109,445 acres of coal not priced.

Classifications of coal and noncoal land, June 30, 1918, in acres.

State.	Classifications outstanding June 30, 1917.		Net result of classifications, 1917–18.		Classifications outstanding June 30, 1918.		
	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	3,362,466	9,355,748	+ 3,887	+ 1,582	3,366,353	9,357,330	12,723,683
Idaho	2,113	7,936,925	+ 2,490	+335,331	4,603	8,272,256	8,276,859
Montana	5,621,322	21,759,039	+ 275,437	+ 44,277	5,896,759	21,803,316	27,700,075
Nevada	5,880	2,428	.....	.....	5,880	2,428	8,308
New Mexico	675,097	3,733,702	+ 8,420	+ 19,298	683,517	3,753,000	4,436,517
North Dakota	2,375,992	3,180,855	+9,033,797	−333,521	11,409,789	2,847,334	14,257,123
Oregon	17,124	1,062,095	+ 320	.....	17,444	1,062,095	1,079,539
South Dakota	250,123	6,956,108	− 5,249	+ 5,249	244,874	6,961,357	7,206,231
Utah	1,075,571	3,307,091	+ 12,181	.....	1,087,752	3,307,091	4,394,843
Washington	148,620	1,582,536	+ 806	+ 2,313	149,426	1,584,849	1,734,275
Wyoming	7,622,965	15,281,320	− 209,581	+209,770	7,413,384	15,491,090	22,904,474
	21,226,708	74,498,879	+9,122,508	+284,299	30,349,216	74,783,178	105,132,394

Area and valuation of coal lands June 30, 1918.

State.	Appraised coal land June 30, 1917.	Coal land appraised, 1917–18.		Net result of appraisals, 1917–18.	Total appraised coal land outstanding June 30, 1918.	Total valuation of appraised coal land outstanding June 30, 1918.	Average value per acre.
		Total coal land appraised.	Coal land reclassified as noncoal land and re-withdrawn.				
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*		
Arkansas	60,715	.....	.....	.....	60,715	$1,473,762	$24.26
California	7,720	.....	.....	.....	7,720	585,086	75.70
Colorado	2,877,487	3,887	.....	+ 3,887	2,881,374	195,522,340	67.85
Idaho	2,113	2,490	.....	+ 2,490	4,603	89,624	19.47
Montana	5,506,779	276,380	943	+ 275,437	5,782,216	137,365,396	23.70
Nevada	5,880	.....	.....	.....	5,880	117,600	20.00
New Mexico	657,145	8,420	.....	+ 8,420	665,565	16,349,351	24.56
North Dakota	2,375,992	9,033,797	.....	+9,033,797	11,409,789	199,382,666	17.40
Oregon	6,875	320	.....	+ 320	7,195	128,051	17.79
South Dakota	250,123	6,437	11,686	— 5,249	244,874	2,711,462	11.07
Utah	1,057,450	12,181	.....	+ 12,181	1,069,631	45,088,853	42.01
Washington	1,060	806	.....	+ 806	1,866	38,520	20.64
Wyoming	7,448,096	1,189	210,770	— 209,581	7,238,515	387,802,633	53.50
	20,257,435	9,345,907	223,399	9,122,508	29,379,943	986,655,344	30.20

Applications for classification as to coal.—During the present year the Survey received 81 applications for classification; 62 of these were requests for classification as coal land and 19 as noncoal land. There were also pending at the beginning of the year 28 applications for coal classification and 3 for noncoal. Of the total 112 received and pending cases, 75 were acted on—55 as coal and 20 as noncoal. At the end of the year there were pending 37 requests for classification, of which 35 were for coal and 2 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 Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming. The examinations were made for the purpose of determining the advisability of adding new areas to the oil reserves wherever the data indicated the presence of oil. These examinations, together with reconsideration of data on file in the light of new information obtained from various sources, resulted in eliminating from withdrawal 117 acres of nonoil land and adding to the withdrawals 171,247 acres of prospective oil land, a net increase of 171,130 acres for the year.

For the first time in a number of years there was no action taken on lands in California. In Wyoming 117 acres in Lincoln County were restored to entry, information obtained by the Survey having shown these lands to be barren of oil. The discovery of oil southwest of the Black Hills in the vicinity of Lusk, Wyo., made it advisable to withdraw certain other favorable areas in northeastern and east-central Wyoming previously known to the Survey but not included in an oil withdrawal. An examination made in south-

eastern Utah, though revealing no favorable structure, indicated the presence of oil in certain strata in which it had not been previously known. On the basis of this new information the President withdrew a small area in Carbon County covering 10,461 acres.

Oil withdrawals and restorations, fiscal year 1917–18, in acres.

State.	Withdrawals outstanding June 30, 1917.	New withdrawals, 1917–18.	Restorations, 1917–18.	Withdrawals outstanding June 30, 1918.
Arizona	230,400	.....	.....	230,400
California	1,257,229	.....	.....	1,257,229
Colorado	87,474	.....	.....	87,474
Louisiana	467,030	.....	.....	467,030
Montana	1,346,105	.....	.....	1,346,105
North Dakota	84,894	.....	.....	84,894
Utah	1,952,326	10,461	.....	1,962,787
Wyoming	923,182	160,835	117	1,083,900
	6,348,640	171,296	117	6,519,819

Classification.—Most of the lands examined and included in oil withdrawals have not been definitely classified as oil lands, and during the fiscal year no such classifications have been made. 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 by lease or otherwise is enacted. Lands included in oil withdrawals may therefore be considered tentatively as oil lands, although, with the exception of some of the land in California, they have not been so classified.

