DEPARTMENT OF THE INTERIOR
JOHN BARTON PAYNE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

FORTY-FIRST ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1920

WASHINGTON
GOVERNMENT PRINTING OFFICE
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FORTY-FIRST ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

INTRODUCTION.

The appropriations for the public work under the United States Geological Survey for the fiscal year 1919–20 comprised items amounting to $1,586,353.50.

In general the results of the varied activities of the Geological Survey may be regarded as meeting with a constantly increasing measure of public approval, as shown by the larger use that is being made of this branch of the public service. Correspondence with all classes of citizens—ranchers and corporation officials, school children and university professors, prospectors and mining engineers—has continued to increase, and this gain has been evident in the requests both for specific information and for publications. Ten years ago a telegraphic request for a map or report was a notable incident; now telegrams of this kind are of daily occurrence.

Especially gratifying has been the popular demand for topographic maps, the increase in sales this year being 70 per cent. The number of all publications—books and maps—distributed during the year exceeded the number printed this year, this disproving the common assertion that Government publications simply accumulate until they become only waste paper. Indeed, an embarrassing feature of much of the correspondence during the year has been the thousands of requests for reports that were out of print, and more reprints than usual of exhausted editions have been authorized to meet an insistent demand. The public is making use of the publications of the Geological Survey as never before.

SPECIAL TOPICS.

PLANNING FOR THE FUTURE.

One of the many official questionnaires recently inquired what part of the Geological Survey's investigations concern the future. It takes only the briefest review of the varied activities of this branch of the Government scientific service to realize that every activity is

forward-looking—that facts are being collected with which to guide present action and to plan for future action. This is true not only of a special investigation like the superpower survey just authorized, but of the collection of stream-gaging records, the making of topographic maps, the study and the estimation of mineral resources and mineral production, and even the interpretation of geologic history. The Geological Survey's function in the classification of the public lands is not simply cooperation with the General Land Office in the administration of the land laws—it is a cooperative effort to insure the best use of these lands, to plan their use so that the West may not have to pay the penalties attaching to an unwise disposition of the Nation's real estate.

The title given to a public address by the Director of the Geological Survey before the Engineers' Club of Philadelphia, "Engineering as prosperity insurance," expressed this idea of the need of larger attention to the future of our country and the part to be played by science and engineering. Federal Trade Commissioner Colver has recently added to this thought the suggestion that our care-free days of national youth have been passed; we have been spendthrifts with our patrimony and are now reaping our wild oats, but the problems of mature and responsible life are pressing hard upon us, and the need of making provision for our national old age is staring us in the face. But, however we express it, never before have legislators and executives, business men and citizens generally had greater need of exact information.

In the First Annual Report Director King outlined the future of the Geological Survey and emphasized the relation of scientific research to the development of the country's material resources. In a period of rapid expansion and exploitation he gave warning that without adequate information in the possession of the Federal Government as to the needs of industry, without scientific knowledge of all the elements of national wealth, commerce is mere transportation, industry is short-lived, and an equilibrium of population with local resources is not to be attained.

Though for 40 years the Geological Survey's policy has been to contribute to the formation of a national plan, its own outstanding need to-day is a plan for itself—a program. The recognized function of a scientific bureau is to collect and arrange facts upon which the nation may base its plans for future development, but the Geological Survey now finds itself unable to plan adequately its own development. It lacks that assurance of continued appropriations that would encourage or warrant long-term investigations, a few of which are absolutely essential in any forward-looking program of scientific research. The increasing gap between the Government scale

of professional salaries and the scale prevailing in commercial employment causes a "turnover" that makes the administration of scientific work almost hopeless. So it happens that the responsible official whose purpose is to do the work most needed actually has his choice of projects determined largely by the personnel available. For each scientist of fully tested ability the choice has to be made between several pieces of work, all of which deserve immediate attention. Even less satisfactory is the situation in which an urgent call for a field examination has to be met by assigning to it an untried worker under conditions that preclude the expectation of the best results. Thus, though there is no intentional lowering of scientific standards, the product is not wholly satisfactory.

The net result of these conditions is that the Geological Survey is not fully occupying the field which is recognized as peculiarly its own. It could, however, occupy that field. With slightly increased appropriations, and especially with a declaration of intent by Congress to regard the scientific bureau as having successfully passed its probationary period, greater stability might be expected and some progress might be made in the adoption of a program fitted to the country's needs. A program for completing the topographic map of the United States for the use of this generation was outlined in the Fortieth Annual Report (pp. 13–16), but Congress has not yet approved that plan, though it promises to get results most expeditiously and economically. The power program, also presented in the report for last year, has found more encouraging support, as the superpower survey of the eastern industrial zone has now been authorized by Congress. It is hoped that the engineering report on this survey will commend itself so highly to Congress that similar investigations of other parts of the United States may be authorized before the demand for unified electrification becomes so urgent as it has already become along the North Atlantic seaboard.

Another item in the working program whose value was foreseen but whose adoption has not been possible is the mapping of geologic structures favorable to oil accumulation in the Western States prior to the enactment of oil-leasing legislation. The need for such mapping was realized, for it would be helpful alike to the oil operator and to the Government official administering the new law, but neither men nor money have been available to do more than touch the outer edges of this project. Similar preparation for the water-power law was obviously desirable but could be made only in part.

The examination of storage sites made in 1888–1891 was pioneer work that marked a beginning in the larger utilization of the water resources of the West, and it is unfortunate that this special investigation was discontinued, for now authoritative information of this

kind would be invaluable in planning the storage of flood waters for power and irrigation in the West and for power development, improvement of navigation, and flood protection in the East. The Nation can well afford to invest in engineering data for future use. In a word, the Geological Survey, even though its shortcomings have been keenly realized from within, has not yet measured up to its task in the Nation's business.

WASTAGE IN PUBLIC SERVICE.

In too much of the current discussion of the small salaries paid by the Government the emphasis put on the injustice and hardship suffered by the employee has tended to conceal a larger issue—the great harm wrought to the public service—for during this period that has been marked by a failure to adjust salaries to living expenses the Government work may have suffered as much as the Government workers. Many employees, it is true, have continued to render services far in excess of their compensation, but many others have lost heart or have had their minds distracted by the problems of life, with consequent loss in quality of endeavor and of achievement, and the more ambitious and active, attracted by the living wage paid elsewhere, have deserted the Government service. The net result is a loss in efficiency out of all proportion to the false economy represented by the Government pay scale.

Other bureaus may have fared worse, but the losses of employees suffered by the Geological Survey make up a serious item in its failure to do needed work. A slight advance in the salary scale has been quite insufficient to check the exodus of sorely needed specialists. In the competitive market, where the Government salary is doubled, trebled, or even quadrupled by the salary offered by the corporations, the Geological Survey naturally loses men who have just reached their maximum productivity and some who are occupying key positions in its field activities. With these inroads on the working force no attempted economy, no readjustment, however skillful, can prevent a distressing wastage due to interrupted work.

In general, the men who are most desired in the public service could be retained at salaries considerably less than those paid in private employ. It is regrettable that the public service should be even temporarily set on a financial basis so narrow that the professional positions, in which the most capable workers are needed—men and women with the best training and the highest ability—can attract and retain only those who are either able to eke out their Government salaries with private income or willing to sacrifice a certain degree of comfort in living to their love for science and for country. The public servant is worthy of his hire.

WORK OF THE YEAR.

DUTIES OF THE DIRECTOR.

In earlier years the annual report contained a paragraph stating the field and office work of the Director, and Director Walcott's summary could always make reference to his personal scientific research. Field work by the present Director has been confined to inspections and visits to field parties, made largely to acquaint him better with the changing methods and standards of work. For several years even this type of field work has been discontinued, not from choice but by force of the larger volume of administrative duties in Washington.

In addition to the administrative work, the Director has devoted considerable time to the critical reading of manuscripts submitted for publication but perhaps more time to the popular presentation of the results of the varied investigations made by the Survey. The bearing of the scientific, engineering, and statistical work of the Geological Survey upon the public welfare is not fully appreciated except as the results of that work are translated into popular language and their relation to present-day issues is set forth. In part this duty is performed through attendance upon hearings before Congressional committees, but in part larger audiences must be reached at meetings of technical societies. Public addresses by the Director during the year included "Our industry's part," American Mining Congress, St. Louis, Mo., November 18, 1919; "The future of natural gas," Natural Gas Conference, Washington, D. C., January 15, 1920; "Engineering as prosperity insurance," Engineers' Club of Philadelphia, January 20, 1920; "Fluctuations in coal production—their extent and causes," with F. G. Tryon as joint author, and "A foreign oil supply for the United States," American Institute of Mining and Metallurgical Engineers, New York City, February 17, 1920; "The public-service opportunity of the oil geologist," American Association of Petroleum Geologists, Dallas, Tex., March 18, 1920; "The geographic side of geology," American Geographical Society of New York, April 6, 1920; "Industry's need of oil," American Iron and Steel Institute, New York City, May 28, 1920; and "The engineer and national prosperity," conference of Federated American Engineering Societies, Washington, D. C., June 3, 1920. At the April meeting of the American Geographical Society of New York the Charles P. Daly gold medal was awarded to the Director.

In addition to these addresses, two articles on similar subjects were published—"Where the world gets its oil," in the National Geographic Magazine, February, 1920; and "Minerals as essential raw materials," in the Annals of the American Academy of Political and Social Science, May, 1920.

PUBLICATIONS.

The publications of the year numbered 295 and consisted of 1 annual report, 9 professional papers, 3 separates from 1 professional paper, 12 bulletins, 36 separates from 8 bulletins, 15 water-supply papers, 3 separates from 1 water-supply paper, 3 volumes of Mineral Resources of the United States, 69 separates from 4 annual volumes of Mineral Resources, 2 new geologic folios, 69 new maps, a list of United States Geological Survey publications, 3 texts for topographic maps, an advance statement on zinc in 1919, 19 index-map circulars, a list of geographic folios available, 36 press bulletins, and 12 monthly lists of new publications. The total number of pages in these publications was 17,507. Brief notices of the publications in the regular series and of the new maps issued during the year are given below.

FORTIETH ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1919. 1919. 198 pages, 2 plates, 1 text figure.

A detailed account of the work of the Geological Survey during the fiscal year 1919, including reports from each branch, division, and section, abstracts of the publications of the year, and maps showing areas covered by published geologic and topographic maps. The Director outlines the readjustment of the Survey's activities in beginning a return to the regular program of scientific work, after the signing of the armistice, and emphasizes the spirit of full service displayed so universally by the members of the Survey during the war. Copies of two additional citations for the French Croix de Guerre are given. The inadequacy of Government compensation as shown by the large "turnover" in the Survey—19 per cent in each of the last two years—is illustrated graphically by a diagram showing the discrepancy between average salaries received by Survey geologists and average salaries offered by outside employers. The loss of efficiency resulting from a recent retrenchment measure, whereby the space allotted to the Survey's force has been reduced to 75 square feet each for scientist and clerk alike, is clearly set forth. A program for completing an adequate map of the whole territory of the United States by 1932 is outlined, and an indorsement of such a program by a conference of the engineering profession is quoted. The preparation of a world atlas of commercial geology, begun during the war for the benefit of the war boards, is to be continued, and the atlas will be published in parts for the information of the general public, which needs to know not only our own mineral resources but those of other countries. The report records the death of Dr. George F. Becker, the last member of the group of distinguished geologists who were associated in the organization of the United States Geological Survey in 1879. In the 40 years since that date the annual appropriations for the Survey have increased from $106,000 to $1,437,745 and the personnel from 39 to 967.

PROFESSIONAL PAPER 111. The ore deposits of Utah, by B. S. Butler, G. F. Loughlin, V. C. Heikes, and others. 1920. 669 pages, 57 plates, 74 text figures, 1 insert.

About 12 years ago the Geological Survey planned the preparation of a series of volumes in each of which should be described the geology and ore

deposits of a single State. The plan was to summarize and bring up to date the detailed work that had been done on individual districts, to make reconnaissance examinations of other districts, and to extend knowledge of the general geology of the State sufficiently to provide an adequate setting for the descriptions of the mining districts. The first volume of this series, Professional Paper 68, on New Mexico, appeared in 1910; the second volume is Professional Paper 111, just issued. Utah far surpasses New Mexico in the development and output of its mines and the mineralogic variety of its ores, and it contains a large number of minor districts concerning which little geologic information has hitherto been available. For these reasons the present volume is necessarily rather bulky, but it constitutes a valuable reference work containing much information that can not be found elsewhere. An interesting result which has come from the general survey of all the known ore deposits of the State is the generalization by Mr. Butler that the occurrence of ore bodies around an intrusive rock, within depths accessible to mining, depends upon the vertical distance between the present erosion surface and the original top or apex of the igneous mass. The production of metals on a commercial scale in Utah began in 1865; 50 years later the annual output of metallic ore had reached 10,000,000 tons, valued at $55,000,000, and in 1917 it was 15,000,000 tons, valued at $99,000,000. The paper contains an extensive bibliography and is elaborately illustrated. A brief appendix describes and figures some Carboniferous and Triassic fossils that occur in Utah, with the purpose of aiding the geologist to discriminate and identify the rock groups that he is called upon to investigate.

PROFESSIONAL PAPER 112. Upper Cretaceous floras of the eastern Gulf region in Tennessee, Mississippi, Alabama, and Georgia, by E. W. Berry. 1919. 177 pages, 33 plates, 12 text figures.

The area of outcrop of the Upper Cretaceous deposits in the eastern Gulf region borders the inland margin of the Coastal Plain, and the belt from which determinable plant fossils have been collected extends from west-central Tennessee southward and eastward to west-central Georgia. Most of the plants come from the basal formation of the Upper Cretaceous series—the Tuscaloosa formation. As the geologic work of the author of this paper and his associates in this area was of a reconnaissance nature only, the paper is regarded simply as a preliminary report, though it fully describes the extensive collections that have so far been obtained. The Tuscaloosa formation contains abundant deposits of workable clays, and the economic development of these clays will probably lead to the discovery of additional representatives of the flora. The collections described comprise nearly 200 species from 23 localities. The paper is illustrated with geologic sections at the plant localities and views of the plant-bearing beds in addition to the plates showing the fossils.

PROFESSIONAL PAPER 113. Iron-depositing bacteria and their geologic relations, by E. C. Harder. 1919. 89 pages, 12 plates, 14 text figures.

The investigations of Pasteur disclosed the deadly power of bacteria in disease and their great efficiency in processes of fermentation and decay. Realization of the influence of bacteria in affecting the character and fertility of soils, in bringing about rock decay, and in producing other geologic results has come more slowly. As early as 1836, however, it was found that certain bacteria have the power of withdrawing iron from solution and causing its precipitation as ferric hydroxide. Since that time these organisms have been studied by many investigators, but they have ap-

proached the subject with the biologist's point of view and have given only minor consideration to its geologic significance. Mr. Harder has for a number of years been engaged in a study of iron ores in different parts of the world and has paid special attention to the origin of the deposits. In an investigation of the Cuyuna iron range of Minnesota he found an opportunity in the laboratories of the University of Wisconsin to study the iron-depositing bacteria, and this paper presents the results of that research. Mr. Harder found that in addition to the iron-depositing bacteria proper probably many of the common bacteria of soil and water are active in the precipitation of iron compounds. This result is believed to be new. The report contains a valuable critical summary of previous work on this subject and should serve a useful purpose in bringing before geologists a digest of practically all that is known of it, supplemented by a carefully prepared bibliography. The book is well illustrated with photomicrographs and other views of the bacteria.

PROFESSIONAL PAPER 115. The copper deposits of Ray and Miami, Ariz., by F. L. Ransome, 1919. 188 pages, 54 plates, 29 text figures.

The Ray and Miami districts, in central Arizona, have yielded over a billion pounds of copper since 1907, when the low-grade ores of these districts were first successfully exploited on a large scale, and the three principal mining companies have declared dividends amounting to $68,000,000. The copper ores are due to the intrusion, probably in Tertiary time, of great masses of granite and allied rocks, some of which are several miles in diameter, followed by downward enrichment. The ore-depositing solutions that accompanied the intrusive granitic material penetrated the rocks through a multitude of small irregular fissures, which were doubtless a consequence of the intrusion and solidification of the granite. The deposits thus formed were later enriched by the agency of downward-percolating atmospheric water. The author concludes that the greater part of the enrichment was effected before the eruption of the dacite of the region, which he assigns to late Tertiary time, and thus, of course, before the deposition of the still later Gila conglomerate. This conclusion suggests the possibility that other ore deposits may yet be discovered beneath certain areas of the conglomerate. Estimates based on drilling and mining place the total ore originally present in the two districts at 260,000,000 tons. The copper tenor of the ore mined averages between 1.5 and 2 per cent. This paper is a characteristic example of the Survey's detailed reports on individual mining districts. It gives a sketch of the physical geography of the region, an elaborate description of the geology in general and in detail for each district, a concise account of mines and mining methods, and full discussions of the mineralogy, geologic relations, and origin of the ore deposits. The report is well illustrated with geologic maps, sections, mine plans, and views, and contains a glossary of the more technical terms used.

PROFESSIONAL PAPER 116. The Sunset-Midway oil field, Calif., Part I, Geology and oil resources, by R. W. Pack. 1920. 175 pages, 45 plates, 15 text figures.

Although the petroleum deposits of the United States are wonderfully rich and a vast quantity of oil remains to be taken from them, they are by no means inexhaustible, and if the next generation is not to feel the pinch of the dwindling supply it is essential that the present generation so utilize these deposits as to permit the least possible waste. The search for new oil pools is now occupying the full attention of most of the petroleum geologists of the country and will become increasingly keen as the demand for oil

increases, but the geologist will in the future render his chief service to the petroleum industry through intensive studies of the productive fields, made for the purpose of aiding in the efficient extraction of the oil. The proper interpretation of the well records and the correlation of these data with the areal geology depend upon the geologist, and his work should afford the comprehensive picture of the underground conditions that is so essential to the petroleum operator. During the last 18 years the United States Geological Survey has been investigating the petroleum resources of California and has examined both productive and prospective fields. The results of much of this work have been set forth in published reports, some preliminary and others more detailed. The report on the Sunset-Midway field now published consists of two parts, of which the second (Professional Paper 117) is noticed below. The present paper constitutes the first part of the report. It describes the geology of the general region of which the productive areas form a small part, and into this setting are fitted the details of the geology of the productive areas as derived chiefly from a study of the well records. The interpretation of the geologic conditions is not presented as a completed picture, accurate in all details, but as a framework into which may be set other data that become available from time to time, and it should thus serve in the guidance of future work. The Sunset-Midway field is in the western part of Kern County, about 40 miles southwest of Bakersfield. Its active development began in 1900, and it has produced over 2,850,000,000 barrels of oil. This report gives a large amount of detail and is profusely illustrated with maps, sections, and views.

PROFESSIONAL PAPER 117. The Sunset-Midway oil field, California, Part II, Geochemical relations of the oil, gas, and water, by G. S. Rogers. 1919. 100 pages, 2 plates, 8 text figures.

Contains analyses of the oil and gas and the oil-field waters at the Sunset-Midway field and a discussion of their composition in relation to their geologic occurrence, some figures on the geothermal gradient, and a brief study of the invasion of the oil sands by water. California petroleum differs in many important respects from the varieties produced in other parts of the United States and has been much studied by chemists. This paper gives a large amount of information bearing on the geochemical character of the oil and its relations to the accompanying gas and water. The author also discusses the probable changes that the oil and gas have undergone in the course of their migration. The paper contains two maps and several diagrams.

PROFESSIONAL PAPER 118. Some American Jurassic ammonites of the genera *Quenstedticeras*, *Cardioceras*, and *Amoeboceras*, family Cardioceratidae, by J. B. Reeside, jr. 62 pages, 24 plates, 1 text figure.

Describes and figures 33 species and 2 varieties of Jurassic ammonites. Of these forms 30 have not been previously described. The new species were obtained mainly from the Sundance formation of Wyoming, but the interpretation of the data furnished by the study of these fossils has been hindered somewhat because the exact stratigraphic location of much of the material is unknown. However, a knowledge of the general relationship of these forms to those of other areas, as here set forth, is in itself of value to the stratigrapher and systematist.

PROFESSIONAL PAPER 119. Reptilian faunas of the Torrejon, Puerco, and underlying Upper Cretaceous formations of San Juan County, N. Mex., by C. W. Gilmore. 70 pages, 26 plates, 33 text figures.

The collection of vertebrate fossils described in this paper is especially rich in turtle remains, which in the large number of specimens and the excellent state of their preservation constitute the best single collection of fossil turtles that has ever been made in the southwestern United States. The recovery of nearly perfect individuals of several genera hitherto known only from very fragmentary materials forms a distinct contribution to our knowledge of the skeletal anatomy of these extinct turtles, and the acquisition of good specimens representing species of the same genera from successive geologic formations affords data for study of the structural changes that may have taken place in a genus over considerable periods of time. The paper describes 29 species of turtles, of which 16 are new; also a number of fragmentary dinosaur remains.

PROFESSIONAL PAPER 120. Shorter contributions to general geology, 1918; David White, chief geologist. 1919. 208 pages, 30 plates, 19 text figures.

Contains nine papers by ten authors. These papers had previously been published separately and were noticed in the Thirty-ninth and Fortieth annual reports.

PROFESSIONAL PAPER 125–A. An Eocene flora from trans-Pecos Texas, by E. W. Berry. 1919. Pp. 1–9, Pls. I–III, figs. 1–2.

Describes a small collection of fossil plants obtained in the Barilla Mountains, about 15 miles south of Toyahvale, near the line between Reeves and Jeff Davis counties, Tex. Although the collection contains only a few species it has enabled the author to assign a definite age to the beginning of igneous activity in this region and to establish correlations between the floras of the Mississippi embayment and the Rocky Mountains.

PROFESSIONAL PAPER 125–B. Gradations from continental to marine conditions of deposition in central Montana during the Eagle and Judith River epochs, by C. F. Bowen. 1919. Pp. 11–21, Pl. IV.

An area of about 1,200 square miles in Rosebud and Dawson counties, Mont., heretofore geologically unexplored, was recently studied and mapped by Mr. Bowen and found to be of considerable geologic interest. Changes in the character of sediments from sandstone to shale and from fresh-water to marine deposits imply corresponding changes in physiographic conditions during their accumulation and therefore furnish a basis for the interpretation of the past history of the region in which they are found. Such changes occurred in north-central Montana during the Upper Cretaceous epoch. Mr. Bowen's studies have shown that, although eastern Montana remained beneath the sea throughout most of Upper Cretaceous time, in the central part of the State, at least as far west as the front of the Rocky Mountains, there were oscillations of land and sea level produced either by rhythmic gentle depressions of the sea floor or by uplifts of the land mass to the west. These changes are recorded in the rocks of the region.

PROFESSIONAL PAPER 125–C. Pliocene and Pleistocene fossils from the Arctic coast of Alaska and the auriferous beaches of Nome, Norton Sound, Alaska, by W. H. Dall. 1920. Pp. 23–37, Pls. V–VI.

Discusses the geology of the fossiliferous Pliocene and Pleistocene deposits of the Arctic coast and the Nome region and describes 20 or more new species. Outlines the bearing of the geologic data on the theories relating to the immigration of Asiatic land animals into America.

BULLETIN 666. Our mineral supplies; H. D. McCaskey and E. F. Burchard, geologists in charge. 1919. 266 pages, 1 plate, 6 text figures.

In September, 1914, soon after the beginning of the war in Europe, the Director of the United States Geological Survey summarized the mineral

reserves of this country and offered certain suggestions as to making America industrially independent. At that time it was clearly recognized that the United States would soon face unusual conditions resulting from the depletion or exhaustion of our stocks of imported minerals. As the war progressed and ocean commerce became more unsettled, the difficulty of obtaining supplies of certain minerals increased, and the Geological Survey was called upon for an ever-increasing amount of information and advice concerning these minerals, and also concerning the commercial situation with respect to other more plentiful minerals and their derivatives. In order to meet this demand with published information the series of papers now assembled in a single volume was prepared by the members of the Survey staff who were most familiar with the minerals required. The first of these papers was issued April 13, 1917, one week after the United States entered the war, and all but two of the chapters were available in 1917. The complete volume contains an introduction, a bibliography, and 32 papers on mineral supplies. The introduction, which has not been issued separately, includes tables showing domestic mineral supplies in three classes—(1) adequate to all probable peace and war needs; (2) sufficient for a large part of peace and war needs; and (3) chiefly inadequate in quantity or quality or both for peace and war needs.

BULLETIN 678. Clays and shales of Minnesota, by F. F. Grout, with contributions by E. K. Soper. 1919. 256 pages, 16 plates, 38 text figures.

A discussion of the distribution, origin, properties, classification, and adaptability of the clays and shales of Minnesota. The general object of the work has been to assist in the development of the clay resources of the State. The investigation covered the brick supply for every town of 1,000 or more inhabitants and for every county in the State and included surveys of deposits that are now developed at only a few places, a search for new deposits, and a determination of the qualities of these deposits and of certain mixtures so as to ascertain their suitability for refractory wares, pottery, paving brick, and other high-grade products. The detailed results of the tests are arranged by counties, so that anyone interested in the resources of a particular locality can easily find the data referring to them. The investigation was made in cooperation with the Minnesota Geological Survey and is an excellent example of cooperative geologic work of great practical utility. The report contains a section on the technology of clay, with explanations of technical terms and recommendation of processes for experiments. It also recommends certain areas for prospecting and development and makes suggestions as to the possibility of utilizing some of the clays for products of higher grade and consequently greater value than common brick. It shows that the Minnesota products are not inferior to those now brought into the State in large quantities from Wisconsin, Iowa, and Illinois at unnecessarily high prices. The broader problems of ceramics are treated only incidentally, but some of the important scientific conclusions of the American Ceramic Society, the Bureau of Standards, and other State surveys are briefly reviewed. A more extended discussion of the scientific results of the investigation is to be published later. The book is well illustrated with halftone views, diagrams, sketches, maps, and geologic sections.

BULLETIN 686. Structure and oil and gas resources of the Osage Reservation, Oklahoma. Advance chapters as follows:

686–S. T. 24 N., Rs. 11 and 12 E., by O. B. Hopkins and Sidney Powers. 1919. Pp. 237–253, Pls. XXXVII–XL, fig. 1s.

686–T. T. 27 N., R. 11 E., by H. M. Robinson and R. V. A. Mills. 1919. Pp. 255–277, Pls. XLI–XLII, figs. 41–43.

686–U. Tps. 21–23 N., Rs. 6–7 E., and Tps. 23–25 N., Rs. 3–5 E., by C. F. Bowen, P. V. Roundy, C. S. Ross, and Frank Reeves. 1919. Pp. 279–301, Pls. XLIII–XLV, fig. 1u.