On account of the diversion of the field force from the examination of oil-shale lands to other more pressing work, there were no classifications of such lands during the fiscal year. The field examinations made will eventually lead to extension of the classified areas in Colorado and to classifications in Nevada. As the result of previous work, 3,992,036 acres remain classified as oil-shale land.

Applications for classification.—During the year the Survey received 6 applications for classification of lands with respect to oil content. At the beginning of the year there were also pending 6 applications for classification as to oil, making a total for the year of 12 cases. Eleven of these were acted on during the year, and one remained pending at the close of the year.

POTASH.

Search for potash.—Reconnaissance work in search of commercial deposits of potash was continued by the geologic branch of the Survey during the fiscal year. No new areas were withdrawn, and no changes were made in the two existing reserves in California—Searles Lake and Panamint valleys—aggregating 91,207 acres, or in the potash reserves of 39,422 acres at Columbus Marsh, Nev.

Potash leasing act.—The act of Congress approved October 2, 1917, entitled "An act to authorize exploration for and disposition of potassium" (40 Stat., 297), authorizes the Secretary of the Interior, in his discretion, to issue permits giving the exclusive right for two years to prospect for chlorides, sulphates, carbonates, borates, silicates, nitrates, and other salts of potassium on not more than 2,560 acres of vacant public land, and to issue leases for the exploitation of the deposits. Patents may be issued for one-fourth of the area covered by a prospector's permit, if a commercial deposit of potash is discovered. Applications for such prospecting permits are submitted to the Commissioner of the General Land Office, within whose jurisdiction falls the decision as to granting or refusing the permit. In the last two quarters of the fiscal year 70 such applications have been submitted to the Survey for report and recommendation. Action has been taken on 46 of these applications, and the remaining 24 were still pending in the Survey at the end of the year.

PHOSPHATE.

Regulations.—No change in the procedure affecting the classification of phosphate land has been made. 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 no field examinations of phosphate deposits were made, but 248,030 acres in Idaho and Montana were withdrawn and 30,034 acres in Montana were restored on the basis of field work in other years.

Phosphate withdrawals and restorations, fiscal year 1917–18, in acres.

State.	Withdrawals outstanding, June 30, 1917.	Withdrawals, 1917–18.	Restorations, 1917–18.	Withdrawals outstanding, June 30, 1918.
Florida	119,737			119,737
Idaho	966,377	49,340		1,015,717
Montana	119,227	198,690	30,034	287,883
Utah	302,465			302,465
Wyoming	998,592			998,592
	2,506,398	248,030	30,034	2,724,394

Classification.—Examinations of land in Indian reservations are frequently made for the information of the Office of Indian Affairs. If these examinations are made for the purpose of determining whether 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 phosphate reserves and are included in the table given on page 135.

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, 1918, 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 one application for classification of withdrawn lands as nonphosphate land, and one such application was pending at the beginning of the year. One of these was acted on and the other was pending at the end of the year.

METALLIFEROUS LANDS.

Classification.—The Gila River Indian Reservation was examined as to its mineral character in the preceding fiscal year, and on the basis of this examination the lands of the reservation were classified this year—3,235 acres as mineral land and 367,979 acres as nonmineral.

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, 1917, the area included in outstanding withdrawals was 2,429,097 acres. During the year 137,505 acres additional were withdrawn and 2,230 acres previously included in power-site reserves were restored to the public domain. On June 30, 1918, the total area withdrawn in connection with water power was 2,564,372 acres.

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1917–18, in acres.

State.	Withdrawals outstanding June 30, 1917.	New withdrawals, 1917–18.	Restorations, 1917–18.	Withdrawals outstanding June 30, 1918.
Alabama	120	.....	.....	120
Alaska	69,300	12,235	520	81,015
Arkansas	22,354	.....	.....	22,354
Arizona	300,324	44	.....	300,368
California	264,006	13,217	.....	277,223
Colorado	276,504	10	.....	276,514
Idaho	262,494	3,315	342	265,467
Michigan	1,240	.....	.....	1,240
Minnesota	12,309	.....	.....	12,309
Montana	164,297	195	80	164,412
Nevada	27,361	.....	.....	27,361
Nebraska	761	.....	.....	761
New Mexico	62,602	.....	.....	62,602
Oregon	317,318	105,414	760	421,972
Utah	447,424	204	.....	447,628
Washington	113,780	281	528	113,533
Wyoming	86,903	2,590	.....	89,493
	2,429,097	137,505	2,230	2,564,372

Water-power designations.—The act of June 9, 1916 (39 Stat., 218), revesting in the United States title to lands in Oregon held by the Oregon & California Railroad Co., provides for classification as "power-site lands" of the revested lands found to be chiefly valuable for water-power sites. On June 10, 1918, all the revested lands which had been classified as agricultural lands, this class including all lands not classified as power-site or timber lands, were opened to entry under the homestead laws. During the fiscal year prior to June 10, 1918, 109,508 acres of the revested lands were designated as power-site lands. On June 30, 1918, the total area classified as power-site lands under the provisions of the act referred to was 141,273 acres. In general, such of these lands as were not otherwise withdrawn have also been included in power-site reserves under appropriate acts of Congress. The designation heretofore made of 764,438 acres of land valuable for water power in Arizona and 201,000 acres of such land in New Mexico under the enabling acts of those States remains unchanged.

Applications for reclassification.—At the beginning of the fiscal year 18 applications for the reclassification of lands included in power-site reserves were awaiting action, and during the year 90 were received, making a total of 108 cases. Action was taken on 90 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 made to the Secretary of the Interior on 21 applications for power permits under the act of February 15, 1901, including 5 applications for preliminary and 5 for final permits involving the development of water power and 11 applications for final permits for electrical transmission lines. Favorable reports were also rendered on 14 applications for grants under the act of March 4, 1911, for rights of way for electrical transmission lines.

Numerous applications involving extensions of time under permits and grants, modifications of stipulations of permittees and grantees, and approvals of transfers of permits and grants have been considered and reported upon to the Secretary. A large amount of correspondence of the Interior Department relative to right of way matters in general has been initiated by the Geological Survey or has been assigned to it for handling.

In pursuance of the Secretary's instructions of August 24, 1916, 32 permittees under the act of February 15, 1901, and grantees under the act of March 4, 1911, to whom permits and grants have been issued by the Secretary of the Interior since January 1, 1913, were called on for detailed reports of their operations during the calendar year 1917. These reports cover the operations of many of the larger power systems of the public-land States and present a great amount of valuable information. The reports show that public lands under permits or grants issued by the Secretary of the Interior since January 1, 1913, were used during the year for the genera-

tion or transmission of over 2,000,000,000 kilowatt-hours of electric energy.

As the foregoing statement indicates, the Geological Survey holds an important place in the scheme of governmental administration of hydroelectric power development and transmission on public lands, as it is at present worked out in the Interior Department. A considerable amount of work has been done in the hydrographic division on various aspects of such administration which, although not directly productive of tangible results at this time, will nevertheless prove of great value as a foundation for the more comprehensive consideration of this subject which seems reasonably certain to come.

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 1917–18.

	Pending June 30, 1917.	Received, 1917–18.	Acted on, 1917–18.	Pending June 30, 1918.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 14, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 990), etc.	20	57	68	9
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc.	16	77	86	7
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.	29	26	34	21
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 11, 1898 (30 Stat., 404), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.	7	129	127	9
Total number of applications for original consideration	72	289	315	46
Additional applications for reconsideration	21	5	11	15

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.

During the year these withdrawals have been increased by 1,728 acres as a result of an Executive order creating a withdrawal under the act of June 25, 1910, in order to protect possible future extensions of the municipal water-supply system of the city and county of Denver, Colo. This withdrawal was based on a departmental recommendation.

The following table shows the area of such withdrawals outstanding:

Reservoir sites outstanding June 30, 1918.

	Acres.		Acres.
Arizona	23,040	Oregon	10,619
Colorado	1,728	Washington	35,943
Montana	9,080		
North Dakota	1,569		81,979

Carey Act segregations.—During the year three 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. Reports on all these lists had been submitted before the end of the year, and supplemental reports on two 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 58 such cases were received, and 66 were carried over from the preceding year. Of these 124 cases 90 were reported on and 34 were pending June 30, 1918. Supplemental report was rendered on 1 case, and 5 requests for such reports were pending at the end of the year.

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), March 4, 1915 (38 Stat., 1162), July 3, 1916 (39 Stat., 344), September 5, 1916 (39 Stat., 724), and February 20, 1917 (39 Stat., 925), was continued during the year. As a result of the investigations of surface and ground-water conditions, designations based on Survey classifications have been made during the fiscal year in a large number of cases involving lands regarding which data previously available were insufficient for decision and in many cases regarding which data available indicated that the land was not properly subject to designation.

Action on petitions under the enlarged-homestead acts, fiscal year 1917–18.

State.	Pending June 30, 1917.	Received, 1917–18.	Total.	Action taken, 1917–18.					Pending June 30, 1918.	Cases reconsidered.
				All designated.	Part designated.	Refused.	Recalled.	Total.		
Arizona	100	57	157	86	6	21	4	117	40	15
Arkansas	.....	1	1	.....	1	.....	.....	1	.....	.....
California	387	394	781	190	2	71	65	328	453	13
Colorado	1,223	1,258	2,481	1,493	27	100	94	1,714	767	1
Idaho	1,258	662	1,920	1,031	28	198	100	1,357	563	84
Kansas	35	175	210	171	1	3	6	181	29	11
Montana	878	1,549	2,427	1,733	43	87	43	1,906	521	153
Nebraska	.....	1	1	.....	1	.....	.....	1	.....	.....
Nevada	55	10	65	9	.....	15	4	28	37	.....
New Mexico	830	464	1,294	619	8	88	79	784	510	45
North Dakota	191	287	478	82	5	16	11	114	364	14
Oklahoma	.....	1	1	.....	1	.....	.....	1	.....	.....
Oregon	500	174	674	88	3	11	16	118	556	6
South Dakota	415	204	619	153	5	35	19	212	407	12
Utah	648	373	1,021	384	15	64	7	470	551	19
Washington	220	168	388	239	1	14	7	261	127	8
Wyoming	469	448	917	337	3	68	19	427	490	33
	7,209	6,226	13,435	6,615	150	781	474	8,020	5,415	414

The general provisions of the acts, which apply in 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." Entries may be allowed for the surface only of mineral land containing coal, phosphate, nitrate, potash, oil, gas, or asphaltic minerals. As a prerequisite to the allowance of an entry under these acts 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.

Since the enactment of the preference-right amendment to the enlarged-homestead act, on March 4, 1915 (38 Stat., 1162), the entire energy available for enlarged-homestead classification work has been required for considering individual petitions for designation by prospective entrymen. In consequence general designations of large areas are made only in rare instances.

Enlarged-homestead designations, fiscal year 1917–18, in acres.