686–V. T. 27 N., R. 10 E., by H. M. Robinson and R. V. A. Mills. 1919. Pp. 303–327, Pls. XLVI–XLVIII, figs. 44–45.

Four additional pamphlets in the series on the Osage Reservation. Each one contains a map showing the geologic structure of the area discussed.

BULLETIN 691. Contributions to economic geology (short papers and preliminary reports) 1918, Part II, Mineral fuels; David White, G. H. Ashley, and M. R. Campbell, geologists in charge. 1919. 361 pages, 44 plates, and 45 text figures.

Contains 14 papers by 13 authors. These papers had previously been published separately and were noticed in the Thirty-ninth and Fortieth annual reports.

BULLETIN 692–B. Water-power investigations and mining developments in southeastern Alaska, papers by G. H. Canfield, Theodore Chapin, and R. M. Overbeck. 1919. Pp. 43–136, Pls. I–II.

BULLETIN 692–D. Mining and mineral deposits in the Cook Inlet-Susitna region, Alaska, papers by S. R. Capps, J. B. Mertie, jr., and G. C. Martin. 1919. Pp. 177–282, Pls. IV–VI, figs. 3–6.

BULLETIN 692–E. Sulphur deposits and beach placers of southwestern Alaska, by A. G. Maddren. 1919. Pp. 283–319, Pls. VII–VIII, figs. 7–12.

BULLETIN 692–F. Mining in the Fairbanks, Ruby, Hot Springs, and Tolstoi districts, Alaska, papers by Theodore Chapin and G. L. Harrington. 1919. Pp. 321–351, Pl. IX, fig. 13.

BULLETIN 692–G. Mineral resources of Seward Peninsula, Alaska, by G. L. Harrington. 1919. Pp. 353–400, Pl. X.

Five chapters of the annual progress report on investigations in Alaska for 1917, including a number of short papers on the areas indicated in the titles.

BULLETIN 692. Mineral resources of Alaska; report on progress of investigations in 1917, by G. C. Martin and others. 1919. 420 pages, 10 plates, 13 text figures.

The fourteenth of a series of annual bulletins treating of the mining industry of Alaska and summarizing the results achieved during the year 1917 in the investigation of the mineral resources of the Territory. Contains statistics of mineral production, notes on the progress of the mining industry, and preliminary reports on investigations made by the Geological Survey. Includes 25 papers by 9 authors, also a list of recent Survey publications on Alaska. These papers, grouped according to regions covered, were published in 7 separate chapters in 1918 and 1919.

BULLETIN 694. Bibliography of the metals of the platinum group—osmium, platinum, palladium, iridium, rhodium, ruthenium—1748–1917, by James Lewis Howe and H. C. Holtz. 1919. 555 pages.

The first edition of this bibliography, by Dr. Howe, was published in 1897 as a volume of the Smithsonian Miscellaneous Collections and gave a list of the articles on the metals of the platinum group found in scientific literature to the end of 1896. A supplement to this edition, prepared by Dr. H. C. Holtz, of Amsterdam, brought the record down to 1910 but was never published. Dr. Howe received from a Paris friend the manuscript of this supplement and has filled its gaps and brought the record down to the

end of 1917. It was his aim to make the record of the chemistry of these metals as complete as possible, but several other divisions of the subject have not been followed beyond the earlier references. The book is printed in large, easily readable type and contains an author index and a subject index.

BULLETIN 695. The data of geochemistry (fourth edition), by F. W. Clarke. 1920. 829 pages.

Most of the rocks that form the crust of the earth consist of aggregates of mineral species, which in turn are in the main compounds of two or more chemical elements. The reactions that took place during the formation of the rocks were strivings toward chemical equilibrium, and the final result was a maximum of stability under existing conditions. All rocks are subject to the action of various agencies which bring about chemical changes. Every such change implies a disturbance of equilibrium and eventually a reestablishment of the maximum possible stability under the new conditions. The study of these changes is the province of geochemistry. To determine what changes are possible and how and when they occur, to observe the phenomena that attend them, and to note their final results are the functions of the geochemist. The literature on geochemistry is vast, but widely scattered and in part difficult of access. To bring some of the data together, to formulate a few of the problems, and to present certain general conclusions in their modern form are the purposes of this memoir. The present volume is the fourth edition of this work, of which the first edition was published in 1908. The text has been revised and enlarged for this edition. The book has an exceptionally complete index and is of great value to all students of geology and chemistry.

BULLETIN 696. A catalogue of the Mesozoic and Cenozoic plants of North America, by F. H. Knowlton. 1919. 815 pages.

An expansion of the author's "Catalogue of the Cretaceous and Tertiary plants of North America," published in 1898. In the 20 years since that bulletin was issued there has been great activity in North American paleobotany and the number of described species has been nearly doubled. The scope of the catalogue has been extended to include the whole of the Mesozoic as well as the Cenozoic plants, but it does not cover Greenland and Mexico. For each genus, each American form that is known only in a fossil state, and each Old World form that is recognized in North American strata, the original date and place of publication are given, followed by all or the most important references. For each living species that has also been found in a fossil state only the authority is given, followed by references to the fossil occurrences. The synonymy is placed under the species to which it belongs, but each synonym is also entered in its alphabetic place, with a cross reference. Besides the catalogue, which covers 618 pages, the book contains a correlation table showing the approximate position of the plant-bearing beds, a biologic classification of the genera, with index, and separate alphabetic lists of the genera and species occurring in each formational unit.

BULLETIN 698. Bibliography of North American geology for 1918, with subject index, by J. M. Nickles. 1919. 145 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 1918. The book is indexed and contains lists of chemical analyses reported and of minerals, rocks, and geologic formations described.

BULLETIN 699. The Porcupine gold-placer district, Alaska, by H. M. Eakin. 1919. 28 pages, 8 plates.

The Porcupine gold-placer district lies in the headwater region of Chilkat River, near the British Columbia boundary, about 100 miles northwest of Juneau, or 25 miles west of Skagway. Productive mining began here in 1899 and continued so successfully that the district has ranged as one of the most important placer fields in Alaska. This district was visited by Geological Survey parties in 1899, 1903, and 1916, and the present bulletin gives a summary of the knowledge thus obtained. It includes a geologic map and several views of the district. The total output to the end of 1916 is estimated at $1,200,000.

BULLETIN 700. The analysis of silicate and carbonate rocks, by W. F. Hillebrand. 1919. 283 pages.

The fourth edition of Dr. Hillebrand's treatise on rock analysis, previous editions of which were published as Bulletins 176, 305, and 422. In the nine years since the appearance of Bulletin 422 many new methods and modifications of methods of rock analysis have been published, and such of these as are certainly or probably valuable are described in the present edition. The earlier text has also been extensively revised, and this bulletin shows many changes and additions, with some omissions. This book is a standard manual of rock analysis and has been translated and republished abroad.

BULLETIN 701. Geothermal data of the United States, including many original determinations of underground temperature, by N. H. Darton. 1920. 97 pages, 1 plate, 3 text figures.

Presents all available published data bearing on the rate of increase of underground temperature with increasing depth in the United States, together with several hundred original observations by the writer and his associates. The principal feature brought out by these data is the fact that the geothermal gradient varies widely from place to place, though probably subject to certain regional relations. A few similar compilations have been previously published, with attempts to show the relation of temperature increases to many underground factors, such as variation in conductivity of rocks, volcanic influences, and movement of underground water, but extended special investigations must be made before the weight of such factors can be adequately determined. This bulletin records observations made in 39 States. The deepest observation, at a depth of 7,310 feet in the Goff well, near Clarksburg, W. Va., showed an increase of 1° in about 70 feet.

BULLETIN 705. Conservation through engineering, by F. K. Lane. 1920. 38 pages.

The annual report of the Secretary of the Interior to the President contained a plea for constructive policies that deserves a hearing also by the engineers and business men who are developing the power resources of the country. The largest conservation for the future can come only through the wisest engineering of the present. The conditions under which the utilization of natural resources is demanded are outlined by Secretary Lane, who recommends a program that calls for the cooperation of engineer and legislator. To bring this power inventory to the attention of the men who furnish the country with its coal and oil and electricity, this extract from the Secretary's administrative report is reprinted as a bulletin of the United States Geological Survey.

BULLETIN 709–A. Triangulation and primary traverse in Delaware, Maryland, and West Virginia, 1916–1918, including results of leveling in Gunpowder quadrangle, Maryland, in 1918; R. B. Marshall, chief geographer. 1919. Pp. 1–22, Pls. I–II.

BULLETIN 709–B. Primary traverse in Florida, 1917; R. B. Marshall, chief geographer. 1919. Pp. 23–41, Pl. II.

Two chapters of a new bulletin giving results of triangulation and primary traverse during the years 1916 to 1918. This bulletin follows Bulletin 644, which contained results of similar work done in 1913 to 1915. Chapter A contains a map of the United States showing condition of astronomic location and primary control to January 1, 1919.

BULLETIN 710–A. A reconnaissance of the Pine Creek district, Idaho, by E. L. Jones, jr. 1919. Pp. 1–36, Pl. I.

The Pine Creek district, which lies west and south of the Coeur d'Alene region, had until recently been only slightly developed, but under the stimulus of high metal prices discoveries have been made and several old prospects whose ores could formerly not be profitably marketed have become productive. This report sets forth the geology of the district and describes the mines and prospects. The ores contain zinc, lead, and antimony. The total production of the district is not known, but ore to the value of several hundred thousand dollars was shipped in 1916.

BULLETIN 710–B. Deposits of manganese ore in New Mexico, by E. L. Jones, jr. 1919. Pp. 37–60, fig. 1.

The high prices for manganese ore that prevailed in 1917 and the summer of 1918 and the necessity for the production of domestic ores brought about by the curtailment of imports led to the search for and discovery of many deposits in some of the Western States. Most of the deposits in New Mexico were examined by the Survey, and the available information concerning them is here set forth. The total production in New Mexico of ores containing 35 per cent or more of manganese to December 31, 1918, was about 5,600 tons. Most of the deposits are small, the cost of mining and transportation is high, and at pre-war prices probably none of the deposits can be worked at a profit.

BULLETIN 710–C. Deposits of manganese ore in Costa Rica and Panama, papers by J. D. Sears. 1919. Pp. 61–91, Pl. II, figs. 2–29.

Throughout the war the Geological Survey made special field examinations and laboratory studies of deposits of ores of metals used in the manufacture of ferroalloys, pig iron, and steel and made estimates of tonnage for the war boards that were interested in the question of what supplies were available as substitutes for foreign ores. This paper gives the results of the examination of manganese deposits in Costa Rica and Panama. In Costa Rica the deposits are widespread, but most of them are either of low grade or of small extent. In October, 1918, ore was being produced at only three of the deposits. Labor is cheap, and deposits of any reasonable size could be developed at moderate expense, but only one other group of prospects seems to be promising. The two deposits in Panama described are northeast of the Canal Zone and contain 25,000 to 30,000 tons of manganese ore. An assay of the ore from one deposit showed 55 per cent of manganese.

BULLETIN 710–D. Deposits of manganese ore in Arizona, by E. L. Jones, jr., and F. L. Ransome. 1920. Pp. 93–184, Pls. III–VIII, figs. 36–37.

Deposits of manganese ore have long been known in some of the old mining districts of Arizona, but prior to 1915 the ore had been mined only incidentally where it formed the gangue of silver ores or was needed as a flux

for use in local smelters. Manganese ore as such was first shipped from the Tombstone district in 1915 and from the Globe and Bisbee districts in 1916. The high prices that were offered for manganese ore in 1916, 1917, and 1918 and the fact that the opening of new deposits would render patriotic service greatly stimulated the production of the ore and the search for new deposits. This paper sets forth the results of investigations made by two geologists of the Geological Survey who visited many deposits in different parts of the State. The deposits examined, about 75 in number, are scattered across the State from east to west but are all south of the Santa Fe Railway. Some of them are near a railroad, but most of them are more than 15 miles distant. The paper contains maps, sections, and views.

BULLETIN 710–E. Deposits of manganese ore in southeastern California, by E. L. Jones, jr. 1919. Pp. 185–208, Pl. IX.

Describes the manganese deposits in the desert region west of Colorado River, which in 1917 and 1918 yielded over 6,000 tons of high-grade ore and in which at least 30,000 tons is available. The costs of mining, transportation to the railroads, and shipment to furnaces east of Mississippi River are high, and when high-grade foreign ores are available these deposits can probably not be worked at a profit unless a nearer market can be found.

BULLETIN 710–F. Deposits of manganese ore in Nevada, by J. T. Pardee and E. L. Jones, jr. 1919. Pp. 209–248, Pl. X, figs. 38–39.

One of the reports on the Geological Survey's special investigations of manganese deposits that were made as a result of the war demand. During the war Nevada contributed about 25,000 tons of manganese ore, or 2 per cent of the total amount needed by the country. In December, 1918, production practically ceased. The deposits described in this paper are widely distributed over the State and are of several classes. The paper contains an index map showing their location and a plan and cross section of one of the deposits discovered during the war.

The pamphlet contains an index, title page, and table of contents for the use of those who may wish to bind the separate chapters of Bulletin 710.

BULLETIN 711–A. The Farnham anticline, Carbon County, Utah, by F. R. Clark. 1919. Pp. 1–13, Pls. I–II, fig. 1.

Describes a small upfold about 10 miles southeast of Price, Utah, on the automobile highway known as the Midland Trail. This anticline is structurally favorable for the accumulation of oil and gas, and the author concludes that the geologic conditions appear to warrant one or more test holes, locations for which are suggested.

BULLETIN 711–B. Oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah, by D. D. Condit. 1919. Pp. 15–40, Pl. III, figs. 2–3.

Sets forth the results of a further investigation of the oil shales in the area near Dillon and Dell, in southwestern Montana, which were described briefly in Bulletin 661–I. The examination covered also the beds of the oil-shale formation in neighboring parts of Idaho, Wyoming, and Utah. The best beds in the Dillon-Dell area were found to yield 25 to 30 gallons of oil to the ton. No other promising localities were discovered.

BULLETIN 711–C. Peat in the Dismal Swamp, Virginia and North Carolina, by C. C. Osbon. 1919. Pp. 41–59, Pls. IV–VI.

The Dismal Swamp occupies a poorly drained depression lying between the ancient delta of James River, which forms the plain east and southeast of Norfolk, and the highlands on the west. In this depression peat has been accumulating since the Columbia epoch of Pleistocene time. In the earlier

stages of peat formation the swamp vegetation was mainly algae and mosses, which formed fine-grained peat, but as the water became shallower coarser plants established themselves, and it is believed that deciduous and coniferous trees have contributed the greater part of the dead vegetation from which the peat deposits of the region were formed. This paper gives an outline of the interesting story of the origin of peat, describes the deposits in the Dismal Swamp region, and discusses the uses of peat and methods of utilizing the deposits and marketing the product. It is illustrated by a map and halftone views.

BULLETIN 711–D. Oil in the Warm Springs and Hamilton domes, near Thermopolis, Wyo., by A. J. Collier. 1920. Pp. 61–73, Pls. VII–X, fig. 4.

Wildcat wells drilled near Thermopolis, Wyo., within the last two years have demonstrated that the Warm Springs and Hamilton domes, previously regarded as barren, contain oil in commercial quantities. The product of the Warm Springs domes is a heavy, dark oil, derived from beds of the same age as that of the Lander field, and the output is estimated at 800 to 1,000 barrels a day. The product of the Hamilton dome is a lighter oil derived from younger beds—the Chugwater formation, which has not heretofore yielded oil in commercial quantities. This paper describes the geology of the domes and contains maps and sections showing the structure.

BULLETIN 711–E. Gas in the Big Sand Draw anticline, Fremont County, Wyo., by A. J. Collier. 1920. Pp. 75–83, Pl. XI, figs. 4–5.

The Big Sand Draw anticline was tested in 1917–18 by a well that brought in a flow of about 7,000,000 cubic feet of gas a day. As it seemed possible that this anticline might contain a large quantity of oil, the Geological Survey made a careful examination of it to see if light could be thrown on some of the obscure points regarding its structure. This paper sets forth the results of the examination and gives a map and a hypothetical cross section based on the data obtained. A second well yielded 10,000,000 to 12,000,000 cubic feet of gas a day, and other tests are being made to determine whether oil may be found at greater depth or in a lower structural position.

BULLETIN 711–F. The Abram Creek-Stony River coal field, northeastern West Virginia, by G. H. Ashley. 1920. Pp. 85–103, Pls. XII–XIII.

The Abram-Creek Stony River coal field is a southward continuation of the Georges Creek and Elk Garden fields of Maryland and West Virginia. It contains a large body of low-volatile semibituminous coal and is nearer tidewater than any other Appalachian field except the Georges Creek and Upper Potomac. The coal is at present entirely undeveloped, and the area is without railroads, but it would require only a few miles of branch roads to reach lines running to Baltimore or Newport News. Interest had been aroused in this area because of the approaching exhaustion of the neighboring districts, and this report, which is based on two reconnaissance trips in the spring of 1918, was prepared to meet the need of information that is expected to arise. The report contains a new topographic map of the field, numerous graphic sections of the coal, analyses, and detailed descriptions of the different beds. The estimated recoverable coal in this field amounts to 422,000,000 tons.

BULLETIN 711–G. Geology and oil and gas prospects of the Huntley field, Montana, by E. T. Hancock. 1920. Pp. 105–148, Pls. XIV–XVIII, figs. 6–7.

The geology of the general region including the Huntley field, in Yellowstone and Big Horn counties, south-central Montana, has been studied at different times since 1882. The investigation whose results are set forth in this paper was undertaken primarily to make a detailed study of the

stratigraphy and structure in order to locate such structural features as have elsewhere been found to bear a definite relation to accumulations of oil and gas. The paper discusses the geology in detail and is illustrated by a geologic map, a plate of columnar sections, and several halftone views. There are in this area few surface indications of oil and gas, and logs of wells near the area do not indicate the presence of sands at all comparable with those of some of the productive fields of Wyoming. Some of the domes in the Lake Basin field, of which the Huntley field is an extension, are better adapted for the accumulation of oil and gas than any of the structural features in this field, and yet they seem to have yielded only showings of gas.

BULLETIN 711–H. Anticlines near Maverick Springs, Fremont County, Wyo., by A. J. Collier. 1920. Pp. 149–171, Pls. XIX–XXI, fig. 4.

Owing to the great demand for petroleum and its products and the success of oil wells in many parts of Wyoming, every locality in the State which is known to be at all favorable for the accumulation of petroleum is being tested with the drill, and vigorous search is being made for new localities. A well drilled in 1917–18 near Maverick Springs, Fremont County, brought in a flow of dark oil, and several other successful wells have since been drilled in the same vicinity. Development has not proceeded far enough to justify a prediction of the ultimate output of the field. It is 42 miles from the nearest railroad point, and if oil is discovered here in quantity a pipe line must be laid to that point before the field can be thoroughly developed. This paper describes the geologic features of the field and contains a topographic map and cross sections showing the structure.

This pamphlet contains an index, title-page, table of contents, and introduction for the use of those who may wish to bind the separate parts of Bulletin 711.

BULLETIN 712–A. The Alaskan mining industry in 1918, by G. C. Martin. 1919. Pp. 1–52.

BULLETIN 712–B. Water-power investigations in southeastern Alaska, by G. H. Canfield. 1919. Pp. 53–90.

BULLETIN 712–C. Nickel deposits in the lower Copper River valley, Alaska, by R. M. Overbeck. Pp. 91–98, fig. 1.

BULLETIN 712–D. Preliminary report on the chromite of Kenai Peninsula, Alaska, by A. C. Gill. 1919. Pp. 99–129, Pls. I–III.

BULLETIN 712–E. Mining in the Matanuska coal field and the Willow Creek district, Alaska, by Theodore Chapin. 1920. Pp. 131–176, Pls. IV–VI, figs. 2–5.

BULLETIN 712–F. Placer mining in the Tolovana district, Alaska, by R. M. Overbeck. 1920. Pp. 177–184.

BULLETIN 712–G. Mining in northwestern Alaska, by S. H. Cathcart. 1920. Pp. 185–198, figs. 6–10.

Chapters of the annual report on investigations of the mineral resources of Alaska for 1918. Contain several papers on the areas or subjects named in the titles.

BULLETIN 715–A. Potash deposits in Spain, by H. S. Gale. 1920. Pp. 1–15, Pls. I–III, figs. 1–3.

Potash was discovered accidentally in the salt deposits of the Province of Barcelona, in the northeast corner of Spain, in 1912, though the salt deposits themselves had been known for a hundred years. The potash field is about 75 miles long, and the claims or concessions form a practically continuous belt with a maximum width of 18 miles. A main-line railway

skirts the southern border of the field. This paper is based on a brief visit to the field in 1919 and sets forth the available information regarding it, with views and a sketch map. Mr. Gale concludes that the prospects of producing enough potash to meet Spanish needs seem promising, but that it is too soon to estimate the future position of this field in the world production of potash.

BULLETIN 715–B. The potash deposits of Alsace, by H. S. Gale. 1920. Pp. 17–55, Pls. IV–V, figs. 4–5.

Potash was discovered in Alsace in 1904, and the field, though less extensive than the famous Stassfurt region of Germany, was very soon recognized as having several advantages over the older field. The Alsatian deposits occur in regular beds underlying a large area, and the salts are very rich in potash and require only the simplest chemical treatment to yield a marketable product. The return of Alsace to France has broken the German monopoly of potash and stimulated interest in the Alsatian field. Mr. Gale visited the field in 1919 and presents in this paper the results of his own observations, together with a summary of previous reports on the field and an annotated bibliography. The field lies in the Rhine Valley, directly on the routes of main-line water and rail transportation. In 1913 it yielded 350,000 tons of crude salts. The paper contains some views of the mining plants and a section of one of the potash beds.

BULLETIN 716–A. Geology of Alamosa Creek valley, Socorro County, N. Mex., by D. E. Winchester. 1920. 18 pages, 5 plates.

During a detailed study of the coal resources of an area in Socorro County, N. Mex., considerable information relative to the stratigraphy and structure of the region was collected. Owing to the present interest in the oil and gas possibilities of New Mexico the observations made have been recorded in this paper as a guide in the search for petroleum and natural gas. The area described covers about 600 square miles and forms the southeastern part of the great San Juan Basin of New Mexico and Colorado. It contains no surface indications of oil and gas, so far as known, but the geologic conditions appear not to preclude their occurrence, and the author suggests certain localities where tests might be made. The paper contains a geologic map and several views.

BULLETIN 716–B. The Upton-Thornton oil field, Wyo., by E. T. Hancock. 1920. 20 pages, 1 plate, 1 text figure.

A small tract adjacent to the Chicago, Burlington & Quincy Railroad on the line between Crook and Weston counties, Wyo., has for the last few years yielded a moderate quantity of oil of excellent quality. This tract, which lies a short distance northwest of Thornton, is described in the present report, together with two structural domes that occur near Thornton and near Upton, a few miles to the southeast. The purpose of the investigation was to assist in the development of the field by making a detailed study of the geology in order to determine the position of the oil-bearing sands and the possibility of obtaining oil and gas in other sands. The two domes are uplifts of the rock beds, of the type that has elsewhere been found to have a definite relation to accumulations of oil and gas, and the author suggests that they should be carefully tested by drilling. The paper contains a map showing the geologic structure of the field.

WATER-SUPPLY PAPER 425. Contributions to the hydrology of the United States, 1917; N. C. Grover, chief hydraulic engineer, 1919. 161 pages, 14 plates, 7 text figures.

Contains five papers by four authors. Three of the papers were published in 1917; the other two were delayed by conditions due to the war until December, 1918.

WATER-SUPPLY PAPER 429. Ground water in the San Jacinto and Temecula basins, Calif., by G. A. Waring. 1919. 113 pages, 14 plates, 15 text figures.

The basins of San Jacinto and Temecula rivers lie in the western part of Riverside County, Calif., and cover somewhat less than 2,000 square miles. The San Jacinto basin is a plateau in relation to the adjacent lowlands of the Santa Ana River valley, for it lies 500 to 1,000 feet above them; but it is rimmed on all sides by an irregular upland and is distinctly a basin in form. The climate of this area is typical of the moderately elevated interior basins of southern California. The year is divided into a wet and a dry season, and the seasonal precipitation as recorded at two stations for varying periods between 1887 and 1916 averages 13 inches. The average annual temperature is about 62°. The effect of low precipitation and high temperature is shown in the character of the native vegetation, which consists largely of sagebrush and chaparral. Irrigation is necessary for agriculture, and several systems have been established, using both surface water and ground water. This report gives a sketch of the geology of the area and describes the ground-water supply in detail, with sections on the use of the water in irrigation and on its quality. Several of the pumping plants are described, and suggestions on suitable equipment and methods of operation are given. The report is based on a study begun in 1904 by W. C. Mendenhall and continued at intervals since then by G. A. Waring and Herman Stabler. It is illustrated with views of the region and detailed topographic and geologic maps.

WATER-SUPPLY PAPER 436. Surface-water supply of the United States, 1916, Part VI, Missouri River basin; N. C. Grover, chief hydraulic engineer; W. A. Lamb and Robert Follansbee, district engineers. 1919. 256+xliii pages, 2 plates.

WATER-SUPPLY PAPER 439. Surface water supply of the United States, 1916, Part IX, Colorado River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, E. A. Porter, and C. C. Jacob, district engineers. 1919. 198+xxxiv pages, 2 plates.

WATER-SUPPLY PAPER 440. Surface water supply of the United States, 1916, Part X, The Great Basin; N. C. Grover, chief hydraulic engineer; E. A. Porter, C. C. Jacob, H. D. McGlashan, F. F. Henshaw, G. C. Baldwin, and Robert Follansbee, district engineers. 1919. 331+xxxviii pages, 2 plates.

WATER-SUPPLY PAPER 442. Surface water supply of the United States, 1916, Part XII, North Pacific drainage basins, A, Pacific basins in Washington and upper Columbia River basin; N. C. Grover, chief hydraulic engineer; G. L. Parker and W. A. Lamb, district engineers. 1919. 203+li pages, 2 plates.

WATER-SUPPLY PAPER 443. Surface water supply of the United States, 1916, Part XII, North Pacific drainage basins, B, Snake River basin; N. C. Grover, chief hydraulic engineer; G. C. Baldwin, G. L. Parker, and F. F. Henshaw, district engineers. 1919. 186+li pages, 2 plates.