State.	Outstanding June 30, 1917.	Designations, 1917–18.	Cancellations, 1917–18.	Outstanding June 30, 1918.
Arizona	25,339,047	128,596	.....	25,467,643
California	7,212,448	345,425	.....	7,557,873
Colorado	26,960,493	904,701	720	27,864,474
Idaho:				
Sections 1–5 only	10,042,677	311,125	290,828	10,062,974
Section 6	124,909	387,928	.....	512,837
	10,167,586	699,053	290,828	10,575,811
Kansas	468,139	41,695	.....	509,834
Montana	49,520,245	858,066	246	50,378,065
Nevada	46,301,752	3,004	.....	46,304,756
New Mexico	28,748,456	1,256,540	16,562	29,988,434
North Dakota	11,495,203	136,182	.....	11,631,385
Oregon	17,996,794	155,730	1,605	18,150,919
South Dakota	15,485,989	162,887	.....	15,648,876
Utah:				
Sections 1–5 only	7,486,322	51,396	35,898	7,501,820
Section 6	1,333,369	91,305	400	1,424,274
	8,819,691	142,701	36,298	8,926,094
Washington	5,447,144	116,794	.....	5,563,938
Wyoming	21,670,874	209,706	98,824	21,781,756
	275,633,861	5,161,080	445,083	280,349,858

A set of State maps showing the areas covered by the designations outstanding June 30, 1918, 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 and 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 are reasonably required to support a family.

The appropriation for the administration of the law was made available just before the end of the preceding fiscal year, but it was not until the later part of August that the first field party could be assembled, organized, and equipped. Additional parties were organized and assigned to work in the several States as rapidly as qualified men could be obtained, but data sufficient to make classification in any State were not received until late in the fall.

In the meantime the office force was put under great pressure by reason of the large number of petitions for designation which were filed immediately on the passage of the act and transmitted to the Survey beginning practically with the fiscal year. Only 3,000 petitions were pending on July 1, 1917, but they were received at an

average rate of about 6,000 per month for the next six months, and at the end of the fiscal year a total of more than 49,000 had been received. A great amount of work was necessarily involved in recording and filing these petitions and assigning them to the proper field parties.

The first designation was approved November 28, 1917, and thereafter the classification work progressed rapidly until the end of the fiscal year, when more than 7,500,000 acres had been designated in eight States.

During the year there were closed in the records of the Survey more than 14,000 cases, or nearly 30 per cent of the total number filed, and of these nearly 11,000, or more than 75 per cent of those acted on, received favorable consideration. In addition there were, at the end of the year, approximately 9,800 cases which had been approved for designation by the land-classification board but for which formal recommendation had not been made to the Secretary. Final action in these cases was delayed pending receipt from the General Land Office of notification of the action on proposed stock driveways in the areas concerned.

The following table shows the status of stock-raising petitions and the area of land designated as subject to entry under the law:

Designations and action on applications under the stock-raising homestead act, fiscal year 1917–18.

State.	Pending June 30, 1917.	Received, 1917–18.	All designated.	Part designated.	Refused.	Recalled.	Total.	Pending June 30, 1918.	Area designated (acres).
Arizona	118	1,084	.....	.....	17	74	91	1,111	.....
Arkansas	.....	1	.....	.....	.....	.....	.....	1	.....
California	203	2,232	.....	.....	23	144	167	2,268	.....
Colorado	350	5,716	2,472	.....	117	294	2,883	3,183	1,432,766
Idaho	48	3,031	.....	.....	13	153	166	2,913	.....
Kansas	24	172	38	.....	5	44	87	109	15,384
Montana	567	7,455	101	.....	25	732	858	7,164	55,538
Nebraska	16	86	83	.....	.....	1	84	18	38,648
Nevada	58	101	.....	.....	.....	.....	.....	159	.....
New Mexico	141	10,335	2,463	2	211	523	3,199	7,277	2,188,698
North Dakota	261	435	326	.....	132	38	496	200	190,797
Oklahoma	.....	77	.....	.....	.....	2	2	75	.....
Oregon	407	3,012	.....	.....	14	203	217	3,202	.....
South Dakota	532	2,849	1,877	1	242	159	2,279	1,102	1,156,229
Utah	8	1,364	.....	.....	8	41	49	1,323	.....
Washington	90	610	.....	.....	1	26	27	673	.....
Wyoming	179	7,471	3,341	3	105	330	3,779	3,871	2,460,902
	3,002	46,031	10,701	6	913	2,764	14,384	34,649	7,538,962

NOTE.—Ten petitions were returned to the Survey for reconsideration.

PUBLIC WATER RESERVES.

Section 10 of the stock-raising homestead act of December 29, 1916 (39 Stat., 862), provides that lands containing water holes and other bodies of water needed or used by the public for watering may be reserved under the provisions of the act of June 25, 1910 (36 Stat., 847), and that such lands, whether withdrawn prior or subsequent to

the passage of the stock-raising homestead act, shall be open to the public use for such purposes and under such general rules and regulations as the Secretary of the Interior may prescribe so long as the withdrawal may be continued in force. While no general rules or regulations for their use have been issued, the creation of public water reserves has been continued under the authority thus expressly recognized as having been granted to the President by the withdrawal act of June 25, 1910. Some public water reserves contain stock-watering places which control surrounding areas of open public range, and it is regarded as desirable that permits be issued to use such withdrawn watering places under conditions that will result in greater protection for public grazing privileges by limiting the number of head of stock grazed to the carrying capacity of the range or otherwise.

During the year all cases referred to the Survey from the General Land Office under the cooperative agreement with that bureau were considered with the view of determining whether the lands affected in any case should and could properly be included in a public water reserve. In a considerable number of these cases the data available were insufficient for decision on this question and field examination was necessary. These examinations have been made by field agents of the Survey or the General Land Office.

At present about 950 watering places consisting of springs, creeks, and other sources of water supply have been considered, and nearly 900 of these are now included in public water reserves. During the year 4,756 acres have been withdrawn and 1,030 acres have been restored, making a net increase of 2,926 acres in the area withdrawn.

Public water reserves withdrawn from entry and restored to entry, fiscal year 1917–18, in acres.