WATER-SUPPLY PAPER 444. Surface water supply of the United States, 1916, Part XII, North Pacific slope drainage basins, C, Lower Columbia River basin and Pacific slope drainage basins in Oregon; N. C. Grover, chief hydraulic engineer; F. F. Henshaw and G. L. Parker, district engineers. 1919. 190+li pages, 2 plates.

These papers present in condensed form the results of measurements of stream flow in the basins named in the titles during the year ending September 30, 1916. Data for gaging stations are given under the following heads: Location, Drainage area, Records available, Gage, Discharge meas-

urements, Channel and control, Extremes of discharge, Winter flow, Diversions, Regulation, Accuracy, and Cooperation. The books contain tables giving gage heights and daily and monthly discharges at each station and halftone plates showing typical gaging stations, current meters, and automatic water-stage recorders. At the end of each book is a list of gaging stations maintained now or in the past in the drainage basins covered and an annotated list of publications by the United States Geological Survey relating specifically to the region, as well as a similar list of reports that are of general interest in connection with hydrology and brief references to reports published by State and other organizations.

WATER-SUPPLY PAPER 446. Geology and ground waters of the western part of San Diego County, Calif., by A. J. Ellis and C. H. Lee. 1919. 318 pages, 47 plates, 18 text figures.

Extensive utilization of the underground water in San Diego County was begun only a few years ago, and much additional development is still possible. The potential demand probably exceeds that in any other settled part of California. Irrigation is necessary for the successful cultivation of most of the crops to which the climate and soil of the region are adapted. The climatic and scenic features of much of the county are attracting an ever-increasing number of temporary or permanent residents, and the demand for water for household and garden uses is destined to exceed the demand for water for irrigation in commercial agriculture. The surface waters of the county, though at times overwhelming in volume, are not reliable, and their utilization requires expensive storage and transmission works. The supplies of ground water, on the other hand, if available at all, are relatively reliable, especially if they are drawn upon only to supplement surface supplies. They are also protected from evaporation and can be more easily protected from pollution, to both of which the surface waters are subject. The major river valleys, with ample stores of ground water and low pumping lifts, have been largely developed, but there still remains much additional land in small tracts outside these valleys that can be irrigated from ground water obtained locally. The importance of ground water as a reserve in periods of drought makes accurate knowledge of the quantity available essential to permanent settlement. The investigations reported in this paper were made not only to suggest where and how ground water may be obtained but also to indicate the limits to which the supplies of ground water should be utilized. The investigations covered an area of about 3,000 square miles and were made by the United States Geological Survey in cooperation with the State of California and the city of San Diego. The field work included a study of the geology and physiography of the area, measurements of water level in wells, observations of stream flow, tests of typical wells and pumping plants, collection of information concerning other wells and plants, tests of porosity of water-bearing deposits, collection of records of precipitation and evaporation, and collection of water samples. The observations on ground water were continued without interruption for about a year. The report sets forth the information obtained and the conclusions reached in great detail, with elaborate illustrations, including numerous diagrams and topographic maps.

WATER-SUPPLY PAPER 448. Gazetteer of streams of Texas, prepared under the direction of Glenn A. Gray. 1919. 267 pages.

A gazetteer of streams, lakes, and ponds shown on topographic maps published by the Geological Survey, county maps, the post-route map, and

other maps from miscellaneous sources. Contains about 4,000 names with brief descriptions.

WATER-SUPPLY PAPER 450–A. Geology and water resources of the Gila and San Carlos valleys in the San Carlos Indian Reservation, Ariz., by A. T. Schwennesen. 1919. Pp. 1–27, Pls. I–IV, figs. 1–2.

In recent years the Indian farmers in the valleys of Gila and San Carlos rivers, in the San Carlos Indian Reservation, Ariz., have been seriously handicapped by an inadequate supply of water for irrigating their crops. The present system uses surface water from the streams, and any extensions to it would be subject to the same liability of failure. At the request of the United States Office of Indian Affairs, the Geological Survey made an investigation to determine the feasibility of drilling wells to obtain a supply of ground water for use in irrigation, and this paper sets forth the results. The author concludes that sufficient water can be obtained in the river valleys by pumping from shallow wells. The water in the San Carlos Valley is suitable for this purpose, but that obtained from such wells in the Gila Valley is heavily mineralized and might eventually be deleterious to crops. This point should be determined by actual experiment. The paper contains several maps.

WATER-SUPPLY PAPER 450–B. Ground water in Lanfair Valley, Calif., by D. G. Thompson. 1920. Pp. 29–50, Pls. V–VI, fig. 3.

Lanfair Valley is an alluvial plain covering about 260 square miles in the east-central part of San Bernardino County, Calif. During the last two or three years many settlers have taken up homesteads in this valley and have been attempting to raise crops by dry farming, on the whole with only fair success. This paper gives data on the supply of ground water in the valley. The water seems to be of satisfactory quality for irrigation, but the supply is apparently nowhere sufficient, and the high lift required to bring it to the surface in the main part of the valley prohibits its use for irrigation except on especially valuable crops. The paper contains a topographic map of the valley and adjacent region.

WATER-SUPPLY PAPER 450–C. Ground water in Pahrump, Mesquite, and Ivanpah valleys, Nevada and California, by G. A. Waring. 1920. Pp. 51–86, Pls. VII–XI, figs. 4–5, 1 insert.

In eastern California and southern Nevada there are numerous detached drainage basins that have no outlets for their surface water. Most of these basins contain no large perennial streams, but water is obtained from springs. Within the last few years attempts have been made in the three basins described in this paper to obtain water for irrigation by sinking wells, and the paper sets forth the results of an examination made to determine the amount of ground water available and its adaptability to successful farming. The examination showed that water of good quality for irrigation can be obtained in some parts of each of the three basins. The paper contains a topographic map of the region and several views and well sections.

This pamphlet includes an index, title-page, and table of contents for the use of those who may wish to bind the separate parts of Water-Supply Paper 450.

WATER-SUPPLY PAPER 454. Surface water supply of the United States, 1917, 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. 1919. 154 pages, 2 plates.

WATER-SUPPLY PAPER 455. Surface water supply of the United States, 1917, Part V, Hudson Bay and upper Mississippi River basins; N. C. Grover, chief hydraulic engineer; W. G. Hoyt, district engineer. 1919. 207+xxx pages, 2 plates.

WATER-SUPPLY PAPER 457. Surface water supply of the United States, 1917, Part VII, Lower Mississippi River basin; N. C. Grover, chief hydraulic engineer; Robert Follansbee, district engineer. 1919. 35+xxxiii pages, 2 plates.

WATER-SUPPLY PAPER 458. Surface water supply of the United States, 1917, Part VIII, Western Gulf of Mexico basins; N. C. Grover, chief hydraulic engineer; G. A. Gray and Robert Follansbee, district engineers. 1919. 106+xxviii pages, 2 plates.

Similar in scope to Water-Supply Papers 436, 439, 440, 442, 443, and 444, noticed above.

WATER-SUPPLY PAPER 485. Surface water supply of Hawaii, July 1, 1917, to June 30, 1918; N. C. Grover, chief hydraulic engineer; C. T. Bailey, acting district engineer. 1919. 169 pages.

Presents the results of measurements of stream flow in the Hawaiian Islands during the period named. Most of the data were collected under a cooperative agreement with the Territory of Hawaii, which has borne 60 to 80 per cent of the cost of the field work. This cooperative work has been carried on since July 1, 1910. The United States Army, the city and county of Honolulu, and several individuals and corporations have also coooperated in the investigations. The book contains in addition to the stream measurements records of rainfall at 33 stations in the islands.

MINERAL RESOURCES OF THE UNITED STATES, 1916. Part I, Metals; H. D. McCaskey, geologist in charge. 1919. 933 pages, 3 plates, 10 text figures, 1 insert. (One advance chapter also published during the year.)

MINERAL RESOURCES OF THE UNITED STATES, 1916. Part II, Nonmetals; E. F. Burchard and G. F. Loughlin, geologists in charge. 1919. v+1,115 pages, 4 plates, 23 text figures.

MINERAL RESOURCES OF THE UNITED STATES, 1917. Part II, Nonmetals; G. F. Loughlin, geologist in charge. 1,287 pages, 1 plate, 42 text figures, 5 inserts. (Seven advance chapters from Part I and five from Part II also published during the year.)

MINERAL RESOURCES OF THE UNITED STATES, 1918. Fifty-five advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1919. One advance chapter.

GEOLOGIC FOLIO 209. Newell, S. Dak., by N. H. Darton. 1919. 7 pages, 3 maps, 1 sheet of illustrations.

The Newell quadrangle, which covers 850 square miles in Butte and Meade counties, S. Dak., lies near the western margin of the Great Plains province, a vast area that extends from the foot of the Rocky Mountains eastward to the valley of the Mississippi. The front ridges of the Black Hills rise a short distance south of the quadrangle, but most of it lies at altitudes between 2,700 and 3,000 feet above the sea, and the maximum relief is less than 1,000 feet. Some of the striking topographic features of the quadrangle are the steep fronts of certain cuestas or sloping plains and the numerous "tepee buttes," steep-sided conical buttes as much as 100 feet high. The only valuable mineral resources of this area are the soils and the underground water. Flowing water can be obtained in a considerable area in the southwestern part of the quadrangle. This folio contains maps showing the topography, geology, and artesian-water conditions of the quadrangle and a sheet of half-tone views.

GEOLOGIC FOLIO 210. Herman-Morris, Minn., by F. W. Sardeson. 1919. 10 pages, 8 maps, 12 text figures.

This folio describes the Herman, Barrett, Chokio, and Morris quadrangles, which cover 835 square miles in western Minnesota, near the latitude of the line between North and South Dakota. These quadrangles lie in the Glaciated Plains province, and the surficial deposits are entirely of glacial origin. These deposits are underlain by pre-Cambrian crystalline rock, which is nowhere exposed in this area but has been reached in wells at depths of 42 to 480 feet. The area is in general a gently undulating plain whose greatest relief is about 380 feet, but in detail the surface is diversified by the numerous roundish lakes, irregular knobs, and other features so characteristic of a glaciated region. A low plain in the northwestern part of the area is a portion of the bed of the glacial Lake Agassiz, and across it extend two beach ridges that mark different stages of the lake. The principal mineral resources of this area are the abundant water and the rich soil. This folio contains a topographic map and a geologic map of each of the four quadrangles.

TOPOGRAPHIC AND OTHER MAPS, as follows:

Arizona.

State map. Scale, 1 inch=8 miles.

Base map of the State printed in black only. Shows the county and township boundaries, the names of all towns, and most of the names of even the small settlements, the railroads, all rivers, and many of the smaller streams and water features.

California.

Adelaida. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° 30′ to 35° 45′; longitude, 120° 45′ to 121°.

Map of the mountains a short distance east of the Pacific Ocean somewhat south of the west-central part of California. The higher points are in the Santa Lucia Range, in the southwestern part of the area, and stand at elevations of 2,500 to 2,900 feet, but throughout the area the summits of the uplands rise to elevations of 1,500 to 2,000 feet. Several good examples of discontinuous streams, such as Santa Rita, Jack, and Sheepcamp creeks, are represented.

Junipero Serra. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° to 36° 15′; longitude, 121° 15′ to 121° 30′.

Map of part of the mountains a short distance from the coast in Monterey County, southwestern California. There are no towns in the area. The slopes of the mountains are everywhere steep, so that in only a few places are they traversed by trails, and even along the floors of the valleys of the larger streams there is but little travel, not much more than 10 miles of first-class road being found within the entire area.

King City. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° to 36° 15′; longitude, 121° to 121° 15′.

Map of part of Salinas River in Monterey County, which flows on a broad valley floor, on either flank of which rise ranges of dissected mountains that drain northwestward. Few of the peaks rise to elevations of more than 2,500 feet, or about 2,200 feet above the floor of the main valley. No perennial streams except Salinas River are indicated.

Kismet. Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 37° to 37° 7′ 30″; longitude, 120° to 120° 7′ 30″.

Map of the dissected plain east of the lowland of the Great Valley of California southeast of Merced. The surface of the plain slopes in general

southwestward. In the eastern part it stands at an elevation of about 400 feet, and in the southwestern part at an elevation of 250 feet. None of the streams represented are perennial.

La Grange. Scale, 1 inch=½ mile; contour interval, 5 feet. (Part of quadrangle.) Latitude, 37° 37′ 30″ to 37° 45′; longitude, 120° 22′ 30″ to 120° 30′.

Map of part of Tuolumne River and the adjacent hilly region in Tuolumne and Stanislaus counties. Numerous developments of the water resources, including dams, canals, ditches, and reservoirs, are indicated on the map. The geology of this region is described and mapped on the scale of 1 inch to 2 miles in the Sonora folio, No. 41 (out of print, but available in the larger public libraries).

Merced Falls. Scale, 1 inch=½ mile; contour interval, 5 feet. (Part of quadrangle.) Latitude, 37° 30′ to 37° 37′ 30″; longitude, 120° 15′ to 120° 22′ 30″.

Map of a small area adjacent to Merced River. In the eastern part of the area the river flows in a narrow canyon, along whose steep north and west walls are laid the tracks of the Yosemite Valley Railroad. Farther west the valley broadens out, terraces appear here and there on its sides, and the lowland has topographic features formed by the river during its overflow or during its change of course.

Orestimba. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 37° 15′ to 37° 30′; longitude, 121° to 121° 15′.

Map of parts of Stanislaus and Merced counties. The eastern part of the area is the broad, flat plain adjacent to San Joaquin River, and the western part, which rises rather abruptly from the plain, consists of mountains that culminate in Orestimba Peak (2,073 feet). A noteworthy feature of the mountainous area is the north-south trend of many of the ridges and lowlands, which probably conforms to the trend of the lines of geologic structure.

Paso Robles. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° 30′ to 35° 45′; longitude, 120° 30′ to 120° 45′.

Map of part of San Luis Obispo County, a dissected, hilly region of moderate elevation, practically devoid of perennial streams. One of the most noteworthy features is the broad-floored valley of Salinas River, in which no stream is represented except for a stretch of about 1 mile near San Miguel. The course followed by Salinas River during the short periods when it is actually a stream is shown by stippling representing sand.

Raynor Creek. Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 37° 7′ 30″ to 37° 15′; longitude, 120° to 120° 7′ 30″.

Map of part of the foothills in Merced, Mariposa, and Madera counties and the dissected plain that slopes westward from them to form the lowlands of the Great Valley of California. The trench occupied by Chowchilla River in times of heavy run-off, which traverses both the hills and the plain, is mapped without even an indication of an intermittent stream. This map should be of special value to teachers of physiography in illustrating numerous kinds of topography.

San Simeon. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° 30′ to 35° 45′; longitude, 121° to 121° 15′.

Map of part of the coast of California and the Santa Lucia Range, in San Luis Obispo County. A slightly settled mountainous region, whose highest points rise to elevations of 3,500 feet and much of whose surface stands at elevations of more than 2,000 feet. Rocks and rocky islets

project above the sea at frequent intervals a short distance offshore, and the coast line is somewhat irregular.

Sulphur Springs. Scale, 1 inch=½ mile; contour interval, 5 feet. (Part of quadrangle.) Latitude, 37° to 37° 7′ 30″; longitude, 119° 37′ 30″ to 119° 45′.

Map of part of San Joaquin River and the dissected hilly country adjacent to it in Madera and Fresno counties. In the eastern part of its course the river flows in a narrow canyon whose walls rise precipitously more than 200 feet above it, but farther west the slopes are less steep and their smoothness is interrupted by terraces at several different elevations.

Colorado.

Daton Peak. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 40° 15′ to 40° 30′; longitude, 107° 15′ to 107° 30′.

Map of parts of Moffat and Routt counties, in northwestern Colorado. In the southern part of the region there are mountain peaks that rise to elevations above 9,000 feet. These are outliers of the great "Flattops," or White River Plateau, one of the most conspicuous features in western Colorado. The flanks of these mountains descend northward to a valley that stands at an elevation of 6,500 to 7,000 feet, occupied by Williams Fork and its tributaries. North of this valley steep slopes, broken by small terraces, lead to the upland that culminates in the peaks of the Williams Fork Mountains. From the summit of this range the slopes descend northward more or less smoothly to the valley floor of Yampa River, which occupies the extreme northern part of the area mapped. The long, gentle northern slopes and the steep, short southern slopes are due to the northward dip of the rocks.

Colorado-Wyoming.

Home. Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 40° 30′ to 41°; longitude, 105° 30′ to 106°.

Map of part of Larimer and Jackson counties, Colo., and of a strip less than a quarter of a mile wide and 26 miles long in Albany County, Wyo. The topography is mountainous. Many of the peaks of the Medicine Bow Mountains rise to elevations of more than 12,000 feet above the sea and the lowest points to about 7,500 feet. Most of the region lies in the Colorado and Arapahoe national forests and the Rocky Mountain National Park.

Georgia.

Claxton. Scale, 1 inch=1 mile; contour interval, 19 feet. Latitude, 32° to 32° 15′; longitude, 81° 45′ to 82°.

Map of area in eastern Georgia 30 to 40 miles west of Savannah, including parts of Evans, Tattnall, Liberty, Bryan, and Bulloch counties, a region of low relief, whose uplands nowhere stand as much as 200 feet above the sea and whose lowlands have an elevation of at least 60 feet. The largest stream, Canoochee River, flows in numerous small angular bends on a moderately wide valley floor.

Egypt. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 32° 15′ to 32° 30′; longitude, 81° 15′ to 81° 30′.

Map of part of the Coastal Plain in Effingham and Bulloch counties, in eastern Georgia, whose uplands stand about 100 feet above sea level and whose lowlands are less than 20 feet above the sea. Much of even the higher ground is swampy, and the lowlands near the river are so wet that practically everywhere they are untraversed by roads.

Glennville. Scale, 1 inch = 1 mile; contour interval, 10 feet. Latitude, 31° 45′ to 32°; longitude, 81° 45′ to 82°.

Map of parts of Liberty, Tattnall, and Wayne counties, in eastern Georgia. Most of the area stands between elevations of 50 to 175 feet above the sea. The lowest part of the region is the area occupied by Altamaha River, southwest of which steep slopes, 100 feet high, lead to the nearly flat upland. North of this stream there is a lowland 7 miles or more wide, whose surface stands at an elevation of less than 100 feet. North of this lowland moderately steep slopes, 50 feet or more high, lead to an upland whose surface stands at about the same elevation as that of the upland southwest of the river, 160 to 175 feet.

Millen. Scale, 1 inch = 1 mile; contour interval, 10 feet. Latitude, 32° 45′ to 33°; longitude, 81° 45′ to 82°.

Map of part of Jenkins, Screven, and Burke counties, in eastern Georgia, a region much dissected by streams, whose valleys in their lower stretches are swampy and are avoided by roads. The largest river shown is the Ogeechee, which flows through a swampy lowland, more than a mile wide, in the southwestern part of the area.

Georgia-South Carolina.

[See also South Carolina-Georgia.]

Greens Cut. Scale, 1 inch = 1 mile; contour interval, 20 feet. Latitude, 33° to 33° 15′; longitude, 81° 45′ to 82°.

Map of parts of Burke and Richmond counties, Ga., and Aiken and Barnwell counties, S. C., a region of rather low relief. The highest point in the area mapped is about 300 feet above the sea; the lowest points, which lie along Savannah River, a stream that marks the boundary between the two States, are about 100 feet above the sea. On the higher uplands are numerous depressions, whose form and distribution suggest that they may be sink holes.

Idaho.

[See Montana-Idaho.]

Kentucky-Virginia.

Nolansburg. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 36° 45′ to 37°; longitude 83° to 83° 15′.

Map of part of plateau region formed of northward-dipping rocks, considerably dissected by tributaries of Cumberland River. Noteworthy features of the region are the steep northward-facing slope of Pine Mountain and the lowland followed by Laurel and Line forks, features apparently due to an old fault that lies essentially in the course followed by the lowland.

Maine-New Hampshire.

Portsmouth. Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15′; longitude, 70° 30′ to 71°.

This map is a double sheet formed by combining the maps of the resurveyed York and Dover quadrangles. The surface of the country is decidedly uneven, as knobs and low hills separated by swamps occur with no regular arrangement. The highest point in the area is Mount Agamenticus (692 feet above sea level), a well-known local landmark.

York. Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15′; longitude, 70° 30′ to 70° 45′.

Map showing the results of the resurvey of the York quadrangle. It also forms the eastern part of the double sheet known as the Portsmouth map.

Minnesota.

St. Francis. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 45° 15′ to 46°; longitude, 93° 15′ to 93° 30′.

Map of part of the glaciated plain of east-central Minnesota north of Minneapolis and St. Paul, which is characterized by irregularly distributed small knobs and depressions, the larger of which contain lakes. The largest stream of the region, Rum River, flows alternately through swampy lowlands and through tracts of higher ground. Nowhere has the drainage of the area been long or effectively established.

Montana-Idaho.

St. Regis. Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 47° to 47° 30′; longitude, 115° to 115° 30′.

Map of part of the Bitterroot and Coeur d'Alene mountains, many of whose peaks rise to elevations of more than 7,000 feet, and whose lowest points, in the valley of the largest stream, Clark Fork, are only about 2,600 feet above the sea. The valley of St. Regis River, a tributary of Clark Fork, is followed by both the Chicago, Milwaukee & St. Paul and the Northern Pacific railways as they climb westward to cross the Bitterroot Mountains.

New Hampshire.

[See also Maine-New Hampshire.]

Gilmanton. Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° 15′ to 43° 30′; longitude, 71° 15′ to 71° 30′.

Map of part of the hilly region of central New Hampshire south of Lake Winnepesaukee. Many of the low areas are occupied by lakes and ponds or by marshy tracts, which appear to mark the sites of lakes that have been drained or filled. The present aspect of the region is in large measure due to glaciation.

Mount Pawtuckaway. Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15′; longitude, 71° to 71° 15′.

Map of parts of Strafford and Rockingham counties, in the eastern part of New Hampshire, an area characterized by numerous ponds and marshes, many low hills, and a few small higher tracts, such as Pawtuckaway and Saddleback mountains. The diversified topography is largely due to ancient glaciation.

New Mexico.

Columbus. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 31° 45′ to 32°; longitude, 107° 30′ to 107° 45′.

This area has been described by Prof. W. M. Davis as follows:

"The map shows an area west of the Rio Grande, adjoining Mexico. The minutely dissected Tres Hermanas Mountains, in the western part of the area, rise to heights above 5,500 feet, and the long piedmont slope of the Florida Mountains enters the area from the north. A rectangular system of roads serves the ranches on the plains east of the piedmont slopes, but the roads in the mountainous area on the west follow courses that are governed by topographic features. A railway runs in a straight line for 7 miles across the plains but turns and winds somewhat as it passes toward and through the mountains. The 'Deming road,' which runs a little west of north straight across the area, follows the bed of a railroad that was graded many years ago but that was abandoned, no tracks having been laid. It was this road that Gen. Pershing and his troops fol-

lowed when he pursued Villa into Mexico after the bandit's raid on Columbus in March, 1916."

Pratt. Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 31° 45′ to 32°; longitude, 108° 45′ to 109°.

Map of part of Grant County, in the extreme southwestern part of New Mexico, whose most interesting topographic features are the rugged Peloncillo Mountains. The highest peaks of these mountains rise to elevations of over 6,000 feet, and from their base extend sloping plains, those on the western flank forming part of San Simon Valley and those on the eastern flank Animas Valley. Tank Mountain rises above the eastward-sloping plain as an outlying rocky ridge. A low gap through the Peloncillo Mountains, Antelope Pass, affords a fine route, which is used by the El Paso & Southwestern Railroad. No perennial streams occur in the region.

New Mexico-Texas.

Canutillo. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 31° 45′ to 32°; longitude, 106° 30′ to 106° 45′.

Map of part of southwestern New Mexico and western Texas, whose surface in different parts presents great topographic contrasts. In the eastern part are the rugged slopes and sharp crests of the Franklin Mountains, whose peaks rise to elevations of more than 6,000 feet. Farther west the slopes become more gentle and descend to the valley of the Rio Grande, which is here 2 or 3 miles wide, though farther south this lowland is absent and the river flows through a narrow canyon, at the eastern end of which is the city of El Paso (the pass). West of the lowland rather steep slopes rise about 300 feet above the river and lead to a nearly flat upland or plateau that stands at an elevation of about 4,100 feet. The map should be of great service in classroom studies of physiography.

North Carolina.

[See Virginia-North Carolina.]

Oregon.

Willamette Valley, sheet 9 (part of double quadrangle). Scale, 1 inch=½ mile; contour intervals, 5 feet and 25 feet. Latitude, 44° 37′ 30″ to 44° 45′; longitude 123° 7′ 30″ to 123° 22′ 30″.

Map of part of Willamette River and the hilly region west of it. The lowlands for several miles from the river have been formed during the earlier stages of the development of the region and show terraces and abandoned courses of the stream. Only the lower slopes of the canyons that occupy the western part of the area are mapped.

South Carolina.

Charleston. Scale, 1 inch=⅓ mile; contour interval, 5 feet. Latitude, 32° 45′ to 32° 52′ 30″; longitude, 79° 52′ 30″ to 80°.

Fort Moultrie. Scale, 1 inch=⅓ mile; contour interval, 5 feet. Latitude, 32° 45′ to 32° 52′ 30″; longitude, 79° 45′ to 79° 52′ 30″.

Johns Island. Scale, 1 inch=⅓ mile; contour interval, 5 feet. Latitude 32° 45′ to 32° 52′ 30″; longitude, 80° to 80° 7′ 30″.

Three of the group of maps on a large scale (1:21,120) which show some of the coastal country adjacent to Charleston. Little of the region is as much as 40 feet above the sea, and much is swampy land practically at

sea level, sparsely inhabited except in the immediate neighborhood of Charleston, which owes its position to the good harbor afforded by the drowned lower courses of Cooper, Wando, and Ashley rivers.

Ridgeville. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 33° to 33° 15′; longitude, 80° 15′ to 80° 30′.

Map of a part of the Atlantic Coastal Plain, showing a flat area standing about 100 feet above the sea, traversed by flat-bottomed valleys that are occupied by tributaries of Edisto River and bordered by steep escarpments.

The Jetties. Scale, 1 inch=⅓ mile; contour interval, 5 feet. Latitude, 32° 37′ 30″ to 32° 45′; longitude, 79° 45′ to 79° 52′ 30″.

Map of the Atlantic Ocean off the entrance to the port of Charleston, in which less than a square mile of land is shown. Noteworthy features of the area are the two long jetties that protect the entrance to the harbor and that extend 3 to 4 miles out into the sea. The depths of the ocean offshore are shown by contours drawn through points 5, 10, and 20 feet below mean low-water level.

Wadmelaw Island. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 32° 30′ to 32° 45′; longitude, 80° to 80° 45′.