State.	Withdrawals outstanding July 1, 1917.	New withdrawals, 1917–18.	Restorations, 1917–18.	Withdrawals outstanding June 30, 1918.
Alaska	(a)			(a)
Arizona	12,438	628		13,066
California	52,474			52,474
Colorado	480			480
Idaho	7,210			7,210
Montana	3,304	1,940		5,264
Nevada	4,336	417		4,753
New Mexico	2,286	640		2,926
Oregon	2,482			2,482
Utah	33,827	1,080	280	34,627
Washington	40			40
Wyoming	82,831	31	1,550	81,312
	201,708	4,756	1,830	204,634

a Not known.

WELL-DRILLING RESERVES.

The sundry civil act of June 12, 1917 (40 Stat., 105), appropriating funds for gaging streams and determining the water supply of the United States, provided that "$25,000 may be used to test the existence of artesian and other underground water supplies suitable for irrigation in the arid and semiarid regions by boring wells." In the administration of this act certain tracts were selected by the Geological Survey on which to drill test wells, and in order to protect these tracts while the tests were being made, two small reserves were created under the authority of the act of June 25, 1910 (36 Stat., 847), as amended August 24, 1912 (37 Stat., 497). Well-drilling reserve No. 1 withdrew from entry 40 acres of public land in south-central Montana. Well-drilling reserve No. 2 withdrew from entry 80 acres of public land in the Steptoe Valley, Nev.

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 23,880 pages of manuscript were edited and prepared for printing, and proof sheets comprising 3,864 galley proofs and 16,519 page proofs were read and corrected. Indexes were prepared for 40 publications, covering 29,731 pages. Brief notices of the publications issued during the year are given on pages 12–30.

This section assisted in the translation from the French of the "Manual for the artillery orientation officer," published 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 preparing copy and reading proof.

SECTION OF ILLUSTRATIONS.

The number of illustrations prepared was 1,660, comprising 167 maps, 442 photographs prepared for reproduction, 488 diagrams and sections, 415 paleontologic drawings and photographs, and 148 miscellaneous illustrations. The illustrations sent to the printer were reproduced by chromolithography, photolithography, the photogelatin process, halftone engraving, zinc etching, wax engraving, copper etching, and cuts already engraved, a total of 1,316 subjects. Proofs to the number of 1,462 were examined. Electrotypes of 16 cuts were furnished to outside applicants. At the end of the year material for illustrating 30 reports was in preparation.

DIVISION OF DISTRIBUTION.

Editions of 225 new books and pamphlets, 8 reprinted books and pamphlets, 1 new geologic folio, 5 new geologic maps, 101 new or revised topographic maps (including 24 colored photolithographs), 184 reprinted topographic maps, 2 new photolithographed maps, and 12 reprinted photolithographed maps, making a total of 538 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 466,428 books and pamphlets, 8,704 folios, 494 geologic maps, 703,338 topographic and other maps, a grand total of 1,178,964.

The division distributed 565,440 books, 11,215 folios, and 530,761 maps, a total of 1,107,416, of which 8,350 folios and 354,459 maps were sold. The total amount received and deposited in the Treasury as the result of sales of publications was $25,491.84. The sales of topographic and geologic maps amounted to $24,639.89, of topographic and geologic folios to $851.95. The division received and answered 70,646 letters.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

The work on geologic folios having been discontinued because the engraving division was occupied with more urgent work closely related to the exigencies of the war, little progress was made in the publication of folios during the year. Only material in progress of engraving or printing was finished.

One folio (Deming, N. Mex.; Folio 207) was issued early in the year before work was stopped, and three other folios (Colchester-Macomb, Ill.; Newell, S. Dak.; and Herman-Morris, Minn.) were nearly completed. The Elkton-Wilmington (Md.-Del.), Black Hills (S. Dak.), and Syracuse-Lakin (Nebr.) folios were in various stages of progress.

During the year G. W. Stose, the geologist in charge of the section, edited geologically the illustrations, including maps and color guides, for 51 reports.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 130 topographic maps were on hand for publication, and the accessions during the year were 116, making a total of 246 maps. Of these, 1 was withdrawn for additional field work, 2 were combined with maps of adjoining quadrangles, 100 have been published, 121 are in press, and 22 have not yet been transmitted to the engraving division. Of the 103 maps published during the year (see list, pp. 30–31) 72 are new engraved maps, 26 are photolithographs, and 5 are new combinations or new editions of engraved maps. The

following statement shows the comparative status of map editing and map publication on June 30 for the last five years:

Progress of map publication for five years ended June 30, 1918.

	1914	1915	1916	1917	1918
Published during the year	102	107	153	95	103
In process of engraving and printing	69	57	97	111	121
In hand for engraving	114	91	52	19	22

The manuscripts edited during the year comprise 75 maps prepared for engraving, 19 maps for photolithography, 4 maps of army cantonments, 181 maps or sheets for the illustration of 34 Survey reports, and corrections for 199 maps about to be reprinted. The proof read comprises 113 new topographic maps and corrections to 91 old maps. The index maps for 2 circulars of the series 9–323 were revised and reprinted, and 4 of the State circulars were revised and reprinted.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND FOLIOS.

During the fiscal year 24 special new topographic war maps were photolithographed and printed in black and colors, and 2 special maps showing Army cantonments (Camp Dix, N. J., and Camp Sherman, Ohio) were compiled and printed; 72 topographic maps were engraved and printed, the Harrison, Ohio, fractional map having been combined and printed as a part of the Hamilton, Ohio, map; 2 new State maps (Idaho and Wisconsin) were photolithographed and printed in black; new editions of the United States map showing coal fields, United States map showing oil and gas fields, and the La Moure, N. Dak., topographic map were issued, making a total of 103 new maps printed and delivered.