Map of part of the coastal region of South Carolina, an area in Charleston County. Maps of the eastern half of this area have also been recently published on a scale of 3 inches to the mile, contour interval 5 feet, as the Legareville and Kiawah Island sheets. No point in the area is as much as 40 feet and most of it is less than 20 feet above the sea.

South Carolina-Georgia.

[See also Georgia-South Carolina.]

Peeples. Scale, 1 inch = 1 mile; contour interval, 10 feet. Latitude, 32° 45′ to 33°; longitude, 81° 15′ to 81° 30′.

Map of part of Savannah River, which here forms the boundary between the States of South Carolina and Georgia, and the low swampy plain adjacent to it in Barnwell and Hampton counties, S. C., and Screven County, Ga. The lowland, 3 to 5 miles wide, through which the main river flows, is an untraversable swamp, and the only good roads leading to the stream are those on the higher ground, where the river in its irregular course swings against the bluffs to the east of this lowland.

Texas.

[See also New Mexico-Texas.]

Aldine. Scale, 1 inch = ½ mile; contour interval, 1 foot. Latitude, 29° 52′ 30″ to 30°; longitude, 95° 22′ 30″ to 95° 30′.

Map of part of the plain in Harris County, whose surface at no place within the area shows differences of elevation of as much as 50 feet. Numerous irregularly distributed small depressions occur throughout the region. Crescentic ridges, some of which are nearly complete rings an eighth of a mile in diameter, are common and form unusual topographic features.

Alief. Scale, 1 inch = ½ mile. Contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 37′ 30″ to 29° 45′; longitude, 95° 30′ to 95° 37′ 30″.

Map of part of plain in Harris County, southwest of Houston. The use of a very small contour interval permits the representation of many minute details of topography, but the greatest differences in elevation throughout the area are less than 50 feet.

Almeda. Scale, 1 inch = ½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 30′ to 29° 37′ 30″; longitude, 95° 22′ 30″ to 95° 30′.

Map of part of southern Harris County, 10 to 15 miles south of Houston, a region of slight relief, standing 50 to 70 feet above sea level. No perennial streams are indicated on the map.

Beaver Creek. Scale, 1 inch = ½ mile; contour interval, 5 feet. Latitude, 33° 52′ 30″ to 34°; longitude, 98° 52′ 30″ to 99°.

Map of part of the dissected plain in Wichita and Wilbarger counties. A noteworthy feature of the region is that none of the streams except Beaver Creek are perennial. Beaver Creek flows in a narrow trench cut at least 25 feet below the flat surface, which appears to have been the flood plain of a former larger stream.

Cedar Bayou. Scale, 1 inch = ½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 45′ to 29° 52′ 30″; longitude, 94° 52′ 30″ to 95°.

Map of the extreme eastern part of Harris County, in east-central Texas, a nearly flat plain in which Cedar Bayou has cut a steep-sided trench, the floor of which is so narrow that it is entirely occupied by the stream. The greatest difference in elevation throughout the quadrangle is less than 45 feet, the lowest point being practically at sea level.

Clodine. Scale, 1 inch = ½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 37′ 30″ to 29° 45′; longitude, 95° 37′ 30″ to 95° 45′.

Map of the southern part of Harris County, most of which is a plain. Many small intermittent ponds are scattered irregularly over the surface. A more or less rectangular system of ditches intersects the region. Buffalo Bayou, the only perennial stream represented, has had its original circuitous course artificially straightened, so that as mapped it presents a singular appearance.

Crosby. Scale, 1 inch=½ mile; contour interval, 1 foot. Latitude, 29° 52′ 30″ to 30°; longitude, 95° to 95° 7′ 30″.

Map of part of eastern Harris County, most of which is flat plain but whose southwestern part is traversed by San Jacinto River, which, with its tributaries, has cut a trench whose lowest parts are 30 to 40 feet below the adjacent upland. In the trench are many irregular-shaped knolls and depressions which represent features carved by the stream during earlier stages of its development. The small contour interval used allows most of even the smallest details to be clearly represented.

Fowlkes. Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 33° 52′ 30″ to 34°; longitude, 98° 45′ to 98° 52′ 30″.

Map of part of Wichita River in Wichita County and the dissected low rolling hills to the north. Few places within the mapped area have elevations above sea level greater than 1,135 feet or less than 975 feet.

Harmaston. Scale, 1 inch=½ mile; contour interval, 1 foot. Latitude, 29° 52′ 30″ to 30°; longitude, 95° 7′ 30″ to 95° 15′.

Map of a small part of Harris County, including the southern part of the Humble oil field. The only break in the level upland is that made by the valley of San Jacinto River, which is a flat trough about 1 mile wide and 25 to 40 feet deep. All irregularities of the surface are represented by the contour lines, so that an engineer could plan drainage ditches or railroad grades from this map without a transit or level.

Hockley. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 30° to 30° 7′ 30″; longitude, 95° 45′ to 95° 52′ 30″.

The territory represented by this map is a small part of northwestern Harris County, in the vicinity of the town of Hockley, 30 miles northwest

of Houston. The map shows the surface in great detail, every bank and hillock a foot or more high being represented. The country is greatly rolling, with many depressions, like sinkholes, ranging from a few feet to 1,000 feet or more in diameter. The lowest land in Spring Creek valley is 175 feet above the sea, and the highest west of Hegor School about 280 feet. Spring Creek flows in a narrow valley bordered by a belt of broken country 50 to 75 feet high.

Humble. Scale, 1 inch=½ mile; contour interval, 1 foot. Latitude, 29° 52′ 30″ to 30°; longitude, 95° 15′ to 95° 22′ 30″.

Map of part of the dissected plain north of Houston, in Harris County, the most noteworthy feature of which is Humble, a town that has grown up as the result of the discovery of oil in its vicinity. The oil wells and many large tanks for the storage of oil indicate the importance of the oil industry of this region.

Katy. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 45′ to 29° 52′ 30″; longitude, 95° 45′ to 95° 52′ 30″.

Map of part of western Harris County, a plain whose surface slopes gently and rather uniformly southeastward from an elevation of about 170 feet in the extreme northwest to about 115 feet in the extreme southeast corner. Numerous narrow depressions, some of which contain lakes, dot the surface of the plain.

Maravillas Canyon. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 29° 30′ to 29° 45′; longitude, 102° 45′ to 103°.

Map of part of Brewster County, in the south-central part of the State, a region whose surface is so much dissected that its relief is strong, the high points standing at elevations of nearly 4,000 feet, whereas the low tracts are not much more than 1,600 feet above the sea. All the streams except the Rio Grande are intermittent, a fact that makes the course of Maravillas Canyon across the area especially noteworthy.

Morgan Point. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 37′ 30″ to 29° 45′; longitude 94° 52′ 30″ to 95°.

Map of part of Galveston and San Jacinto bays and the adjacent country. One of the unique features of the area is the cut that has been dredged across the eastern end of Atkinson Island and the embankment that has been built out to sea from it so as to form a ship channel and breakwater.

Mykawa. Scale 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 29° 30′ to 29° 37′ 30″; longitude, 95° 15′ to 95° 22′ 30″.

Map of south-central part of Harris County, a region of low relief. The difference in elevation between the highest and lowest points shown in the area is less than 25 feet, the range in elevation being from 37 to 61 feet above the sea.

Rose Hill. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 30° to 30° 37′ 30″; longitude, 95° 37′ 30″ to 95° 45′.

Map of a part of northern Harris County which shows a range of relief that is considerable for this part of Texas and is rather accentuated on the map because of the small contour interval. Spring Creek, which forms the northern boundary of the county, has cut a narrow valley about 100 feet below the summit of the near-by uplands.

Seabrook. Scale, 1 inch=1 mile; contour interval, 1 foot. Latitude, 29° 30′ to 29° 37′ 30″; longitude, 95° to 95° 7′ 30″.

Map of the extreme southeastern part of Harris County, which abuts on Galveston Bay and is traversed by several streams whose courses here and there are expanded into long, rather narrow lakes of irregular outline. The

surface of the upland is nearly flat, and the highest parts of it stand only a little more than 30 feet above the sea.

Stuebner. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 30° 7′ 30″ to 30° 15′; longitude, 95° 30′ to 95° 37′ 30″.

Only a small part of this quadrangle, about 12 square miles, is shown on the map, which covers the extreme northern part of Harris County in great detail by contours 1 foot apart. The altitude ranges from about 105 feet in the valley of Spring Creek to 185 feet on a hill near Stuebner.

Swanson. Scale, 1 inch=½ mile; contour interval, 1 foot. Latitude, 29° 52′ 30″ to 30°; longitude, 95° 45′ to 95° 52′ 30″.

Map of part of the plain of Harris County, in eastern Texas. The greatest difference in elevation in the area is less than 80 feet, the difference between the tract north of Cypress Creek, some of whose hills rise to elevations of nearly 225 feet, and the valley of Bear Creek, in the extreme southern part of the area, whose lowest point is 145 feet above the sea. The region includes numerous more or less circular depressions, some of which contain small ponds or intermittent lakes.

Weeden. Scale, 1 inch=½ mile; contour interval, 1 foot. (Part of quadrangle.) Latitude, 30° to 30° 7′ 15″; longitude, 95° 15′ to 95° 22′ 30″.

Map of part of San Jacinto River and of its tributary Spring Creek, which forms the northern boundary of Harris County, and the dissected plain to the south. The town of Humble, which has sprung up owing to the discovery of oil in certain of the rocks that underlie part of the region, is the only settlement indicated.

Virginia.

Cape Henry. Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 36° 45′ to 37°; longitude, 75° 56′ to 76° 15′.

Map of the region adjacent to Cape Henry, the southern headland at the entrance of Chesapeake Bay, a splendid illustration of the diverse topographic forms produced by the sea, the wind, and the broad movement of the land with respect to the sea. The unique feature of the map is the series of dune ridges and beaches that form the triangular tract near whose northern apex stands the Cape Henry lighthouse.

Ivor. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 45′ to 37°; longitude, 76° 45′ to 77°.

Map of parts of Southampton, Isle of Wight, Sussex, and Surry counties, in southeastern Virginia. This region is part of a dissected plain whose uplands, large areas of which are practically flat, stand at an elevation of about 90 feet. None of the rivers have well-marked valleys, and the courses of most of the smaller streams are bordered by swamps.

Jarratt. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 45′ to 37°; longitude, 77° 15′ to 77° 30′.

Map of part of Sussex, Dinwiddie, Greensville, and Southampton counties, in southeastern Virginia, a region of low relief whose highest points are not 150 feet above the sea. Swamps occur in the valley plain and along most of the small streams. The relatively flat uplands are better drained and are followed by the roads.

King William. Scale, 1 inch=1 mile; contour intervals, 10 and 20 feet. Latitude, 37° 30′ to 37° 45′; longitude, 77° to 77° 15′.

Map of part of the Coastal Plain in eastern Virginia 10 to 25 miles east of Richmond. The notable topographic features of the area are the broad-floored valleys of Mattaponi and Pamunkey rivers and the flat-topped dissected upland north and south of these valleys. The flatness of the upland

is especially evident in the territory between these rivers. The highest point in the area mapped is about 180 feet above sea level, but most of the upland stands at elevations between 120 and 150 feet.

New Kent. Scale, 1 inch=1 mile; contour interval, 10 and 20 feet. Latitude, 37° 30′ to 37° 45′; longitude, 76° 45′ to 77°.

Map of the junction of Pamunkey and Mattaponi rivers, in southeastern Virginia, and the dissected adjacent low plain. Both streams flow in meandering courses on a marshy floor, above which a terrace rises to an elevation of 20 to 30 feet, and above the terrace rise rather steep slopes, leading to the flat-topped uplands, which stand at an elevation of about 120 feet.

Surry. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 37° to 37° 15′; longitude, 76° 45′ to 77°.

Map of part of James River and the coastal plain through which it flows. Near the main river and the larger streams the plain is much dissected by ravines and small valleys, but farther away there are tracts, some of them several square miles in extent, whose surface shows differences of elevation of less than 10 feet.

Virginia-North Carolina.

Boykins. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 30′ to 36° 45′; longitude, 77° to 77° 15′.

Map of parts of Southampton County, Va., and Hertford and Northampton counties, N. C., a region considerably dissected by streams, though the tops of its uplands, especially in its eastern part, are nearly flat and seem to be remnants of an eastward-descending plain that stands at an elevation of 80 to 95 feet. In addition to this plain a higher, more dissected one is represented by gently rounded ridge tops that stand at an elevation of about 130 feet. A lower and almost perfectly flat surface at an elevation of 30 to 35 feet forms a terrace which is a prominent feature along the principal streams. Nottoway and Meherrin rivers generally flow in broad, flat valleys cut in the lower plain, and the bottoms of these valleys are swampy and less than 20 feet above the sea.

Emporia. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 30′ to 36° 45′; longitude, 77° 30′ to 77° 45′.

Map of part of Brunswick and Greensville counties, Va., and Northampton County, N. C., a region in the western part of the Coastal Plain province and the eastern part of the Piedmont province where hard rocks are exposed at the surface. The ponding of Meherrin River by the dam built a short distance west of Emporia is a notable feature of the region.

Holland. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 30′ to 36° 45′; longitude, 76° 45′ to 77°.

Map of parts of Nansemond, Southampton, and Isle of Wight counties, in southeastern Virginia, and Gates and Hertford counties, in northeastern North Carolina. Most of the region is a somewhat dissected plain traversed by Chowan River and its two large branches, Nottoway and Blackwater rivers, and their tributaries. Practically no point in this area stands more than 100 feet above the sea.

Suffolk. Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 36° 30′ to 36° 45′; longitude, 76° 30′ to 76° 45′.

Map of part of the region southwest of Norfolk, including the western margin of the Dismal Swamp and the dissected plain to the west. A rather abrupt slope borders the swamp, whose surface stands 20 to 30 feet above the sea, and leads from it to nearly flat uplands, whose surface stands 60 to 70 feet above the sea.

Washington.

Port Crescent. Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 48° to 48° 15′; longitude, 123° 30′ to 123° 45′.

Map of part of Juan de Fuca Strait and the foothills of the Olympic Mountains, to the south, in Clallam County. Many of the peaks, though not more than 10 miles distant from the strait, rise to elevations above 5,000 feet. The slopes of the hills are so steep that on the map most of the intermediate contours for elevations above 1,000 feet are omitted and only the accented contours are shown. As a result the same effect is produced as if a 100-foot contour interval had been used for the mountains.

Van Zandt. Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 48° 45′ to 49°; longitude, 122° to 122° 15′.

Map of part of mountainous region of northwest Washington, including the international boundary and the country south of it. It represents a region of strong relief, whose highest peaks rise to elevations of nearly 5,000 feet and some of whose lowlands are not more than 250 feet above the sea. Nooksack River, the largest stream, follows an exceedingly irregular course, which does not everywhere correspond to the largest valley. In fact, "Columbia Valley," which is a broad-floored valley extending from the international boundary to one of the great bends of Nooksack River, has no large stream in it. The present intricate arrangement of the drainage lines is probably due to the former glaciation of much of the region.

Wyoming.

[See Colorado-Wyoming.]

GEOLOGIC BRANCH.

SCOPE AND ORGANIZATION OF WORK.

The geologic work of the Survey comprises all phases of geology, including stratigraphy, structure, petrology, paleontology, physiography, glaciology, metallography, mineralogy, chemistry, and physics, as well as a census of the country's mineral resources. It includes also special investigations made for other departments of the Government or for commissions, States, and municipalities. The results of nearly all these investigations are made public in printed reports, some of which are published by cooperating organizations or in professional or technical journals.

The geologic branch consists of four divisions:

1. The division of geology, Sidney Paige, geologist in charge, conducts areal geologic surveys and special economic investigations and researches. It is also engaged in preparing the geologic map of the United States, and through field examinations it cooperates in the classification of the mineral lands of the public domain.

2. The division of Alaskan mineral resources, A. H. Brooks, geologist in charge, carries on topographic, hydrologic, and geologic surveys in Alaska. To render more efficient assistance to the development of the resources of Alaska a branch office is maintained the year around at Anchorage.

3. The division of mineral resources, Edson S. Bastin, geologist in charge until January, G. F. Loughlin, geologist in charge since January, keeps the public informed as to the state of the mineral industries and the rate of production of mineral commodities in the United States. This division also compiles and prepares for publication information concerning foreign mineral deposits—their geology, quality, reserves, state of development, output, and trade distribution. Branch offices of this division are maintained at San Francisco, Salt Lake City, and Denver.

4. The division of chemical and physical research, George Steiger, chief chemist, acting in charge, makes the chemical analyses that are essential to the work of the geologic branch and conducts physical and chemical researches bearing upon geologic problems.

The scope of the work and the activities of these divisions are more fully described in their respective reports, given below.

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The scientific force of the division of geology at the beginning of the fiscal year consisted of 80 geologists, 22 associate geologists, 18 assistant geologists, 3 junior geologists, and 6 geologic aids. During the year 15 geologists resigned to take professional positions in commercial life at higher salaries, 1 died, 3 returned from the Army, 12 were appointed, and 2 were transferred from another division. The total number of geologists in the division at the end of the year was 130, a net gain of 1. Nine of these were appointed as geologic aids or assistant geologists near the end of the year.

The division is organized in 12 sections, named below, and it also exercises administrative supervision of the section of geologic map editing, a part of the publication branch. The principal activities of the sections are described in the annual reports for 1917 (pp. 43–47) and 1919 (pp. 60–64).

1. The section of eastern areal geology, Arthur Keith, geologist in charge.
2. The section of western areal geology, Sidney Paige, geologist in charge.
3. The section of Coastal Plain investigations, T. Wayland Vaughan, geologist in charge. The subsection of sedimentary investigations, E. W. Shaw, geologist in charge.
4. The section of glacial geology, W. C. Alden, geologist in charge.
5. The section of paleontology and stratigraphy, T. W. Stanton, geologist in charge.
6. The section of geology of metalliferous deposits, F. L. Ransome, geologist in charge.
7. The section of petrology, E. S. Larsen, jr., geologist in charge.

8. The section of geology of iron and steel alloy metals, E. F. Burchard, geologist in charge.

9. The section of the geology of nonmetalliferous deposits, H. S. Gale, geologist in charge.

10. The section of the geology of eastern coal fields, G. H. Ashley, geologist in charge until September 4, when its administration was united with that of the section of the geology of western coal fields.

11. The section of the geology of western coal fields, M. R. Campbell, geologist in charge.

12. The section of the geology of oil and gas fields, nominally in charge of the chief geologist, but with K. C. Heald, assistant chief of section, acting in charge.

The committee on geologic names, T. W. Stanton, chairman, during the year examined 86 manuscripts, comprising 11,667 pages and involving 2,240 geologic names. In addition a large amount of work was done on the stratigraphic catalogue of the United States, and progress was made on the stratigraphic lexicon.

PUBLICATIONS.

Nine professional papers and three chapters of a tenth paper were issued during the year. Five complete bulletins, 22 parts of five other bulletins, and two geologic folios were published. Titles and brief abstracts of these publications are given on pages 12–30. In spite of the large size of the original editions it was found necessary to republish one professional paper, two bulletins, and 17 parts of two other bulletins to meet the public demand. Besides the official publications 49 papers were, with the permission of the Director, published by scientific societies or in scientific and technical journals. Nine reports based on work done in cooperation with State geological surveys have been transmitted to the States for publication.

PROGRESS OF GEOLOGIC MAPPING.

The areas in the United States [1] covered by geologic maps published by the Survey and the general nature of the work in each area are shown in the map forming Plate I. This map does not, however, indicate areas on which reports prepared by this Survey have been submitted for publication to cooperating State organizations or to other bureaus and departments of the Federal Government.

The resumption of normal geologic work being dependent on the completion of reports on investigations of war minerals and the preparation of reports on field studies made before the war, a considerable part of the geologic staff was occupied with office work during the year, and the areas covered by field investigations were therefore

[1] The progress of geologic surveying in Alaska is shown on page 92.

less than those that would otherwise have been covered even with the reduced staff. A summary statement of the work is given below:

Progress of geologic mapping, fiscal year 1919–20.

	Square miles.
Detailed mapping	5,250
Reconnaissance mapping	14,480
Exploratory mapping	32,780
	52,510
Lands classified	4,375

FINANCIAL STATEMENT.

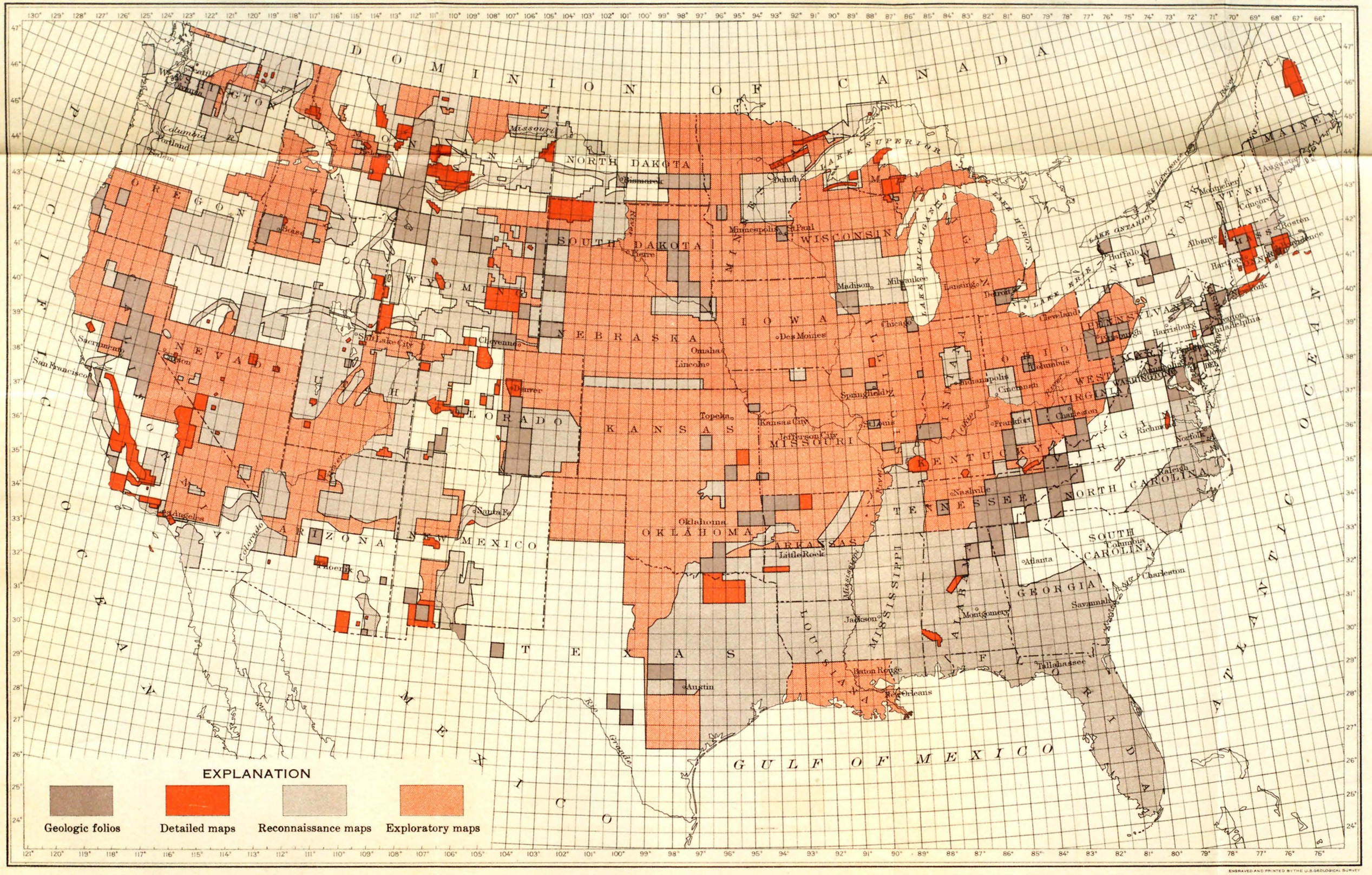
The total funds available for the geologic work of the Survey in the United States for the fiscal year 1919–20 were as follows:

Geologic surveys	$347,073.50	
Repayments	2,914.46	
		$349,987.96
Scientific assistants		11,700.00
Search for potash deposits (part of appropriation for chemical and physical researches)		5,974.66
		367,662.62

The authorized expenditures, classified by subjects, were approximately as follows:

Economic geology of metalliferous deposits (mainly war minerals)	$58,129.00
Economic geology of nonmetalliferous deposits (mainly potash, nitrates, and war minerals)	33,960.00
Economic geology of fuels (oil, gas, coal, and peat)	69,886.00
Geographic handbooks and related educational work	3,626.00
Scientific researches not directly connected with economic purposes (paleontology, etc.)	88,020.00
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, instruments, and supplies	93,185.00
Land-classification board	20,856.00
	367,662.00

Of the amounts allotted to this division, $64,597 was used directly for field expenses, including the search for potash. About 66 per cent of this amount was expended west of the one hundredth meridian and about 34 per cent east of it. With the $20,856 appropriated for the operations of the land-classification board, 74 per cent of the total, exclusive of the allotment for supervision, was spent for investigations west of the one hundredth meridian—that is, essentially in the public-land States. The expenditures for supervision, etc., are divisible between the eastern and western work in about the same proportion.



EXPLANATION

Geologic folios | Detailed maps | Reconnaissance maps | Exploratory maps

AREAS COVERED BY GEOLOGIC MAPS PUBLISHED BY UNITED STATES GEOLOGICAL SURVEY PRIOR TO JULY 1, 1920

Scale 1/14000000

100 0 100 200 300 400 500 Miles

ENGRAVED AND PRINTED BY THE U.S.GEOLOGICAL SURVEY

COOPERATION.

The requests for cooperation have involved more work than ever before, and, as far as possible, they have received prompt response. It is regretted, however, that on account of the reduced staff of qualified geologists six requests received from State geological surveys for cooperation, with offers of equal contribution to the cost of the work, could not be granted.

As usual, effective cooperation has been maintained between the division of geology and other divisions, particularly the divisions of mineral resources and Alaskan mineral resources. The paleontologic work in Alaska is largely cared for by the paleontologists of the division of geology. The cooperation of the division of chemical and physical research with other divisions of the geologic branch is fundamental and continuous. Within the department frequent cooperative assistance has been rendered to other bureaus, notably the Bureau of Mines, the Office of Indian Affairs, and the General Land Office.

The division of geology, through the preparation of special reports or through special examinations, has cooperated with the War Department, the Navy Department, the State Department, and the Department of Justice; with the United States Public Health Service, the Office of the Supervising Architect, and the Bureau of Internal Revenue in the Treasury Department; with the Bureau of Standards, the Bureau of Fisheries, and the Bureau of Foreign and Domestic Commerce in the Department of Commerce; and with the United States National Museum, the Carnegie Institution, the American Museum of Natural History, the Brooklyn Museum of Natural History, the Museum of Natural History of Paris, and the Geological Survey of Canada. Investigations have been undertaken at the request of the governments of the Virgin Islands, Porto Rico, the Dominican Republic, and the Republic of Haiti. Assistance has been given also to the geologic departments of a number of American universities and colleges.

In strictly geologic investigations or paleontologic studies the Survey, through the division of geology, has cooperated with the geological surveys or equivalent agencies in 29 States—Arizona, Arkansas, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Jersey, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Virginia, Washington, West Virginia, and Wisconsin. Informal cooperation exists between the Survey and all States having geological surveys. Cooperative assistance has also been rendered to the cities of Dallas, Tex., and Shreveport, La.

GENERAL REVIEW OF THE WORK OF THE YEAR.

Loss in efficiency and morale of the scientific staff.—The year 1919–20 has been one of unprecedented stress in the geologic branch and in the division of geology in particular. A scientific staff already depleted on account of inadequacy of salaries has been further reduced until in four of the sections there are not enough experienced geologists left to train the recruits enlisted to replace men lost. A number of geologists who had patriotically remained in the service after the declaration of the armistice, notwithstanding the difficulty of meeting the rising cost of living and the inconvenience of carrying on scientific work in wholly inadequate quarters, have resigned. In addition to 15 geologists who have left the service, 19 geologists have taken leave without pay for parts of the year in order to earn in other employment enough money to make their incomes equal to the necessary expenditures of ordinary living. Among those who have resigned are B. S. Butler, E. C. Harder, D. E. Winchester, D. Dale Condit, Edwin Kirk, E. T. Hancock, and E. L. Jones, jr. The universities, offering more inviting salaries, as well as long vacations, sabbatical years, opportunities for private practice, and reassuring retirement prospects, have united with the oil and mining companies in taking from the Survey some of its best geologists. Three well-known specialists, E. S. Bastin, J. B. Umpleby, and Adolph Knopf, have taken university chairs, and three others have been granted leave of absence to teach at higher salaries for a part of the year. The changes in the personnel in the divisions of Alaskan mineral resources, chemical and physical research, and mineral resources are noted in the reports of the chiefs of those divisions. The greatest breakdown of the staff of the division of geology has been suffered by the coal, oil, and metal sections, the first of which was nearly wiped out. In view of this deplorable disintegration of its force the Survey is fortunate in that the impairment of the morale of its scientific staff has not been greater.

The extent of the work has been limited by the greatly increased cost of field operations, as well as by the loss of highly trained geologists. The continued advance in the wages of temporary field assistants and laborers, prices of equipment, provisions, and other supplies, storage and keep of animals, living rates, and traveling expenses has not been covered by any increase in the funds appropriated. The loss of a geologist of large experience in professional work and of special knowledge of a particular kind is a loss of years of training in methods of geologic research, in the standards of execution of Survey work, and in the production of reports. The expert knowledge of a particular subject or of a special field, gathered in the course of a professional career in the Survey, is an asset of

notable public value. The resignation of a geologist may leave a project unfinished or a report incomplete, whose completion may require the duplication of the greater part of the field investment and the assignment to the project of a less experienced geologist. Obviously it may also involve great loss of time, which is the equivalent of money. The Government loses further by having to pay relatively higher salaries for new men of less experience and inferior qualifications, while at the same time it must sacrifice a part of the efficiency of the remaining specialists, either by requiring them to perform administrative work or by assigning to them the work of training recruits in technical work or in the preparation of reports. The scientific output of several of the leading members of the field staff has been seriously or totally interrupted by their enforced assumption of administrative responsibilities.

Some of the losses sustained by the lack of suitably trained geologists to take charge of projects that are already in progress and that are of large value to the public are mentioned in the description of the work by States. In some regions urgently needed geologic investigations have been definitely suspended. Requests for cooperative work received from six States—Florida, Georgia, Tennessee, Kentucky, Pennsylvania, and Michigan—could not be granted.

Principal work done.—After finishing its studies of war minerals and other studies of military importance the Geological Survey resumed its normal work. During the year economic reports on deposits containing manganese, chromite, tungsten, helium, white clays, mica, asbestos, magnesite, mercury, and peat have been submitted, printed, or nearly completed. Theoretical contributions also, carrying forward our knowledge of the mode of occurrence and genesis of some ores, have been by-products of the war studies.

Several of the broader investigations, of both economic and of constructive scientific value, begun before the war have been revived, completed, or published. Examples are F. L. Ransome's work on the copper deposits of the Ray and Miami districts, and B. S. Butler's studies of the ore deposits of Utah, which have been embodied in Professional Papers 115 and 111, respectively. A folio on the Ray quadrangle has been submitted by Mr. Ransome, who is now working on a paper on the mining districts of Arizona, and Mr. Butler (resigned in June), assisted by F. C. Calkins, has been carrying forward detailed examinations of the geology and ore deposits of the Cottonwood district, Utah. A valuable paper on primary sulphate minerals and ore deposits, unofficially published by Mr. Butler, is the outgrowth of his years of study of western ore deposits, chiefly copper.

Arrangements have been made by which Mr. Bastin will continue his studies of silver enrichment. Sidney Paige has finished his report

on the Tyrone district, in New Mexico, and Adolph Knopf and H. G. Ferguson resumed their studies of the Rochester, Divide, and Manhattan districts, in Nevada, and of the Mogollon district, in New Mexico, and have completed their reports. F. C. Schrader is reviewing his recent field mapping and economic work in the Carson City quadrangle in Nevada. Mr. Umpleby, since he left the service, has completed a report on the Shoshone district, in Idaho, and F. B. Laney and D. C. Livingston are carrying along the detailed study of the Seven Devils and Sawtooth districts, also in Idaho, Mr. Livingston representing the State.

Among the noteworthy work of the geologists of the nonmetals and fuel sections is a study by G. R. Mansfield of the greensands of New Jersey. A classification of coals prepared by G. H. Ashley prior to his acceptance of the more remunerative position of State geologist of Pennsylvania includes new evidence as to the origin of coal. Papers by A. E. Fath on the Eldorado oil field, Kans., and on the origin of the minor folds and faults in the oil region of southeastern Kansas and northeastern Oklahoma are valuable contributions to the geology of oil and gas. D. F. Hewett, in the course of his detailed geologic and structural mapping of possible oil territory in the southern part of the Big Horn Basin, is working out the history of a newly discovered thrust known as the Hart Mountain fault, which appears to exceed in extent the Lewis overthrust, in northern Montana, and may perhaps rival the Bannock thrust, in southeastern Idaho.

The examinations of the Mid-Continent and Appalachian natural-gas fields made by the late G. S. Rogers in the interest of the military and the naval service have resulted in a compilation of all available information regarding the occurrence and distribution of helium in natural gas as well as an appraisal of the commercial resources of helium in the natural gases of the United States. The results of the work are given in Professional Paper 121, now in press.

A bibliography of the metals of the platinum group, 1748–1917, by Jas. Lewis Howe and H. C. Holtz, has been issued as Bulletin 694.

Field studies of reported deposits of potash and nitrate in the Pacific Coast States and in the Southwest, by H. S. Gale, L. F. Noble, and G. R. Mansfield, not only contribute to our knowledge of the potash and nitrate resources of the United States but combine to form an analytical determination of the physiographic, climatic, rock, soil, and water conditions that control the mode of occurrence of nitrates and potash salts in the western Pleistocene and Recent lake basins.

Studies of the stratigraphy, extent, and geologic history of the salt deposits in the "Red Beds" of the Southwest, made by N. H. Darton in search for associated deposits of potash salts and reported in a manuscript on the Permian salt deposits of United States,

yielded valuable by-products consisting of a topographic base map and a reconnaissance geologic map of New Mexico on a scale of 4 miles to the inch. A similar by-product is a new geologic map of Wyoming on a scale of 1:500,000, prepared under the direction of M. R. Campbell to accompany a report by W. B. Emery giving the results of examinations of coal and possible oil lands in Wyoming for the purpose of classification. Details of stratigraphic and areal geology in Montana, gathered mainly in a similar examination of lands, are now being cooperatively contributed to the Montana State Bureau of Mines for incorporation in a large-scale geologic map to be issued by that bureau. Another State map compiled by the Geological Survey is a general geologic map of Utah on a scale of 12 miles to the inch, contained in Professional Paper 111. A reconnaissance geologic survey of parts of eastern Arizona is now being made by Mr. Darton in cooperation with the State School of Mines, to obtain data for a complete geologic map of that State.

On the other hand, the investigation of the stratigraphy, extent, and composition of the oil shales and of the reported coal deposits of northern Nevada made in 1918 and the examination of the Tertiary basins east of the Cascade Mountains in Oregon made in 1919 to determine their depth, structure, and possible content of oil may be regarded merely as by-products of a comprehensive study of the physiographic, geologic, and climatic history of the fresh-water Tertiary lake basins of the Northwest and of their relations to the great tectonic and volcanic phenomena of late Tertiary and early Pleistocene time. At the request of the Idaho Bureau of Mines and Geology similar studies were begun in June in western Idaho to determine the possibility of developing commercial oil or gas resources in that part of the State.

The paleontologic investigations of the oil shales of the Green River group in and around the Uinta Basin and of the Miocene basins in Nevada, begun by the late C. A. Davis, were resumed by Harvey Bassler, a young geologist specially qualified to determine the origin of the shales and the sources of their hydrocarbons, but Mr. Bassler had only begun his work when he resigned to make structural studies in South America for investors seeking oil and gas. It is regrettable that the examinations of these shales, on which the United States may be compelled to rely for oil, have been again suspended, this time on account of inadequate Government salaries.

Tests of the applicability of refined methods of magnetic surveying to prospecting for pyrrhotitic copper ores were made in November by W. O. Hotchkiss, State geologist of Wisconsin, an expert in magnetic surveys, and Adolph Knopf, of this Survey, at Ducktown, Tenn. The results, though not decisive, indicate that these methods

may be useful in the search for ores even so feebly magnetic as those at Ducktown, but the practical value of these tests and of those to be made in other regions can be determined only after they have been compared with the results shown by mining.

A report by E. C. Harder on iron-depositing bacteria and their geologic relations, based largely on a study of the iron ores of the Cuyuna range, Minn., published early in the year as Professional Paper 113, has already been reprinted to satisfy the public demand.

In addition to geologic researches that are applicable mainly to economic problems but that yield what has been called "purely scientific" by-products, researches were made in the field of "pure" geology, which, however, can not properly be detached from work of economic application. Among the members of the Survey staff no sharp distinction is made between "economic" and "scientific" researches.

In glacial geology W. C. Alden is studying the drift of the foothills and plains along the northern Rocky Mountains for the purpose of connecting and of correlating more definitely the glacial history of the mountain country of the Northwestern States with the more fully elaborated history of the region east of the Mississippi. The study of the glacial history of the Sierra Nevada has been begun by F. E. Matthes, and the recent work of Frank Leverett on the morainal systems, old shore lines, differential movements, soils, and former drainageways of the northern Lake States is now brought to fruition in a manuscript that forms an important addition to the records of the glacial history of North America under the title "The moraines and shore lines of the Lake Superior basin."

The study of the basins of the fresh-water lakes of western Montana, already begun by J. T. Pardee, was resumed by him in June. His work includes the investigation of the glacial deposits and their relations to the lake basins and to the formation of the placer deposits; of the comprehensive problems of the history of these basins, including the origin and conditions of deposition, erosion, deformation, and drainage; and of the origin, age, and correlation of the terrace systems of Columbia River. The results of this study and of that of J. P. Buwalda, of the United States Geological Survey, and the geologists of the University of California should together serve to work out the history and the relations of the Tertiary fresh-water basins of the Northwest, the sources of their sediments and the conditions of sedimentation, their relations in time to the Columbia and Snake River lava systems, their place in the physiographic history of the northwestern Rocky Mountains and northern Great Basin, and their relations in time to the origin of the different structural features, including the later fault systems, so many of which

are being worked out by geologists examining deposits of ores and fuels.

The work of the paleontologists, though their field examinations were curtailed during the war, has this year been prosecuted under favorable conditions and, as usual, forms an essential part of the Survey's scientific activities. Fortunately, the services of the paleontologists are not sought by the oil companies so persistently as the services of the geologists; only one member of the staff has been lured away. The details of the Survey's paleontologic work is given in the accounts of operations of the divisions by States. Only a few of the larger projects and productions can be mentioned here. Contributions to our knowledge of Tertiary Bryozoa were prepared under Survey auspices by F. Canu and R. S. Bassler, though published by the United States National Museum. F. H. Knowlton's catalogue of Mesozoic and Cenozoic plants of North America has been issued as Bulletin 696, and his monographic paper on the Laramie flora of the Denver Basin, which has long been needed, is now in preparation for publication as Professional Paper 130. A report by E. W. Berry on the Upper Cretaceous floras of the eastern Gulf region in Tennessee, Mississippi, Alabama, and Georgia has been published as Professional Paper 112, and Mr. Berry has submitted for publication a report on the Eocene flora of southeastern North America. Other paleontologic investigations in progress are studies of fossil floras by Messrs. Knowlton and Berry, of the invertebrates of the Morrow and other Carboniferous formations by G. H. Girty; of the Mollusca of the west-coast Tertiary, by W. H. Dall; and of the Foraminifera of the Cretaceous and Tertiary of the Gulf and Caribbean regions, by J. A. Cushman. A paper on some American Jurassic ammonites, by J. B. Reeside, jr., has appeared as Professional Paper 118. A description of a remarkable fauna from the Ripley formation in west Tennessee, by Bruce Wade, was cooperatively contributed without expense to the Survey other than that involved in the preparation of the illustrations.

T. W. Stanton has made progress in his work on the Comanche faunas of the Southwest, and the Survey is cooperating with the University of California in work on Prof. J. P. Smith's monograph on the Triassic ammonites of the Pacific coast region. The study by E. O. Ulrich of the stratigraphy, paleontology, and paleogeographic history of the formations comprising or in contact with the groups for which he proposes the terms "Ozarkian" and "Canadian" as names of Paleozoic systems is still engaging his attention. He has also completed a monographic study of the trilobites belonging to the family Lichadidae.

Paleontologic researches relating to the origin and distribution of the faunas of the Caribbean and Central American provinces,

including the Gulf Coastal Plain region of the United States, somewhat fully outlined in the Fortieth Annual Report, have been continued by T. W. Vaughan. The work on the geologic history of this part of the Western Hemisphere is naturally being pushed with greatest energy in the American insular possessions and in the Republics of Santo Domingo and Haiti, where cooperative geologic surveys have been organized under the direction of the United States Geological Survey, the geologic work being done under the supervision of Mr. Vaughan. These surveys, which are undertaken primarily to determine the geologic structure and mineral resources of the countries, have already afforded good results, which promise to make it possible to fix the geologic dates of periods of mountain building by folding and block faulting, to define the successive periods of greater igneous activity, and to correlate in time the geologic and paleontologic events in the regions studied with corresponding events in the United States, as well as in other parts of the world.

The most notable paleontologic work completed during the year is a monograph on the Titanotheres, by Henry Fairfield Osborn, distinguished among world paleontologists and president of the American Museum of Natural History. This work is a product of a study begun nearly 20 years ago by the Survey and now completed under its auspices, with the cooperation of the American Museum of Natural History and the United States National Museum and through the courtesy of many other scientific institutions. This monumental work forms a milestone in the progress of paleontologic research in North America.

The publication of geologic folios, suspended during the war, is now again going forward. Two folios have been completed during the year, two are now in press, and the engraving of maps for three others is in progress. A large number of folio manuscripts, nearly ready for publication, have accumulated. Most of these antedate the war, and the delay in their publication is to be regretted, especially on account of the resignation of some of the authors. Field investigations and conferences relating to correlation, to features of structure, and to other elements necessary to the completion of texts and maps to cover quadrangles in Alabama, Tennessee, Virginia, and southeastern Pennsylvania have been made, and a considerable number of manuscripts should be ready for transmission early in the coming year, but the geologic force is at present quite inadequate to insure the immediate completion of work covering many quadrangles, from some of which it has been necessary to transfer the field geologists to other more pressing projects.

The studies of the areal, igneous, and structural geology, the geologic history, and the physiography of the San Juan region of Colo-

rado, resumed in 1918 and 1919, is now progressing rapidly, Whitman Cross, W. W. Atwood, E. S. Larsen, and C. S. Ross having returned to the field again in June, with the prospect of completing the field work in the summer of 1920. Progress has been made in the preparation of the group of reports that will embody the results of the investigation of the San Juan region. A report on the microscopic determination of nonopaque minerals, by Mr. Larsen, is now in press as Bulletin 679.

The material assembled by the late Arnold Hague for incorporation in a monographic description of the Yellowstone Park appears to be nearly complete, though additional field studies of the work of the glaciers and the preparation of descriptions and maps are needed. No one is now available, however, to make the necessary additional field examinations and perform the relatively small amount of labor required to prepare the report for publication.

As one of the products of his years of study of the stratigraphy, structure, and geologic history of the older Paleozoic and metamorphic belts of the northern Appalachian region, Arthur Keith is preparing a report on the structure of the Taconic Range, in western New England and New York.

A report by G. R. Mansfield on detailed examinations of several quadrangles in southeastern Idaho is nearly ready for transmission for publication as a professional paper.

Two geographic handbooks, one on the New England States and the other on the region including Virginia, Maryland, and Delaware, will be completed before the end of 1920. The scope and the character of these two reports, which were begun in cooperation with the Council of National Defense, were modified when it became apparent that the war would not be brought to the coast of the United States and that the need for geographic information especially prepared for military use was not immediate. Accordingly, the field examinations have been extended and the texts revised or rewritten to make these handbooks available for popular education.

Other geographic books designed to furnish instruction in popular form as to the scenic and other features of the country and their origin are the guide to the Denver & Rio Grande Railroad from Denver to Salt Lake by Mr. Campbell and the popular guide to the Yosemite Valley region by Mr. Matthes. Texts describing in popular language the salient features of some quadrangles of unusual interest for which new topographic maps are issued are now in preparation, and it is hoped that they may assist in affording a better understanding of the nature and origin of the topographic features shown on the maps.

To assist in the understanding of the conditions of geologic deposition and in the determination of geologic history the Survey has

endeavored to build up a sedimentary laboratory and to encourage a study of sedimentation both by developing specialists and by stimulating the interest of geologists, in and out of the Survey, in that subject. In this study the drillings from wells sunk in search of potash in the Black Rock and Smoke Creek desert playas of northern Nevada were examined some time ago by M. I. Goldman. During the last year Mr. Goldman's work has been aided by the better equipment of the sedimentary laboratory and by its organization as a subsection in charge of E. W. Shaw, who has given much time to researches in sedimentation. This subsection is a part of the section of Coastal Plain investigations, which is under the general supervision of T. W. Vaughan. Several geologists, notably C. K. Wentworth and the paleontologists who are working on microscopic faunas, are now cooperating in this work, which is being coordinated with similar work done in several laboratories under university auspices.

The observations of gravity made in cooperation by the Geological Survey and the Coast and Geodetic Survey have been limited in number and in geographic extent by delays incident to the construction of new types of apparatus that will permit greater mobility of equipment and the establishment of stations out of contact with direct telegraphic connection. Most of the stations occupied are at points chosen for the purpose of checking and confirming several anomalies of gravity that have been inexplicable or of observing the amount of the anomalies where the known stratigraphy and structure furnish satisfactory data for determining the gravity at closely contiguous points that afford widely contrasting results. Observations of the force of gravity at a considerable number of points in different regions, carefully chosen to determine the effects of known thicknesses of light-gravity rocks at the surface or of known contrasting conditions resulting from faulting or folding, may afford criteria that will not only be of use in interpreting anomalies not yet explained but will be of practical service in the formulation of deductions as to the probable thickness of the unaltered and relatively light rocks in parts of the country where the distance to the basement complex or underlying metamorphic and crystalline rocks is not known. The pendulum may thus eventually be of service in studies of geologic history as well as in studies of isostasy.

The division of geology has cooperated with the division of chemical and physical research in observations of temperature at different depths in a number of deep wells drilled in the Appalachian, Mid-Continent, and Rocky Mountain oil fields. These measurements of the temperature of deep wells by Mr. Van Orstrand are more accurate than any heretofore made, and their accumulation will afford a means of showing the temperature gradient of the outer strata of

the crust of the earth in different parts of the United States. These observations will also show whether the temperature of oil-bearing areas is greater than that of the surrounding regions and whether the temperature of the rocks in the more strongly folded anticlines is greater than that of those in the horizontal beds on either side. Studies and tests of the relations of sizes of grains and pore spaces of oil sands to the volume and duration of their productivity are now being made by A. E. Melcher. It is much to be regretted that the funds available and the scientific staff of the physical laboratory are not adequate for the solution of many other problems connected with the origin, migration, and conditions of occurrence of oil and natural gas. Progress in oil geology is now greatly retarded by the lack of work in experimental physics to solve questions connected with the discovery and the extraction of oil, as well as with its most efficient utilization.

A special public service, appropriate to peace, is exemplified in the work of the Director and F. G. Tryon in their effort to assure the adequacy of the coal supply, both by maintaining the special information service covering the production, distribution, and reserves from week to week and by urging the greater conservation of coal through its more efficient utilization and through the substitution, where practicable, of power generated by water for power generated by coal. Through unofficially published articles and addresses the Director, Eugene Stebinger, and the chief geologist have endeavored not only to give warning of the prospective rapidly increasing dependency of the United States on foreign oil but to point out, through discussions of the distribution of prospective oil fields in other parts of the world and estimates of the great foreign reserves, the fact that only a part of the world's store of oil is controlled by or accessible to citizens of our own country.

WORK OF THE DIVISION, BY STATES.

ALABAMA.

Several points of large mineral production in northern Alabama were visited by the Director in September in company with the Association of American State Geologists.

The folios covering the Bessemer, Vandiver, Columbiana, and Montevallo quadrangles, in Alabama, have been reviewed and partly rewritten by Charles Butts, who revisited a number of critical points. Field observations of the older Paleozoic rocks in the Birmingham district, notably those of the Ordovician and Silurian systems, were made for regional correlation by E. O. Ulrich and Mr. Butts. Sections of the Mississippian series near Huntsville were examined under cooperative agreement by Stuart Weller to gain a better understand-

ing of the faunal and stratigraphic features of the Mississippian series in southeastern Missouri, southern Illinois, and western Kentucky.

Carboniferous fossils from the State were studied by G. H. Girty, and Tertiary fossils were examined and reported on, with correlations, by W. H. Dall and W. C. Mansfield. Tertiary corals were studied by T. W. Vaughan, and the fossil Foraminifera found in the drill cuttings at several localities were examined by Julia Gardner and J. A. Cushman. Tertiary Foraminifera from Alabama are described by Dr. Cushman in a report on American species of *Orthophragmina* and *Lepidocyclina*, now ready for distribution as Professional Paper 125–D.

The Upper Cretaceous flora of the State is described by E. W. Berry in Professional Paper 112, and a description of the fossil plants of the middle and upper Eocene formations, by the same author, is now in preparation for publication as a professional paper.

The older Tertiary, Eocene, and Oligocene Bryozoa of Alabama are described by F. Canu and R. S. Bassler in a monographic report prepared under the auspices of the Survey but issued as Bulletin 106 of the United States National Museum.

Some of the more valuable deposits of white clay in Alabama are described by Prof. Heinrich Ries in a report on high-grade clays of the eastern United States, now in preparation for publication as Bulletin 708.

The stratigraphy and structure of southeastern Alabama were examined by O. B. Hopkins to determine whether they are favorable to the occurrence of oil and gas. The conclusions, which are essentially negative, were contributed to the press.

A brief statement on the manganese deposits of the northern part of the State is incorporated in a report on the manganese deposits of the Southern States, transmitted by G. W. Stose for publication by the Tennessee Geological Survey.

ARIZONA.

A folio covering the Ray quadrangle, which includes the Ray, Troy, and other important mining districts in Arizona, was completed and submitted by F. L. Ransome, chief of the section of metalliferous deposits. A report on the copper deposits of the Ray and Miami districts, by Mr. Ransome, has been published as Professional Paper 115. Mr. Ransome has made substantial progress on a general report on the geology and ore deposits of Arizona.

A short report on some of the geologic features of the lower Gila region, by C. P. Ross, will be issued as a chapter of "Shorter contributions to general geology." A report on deposits of manganese ore

in Arizona, by E. L. Jones, jr., and F. L. Ransome, has been published as Bulletin 710–D.

Older Paleozoic fossils from several localities in the State were examined by Edwin Kirk, and Carboniferous fossils collected by Kirk Bryan were reported on by G. H. Girty. Shells from the Quaternary deposits were studied by W. H. Dall.

The stratigraphy of the Carboniferous rocks in the northwest corner of the State was examined by J. B. Reeside, jr., and Harvey Bassler in connection with a study of the geology of the Virgin City oil field.

Deposits of asbestos near the Roosevelt dam and near Young, Gila County, were examined by J. S. Diller and will be described in a report on the asbestos resources of the United States.

ARKANSAS.

The geology and the results of recent drilling for oil around Eldorado and Stephens, in the southeastern part of Arkansas, were briefly examined by K. C. Heald, whose chief conclusions were issued in press-bulletin form.

A part of the Batesville district was examined by H. D. Miser, who submitted a preliminary and a detailed report on the deposits of manganese ore of the district. The preliminary report is to be published as Bulletin 715–G. The detailed report is now in preparation for publication as a complete bulletin. A paper entitled "Hausmannite in the Batesville district, Ark.," by Mr. Miser, was published in the Journal of the Washington Academy of Sciences. Mr. Miser has in preparation a report on graywacke in the DeQueen quadrangle, Arkansas and Oklahoma.

In response to a request from the Commission of Mines, Manufactures, and Agriculture of Arkansas, a short general description of the geology and topographic features of the State was prepared by Mr. Miser for publication in a State bulletin entitled "Outline of the geology, mineral resources, and soils of Arkansas."

Fossil plants from the middle and upper Eocene formations of the State are described by E. W. Berry in a report on the Eocene floras of southeastern North America, to be published as a professional paper. Eocene Bryozoa are described by F. Canu and R. S. Bassler in a monographic report prepared for the Survey and now in process of publication as Bulletin 106 of the United States National Museum. Eocene invertebrates from the State were examined by W. H. Dall, and the study of the fauna of the Morrow formation was continued by G. H. Girty. Silurian fossils were collected at several places in the State by R. D. Mesler.