Corrections were engraved on the plates of 192 maps, and 11 were in hand for correction. Of the 192 corrected maps, 122 were intended for reprint editions, 59 were in hand for printing, and 11 were corrected for other purposes. Twelve photolithographic State maps were corrected and reprinted, and reprint editions of 59 maps in hand at the beginning of the year were completed. Editions of 3 maps without corrections were also reprinted.

Of the new and reprinted maps 299 different editions, amounting to 703,338 copies, were printed and delivered to the map room. This is an increase of 60 editions and a decrease of 78,306 copies from the preceding year.

One new geologic folio (Deming, N. Mex.) was published during the year. Folio and State editions of the Leavenworth-Smithville, Mo.-Kans., folio and octavo editions of the San Francisco and Detroit folios were also issued during the year. Editions and partial editions

amounting to 8,704 copies were printed and delivered, and extra areal-geology sheets of the different folios, amounting to 494 copies, were also printed and delivered.

OTHER GOVERNMENT MAP PRINTING.

The following war work was done for different branches of the War Department and Navy Department and for other branches of the Government: For the Signal Corps, maps of Belgium, conventional map signs (British and French), map showing military cable and telegraph system Washington to Alaska, map of Fort Monroe and vicinity (1:24,000), outline maps of the United States, drawing of Lewis machine gun, and other miscellaneous work; for the General Staff (War Plans Division), charts showing system of liaison in a division; for the Engineer School, base map of the United States, transfers and sample tint patterns; for the Office of the Chief of Engineers, map of French sector (Aincourt), metric tables, transfers, and stipple patterns; for the Office of Chief of Ordnance, United States base map and other miscellaneous work; for the Army War College, map showing methods of carrying lines of information; for the Surgeon General's Office (Sanitary Corps) and the Chemical Warfare Service, a considerable amount of miscellaneous work; for the Council of National Defense, plates for weekly reports of Bureau of Statistics; for the Navy Department, diagrams of Curtiss airplane; for the Bureau of Construction and Repair, camouflage ship designs and other miscellaneous work; for the Bureau of Standards, illustrations for confidential war report; for the Bureau of Mines under appropriations for war materials investigations, "Chemical plant No. 4," "Gas defense and gas investigations," and a large amount of miscellaneous work.

The following war work was done through the topographic branch: Eight forms, Army and military data; War Department Map No. 809; Army index map; 24 motor-truck route maps; 25 aviation maps; map showing region of Vailly, France; plan of destruction; artillery firing diagram; map of Fort Omaha balloon field; 9 French Mission maps; map of Camp De Lassigny; and 24 special topographic military maps, photolithographed in three or four colors.

For the Government Printing Office the following items were printed and delivered: Illustrations for Preliminary Report No. 6 of the Commission on Navy Yards and Naval Stations (H. Doc. 1946, 64th Cong., 2d sess.); the annual reports of the governor of Alaska, the governor of Hawaii, the Commissioner General of Immigration, the Commissioner of Indian Affairs, the Superintendent of National Parks, and the Superintendent of the Coast and Geodetic Survey; Department of Commerce Special Publication 44, Department of Agriculture Bulletin 680, Bureau of Education Bulletin 32 ("Work

of the natives of Alaska"); soil surveys of San Fernando area, Cal., San Diego area, Cal., Dodge County, Nebr., Ringgold County, Iowa; American Ephemeris and Nautical Almanac, 1918 and 1921; Plane-table manual (Appendix 7, report of the Superintendent of the Coast and Geodetic Survey, 1905); Interstate Commerce Commission Reports, vol. 24; Norway Coast Report, Office of Naval Intelligence Publication 25; Atlas of American Agriculture, Part II (Climatology); Geological Survey Bulletins 655, 658, 659, 660–C, 660–F, 661–B, 661–D, 661–H, 662–A, 662–B, 662–C, 667, 669, 670, 675, 680, 690–B, 691–A, 691–B, 691–C, 691–D, 691–G, 691–H, Professional Papers 100, 106, 107, 108–J, 108–L, 109, 110, 120–C, 120–F; Water-Supply Papers 400, 417, 426; Mineral Resources, 1916, chapters on cement and gypsum. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: For the Navy Department, "A secret and confidential report," Vols. I and II; for the War Department, War Document 653 (confidential); War Document 647 ("Artillery operations of the 9th British Corps at Messines, June, 1917"; for the Department of the Interior, diagram of one national monument; for the General Land Office, map of the Oregon & California Railroad lands in Oregon, cross-section paper; for the National Park Service, geologic map of Rocky Mountain National Park, general-information circulars of seven national parks; for the Department of Agriculture, outline maps of the United States by counties and States, 2-sheet map of the United States, maps of the United States on scales of 1:12,200,000 and 1:17,100,000, outline maps of the world, maps showing quarantine for Texas fever of cattle, map showing life zones of New Mexico, and protractor diagrams.

The following work was done for other bureaus and departments: For the General Land Office, 1,387 township plats, 718 mineral plats, 13 State maps showing homesteads, plats of seven town sites, 135 plats of various grants and reservations, and other miscellaneous work; for the Office of Indian Affairs, maps of two Indian reservations, plats of four town sites, and other miscellaneous work; for the National Park Service, seven automobile guide maps, map showing national parks and monuments, two maps showing proposed enlargements of national parks, and other miscellaneous work; for the Forest Service, recruiting posters, maps of 61 national forests, four recreation maps, five atlas folios, 16 proclamation diagrams of national forests, allotment-estimate forms, grazing-data chart, homestead-entry plats, wall map, account record forms, wood fuel labels, and other miscellaneous work; for the Reclamation Service, general maps of 7 projects, farm-unit plats of 6 projects, and other miscellaneous work; for the Fuel Administration, 13 coal-zone maps, tables of figures, and other miscellaneous work; for the Hydrographic

Office, 84 British Admiralty charts, 147 hydrographic charts, and other miscellaneous work.

Miscellaneous work was also done for the Interstate Commerce Commission, Weather Bureau, Bureau of Mines, Department of the Interior, International Boundary Commission, States Relations Service, Bureau of Standards, Department of Labor, Eight-Hour Commission, Post Office Department, Bureau of Foreign and Domestic Commerce, Bureau of Lighthouses, United States Food Administration, Railway Wage Commission, and Department of Commerce.

This work for various branches of the Government amounted to about $100,000, 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 Corps of Engineers, United States Army (Professional Memoirs); Public Utilities Commission, Augusta, Maine; Matthews-Northrup Works, Buffalo, N. Y.; Atchison, Topeka & Santa Fe Railway Co.; New York State College of Agriculture at Cornell University, Ithaca, N. Y.; H. E. Hale, engineer, Eastern Group, Federal Valuation of the Railroads in the United States, New York, N. Y.; Arthur B. Bibbins, Catoosa, Tenn.; State Department of Health, Augusta, Maine; State Geological Survey, Urbana, Ill.; and Eastman Kodak Co., Rochester, N. Y.; and the money received in payment for the work, amounting to $469.45, was turned into the Treasury of the United States, to be credited to miscellaneous receipts. On requisition of the Government Printing Office, 740 transfer impressions were made and shipped to contracting printers. Under cooperative agreements transfer impressions were furnished without charge to the State geological surveys of New York, Kentucky, Illinois, Virginia, Massachusetts, West Virginia, Maryland, and Iowa.

A large amount of miscellaneous work relating to the map publications was also done, including index circulars and lists of geologic folios, topographic maps, and State maps.

Of contract and miscellaneous printing of all kinds, 2,560,388 copies were printed. Including topographic maps and geologic folios a grand total of 3,272,430 copies were printed and delivered during the year.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 25,818 negatives, of which 1,761 were wet, 1,186 dry, 1,631 paper, and 21,240 field negatives developed; 400 lantern slides; 337 negatives made for photolithographs; 4,025 zinc plates; 171 zinc etchings; 137 celluloids; and 86,416 prints, of which 52,756 were maps and diagrams and 33,660 were photographs for illustrations. In addition, 397 prints were mounted and 1 lantern slide was colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work in the executive division was of the same general character as during the fiscal year 1917, except that the work of the shipping and receiving clerk was retransferred to the division, and the work of the appointment clerk was consolidated with that of the Secretary's Office.

Mails, files, and records.—During the year 142,783 pieces of mail, of which 1,890 were registered, were opened and referred. In addition, 156,425 letters were received direct by the other divisions, making a total of 299,208, an increase of 9 per cent compared with 1917.

Of the letters opened in this division, 16,971 contained $27,438.87 remitted for Survey map publications, a decrease of 37 per cent in number of letters and a decrease of $9,315.01 in amount compared with 1917.

The recording, referring, filing, and mailing of correspondence required the services of 10 clerks. The number of letters mailed through the division was 144,474, a decrease for the year of 47 per cent. This number does not include the outgoing registered mail, which numbered 7,118 pieces, nor 261,424 pieces of letter mail sent direct from other divisions. The total for the Survey was therefore 413,016, a decrease of 27 per cent for the year.

Personnel.—The roll of Secretary's appointees numbered 1,000 at the end of the fiscal year, 66 more than at the end of the fiscal year 1917. There were 234 former employees of the Geological Survey in the military service at the end of the year. The total number of changes in the personnel was 1,891, which included 612 appointments, 546 separations, 652 promotions, 2 demotions, and 79 miscellaneous changes.

During the year 13,947 days of annual leave and 3,825 days of sick leave were granted, being 64 per cent of the amount of annual leave and 17 per cent of the amount of sick leave which it is permissible to grant under the law; 4,174 days of leave without pay were also granted.

Freight and express.—During the year 2,713 pieces of freight and express were handled, of which 1,058 were outgoing and 1,655 were incoming.

SECTION OF FIELD EQUIPMENT.

The section of field equipment is custodian of all field propert and of the topographic field record and computation books.

Several hundred new instruments were purchased, consisting principally of transits, telescopic alidades, compasses, and plane-table and traverse tripods.

In addition to furnishing instruments and supplies for the field parties of the Survey, this section, by cooperative arrangement, furnished surveying instruments and supplies to the War Department to the value of nearly $70,000, principally for use abroad.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to August. 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, 1918.[a]

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00	$6.67	$35,346.67	$33,545.89	$1,800.78
Salaries, scientific assistants	29,900.00	.....	29,900.00	29,899.94	.06
Skilled laborers, etc	20,000.00	.....	20,000.00	19,998.83	1.17
Gaging streams, etc	175,000.00	40,165.14	215,165.14	207,440.08	7,725.06
Chemical and physical researches	40,000.00	5,598.43	45,598.43	44,216.76	1,381.67
Preparation of illustrations	18,280.00	.....	18,280.00	16,423.17	1,856.83
Mineral resources of United States	75,000.00	58.06	75,058.06	72,692.47	2,365.59
Geologic maps of United States	120,000.00	98,119.75	218,119.75	203,206.89	14,912.86
Books for the library	2,000.00	.....	2,000.00	1,662.11	337.89
Topographic surveys	350,000.00	540,056.71	890,056.71	840,369.22	49,687.49
Geologic surveys	350,000.00	10,013.36	360,013.36	346,644.03	13,369.33
Mineral resources of Alaska	100,000.00	7.80	100,007.80	65,315.30	34,692.50
Surveying national forests	75,000.00	2,458.51	77,458.51	49,573.64	27,884.87
Desert watering places	10,000.00	720.00	10,720.00	10,170.10	549.90
Enlarged and stock-raising homesteads	350,000.00	166.18	350,166.18	334,895.11	15,271.07
	1,750,520.00	697,370.61	2,447,890.61	2,276,053.54	[b] 171,837.07

[a] In addition to these appropriations $175,000 for Survey publications was contained in the appropriation for printing and binding but not disbursed by Survey officials.