Sunken and swamp lands in the eastern part of Arkansas were examined by E. W. Shaw for the Department of Justice.

A reprint of Bulletin 691–J, entitled "Asphalt deposits and oil conditions in southwestern Arkansas," by H. D. Miser and A. H. Purdue, has been issued.

A summary of the manganese deposits in Arkansas is given in a paper on the manganese deposits of the Southern States, by G. W. Stose, to be published by the Tennessee Geological Survey.

CALIFORNIA.

Studies of the geology and oil resources of the Los Angeles-Ventura area, California, were continued by W. S. W. Kew, who examined in detail the geology of the Montebello and Rapetto Hills oil fields. Detailed mapping was carried on by Mr. Kew in parts of the Fernando quadrangle and in the Pasadena quadrangle. The foothills east of Los Angeles River and south of the San Gabriel Mountains and San Gabriel Valley in the Pasadena quadrangle were critically examined. A report on the oil resources of the Los Angeles-Ventura region was completed and submitted by Mr. Kew. Areas in Imperial and San Diego counties in which indications of oil were reported to occur were visited by Mr. Kew, who promptly communicated to the press his conclusions as to the possibilities of finding oil there.

Under the general title "The Sunset-Midway oil field, California," two papers entitled "Geology and oil resources" and "Geochemical relations of the oil, gas, and water," by R. W. Pack and G. S. Rogers, respectively, have been issued as Professional Papers 116 and 117.

A paper on the geology and possible oil regions of northwestern Kern County, by W. A. English, is now in press as Bulletin 721. The demand for information respecting the geology of possible oil regions in the State has been so great that a reprint of Bulletin 691–H, on the Salinas Valley-Parkfield area, has been published.

Magnesite deposits at Hewett were examined by R. W. Stone, who is preparing a general report on the magnesite deposits of the United States.

Glacial and physiographic studies in the Yosemite region, including a study of the origin and history of the Yosemite Valley, were continued by F. E. Matthes, who early in July delivered three lectures on the history of the Yosemite Valley in the LeConte Memorial lecture course. These lectures are to be published by the National Park Service. A general report on the valley, designed for publication as a popular bulletin, has been prepared by Mr. Matthes in collaboration with F. C. Calkins, who contributed a description of the bedrock geology. Under the name "Coxcomb Crest," Mr. Matthes describes, in a paper published unofficially, a newly differentiated topographic form in the Yosemite region.

Reports on chromium and manganese ores in parts of California, by Prof. G. D. Louderback, of the University of California, are in preparation for publication. A report on deposits of manganese in southeastern California, by E. L. Jones, jr., has been published as Bulletin 710–E, and a paper on chromite in the Klamath Mountains has been prepared by J. S. Diller and transmitted for publication.

Reported nitrate deposits near West Well, in San Bernardino County, were examined by L. F. Noble, who, on his return from work in the Hawaiian Islands, resumed the preparation of his report on the nitrate deposits of California. A report on nitrate deposits in the Amargosa region, by L. F. Noble and G. R. Mansfield, has been transmitted for publication.

Tertiary and Quaternary fossils from California were examined and reported on by W. H. Dall, who is engaged in a comprehensive study of the invertebrate faunas of the Tertiary formations of the Pacific coast.

COLORADO.

The study of the origin, composition, and history of the igneous and metamorphic rocks of the San Juan region, in Colorado and New Mexico, was continued by Whitman Cross and E. S. Larsen, jr., assisted by C. S. Ross, who resumed field investigations in May. Progress has been made in the general monographic description of the region. The study of the Mesozoic and later formations and of the physiographic history of the region is being continued by Prof. W. W. Atwood, who, with R. F. Webb and P. E. James, geologic aids, resumed field work in June.

The Twentymile Park district of the Yampa coal field, Colorado, was examined for the classification and valuation of the lands by M. R. Campbell, who has nearly completed an economic report on the area. Mr. Campbell also visited several points on the Denver & Rio Grande Route in order to describe them in his guide to the railroad from Denver to Salt Lake, which was submitted by him for publication as a bulletin.

A short report on some deposits of manganese ore in Colorado, by E. L. Jones, jr., has been published as Bulletin 715–D.

Several points in the oil-shale region of the Uinta Basin were visited by Harvey Bassler, who made some progress in the study of the origin of the shales.

A strip along the southern border of the State, embracing those parts of the Trinidad coal field that border the Raton and Brilliant quadrangles, is described by W. T. Lee in the geologic folio covering those quadrangles, which has been submitted in revised form for publication. A report on the geology and ores of Creede, Colo., by

W. H. Emmons and E. S. Larsen, jr., is now in preparation for publication as Bulletin 718.

A monograph on the flora of the Denver formation is in preparation by F. H. Knowlton. "A dicotyledonous flora in the type section of the Morrison formation" is the title of an unofficial publication by Mr. Knowlton. The Cretaceous formations of the South Platte Valley east of Greeley and in the foothill region from Fort Collins north to the Wyoming line were studied in May and June by T. W. Stanton, and the Animas formation, in the southwestern part of the State, was examined by J. B. Reeside, jr. Material on the geology of the Red Mesa quadrangle was compiled by A. J. Collier. A paper on the pre-Cambrian rocks of Gunnison River, by J. F. Hunter, jr., and one on the geology and fuel resources of the Axial and Monument Butte quadrangles, in Moffat County, by E. T. Hancock, have been transmitted for publication as bulletins.

CONNECTICUT.

Additional field work in the lime belt of western Massachusetts and Connecticut and parts of eastern New York was done by T. Nelson Dale, and a progress report on the work has been submitted for publication as a bulletin of the Survey.

The granites of Connecticut are described by Mr. Dale in a manuscript on the commercial granites of New England, transmitted for publication as a bulletin. The peats are reviewed with reference to their distribution, composition, amount, and adaptability for use as fuels or fertilizers by E. K. Soper and C. C. Osbon in a manuscript on the occurrence and uses of peat in the United States, also transmitted for publication.

DELAWARE.

Parts of Delaware were visited by W. T. Lee to gather material for the geographic handbook covering Maryland, Delaware, and the Virginias. The chapter relating to the Coastal Plain region was submitted by Mr. Lee in June. The terraces in the "fall line" zone were reviewed by M. R. Campbell and Laurence LaForge for the same handbook in a study of the physiographic history of the Susquehanna region around Havre de Grace.

A folio on the Elkton and Wilmington quadrangles, an area that lies partly in Maryland and Pennsylvania, is now in press as Folio 211.

FLORIDA.

In conformity with the request of the State Public Health Office at Jacksonville, Fla., an investigation was made and a report submitted by C. P. Ross on the water conditions in the vicinity of Miami, and at the request of the United States Public Health Service certain

of the Florida keys were examined by J. S. Brown to determine the quality and the amount of the water supply.

Structural studies of parts of the State were made by C. Wythe Cooke, and notes based upon field observations of the structure as it may affect the possible occurrence of oil and gas were compiled by O. B. Hopkins and communicated to the State geologist, who gave a summary of Mr. Hopkins's conclusions to the press.

Samples of a well boring at Chipley and fossils collected at other places have been studied by J. A. Cushman, C. Wythe Cooke, Julia A. Gardner, and W. C. Mansfield. The lower Miocene Foraminifera and the species of *Operculina* and *Heterostegina* of the State are described in two papers by J. A. Cushman, submitted for publication as Professional Papers 128–B and 128–E. A paper by Dr. Cushman on American species of *Orthophragmina* and *Lepidocyclina* (Professional Paper 125–D) contains descriptions of species from Florida. A paper entitled "Some relationships of the Foraminifera of the Bryam calcareous marl," by Dr. Cushman, was published in the Journal of the Washington Academy of Science, and a description of the fossil Mollusca of the Alum Bluff formation, by Julia A. Gardner, is being prepared for publication. The fossil Bryozoa of the State are described in two monographic reports by F. Canu and R. S. Bassler, one on the lower Tertiary and one on the upper Tertiary Bryozoa of North America, both prepared under the auspices of the Survey but to be published as bulletins of the United States National Museum. Miocene fossils from several points in the State were examined by W. H. Dall.

The high-grade clays of Florida are described by Heinrich Ries, W. S. Bayley, and others in Bulletin 708, entitled "High-grade clays of the eastern United States," now nearly ready for publication.

GEORGIA.

Foraminifera belonging to the fossil genera *Operculina* and *Heterostegina* are described by J. A. Cushman in Professional Paper 128–E, which is now in press, and the genera *Orthophragmina* and *Lepidocyclina* are described in Professional Paper 125–D, already published. The Eocene and lower Oligocene Bryozoa of Georgia are described by F. Canu and R. S. Bassler in a report entitled "North American early Tertiary Bryozoa," being published as Bulletin 106 of the United States National Museum. Fossil Mollusca of the Alum Bluff formation are described by Julia A. Gardner in a manuscript now being prepared for publication. Material from a well near Fitzgerald was paleontologically examined by W. C. Mansfield.

The geologic structure of a part of the Coastal Plain region of Georgia was briefly studied by C. Wythe Cooke. Data showing the geologic structure of a part of southern Georgia so far as it may

affect the ocurrence of oil and gas were compiled by Oliver B. Hopkins and transmitted to the State geologist. Samples of well borings, including fossils, from Waycross, Ga., were examined and reported on by J. A. Cushman for identification and correlation of the formations.

A valuable contribution to the botanic history of the State, by E. W. Berry, was published as Professional Paper 112, entitled "Upper Cretaceous floras of the eastern Gulf region in Tennessee, Mississippi, Alabama, and Georgia."

The manganese deposits of the Cartersville district are briefly described in a paper by G. W. Stose, to be published in a technical journal.

IDAHO.

In cooperation with the Idaho State Bureau of Mines and Geology, the study of the geology and ore deposits of the Seven Devils district, along Snake River, was begun in the season of 1919 by F. B. Laney for the United States Geological Survey and D. C. Livingston for the State, Mr. Laney being in charge particularly of the geologic examination of the ore deposits. Mr. Laney collaborated with Mr. Livingston in the preparation of a preliminary report on the district, for publication by the State, and in April, 1920, began to extend his investigations into adjacent territory in Oregon. The final results of the cooperative studies will be published as a professional paper of the United States Geological Survey.

A report on the geology and ore deposits of Idaho, which was in preparation by J. B. Umpleby and E. L. Jones, jr., was left unfinished by these geologists at the time of their resignation. Some of the results of their field examinations, however, have been published in reports on individual districts and counties, and include also a manuscript report by J. B. Umpleby, entitled "The ore deposits of Shoshone County, Idaho, with particular reference to the Coeur d'Alene district," which will be published as a bulletin. The notebooks of Messrs. Umpleby and Jones, covering their field work in central Idaho, have been loaned to the Idaho bureau for use by Prof. Livingston in preparing for State publication a report on the mining districts of that part of the State. A report on a reconnaissance of the Pine Creek district, by E. L. Jones, jr., has been issued as Bulletin 710–A.

Economic data on four townships in southeastern Idaho that had been withdrawn as of possible value for deposits of phosphate were prepared by G. R. Mansfield for use in the classification of the land. A report on the economic geology of the Fort Hall Reservation, by Mr. Mansfield, is in press as Bulletin 713.

A report on the geology, geography, and mineral resources of a part of southeastern Idaho, embracing the Wayan, Cranes Nest, Montpelier, Randolph, Crow Creek, Lanes Creek, Slug Creek, and Portneuf quadrangles, has been brought to an advanced stage by Mr. Mansfield. Papers on the Triassic and Jurassic formations of southeastern Idaho, the igneous geology of southeastern Idaho, the Wasatch and Salt Lake formations of southeastern Idaho, and types of Rocky Mountain structure in southeastern Idaho have been transmitted by Mr. Mansfield for unofficial publication. Carboniferous fossils collected by Mr. Mansfield and others were studied by G. H. Girty.

A report on the Yellow Pine cinnabar district, Idaho, by E. S. Larsen, jr., and D. C. Livingston, has been published as Bulletin 715–E, and a short paper on coal in eastern Idaho, by Mr. Mansfield, is in press as Bulletin 716–F.

A report on oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah, by D. Dale Condit, was published as Bulletin 711–B.

ILLINOIS.

Certain phases of the loess and associated clays near Belleville, Ill., were the subject of a conference held in July between Frank Leverett and E. W. Shaw, of the United States Geological Survey, and M. N. Leighton and Stuart Weller, of the Illinois Geological Survey. The facts to be set forth in a joint cooperative report on Hardin County, to be published by the State, were reviewed in the field by Charles Butts and Mr. Weller, the authors of the report.

The New Athens and Okawville quadrangles are mapped and described in detail in Folio 213 of the Geologic Atlas, the maps for which are now in the proof stage.

The regions of cement production in Illinois were visited by E. F. Burchard.

INDIANA.

A report by G. F. Loughlin, describing the characteristics of the Indiana limestone and differentiating the quarry output by grades, is now in progress, the work being done in cooperation with the Supervising Architect of the Treasury, the Bureau of Standards, and the Indiana Quarrymen's Association.

Field studies of the stratigraphy and paleontology of the Mississippian series at several places in Indiana, including Spergen Hill, for purposes of correlation, were made by E. O. Ulrich and Charles Butts.

The peat deposits of Indiana are briefly described with reference to their use as fuels or fertilizers in a report by E. K. Soper and C. C. Osbon entitled "Occurrence and uses of peat in the United States," transmitted for publication as a bulletin.

IOWA.

A reconnaissance study of the glacial deposits of western Iowa was made in the season of 1919 by W. C. Alden with the special object of obtaining criteria for differentiating the older drifts in that State and in eastern Nebraska. A preliminary report on the Quaternary deposits of the region has since been prepared by Mr. Alden.

The Upper Cretaceous sections at a number of points in the western part of the State were examined in the spring of 1920 by T. W. Stanton in cooperation with the assistant State geologist, J. H. Lees.

The gypsum deposits of the State are described by R. W. Stone in Bulletin 697, entitled "Gypsum deposits in the United States."

KANSAS.

A report describing the stratigraphy, geologic structure, and oil resources of the Eldorado district, Kansas, with special reference to the conditions of occurrence of the oil and gas, has been prepared by A. E. Fath for publication by the State Geological Survey, in cooperation with which the investigations were made. Drill cuttings from the district were paleontologically examined by P. V. Roundy. The regional distribution, the trend, and the mode of occurrence of the anticlines and faults in the oil fields of eastern Kansas are described by Mr. Fath in Professional Paper 128–C, under the title "The origin of the faults, anticlines, and buried[6] granite ridge, of the northern part of the Mid-Continent oil and gas field."

The fossil flora of the Cheyenne sandstone is being studied by E. W. Berry, and some Carboniferous fossils collected by C. S. Prosser in the eastern part of the State were studied and arranged by G. H. Girty.

A folio covering the Syracuse and Lakin quadrangles is in press and nearly ready for publication as Folio 212 of the Geological Atlas.

The gypsum deposits of the State are described by R. W. Stone in Bulletin 697, "Gypsum deposits of the United States."

The distribution, mode of occurrence, and amount of helium available in the natural gas of Kansas are discussed by G. S. Rogers in a report on "Helium-bearing natural gas," now in press as Professional Paper 121. This paper contains also data on structure and stratigraphy that will make it valuable to the oil operators of the State.

KENTUCKY.

The study of the stratigraphy and history of the Mississippian formations in central Kentucky was undertaken by Charles Butts. This work includes the mapping of the principal divisions over an

area of more than 400 square miles and is a part of the mapping of the entire Mississippian series about the Cincinnati axis, undertaken in cooperation with the State Geological Survey. The Mississippian formations were examined also in the vicinity of Lebanon Junction and at Colesburg and farther east through Bullitt, Hardin, Marion, Taylor, Boyle, and Pulaski counties. A report on the structure and oil resources of Barren County was prepared by Mr. Butts and has been issued as a bulletin of the State Survey.

Special studies at the Warsaw horizon of the Mississippian series were made by Charles Butts, and data were collected for more exact correlation with beds supposed to be contemporaneous in Indiana, Tennessee, and Alabama.

The coal at a number of mines near Tug River, in eastern Kentucky, was sampled by J. D. Sears to determine its quality and to procure carbonization data defining the possible southeastern boundary of the Appalachian oil field.

The white clays of the western part of the State are described by Prof. Heinrich Ries in a report entitled "High-grade clays of the eastern United States," now in preparation for publication as Bulletin 708.

LOUISIANA.

In response to a request from the city of Shreveport, La., an investigation of the natural-gas reserves possibly available for the use of that city was made by E. W. Shaw, whose informal and brief report transmitted to the Commissioner of Public Utilities of Shreveport was printed by the local papers. The gas resources of the State were further considered in connection with the cooperative examination of the gas supplies tributary to the city of Dallas, Tex.

In cooperation with several of the oil companies, drill cuttings and fossils obtained from a number of wells in Louisiana were examined for the purpose of identifying and correlating so far as possible the formations penetrated by the drill. In these examinations J. A. Cushman identified the Foraminifera, M. I. Goldman studied the chemical and mechanical constitution of the rock, and W. H. Dall and W. C. Mansfield attempted the correlation. Foraminifera of the genera *Orthophragmina* and *Lepidocyclina* are described by Dr. Cushman in a report published as Professional Paper 125-D. The Eocene Bryozoa of the State are described by F. Canu and R. S. Bassler in a report now being published as Bulletin 106 of the United States National Museum. Cretaceous and Tertiary invertebrates from the State were examined by T. W. Stanton and W. H. Dall, respectively.

MAINE.

The geographic features of Maine are described by Arthur Keith in the handbook of New England geography, the manuscript for which is nearly completed. The text will be accompanied by a new map in which the topography is shown in 100-meter contours.

The peat deposits of Maine are described by E. K. Soper and C. C. Osbon, with special reference to their utilization as fuels or in the manufacture of fertilizers, in a bulletin entitled "Occurrence and uses of peat in the United States," transmitted for publication, and the granites of the State are discussed by T. Nelson Dale in a bulletin on the commercial granites of New England, now in hand.

MARYLAND.

The metamorphic and Paleozoic region of Baltimore County, Md., including parts of the Ellicott, Parkton, Westminster, Baltimore, Gunpowder, Laurel, and Relay quadrangles, was studied by E. F. Bliss in cooperation with A. I. Jonas, of the State Geological Survey. Reconnaissance studies of the crystalline schists of Carroll, Howard, and Frederick counties were made in order to ascertain the general relations of the rocks in these areas to those in Baltimore County. Conferences for the field comparison of the Paleozoic beds of this region with those in southern Pennsylvania were held by G. W. Stose, E. F. Bliss, and A. I. Jonas. A report on the geology of the crystalline schists of Baltimore County is now in preparation by Mrs. E. B. Knopf (formerly Miss Bliss) and Miss Jonas.

A manuscript by Mrs. Knopf on the chrome ores of southeastern Pennsylvania and Maryland has been submitted for publication, and a folio by Dr. F. Bascom describing and mapping in detail the geology of the Elkton and Wilmington quadrangles (Folio 211), is now in press.

The problem of providing an adequate supply of artesian water for the naval proving ground and powder plant at Indian Head was investigated by C. W. Cooke.

Geographic data relating in particular to the interstream areas of the Coastal Plain region were collected by W. T. Lee for inclusion in the chapter of the geographic handbook on the Coastal Plain region of Maryland, Delaware, and Virginia.

The Tertiary Bryozoa of the State are described by F. Canu and R. S. Bassler in a report in course of publication by the United States National Museum. Extensive collections of Tertiary and Pleistocene fossils were made by W. C. Mansfield at Cornfield Harbor, Langleys Bluff, and Chancellors Point, and other collections from beds of the same age at several points were studied by W. H. Dall.

The type collection of the flora of the Potomac formation was classified and relabeled by E. H. Knowlton and T. E. Williard.

The white clays of the State are treated by Heinrich Ries in a general report by Ries, Bayley, and others entitled "High-grade clays of the eastern United States," to be published as Bulletin 708.

MASSACHUSETTS.

The dolomitic and calcitic limestone belts in the Stockbridge limestone areas of western Massachusetts were mapped in detail by T. Nelson Dale for description in a bulletin on the lime-producing belt of western Massachusetts and Connecticut now in preparation. A paper on the evidence of a local unconformity between the Berkshire schist and Stockbridge limestone, in the vicinity of Adams, was prepared by Mr. Dale for unofficial publication. The granites of the State are described by Mr. Dale in his forthcoming bulletin on the commercial granites of New England.

A report on the geology of Cape Cod and the islands off the coast of Massachusetts by J. B. Woodworth has been submitted for publication. Quaternary shells from the region were examined by W. H. Dall.

Local examinations were made at several points in the metamorphic area of the State by G. F. Loughlin.

The geographic features of the State are described by Arthur Keith in the manuscript, now nearly completed, entitled "A handbook of the geography of New England." The Connecticut Valley is treated by Prof. W. M. Davis, of Harvard University.

The peat deposits of the State are briefly described, with special reference to their utilization as fuels or in the manufacture of fertilizers, in a paper by E. K. Soper and C. C. Osbon, entitled "Occurrence and uses of peat in the United States," which will be published as a bulletin of the Survey.

A paper on the igneous rocks of Essex County, Mass., by Prof. C. H. Clapp, is now in press as Bulletin 704.

MICHIGAN.

Reconnaissance mapping of the glacial features and shore lines of the northern peninsula of Michigan, in Menominee County and parts of Delta and Chippewa counties, including Drummond Island, and detailed mapping of the surface geology in those parts of the southern peninsula that embrace the Perrinton, Elsie, Chesaning, Burt, St. Charles, Saginaw, and Bay City quadrangles have been carried on by Frank Leverett. This work, which included examinations of swamp and cut-over lands and agricultural conditions, was done in cooperation with the Michigan Geological Survey. At the request

of the Michigan Highway Department, Prof. Leverett devoted a part of the year to the examination of glacial material suitable for road building. Papers on waste lands and on the glacial geology of Michigan were presented by Prof. Leverett before the Michigan Academy of Sciences.

The gypsum resources of the State are described by R. W. Stone in a report entitled "Gypsum deposits of the United States," now in press as Bulletin 697, and the peats are briefly described with reference to their value for use as fuels or in fertilizers by E. K. Soper and C. C. Osbon in a general report entitled "Occurrence and uses of peat in the United States," to be published as a bulletin.

MINNESOTA.

A report on the moraines and shore lines of the part of the Lake Superior basin that lies within the United States has been prepared by Prof. Frank Leverett.

The Herman, Barrett, Chokio, and Morris quadrangles, which include parts of Grant and Stevens counties, Minn., are mapped and described in detail by F. W. Sardeson in Folio 210 of the Geologic Atlas.

Further investigations of the Cuyuna range and work in the preparation of the final report thereon have been suspended on account of the resignation of E. C. Harder, geologist in charge of the project. A preliminary report on the range has been published by the State, in cooperation with which the studies were carried on. A report by Mr. Harder, entitled "Iron-depositing bacteria and their geologic relations," published as Professional Paper 113, is in large part based on these investigations, which, like the studies of the peat and glacial formations, were undertaken in cooperation with the State Geological Survey.

A report on the clays and shales of Minnesota by F. F. Grout, with contributions by E. K. Soper, has been published as Bulletin 678.

MISSISSIPPI.

The ground-water resources of Mississippi were the subject of special field examinations during the season of 1919 by L. W. Stephenson. The manuscript of the geologic part of Mr. Stephenson's report, which is cooperative, is practically complete. The preparation of the geologic map to accompany this report required studies of the stratigraphy by C. W. Cooke and of the paleontology by J. A. Cushman. A report by Dr. Cushman on the Foraminifera of the Byram marl has been submitted for publication. Fossil Mollusca from the same formation have been studied by Julia Gardner, and the stratigraphy has been studied by C. W. Cooke, both of whom pre-

pared contributions on the paleontology of the Byram marl. The work is done in cooperation with the State Geological Survey.

The American species of Foraminifera belonging to the genera *Orthophragmina* and *Lepidocyclina* are described by J. A. Cushman in Professional Paper 125–D, and the Upper Cretaceous flora of the State is described by E. W. Berry in Professional Paper 112. A report by Mr. Berry on the fossil plants of the middle and upper Eocene formations is awaiting publication.

Eocene and Oligocene Bryozoa from several localities are described by F. Canu and R. S. Bassler in Bulletin 106 of the United States National Museum.

The white clays at several points in Mississippi are discussed by Prof. Heinrich Ries in a general report on "High-grade clays of the eastern United States," to be published as Bulletin 708.

MISSOURI.

The older Paleozoic formations at a number of points in Missouri were examined by E. O. Ulrich, with the assistance of R. D. Mesler, who made collections of fossils for paleontologic investigation and interstate correlations. A small Pennsylvanian fauna from the State was described by G. H. Girty.

MONTANA.

A reconnaissance examination of the Poplar dome, in Montana, was made by W. T. Thom, jr., and W. P. Woodring in connection with the geologic mapping, with special reference to the classification, of the lignite-bearing lands in central Dawson County.

The results of examinations of the stratigraphy and structure in the Crow Indian Reservation, made in preceding years by C. H. Wegemann, R. W. Howell, and C. K. Wentworth with particular reference to the possible occurrence of oil, gas, and coal, have been considered by Messrs. Wegemann and Wentworth, and the conclusions reached have been embodied in a manuscript now in preparation for publication.

A paper entitled "Oil and gas geology of the Birch Creek-Sun River area, northwestern Montana," by Eugene Stebinger, published as Bulletin 691–E, has been reprinted to meet the demand for descriptions of prospective oil lands in the State.

The practicability of obtaining oil by the distillation of carbonaceous beds in the Permian and Tertiary series is discussed by D. Dale Condit in a paper entitled "Oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah," published as Bulletin 711–B.

A report on the Scobey lignite field in Montana was prepared by A. J. Collier for publication as a bulletin.

A brief report on phosphate rock near Maxville, Mont., was prepared and transmitted by J. T. Pardee for publication as Bulletin 715–J.

The manganese ore deposits of Montana, with those of Utah, Washington, and Oregon, are treated in a report by Mr. Pardee, now ready to be submitted for publication. A paper on iron ore near Stanford, Mont., by L. G. Westgate, has been published as Bulletin 715–F.

A report by Prof. Westgate on chromite deposits in Stillwater and Sweetgrass counties, Mont., is ready for submission.

The fauna of the Eagle formation has been under study by J. B. Reeside, jr., and Cretaceous fossils from several localities have been studied by T. W. Stanton. Carboniferous invertebrates were identified by G. H. Girty.

A report entitled "Geology and oil and gas prospects of the Huntley field, Mont.," by E. T. Hancock, has been published as Bulletin 711–G.

A report entitled "Gradations from continental to marine conditions of deposition in central Montana during the Eagle and Judith River epochs," by C. F. Bowen, was published as Professional Paper 125–B.

Data for use in the preparation of a geologic map of Montana were compiled by J. D. Sears and will be contributed to the State Bureau of Mines and Metallurgy.

The reconnaissance examination of the glacial deposits of the foothills and plains regions, which was discontinued during the war, was resumed in May by W. C. Alden, who has in preparation a report on the Quaternary geology of the Glacier National Park and northern Montana.

NEBRASKA.

Field examinations of the Pleistocene deposits in northeastern Nebraska were made by W. C. Alden with the cooperation of the State geologist. The results will be embodied in a report on the Pleistocene of eastern Nebraska and western Iowa, now in preparation by Mr. Alden.

The type sections of the Dakota sandstone and Niobrara limestone and other associated Cretaceous formations in eastern Nebraska were studied by T. W. Stanton in May and June.

A paper on the potash resources of Nebraska, by W. B. Hicks, in press as Bulletin 715–I, describes the potash-bearing lake basins of the State and discusses the value of the deposits.

NEVADA.

The Manhattan district, in Nevada, which is the subject of an uncompleted report by H. G. Ferguson, was revisited by him in June to determine the results of recent mining development and to supplement the previous observations of the intricate and interesting structure of the region.

The examinations of the Divide district were completed in August by Adolph Knopf, who visited also the Rochester and Round Mountain districts. A report on the Divide district has been submitted by Mr. Knopf for publication as Bulletin 715–K.

Additional field examinations were made by F. C. Schrader in the Carson Sink quadrangle in order to obtain the latest field data for his report on the quadrangle.

The deposits of oil shale at Elko and several other points in northern Nevada are described and mapped by J. P. Buwalda in a report now ready to be submitted for publication.

A short report by J. T. Pardee and E. L. Jones, jr., on deposits of manganese ore in Nevada was published as Bulletin 710–F.

NEW HAMPSHIRE.

The handbook on the geography of New England, now practically completed by Arthur Keith, will describe the geographic features of New Hampshire and will give special consideration to their origin.

The granites of New Hampshire are described by T. Nelson Dale in a bulletin on the commercial granites of New England, now in hand, and the peat deposits are reviewed by E. K. Soper and C. C. Osbon, with special reference to their use as fuels or in fertilizers, in a general bulletin on the occurrence of peat in the United States, also in hand.

NEW JERSEY.

A discussion of the general geology and origin of the ore deposits at Franklin Furnace and Sterling Hill, N. J., has been prepared by A. C. Spencer for inclusion in a report by Dr. Charles Palache on the minerals of Franklin Furnace.

The peat resources of the State are briefly reviewed, with special reference to their value as fuels or in the manufacture of fertilizers, by E. K. Soper and C. C. Osbon, in a bulletin on the occurrence and uses of peat in the United States, transmitted for publication.

NEW MEXICO.

A report on the ore deposits of the Mogollon district, N. Mex., is in preparation by H. G. Ferguson, who revisited the district in June to obtain further details and to note the results of recent develop-

mental exploration. The report will be published as Bulletin 715–L. A report by Sidney Paige on the copper deposits of the Tyrone district has been submitted for publication as a professional paper.

Progress in the preparation of a report on the ore deposits of the Santa Rita district was made by A. C. Spencer.

A brief report on the molybdenum mines near Questa was prepared by C. S. Ross, and a report on deposits of manganese ore in New Mexico, by E. L. Jones, jr., has been published as Bulletin 710–B.

Coal lands in the region around Gallup were examined during the season of 1919 by J. D. Sears, with the assistance of E. S. Bleecker, for the purpose of determining the number and extent of the coal beds in the region and to obtain data for the classification of the lands. A brief examination was made by Mr. Sears of the local stratigraphy and of the results of recent tests for oil in the Seven Lakes district, in eastern McKinley County. Reconnaissance inspection was also made of oil indications near Battle Mesa and Zuni.

A report by N. H. Darton on the geologic structure of parts of New Mexico, transmitted for publication, describes the major structural features of the State and the regional stratigraphy for the use of the oil geologist.

A report on the geology and oil prospects of Alamosa Creek valley, in Socorro County, by D. E. Winchester, has been published as Bulletin 716–A.

A report on coal in San Juan County, by C. M. Bauer and J. B. Reeside, jr., is in course of publication as Bulletin 716–G.

The stratigraphy, the areal distribution, and the history of the deposition of the salt-bearing "Red Beds" of New Mexico are described in a report by N. H. Darton on the Permian salt deposits of the southwestern United States, to be issued as Bulletin 715–M. The field investigations were made in connection with the search for potash. Additional field examinations, resulting in greater refinement in mapping, were made for the revision of the geologic map of New Mexico, prepared by Mr. Darton to accompany this report.

The gypsum resources of the State are described by R. W. Stone in Bulletin 697, which is a general description of the gypsum deposits of the United States, now in press. A magnesite deposit and the Great Eagle fluorspar mine, 30 miles north of Lordsburg, were examined by Mr. Stone.

The text of a folio describing in detail the geology of the Brilliant, Raton, and Koehler quadrangles was revised by W. T. Lee after he had made further examinations of parts of the area. The maps for the folio are being engraved. Mr. Lee has submitted also a special report on the coal resources of the Raton coal field for publication as a bulletin. An article entitled "Notes on the Manzano group,

New Mexico," has been transmitted by Mr. Lee for outside publication.

Rapid reconnaissance examinations of parts of the Taos, Abiquiu, Gallina, Santa Clara, and Jemez quadrangles were made by E. S. Larsen, jr., and C. S. Ross, and local studies were carried on by Whitman Cross in the Jemez Mountains, the Pajarito Plateau, and the Rio Grande canyon to ascertain the source and the time relations of certain basalts and rhyolites of San Luis Valley, Colo.

The Cretaceous and early Tertiary formations flanking the San Juan Mountains were examined in the spring of 1920 by J. B. Reeside, jr., with the assistance of C. E. Dobbin, for the purpose of obtaining data for the more exact correlation of the formations and ascertaining their relations to the igneous history of the San Juan region.

Fossils from the early Paleozoic, the Carboniferous, and the Cretaceous formations of the State were examined by Edwin Kirk, G. H. Girty, and T. W. Stanton, respectively, and Tertiary and Quaternary Mollusca were examined by W. H. Dall.

A description by C. W. Gilmore of the reptilian faunas of the Torrejon, Puerco, and underlying Upper Cretaceous formations of San Juan County has been published as Professional Paper 119.

NEW YORK.

A report on the structure of the Taconic Range, in New York, is in an advanced stage of preparation by Arthur Keith.

The Trenton and Black River sections in the central part of the State were examined by E. O. Ulrich in cooperation with Dr. R. Ruedemann, of the State Geological Survey.

The dolomitic and calcitic limestone belts in the towns of Dover and Amenia, Dutchess County, were mapped in detail by T. Nelson Dale and are described in a manuscript report by him on the lime-producing belts of western Massachusetts and Connecticut and eastern New York.

The peat resources of the State are summarized in a general report by E. K. Soper and C. C. Osbon on the occurrence and uses of peat in the United States, to be published as a bulletin.

NORTH CAROLINA.

The investigation of the iron-ore deposits of North Carolina, made in cooperation with the North Carolina Geological and Economic Survey with the object of preparing a report for publication by that Survey, was continued by W. S. Bayley in June. A report by J. Volney Lewis on deposits of chrome ore in North Carolina is ready for transmission for publication.

The results of the study of the limestones of the State are embodied in a report by G. F. Loughlin, transmitted for publication by the State geologist, in cooperation with whom the work was done.

The mica resources of the State are described in a report on the mica deposits of the United States, by D. B. Sterrett, submitted for publication as a bulletin.

Bryozoa of early Tertiary and late Tertiary age collected at many places in the State are described by F. Canu and R. S. Bassler in reports prepared under the auspices of the Survey but now being published as bulletins of the United States National Museum.

The peat resources of the State are briefly described in a general report by E. K. Soper and C. C. Osbon on the occurrence and uses of peat in the United States, transmitted for publication as a bulletin of the Survey, and in a special paper entitled "Peat in the Dismal Swamp, Virginia and North Carolina," by Mr. Osbon, issued as Bulletin 711–C.

The manganese deposits of the State are briefly described in a paper by G. W. Stose on the manganese deposits of the Southern States in a technical journal.

NORTH DAKOTA.

Coal lands in an area southwest of Missouri River between Mandan and the Fort Berthold Indian Reservation were examined for purposes of classification by A. J. Collier, who has in preparation an economic bulletin on the area. A report on the coals of the southwestern part of the Fort Berthold Indian Reservation, by C. M. Bauer, is under revision for publication. A report describing the New Salem lignite field, by E. T. Hancock, has been submitted for publication in "Contributions to economic geology."

A description of the fauna of the Cannonball marine member of the Lance formation, by T. W. Stanton, has been published as Professional Paper 128–A. The corals of the formation are described by T. W. Vaughan in the same paper.

The geologic conditions in the vicinity of wells drilled or to be drilled near Williston were inspected by W. T. Thom, jr., and W. P. Woodring.

The report on the Nesson anticline, Williams County, by A. J. Collier, published last year as Bulletin 691–G, has been reprinted.

OHIO.

The glacial deposits in the Cleveland, Berea, and Euclid quadrangles, Ohio, which are covered by the Cleveland folio, were in June reviewed by Frank Leverett, who is completing the part of the folio text relating to the Pleistocene deposits.

The mineral resources other than oil and gas of the Woodsfield and Summerfield quadrangles, in eastern Ohio, are described by D. Dale Condit in a report transmitted for publication as a bulletin.

OKLAHOMA.

The geologic structure of parts of Caddo County, Okla., including the Cement oil field, was, at the request of the Office of Indian Affairs, examined by Frank Reeves, who has submitted a report, with maps, on the structure and oil and gas prospects of the region for publication in " Contributions to economic geology."

A report on the geology and oil resources of T. 28 N., Rs. 11 and 12 E., in the Osage Reservation, has been submitted by M. I. Goldman and H. M. Robinson for publication as Bulletin 686–Y, and manuscript and maps covering T. 29 N., Rs. 11 and 12 E., have been nearly completed by Mr. Goldman. Chapters S to V, inclusive, of Bulletin 686 have been published during the year. Chapters B to L, inclusive, have been reprinted to meet an urgent demand for information as to the structure of this region.

Additional data concerning developments on the Osage lands were obtained by K. C. Heald on the occasion of his attendance, by request of the superintendent of the agency, at a sale of Osage land leases at Pawhuska, May 18. Bulletin 691–C, on the geologic structure of the northwestern part of the Pawhuska quadrangle, by Mr. Heald, was reprinted to supply a large demand.

At the request of the Department of Justice the physiographic features and recent changes in Red River in the vicinity of Grandfield, Okla., and Burkburnett, Tex., were studied by E. W. Shaw, in order to assist in determining the ownership of the land, which includes a part of the Burkburnett oil field, the ownership being dependent on the mode of lateral migration of Red River in the area.

The Bristow quadrangle was revisited by A. E. Fath to procure data embodying results of tests made subsequent to the publication by this Survey of structure maps of the quadrangle. The data are to be used by Mr. Fath in completing his report on the geology and oil and gas resources of the quadrangle.

The character and origin of the oil-bearing folds and of the faults in northeastern Oklahoma are discussed in a paper by Mr. Fath on certain geologic features of the northern part of the Mid-Continent oil and gas field, published as Professional Paper 128–C.

A report on the mode of occurrence, distribution, and quantity of helium in the natural gas of parts of northern Oklahoma, by the late G. S. Rogers, is now in course of publication as Professional Paper 121.

The stratigraphy and structure of the region bordering Red River on the south and embracing Madill are described with reference to

its possible content of oil in a paper by O. B. Hopkins, Sidney Powers, and H. M. Robinson, transmitted for publication in "Contributions to economic geology."

Sections of the older Paleozoic beds near Overbrook were examined by R. D. Mesler, and Carboniferous fossils of the Morrow formation were studied for publication by G. H. Girty.

The salt deposits of the "Red Beds" region are discussed by N. H. Darton in a report to be issued as Bulletin 715–M, and the gypsum deposits in a general report by R. W. Stone on the gypsum deposits of the United States, in press as Bulletin 697.

OREGON.

At the request of the Director of the Oregon Bureau of Mines and Geology, the Tertiary lake basins of the State east of the Cascade Mountains were examined by J. P. Buwalda, with special reference to the structure and the possible oil and gas content of the basins, particular attention being given to the areas of wildcat testing. A report by Mr. Buwalda on the results of the work is nearly ready for transmission for publication by the State, in cooperation with which the examinations were made.

The mining geology of the part of the Seven Devils mining district that lies in Oregon has been under examination by F. B. Laney in connection with a general investigation of the geology and ore deposits of the district in cooperation with the Idaho Bureau of Mines and Geology. A preliminary report by Mr. Laney and D. C. Livingston, representing the State, has been submitted for publication by the State. A more extended report on the geology and ore deposits of the region may later be prepared by these geologists for publication by the Survey as a professional paper.

A report on chromite deposits of eastern Oregon, by L. G. Westgate, transmitted for publication in "Contributions to economic geology," gives the results of war-mineral examinations made for the Survey by Prof. Westgate. The chromite ores of the Klamath Mountain region have been reported on by J. S. Diller, and the manganese deposits of the State are described and mapped in a bulletin on the manganese ores in Montana, Utah, Oregon, and Washington, by J. T. Pardee, transmitted for publication.

Invertebrate fossils of Cretaceous age collected in Oregon were examined by T. W. Stanton.

PENNSYLVANIA.

Field examinations of the northern third of the McCalls Ferry and Quarryville quadrangles, in southeastern Pennsylvania, were made by E. F. Bliss and A. I. Jonas, in conference with G. W. Stose,

for the purpose of establishing correlations between the formations in this area and those mapped by Mr. Stose in the less altered region farther northwest. The folio covering these quadrangles is now in preparation. The limestone-bearing areas of the Norristown and Germantown quadrangles also were visited by the party, in conference with Dr. F. Bascom, who has been engaged in mapping the geology of these quadrangles. Additional field observations were made in the New Holland, Lancaster, York, and Middletown quadrangles to correlate the quartzites and limestone of the Lancaster area with those to the southwest.

Some progress was made by Dr. Bascom on the texts covering the Coatesville and West Chester quadrangles. An article on peneplains of the Piedmont province in Pennsylvania has been transmitted by Dr. Bascom for outside publication.

Data bearing upon the later physiographic history of the Delaware Valley, near the southern border of the State, were gathered by M. R. Campbell and Laurence LaForge.

Arrangements have been made for the completion, with the cooperation of the State Geological Survey, of the work in the New Kensington quadrangle, begun in 1918 by G. B. Richardson, who was transferred to the division of mineral resources to take charge of the statistical work on petroleum.

The chrome ores of the southeastern part of the State are described in a report by E. B. Knopf submitted for publication.

A report by B. L. Miller on the economic geology of the Allentown quadrangle is ready for publication as Bulletin 707.

Popular descriptions of the nature and origin of the salient geographic features of the Punxsutawney and Curwensville quadrangles were prepared by G. H. Ashley for publication on the backs of the topographic maps of those quadrangles.

Several valuable clay deposits of the State are described by Heinrich Ries in a report on the high-grade clays of the eastern United States, to be published as Bulletin 708.

A narrow strip along the southern border of the State is covered in the Elkton-Wilmington folio, now in course of publication as Folio 211.

RHODE ISLAND.

A report on the geology of the islands off the coast of Rhode Island has been submitted by J. B. Woodworth for publication as a bulletin.

The granites of the State are described in a report by T. Nelson Dale on the commercial granites of New England prepared for publication as a bulletin.

SOUTH CAROLINA.

The preparation of a report on the geology and ground waters of the Coastal Plain region of South Carolina was continued by C. W. Cooke prior to his absence for a part of the year on account of private research in Mexico.

Bryozoa of early and late Tertiary age from several localities in the State are described by F. Canu and R. S. Bassler in bulletins published by the United States National Museum.

The peat deposits of the State are reviewed, with reference to their utilization in fertilizers or as fuels, by E. K. Soper and C. C. Osbon in a bulletin on the occurrence and uses of peat in the United States.

The manganese deposits of the State are briefly referred to in a report on the "Manganese deposits of the Southern States," by G. W. Stose.

SOUTH DAKOTA.

Cretaceous sections along the eastern margin of the Black Hills from Hot Springs to Rapid City, S. Dak., and on the plains in the valleys of Cheyenne River and Sage Creek were studied by T. W. Stanton. The fossil faunas of the Cannonball marine member of the Lance formation are described by Mr. Stanton in Professional Paper 128–.

The Newell folio (No. 209) was completed and published. The Black Hills folio, covering the Deadwood, Rapid, Harney Peak, and Hermosa quadrangles, is now in process of engraving.

A report by E. T. Hancock on the New Salem lignite field, Morton County, has been transmitted for publication in "Contributions to economic geology."

TENNESSEE.

In November W. O. Hotchkiss and Adolph Knopf spent a few days in the Ducktown copper district, Tennessee, to test the possibility of locating by the dip needle ore bodies that do not appear at the surface.

The studies of the manganese ore deposits of the State made in connection with examinations of war minerals were completed, and a report on the manganese ore deposits of the Southern States was prepared and submitted by G. W. Stose for publication in the Engineering and Mining Journal. Manganese deposits at several points in east Tennessee were further examined by Messrs. Stose and F. C. Schrader, and a comprehensive report on the manganese deposits of east Tennessee has been submitted for publication as a bulletin.

The marble-quarrying area near Knoxville is being mapped, both topographically and geologically, in great detail by K. K. Kimball, the maps to be incorporated in the cooperative bulletins (1) on the Holston marbles of east Tennessee, to be printed by the State Geo-

logical Survey, and (2) on the marble deposits of the southern Appalachian region, the greater part of which was compiled by T. Nelson Dale for publication by the United States Geological Survey.

The principal deposits of clays in western Tennessee are described by Prof. H. Ries in a report on high-grade clays in the eastern United States, now in preparation for publication as Bulletin 708.

Parts of the Waynesboro quadrangle were visited in June by H. D. Miser, to note recent economic developments. Mr. Miser has in preparation a report on the mineral resources of this quadrangle, which he mapped under a cooperative arrangement. An informal report by Mr. Miser on the brown ores of the region embracing this quadrangle was prepared for the War Department.

At the request of the State geologist, the stratigraphy and structure of parts of Sumner County were examined in cooperation with the State Geological Survey by K. F. Mather, whose report on the structure and oil prospects of the area examined is now in press as Bulletin 24 of the State Survey.

Certain of the early Paleozoic formations in east Tennessee were studied in June by E. O. Ulrich, Charles Butts, and R. D. Mesler. Eocene fossils from the State were examined by W. H. Dall.

In May brief paleontologic investigations were made in the Briceville and Rockwood quadrangles by David White, to determine whether coal measures of so late age as the Allegheny of the northern Appalachian coal field occur in deep basins in these quadrangles.

Comprehensive reports on the fauna and flora of the Ripley formation in western Tennessee have been submitted by Bruce Wade and E. W. Berry, respectively, for publication as a professional paper of the United States Geological Survey. The researches on which these reports are based were made in cooperation with the State Survey. A report by Prof. Berry on the Upper Cretaceous floras of the eastern Gulf region in Tennessee, Mississippi, Alabama, and Georgia has been published as Professional Paper 112.

TEXAS.

Observations of drilling in progress in the "Red Beds" region of Texas, with sampling of saline deposits and brines and the collection of well logs, was continued by Orby C. Wheeler as a part of the search for potash in the "Red Beds" region of the Southwest. This work was done in cooperation with the State University Bureau of Economic Geology and Technology. A report by Mr. Wheeler and W. B. Hicks on potash and bromine in the brines and samples from shallow borings in and about the alkali lakes in Linn, Terry, and Gaines counties has been submitted for publication as a bulletin of the Survey. A preliminary note on the potash resources of the area

is included in the report on the production of potash in 1919. The general geology and physiography of this lake region was examined by P. S. Smith in company with Mr. Wheeler, whose headquarters are at Amarillo.

The salt deposits of the "Red Beds" region are discussed by N. H. Darton in a report on Permian salt deposits of the United States, submitted for publication as Bulletin 715–M. The gypsum deposits of the State are described by R. W. Stone in a general report on gypsum deposits in the United States (Bulletin 697).

The reconnaissance examination, with geologic mapping, of the Coastal Plain in southwestern Texas between the Rio Grande and Nueces River, begun by G. C. Matson prior to his resignation, was continued by A. C. Trowbridge and A. G. Maddren. The area covered embraces parts of Maverick, Zavalla, Dimmit, Webb, Duval, Zapata, Starr, Jim Hogg, and Brooks counties. Mr. Maddren resigned early in the year, and the work was resumed in June by Prof. Trowbridge, assisted by W. S. Glock. A report on the geology of the region is now in preparation.

Fossils from the Texas Coastal Plain have been studied by C. W. Cooke and Julia Gardner, and drill cuttings have been examined, with reference to their physical and mineral constitution, by M. I. Goldman and Mr. Cooke.

The systematic description of the fauna of the Comanche series (Lower Cretaceous) was resumed by T. W. Stanton. Reports on Eocene invertebrates were made by W. H. Dall, and Tertiary fossils from deep wells were identified by W. C. Mansfield.

The manuscript of a report by Alexander Deussen on the ground waters of the Coastal Plain of Texas west of Brazos River has been revised for publication. The report by Mr. Deussen on the geology of the Coastal Plain region between Brazos and Nueces rivers is in preparation for publication as a professional paper.

The middle and upper Eocene floras of Texas are described by E. W. Berry in a manuscript now awaiting publication. A paper by Prof. Berry entitled "An Eocene flora from trans-Pecos Texas" has been issued as Professional Paper 125–A. The early Tertiary Bryozoa of the State are described by F. Canu and R. S. Bassler in a monograph prepared under Survey auspices but issued as Bulletin 106 of the United States National Museum.

Stratigraphic and structural studies, with reference to oil problems, were continued during parts of the year in north-central Texas, mainly in Eastland and Stephens counties, by Frank Reeves, C. S. Ross, A. G. Argabrite, F. H. Burton, and E. S. Bleecker. With the cooperation of the oil companies drill cuttings were collected from several places and studied in the office of the Survey. The microscopic fossils from the several horizons represented have been exam-

ined and described by P. V. Roundy, and the lithologic and chemical characteristics of the beds have been studied by M. I. Goldman. These researches have proved both laborious and difficult, but they promise to be of great value to drillers in other regions where oil is found in Carboniferous beds as well as in Texas. Manuscripts covering parts of the area mapped by the geologists are now nearly ready to submit for publication, and a report on the subsurface lithology of the north-central Texas oil field by Mr. Goldman is now well advanced. The fauna of the "Bend formation" is being described by G. H. Girty.

At the request of the mayor of Dallas an investigation of the gas resources tributary to Dallas and other cities of north Texas was made, special attention being given to a new estimate of the contents of the Petrolia field. The principal conclusions reached by E. W. Shaw and P. L. Ports, representing the Geological Survey in this examination, which was conducted under a cooperative arrangement, were promptly communicated to the mayor and issued to the press. A more detailed report by these geologists is now in course of publication as Bulletin 716–D. In connection with the appraisal of the gas resources in the Petrolia field an estimate of the helium content of the field was made by Messrs. Shaw and Ports at the request of the Navy Department, to which the results were communicated. A description of the mode of occurrence and an earlier quantitative appraisal of the helium in the Petrolia field by the late G. S. Rogers will be found in Professional Paper 121, entitled "Helium-bearing natural gas," now in press.

The stratigraphy and geologic structure of parts of Grayson, Fannin, and Collin counties and adjacent territory are described and mapped, with special reference to the oil and gas resources, in a report by O. B. Hopkins, Sidney Powers, and H. M. Robinson, now in preparation for publication.

The sulphur fields of west Texas were visited by P. S. Smith, who investigated the results of recent economic development. Eocene fossils from this region were examined by Julia A. Gardner, and fossil corals by T. W. Vaughan.

At the request of the Department of Justice E. W. Shaw made a study of the evidence as to the method of recent migration of Red River in the vicinity of Burkburnett. The ownership of the rich oil deposits beneath the river is dependent on the method and date of the changes in the channel of the river.

UTAH.

Examinations in the Cottonwood-American Fork region, Utah, were continued by B. S. Butler and F. C. Calkins; detailed areal

mapping of the district was done by Mr. Calkins, and the ores and mining geology was studied by Mr. Butler, who in June resigned to engage in private work. It is hoped that arrangements may be made with Mr. Butler for the completion of his report. Cambrian fossils from this district were identified by Edwin Kirk, and Carboniferous invertebrates by G. H. Girty.

The structure of the region embracing the Virgin City oil field, in southwestern Utah, was examined by J. B. Reeside, jr., and Harvey Bassler, and a report on the oil prospects there has been submitted. The more important conclusions regarding the geologic structure and oil and gas prospects were issued in the press at the end of the field season. A report on the stratigraphy of a part of southwestern Utah is in preparation by these two geologists. A report on the Carboniferous invertebrates in the region examined by Messrs. Reeside and Bassler was made by G. H. Girty.

To supply a demand due to the great interest in the prospects of finding new oil fields in the State, Bulletin 691–A, entitled "The Farnham anticline, Carbon County, Utah," by F. R. Clark, was reprinted. It has also been necessary to reprint Bulletin 691–B, "Oil shale of the Uinta Basin," by D. E. Winchester.

The regions in the northeastern part of the State where oil shale is being developed were visited by Mr. Bassler, who gave close attention to the work now in progress in the utilization of the shale for the production of oil. A report on oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah, by D. D. Condit, has been issued as Bulletin 711–B.

Additional observations were made by M. R. Campbell along the route of the Denver & Rio Grande Railroad in order to complete the manuscript for the guidebook submitted by him for publication as a bulletin. The purpose of this report is mainly educational.

The manganese ores developed at several points in Utah are described by J. T. Pardee in a report on manganese ore in Montana, Utah, Oregon, and Washington, which is now ready for publication in "Contributions to economic geology."

The report by F. R. Clark on the Sunnyside and Wellington quadrangles has been partly revised by M. R. Campbell. A report on the geology of the Lost Creek coal field, Morgan County, by Mr. Clark, has been printed as Bulletin 691–I.

The chapter on land sculpture in the monograph by the late G. K. Gilbert on the geology of the Henry Mountains was reviewed by the physiographic committee with reference to its republication.

VIRGINIA.