[b] The larger part of this balance will be used to pay outstanding obligations.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1918.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Provisions; subsistence and support of persons.	Forage; subsistence and care of animals.
Salaries, office of the Director	$33,545.89	$33,545.89	.....	.....	.....	.....
Salaries, scientific assistants	29,899.94	29,899.94	.....	.....	.....	.....
Skilled laborers, etc	19,998.83	19,998.83	.....	.....	.....	.....
Gaging streams, etc	207,440.08	143,488.48	$13,143.75	$2,050.85	$11,625.70	$655.58
Chemical and physical researches	44,216.76	28,612.83	4,060.68	229.70	3,338.77	332.33
Preparation of illustrations	16,423.17	15,878.33	.....	.30	.....	.....
Mineral resources of United States	72,692.47	66,783.50	1,187.21	68.97	972.94	.....
Geologic maps of United States	203,206.89	142,450.25	54.45	2.60	49.40	.....
Books for the library	1,662.11	.....	.....	.80	.....	.....
Topographic surveys	840,369.22	350,004.65	70,753.82	5,376.16	168,566.47	26,922.04
Geologic surveys	346,644.03	274,774.40	22,297.43	1,141.86	27,657.93	4,625.32
Mineral resources of Alaska	65,315.30	47,048.96	9,193.61	263.68	4,911.21	116.72
Surveying national forests	49,573.64	25,613.98	2,393.12	125.41	7,968.82	6,534.61
Desert watering places	10,170,10	2,288.32	796.24	204.49	1,286.21	101.12
Enlarged and stock-raising homesteads	334,895.11	172,830.20	14,638.33	836.30	63,087.81	2,438.20
	2,276,053.54	1,353,218.56	138,518.64	10,301.12	289,465.26	41,725.92

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1918—Continued.

Appropriation.	Communication service.	Printing, engraving, lithographing, etc	Fuel; furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials, miscellaneous supplies, etc.	Stationery, drafting, etc., supplies.
Salaries, office of the Director						
Salaries, scientific assistants						
Skilled laborers, etc						
Gaging streams, etc	$778.41	$1,153.71	$704.71	$2,558.73	$6,247.53	$1,896.40
Chemical and physical researches	118.10	111.15	204.48	2,552.71	2,083.65	245.03
Preparation of illustrations	1.63	253.13				198.02
Mineral resources of United States	1,671.12	1,052.64		416.10	5.35	457.34
Geologic maps of United States	90.28	3,417.20	181.30	3,103.16	7,781.75	39,311.27
Books for the library						701.06
Topographic surveys	1,129.21	15,178.48	7,238.00	8,542.23	15,828.98	12,966.39
Geologic surveys	495.72	3,809.17	612.04	1,796.71	1,163.47	1,323.65
Mineral resources of Alaska	90.30	448.46	744.82	142.24	721.16	218.31
Surveying national forests	8.85	650.99	145.33	176.26	1,147.56	324.42
Desert watering places	52.24	35.90	17.18	234.01	1,137.84	52.28
Enlarged and stock-raising homesteads	1,059.87	1,641.18	146.79	683.79	274.78	4,657.41
	5,495.73	27,752.01	9,994.65	20,205.94	36,392.07	62,351.58

Appropriation.	Equipment (including live stock).	Rent.	Maintenance, operation, and repair of passenger-carrying vehicles.	Purchase of motor-propelled passenger-carrying vehicles.	Purchase of horse-drawn passenger-carrying vehicles.
Salaries, office of the Director					
Salaries, scientific assistants					
Skilled laborers, etc					
Gaging streams, etc	$13,474.51	$1,839.50	$3,418.20	$4,404.02	
Chemical and physical researches	1,297.96	217.95	287.34	524.08	
Preparation of illustrations	91.76				
Mineral resources of United States	77.30				
Geologic maps of United States	6,756.43		8.80		
Books for the library	960.25				
Topographic surveys	100,943.98	1,797.05	26,700.46	28,326.55	$94.75
Geologic surveys	1,122.88	24.00	3,994.49	1,804.96	
Mineral resources of Alaska	1,409.83	5.00	1.00		
Surveying national forests	3,811.59		672.70		
Desert watering places	2,244.27		1,720.00		
Enlarged and stock-raising homesteads	12,639.25	261.60	34,958.44	24,741.16	
	144,830.01	4,145.10	71,761.43	59,800.77	94.75

During the year the library has been extensively used for war work, the force having been from time to time engaged in aiding Government agencies in investigations that required library research. The war has greatly diminished the number of exchanges received, especially the foreign publications, has made it impossible to distribute the Survey's publications with the usual regularity, and prevented altogether most of the foreign distribution.

LIBRARY.

The accessions of books, pamphlets, and maps numbered 9,831 items, all of which were recorded in the catalogues. The recorded loans were 6,369 books and 349 maps, not including those used by 8,023 readers who consulted the library in person. The catalogue was increased by the addition of 8,168 cards. In accordance with the cooperative cataloguing arrangement 430 title entries were furnished to the Library of Congress for printing, the proof reading for which involved 85 galleys.

The books collated and prepared for the binder numbered 1,156. Eighty-three letters and other papers were translated from foreign languages for other divisions of the Survey.

Proof reading was completed on the bibliography of North American geology for 1916, which was published as Bulletin 665. The bibliography for 1917 (Bulletin 684) was compiled and the proof read. Work was continued on the cumulated bibliography of North American geology.

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