The detailed examination, with mapping, of the Virginia coal field was continued by C. K. Wentworth, in cooperation with the Virginia

Geological Survey, which was represented by A. W. Giles. The work of the field season of 1919 lay chiefly in the western part of the coal field. A report on the geology and coal resources of Russell County is at an advanced stage of preparation by Mr. Wentworth for publication by the State. J. B. Eby assisted Mr. Wentworth in office work in the spring and in field work in June. A description of the Russell Fork fault, in Dickinson and Buchanan counties, was prepared by Mr. Wentworth for unofficial publication.

A report based in part on field examinations of certain areas of Pocono coal in Virginia is in preparation by M. R. Campbell. A paper by C. C. Osbon on peat in the Dismal Swamp, Virginia and North Carolina, has been published as Bulletin 711–C.

The manganese deposits of the State are described in a report by G. W. Stose, which was transmitted for publication in the Engineering and Mining Journal. Detailed descriptions of some manganese mines of the State are being prepared by H. D. Miser for a report on manganese deposits of the western part of the Valley of Virginia, in cooperation with the State Geological Survey, for publication by the State.

Further field studies of the phosphate, gypsum, and salt deposits in the Abington quadrangle were made by G. W. Stose. A paper on the gypsum deposits of the Saltville region by Mr. Stose is incorporated in Bulletin 697, "Gypsum deposits in the United States," by R. W. Stone, now in press.

The principal deposits of white clay in the State are described by Heinrich Ries in Bulletin 708, "High-grade clays of the eastern United States," now in preparation for publication.

Parts of the Piedmont region of Virginia were reviewed by Laurence LaForge for description in the Piedmont chapter of the handbook of the geography of Maryland, Delaware, and the Virginias. Further field studies were made by W. T. Lee of the interstream regions of the Gulf Coastal Plain in order to complete the manuscript on the corresponding chapter of this handbook. The valley region is being described by G. W. Stose; the Allegheny region by M. R. Campbell.

Tertiary Bryozoa from different localities in the Coastal Plain have been described by F. Canu and R. S. Bassler in a report prepared under Survey auspices but published by the United States National Museum. Additional collections of Miocene Bryozoa made by Mr. Lee and others in 1918 have also been studied and described by Messrs. Canu and Bassler. Field studies of the stratigraphy and paleontology of the older Paleozoic formations of the Appalachian Valley in the vicinity of Staunton, Lexington, and Wytheville were made by E. O. Ulrich, Charles Butts, and R. D. Mesler for purposes of interstate correlation. Special examinations for purposes of

correlation and for the collection of fossils from the Carboniferous beds in the southwestern part of the State were made by G. H. Girty and T. E. Williard. Fossil plants from the Potomac group were identified by F. H. Knowlton, and Pleistocene fossils from various localities were studied by W. H. Dall.

VERMONT.

A report on the structure of the Taconic Range, Vt., is being prepared by Arthur Keith.

The granite resources of the State are described by T. Nelson Dale in the bulletin on commercial granites of New England now in preparation.

WASHINGTON.

Coal lands in Lewis County, Wash., were examined and data for their classification were collected by E. J. Saunders, through the cooperation of the Geological Survey of Washington.

The geology of an area near the Rattlesnake Hills was briefly studied by J. P. Buwalda with reference to the possible occurrence of oil and gas in the area.

The manganese deposits and the chromite ores of the State are described by J. T. Pardee in two papers submitted for publication. An article on bementite from western Washington was transmitted by Mr. Pardee for publication in the American Journal of Science.

Reports on Tertiary and Quaternary fossils from western Washington were made by W. H. Dall.

WEST VIRGINIA.

Reconnaissance observations of parts of the Romney, Piedmont, and Winchester quadrangles, W. Va., were made by G. W. Stose in preparation for the description of the valley region in the geographic handbook of Virginia, West Virginia, and Maryland. Some geologic data were also obtained in the Romney region.

Several of the mines in the Tug Fork coal field, along the Kentucky border, were sampled by J. D. Sears to ascertain the quality of the coal and the stage of carbonization, for use in determining the possible southwestern boundary of the Appalachian oil field.

A report on the Abram Creek-Stony River coal field, in northeastern West Virginia, by G. H. Ashley, has been issued as Bulletin 711–F.

Observations of the temperatures of deep wells in the State have been made by C. E. Van Orstrand with the cooperation of the State geologist, Dr. I. C. White, who has also interpreted the logs.

WISCONSIN.

The glacial deposits in northern Wisconsin are described by Frank Leverett in a report on moraines and shore lines of the Lake Superior basin, now nearly ready for submission.

Brief field examinations of the stratigraphy and paleontology of the older Paleozoic formations in the State were made by E. O. Ulrich in cooperation with the State geologist, with a view principally to demonstrating the systemic rank and relations of the Ozarkian and Canadian divisions, previously proposed by Mr. Ulrich.

WYOMING.

The areal geology and structure of the Lance Creek, Mule Creek, and Rock Creek oil districts were mapped by E. T. Hancock with the assistance of C. E. Dobbin, who also collected data on development in the Upton-Thornton region. Reports by Mr. Hancock on the Mule Creek and Lance Creek fields are now in press as Bulletins 716–C and 716–E. A report on the Upton-Thornton oil field by Mr. Hancock has been issued as Bulletin 716–B.

Reports on oil in the Warm Springs and Hamilton domes, near Thermopolis; on gas in the Big Sand Draw anticline, Fremont County; and on anticlines near Maverick Springs, Fremont County, by A. J. Collier, have been issued as Bulletins 711–D, 711–E, and 711–H, respectively.

A report on the geologic structure of parts of the Crow Indian Reservation with reference to oil and the possible occurrence of gas has received attention from C. H. Wegemann and C. K. Wentworth, but owing to the commercial demands on the time of Mr. Wegemann, who is not now a member of the Survey, and the interruptions occasioned by Mr. Wentworth's work in Virginia this report is not yet completed.

In the spring of 1920 the Osage oil district was mapped by A. J. Collier, and near the end of the year he extended his examination to include points of new discoveries to the north.

Additional examinations of structural details and the results of development near Oregon Basin, Little Buffalo, Grass Creek, and Cottonwood Creek were made by D. F. Hewett, who procured information for use in his general geologic report covering several quadrangles embracing these fields. The Hart Mountain overthrust was investigated by Mr. Hewett and described by him in a paper transmitted for unofficial publication. The report by Mr. Hewett and C. T. Lupton on anticlines in the southern part of the Big Horn Basin (Bulletin 656) has been reprinted in response to the urgent demand for information on this region.

The Baxter Basin, in Sweetwater County, is described by A. R. Schultz, with reference particularly to its oil and gas prospects, in Bulletin 702, now in press.

A report on the geology and oil and gas resources of Wyoming, prepared and submitted by W. B. Emery, has been reviewed and transmitted for publication as Bulletin 689–A. A geologic map to accompany this report has been prepared under the direction of M. R. Campbell, and the oil fields and pipe lines of the State have been mapped under the supervision of G. B. Richardson.

The region embracing what is known as the Big Piney oil field was examined for the purpose of classifying the land by E. H. Finch, with the assistance of N. W. Bass, of the land-classification board. The salient conclusions were transmitted to the press in the autumn of 1919.

Detailed examinations of a part of the Kemmerer coal field were also made by Messrs. Finch and Bass with reference to the coal content of some of the sections. Samples of oil shale from the southwestern part of the State were examined and tested with reference to their oil content by Harvey Bassler.

Publication of the report on the Elk Basin oil field by C. J. Hares has been delayed two years awaiting revision of certain points by the author, who is no longer a member of this Survey.

A report entitled "Oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah," by D. Dale Condit, has been published as Bulletin 711–B.

In cooperation with the land-classification board, several of the oil geologists of the geologic branch have been engaged in the definition of the known geologic structure of anticlines in Wyoming.

A manganese deposit in Wyoming is described by E. L. Jones, jr., in Bulletin 715–C, and the gypsum resources of the State are discussed by R. W. Stone in Bulletin 697.

The description of the invertebrate fauna of the Eagle sandstone in northern Wyoming was begun by J. B. Reeside, jr., and Cretaceous plants from various localities were studied by F. H. Knowlton. Invertebrates from the Cretaceous beds at a number of points were examined by T. W. Stanton, and reports on Carboniferous fossils from several localities were made by G. H. Girty.

HAWAIIAN ISLANDS.

Late in the winter L. F. Noble was detailed to the water-resources branch for studies of the lava flows and sediments of the Hawaiian Islands. The lavas are now under petrographic study by Mr. Noble.

The recent marine molluscan fauna of the islands is being made the subject of a comprehensive review by W. H. Dall, based chiefly on the collection of S. Thaanum, of Hilo, Hawaii, and the collection of the Bureau of Fisheries. Tertiary fossils from the islands have also been examined by W. H. Dall.

WEST INDIES.

Porto Rico.—A report on the ground waters of eastern Porto Rico and the larger Virgin Islands of the United States has been prepared by T. W. Vaughan. The Tertiary fossils from these islands have been reviewed by W. H. Dall, with the exception of the Foraminifera collected by Mr. Vaughan, which have been studied by J. A. Cushman.

Virgin Islands of the United States.—The report on the ground waters of the larger Virgin Islands of the United States, investigated at the request of the Navy Department, has been submitted by T. W. Vaughan. Fossil Foraminifera collected in the course of the field investigations have been examined by J. A. Cushman. Studies of the stratigraphy and paleontology and correlations of the geologic formations of the islands were made by T. W. Vaughan.

Cuba.—Manganese deposits in the island of Cuba were examined in May by D. F. Hewett, at the request of the War Minerals Relief Commission.

A report on the chromic iron ores of Cuba has been compiled by E. F. Burchard and will be found in Mineral Resources for 1918. The chrome and manganese ores of Cuba have been described by Mr. Burchard in the Transactions of the American Institute of Mining and Metallurgical Engineers.

Preliminary examinations of samples of well drillings have been made by J. A. Cushman. Some Tertiary Mollusca of Cuba are discussed by C. W. Cooke and Tertiary Foraminifera by J. A. Cushman in an unofficial publication.

Dominican Republic.—The publication of a report on the preliminary geologic reconnaissance of the Dominican Republic has been authorized by the Government of the Republic. Chapters on the structural, stratigraphic, petrologic, and mineralogic features are contributed by C. W. Cooke, D. D. Condit, and C. P. Ross. The Tertiary and Quaternary stratigraphic paleontology is discussed by T. W. Vaughan and W. P. Woodring. The Cretaceous invertebrates were determined by T. W. Stanton; the Tertiary invertebrates by T. W. Vaughan, J. A. Cushman, W. P. Woodring, and W. C. Mansfield; the fossil plants by E. W. Berry. In an unofficial publication J. A. Cushman described Miocene Foraminifera from the Dominican Republic.

Republic of Haiti.—Office work preliminary to the cooperative geologic survey of Haiti under the direction of T. W. Vaughan, chief of the section of Coastal Plain investigations, has included studies of the available geologic data on the Republic by W. P. Woodring and the examination of Tertiary invertebrates already in hand by J. A. Cushman, T. W. Vaughan, and W. P. Woodring.

Other islands.—Fossil Foraminifera from Barbados were examined by J. A. Cushman, and Tertiary fossils from Trinidad were studied by T. W. Vaughan, J. A. Cushman, and W. P. Woodring. Cretaceous invertebrates found in Jamaica were reported on by T. W. Stanton; and Tertiary Mollusca from the Leeward Islands have been described in an unofficial publication by C. W. Cooke.

MEXICO AND CENTRAL AMERICA.

Pleistocene fossils from Mexico and Panama and Tertiary Mollusca from Panama have been reported on by W. H. Dall; and Tertiary fossils from Costa Rica have been submitted to Mr. Dall and J. A. Cushman for examination.

Deposits of manganese ore in Costa Rica and Panama are described by J. D. Sears in Bulletin 710–C.

SOUTH AMERICA.

Reports on collections of Mesozoic invertebrates from Colombia and Brazil were made by T. W. Stanton, and Tertiary fossils from Colombia were examined by W. C. Mansfield and W. P. Woodring.

Pleistocene fossils from Peru submitted by the Brooklyn Museum have been reported on by W. H. Dall, and invertebrate fossils, probably of Devonian age, collected on the east slope of the Andes in Bolivia are under review by G. H. Girty. Tertiary invertebrates from Venezuela, Ecuador, and the Galapagos Islands were examined by W. H. Dall.

CANADA.

Cretaceous fossils from Alberta have been studied by T. W. Stanton, and Pleistocene invertebrates from Saskatchewan by W. H. Dall. Reports on upper Paleozoic fossils from New Brunswick and Nova Scotia have been made by G. H. Girty, and on Pleistocene shells from Vancouver Island, British Columbia, by W. H. Dall. These collections were studied for the Geological Survey of Canada.

OTHER COUNTRIES.

Potash deposits of Alsace, examined by H. S. Gale in 1919, are described in Bulletin 715–B, and the results of investigations by Mr.

Gale in the vicinity of Barcelona, Spain, are published in Bulletin 715–A. Fossil Mollusca from mineral localities in France, submitted by the Museum of Natural History in Paris and by the Municipal Museum of Nice, were examined by W. H. Dall.

Tertiary fossils from Cassel, Germany, have been reported on by W. H. Dall, who also examined Tertiary Mollusca from South Africa.

In cooperation with the Carnegie Institution T. W. Vaughan prepared a preliminary list of the corals of the Samoan Islands.

DIVISION OF ALASKAN MINERAL RESOURCES.

PERSONNEL.

On July 1, 1919, the personnel of the division of Alaskan mineral resources consisted of 1 geologist in charge, 7 geologists, 4 topographers, 1 hydraulic engineer, 1 draftsman, and 2 clerks on annual salaries and 12 temporary field employees. On June 30, 1920, the personnel included 1 geologist in charge, 6 geologists, 2 topographers, 1 hydraulic engineer, and 2 clerks on annual salaries and 1 geologist on a monthly salary.

APPROPRIATION AND CLASSES OF WORK.

In 1918 the appropriation for the investigation of the mineral resources of Alaska was reduced from $100,000 to $75,000. This reduction was made with the approval of the Director because the technical staff of the Alaska service was greatly depleted, owing to the engagement of the men in war service, and investigations in Alaska were not believed to be directly connected with the winning of the war. Unfortunately, however, the appropriation has not yet been restored to its pre-war amount, being still only $75,000. In addition to this reduction the increased cost of transportation, horses, supplies, wages of camp hands, etc., has forced a reduction of about 50 per cent in the field work. As a result the Alaska investigations are much in arrears, at a time when the large expenditures for Government railroad construction demand that every effort be made to encourage the mining industry. It would therefore be wise business policy on the part of the Government to stimulate the mining industry by increasing the knowledge of the distribution and occurrence of the mineral resources of Alaska through surveys and investigations. The division has had the additional handicap of losing the services of a large number of its most experienced technical employees. Attracted by higher salaries, six of the Alaska geologists have during the year gone temporarily or permanently into private work. Three of the Alaska topographic engineers are also on fur-

lough in private work, and two are still in the Army. As it takes many years to build up an efficient technical staff, the cost to the Government of restoring the force is much larger than the payment of salaries that will hold good men in the service.

The Alaska work of the year, like that of the past, has consisted in the making of surveys and investigations of mineral resources, including the preparation of the necessary topographic base maps. Special emphasis has been placed on surveys of the regions tributary to the Government railroad. It should be noted, however, that mining advances in any part of the Territory will directly or indirectly benefit the railroad. The water-power investigations have been continued in southeastern Alaska. These benefit not only the mining but also the wood-pulp and other industries.

FIELD WORK DURING SEASON OF 1919.

Twelve parties were engaged during 1919 in Alaskan surveys and investigations. The length of the field season ranged from 1 to 12 months, being determined by the character of the work and by the climatic conditions prevailing in different parts of the Territory. The parties included 2 geologists, 3 topographers, 1 engineer, and 12 packers, cooks, and other auxiliaries. Eight of the parties were engaged in geologic surveys, three 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 2,700 square miles. Much of the time of the geologists was devoted to the investigation of special problems relating to the occurrence of minerals, the results of which can not be expressed in terms of area. About 2,300 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.

Of the parties whose work may be classified geographically, two parties worked in southeastern Alaska, three in the Cook Inlet-Susitna region, and one each in the Yukon, Copper River, and Kuskokwim regions and Seward Peninsula.

The funds available for field and office work relating to the field season of 1919 included an appropriation of $75,000 for the fiscal year ending June 30, 1920, and the unexpended balance of the appropriation for the year ending June 30, 1919, of which about $16,700 was used in equipping parties for the season's field work. The following tables show the allotments, including both field and office work, of the total funds classified by regions, by kinds of surveys, and by kinds of expenditures. 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, other fixed charges, and the total allotments for the work of the office at Anchorage are included up to the end of the fiscal year 1920, but expenses other than these include only the cost of field and office work during 1919. The "general investigations" include, among other things, the cost of collecting mineral statistics and of office work relating to the field investigations of previous seasons. A balance of about $10,400 from the appropriation for the year ending June 30, 1920, is available for equipping the field parties in 1920.

Approximate general distribution of appropriations for Alaska investigations, field season 1919.

	1918–19	1920
Southeastern Alaska	$500	$13,200
Copper River region		1,800
Cook Inlet and Susitna basin	13,200	22,900
Yukon basin		2,300
Kuskokwim region	3,000	8,700
General investigations		15,700
To be allotted to field work, 1920		10,400
	16,700	75,000

Approximate allotments to different kinds of surveys and investigations, field season 1919.

	1918–19	1920
Reconnaissance geologic surveys	$8,600	$17,600
Special geologic investigations		9,900
Reconnaissance topographic surveys	8,100	9,800
Investigation of water resources		4,200
Collection of mineral statistics		1,900
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation		21,200
To be allotted to field work, 1920		10,400
	16,700	75,000

Allotments for salaries and field expenses, field season 1919.

	1918–19	1920
Scientific and technical salaries		$33,458
Field expenses	$16,700	15,421
Clerical and administrative salaries and miscellaneous expenses		15,721
To be allotted to field work, 1920		10,400
	16,700	75,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a varying amount is spent

each year on special investigations that yield results which can not be expressed in terms of area.

Progress of surveys in Alaska, 1898–1919.

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.	Stream volume measurements.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000	.....	8,635	321	.....	13,815	36	.....	.....	69	429
1911	100,000	8,000	10,550	496	.....	14,460	246	.....	.....	68	309
1912	90,000	.....	2,000	525	.....	.....	298	.....	.....	69	381
1913	100,000	3,500	2,950	180	3,400	2,535	287	.....	.....	.....	.....
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	.....
1918	77,000	.....	3,500	.....	.....	1,200	.....	.....	.....	.....	.....
1919	75,000	.....	2,700	.....	.....	2,300	.....	.....	.....	19	.....
	.....	73,200	107,485	5,507	51,680	151,530	3,731	462	74	.....	.....
Percentage of total area of Alaska	.....	12.48	18.33	0.94	8.81	25.83	0.64	.....	.....	.....	.....

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

General work.—Alfred H. Brooks, geologist in charge of the division of Alaskan mineral resources, left for Alaska August 5 and returned September 30. With John A. Hallowell, assistant to the Secretary of the Interior, he visited the Alaska Railroad, traveling along its entire route to Fairbanks. Special attention was paid to the mineral resources tributary to the railroad, including the Matanuska coal field and the Fairbanks district. A visit was also paid to the Kennecott group of copper mines in the Chitina Valley.

On April 22, 1920, Mr. Brooks was detailed by the Secretary of the Interior as chairman of the Alaska Advisory Committee. The work

of this committee took most of his time until June 11 and considerable since then. It included a three weeks' journey to Seattle and return.

Mr. Brooks, as will be shown, has also given considerable of his time to the preparation of certain reports based on his work with the American Expeditionary Force and the Commission to Negotiate Peace. As a result of the various activities not connected with the work of the Alaska division, Mr. Brooks has prepared for publication the following reports and articles:

Iron and steel industries of Lorraine, Luxemburg, the Sarre district, and Belgium, by Alfred H. Brooks and Morris F. La Croix: U. S. Geol. Survey Bull. 703, 1920.

Military mining: Office of Chief Engineer, U. S. A., Occasional Papers, No. 62, 1920.

The use of geology on the western front: U. S. Geol. Survey Prof. Paper 128–D, 1920.

Influence of geography on the conduct of war (abstract): Pennsylvania Dept. Public Instruction, Educational Cong., 1919, Proc., pp. 540–547, 1920.

Military mining in France: Eng. and Min. Jour., vol. 109, pp. 606–610, 1920.

Application of geology to war (abstract): Eng. and Min. Jour., vol 109, p. 764, 1920; Washington Acad. Sci. Jour., vol. 10, pp. 331–333, 1920.

George C. Martin devoted much time to the administrative work of the Alaska division during Mr. Brooks's assignments to other duties. In addition he devoted a month to preparing the progress report and four months to his report on the oil fields of Alaska.

Arthur C. Hollick was engaged in a study of the Cretaceous flora of Alaska from December 3, 1919, to June 30, 1920. His report on this work is practically completed.

Miss Lucy M. Graves, chief clerk of the division, has assisted the geologist in charge in administrative duties. Much of the work of compiling the statistics of the mineral production of Alaska has been done by T. R. Burch.

Southeastern Alaska.—The investigation of the water resources of southeastern Alaska, begun in 1915 under a cooperative agreement with the Forest Service, was continued throughout 1919. G. H. Canfield, who had charge of this work, maintained automatic gages throughout the year. In addition to these gages others were installed in cooperation with individuals and corporations. The results are briefly summarized in another section of this report. 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 C. H. Florey, forest supervisor at Ketchikan.

A reconnaissance of the geology and mineral deposits of parts of the Glacier Bay and Lynn Canal regions was made by J. B. Mertie, jr. Field work was begun on July 23 and continued until September 18. An area of about 200 square miles was mapped in

reconnaissance. Mr. Mertie also visited the productive mines of the Juneau and Ketchikan districts.

Copper River region.—The completion of the report on the Kotsina-Kuskulana district, which was suspended by the assignment of F. H. Moffit to work for the War Department during the war, required the gathering of a small amount of additional field data in order to bring it up to date. Mr. Moffit spent September in this work.

Cook Inlet and Susitna regions.—Because of the importance of the region tributary to the Government railroad and the growing demand for information concerning it, a special effort is being made to complete the mapping of that region. The work in the Cook Inlet and Susitna regions in 1919 included a topographic and geologic reconnaissance survey of areas between Talkeetna River and Broad Pass and in the upper Kantishna region and detailed investigations at the coal mines in the Matanuska Valley.

A party in charge of S. R. Capps, assisted by S. H. Cathcart, made reconnaissance surveys, on the scale of 1:180,000, of an area of about 300 square miles in the high mountains on the headwaters of the Kantishna and of the upper tributaries of the Susitna. T. P. Pendleton, attached to this party, made topographic surveys of the same area. The party began field work on the north side of the Alaska Range June 28, finished its work August 27, having crossed the Alaska Range, and came out by way of Susitna River.

A topographic reconnaissance survey of an area adjacent to the Government railroad between Talkeetna River and Broad Pass was made by J. R. Eakin from June 22 to September 12. An area of about 600 square miles was mapped on a scale of 1:180,000. R. M. Overbeck completed geologic surveys of the same area.

The Alaska office at Anchorage was continued under charge of Theodore Chapin until February 1, 1920. Mr. Chapin, at his own request, was then furloughed to go to Mexico. His principal work has been as geologic adviser to the Alaskan Engineering Commission, with relation to the development of the Matanuska coal field, but he also made some investigations of copper and gold deposits of the region tributary to the railroad. It has been impossible to find an experienced geologist to take over this important work, and the Anchorage office has therefore been temporarily closed.

Yukon region.—The placer mines of the Eagle and Circle districts were visited by G. C. Martin from August 16 to September 13 for the purpose of obtaining information concerning recent mining conditions and developments.

Goodnews Bay.—Topographic and geologic reconnaissance surveys of an area in the vicinity of Goodnews Bay and the lower Kuskokwim were made by a party in charge of R. H. Sargent. Mr. Sar-

gent mapped topographically an area of 1,400 square miles for publication on the scale of 1:250,000. G. L. Harrington, who accompanied Mr. Sargent's party, made a reconnaissance geologic map of an area of about 2,000 square miles. Field work began July 4 and ended August 17.

Seward Peninsula.—After the end of his field work in the Kuskokwim region G. L. Harrington made investigations of general mining developments in Seward Peninsula. He was engaged in this work till October.

FIELD WORK, 1920.

Alfred H. Brooks is to undertake geologic examinations in the Prince William Sound region and the Ketchikan district, paying special attention to copper deposits. F. H. Moffit, geologist, and C. P. McKinley, topographic engineer, are engaged in making geologic and topographic reconnaissance surveys on the west side of Cook Inlet, includng the Iniskin Bay oil field. J. R. Eakin is extending the topographic reconnaissance surveys in the upper Susitna basin. S. H. Cathcart is making special studies of the distribution and occurrence of mineral deposits in Seward Peninsula. The geology and mineral resources of the Richardson district of the Tanana Valley are to be investigated by P. S. Smith. Investigations of the water powers of southeastern Alaska are being continued by G. H. Canfield. In August G. C. Martin will make an examination of the mineral deposits of the McGrath district of the Kuskokwim Valley. W. G. Westgate is to undertake a geologic examination of the Portland Canal district.

COLLECTION OF STATISTICS.

The collection of the statistics of Alaska mineral production, begun by the Alaska division in 1905, was continued as usual. In 1919 this work was done by George C. Martin, assisted by T. R. Burch.

PUBLICATIONS.

During the year the Survey published two bulletins (Nos. 692 and 699) relating to Alaska. The separate chapters of Bulletin 712 were also issued during the year. Two Alaska bulletins (Nos. 682 and 712) are in press.

The following manuscripts are completed:

Chromite of Kenai Peninsula, Alaska, by A. C. Gill.

The geology of the Cape York tin deposits, by Edward Steidtmann and S. H. Cathcart.

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

Preliminary report on petroleum fields of Alaska, by George C. Martin (Bulletin 719).

The following reports are in hand:

The mineral resources of the region tributary to the Alaska Railroad, by S. R. Capps.

Geology and mineral resources of the White Mountain and Fort Hamlin region, by Eliot Blackwelder and R. M. Overbeck.

Geologic reconnaissance of the Goodnews Bay and lower Kuskokwim region, by G. L. Harrington and A. G. Maddren.

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

The Ketchikan district, by Theodore Chapin.

The Upper Cretaceous floras of Alaska, by Arthur C. Hollick.

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

A number of other manuscript reports are on hand in various stages of completion. Many of them were written by geologists who have left the service. All of them will require more or less office work, and some will entail additional field work. Therefore, though these manuscripts are on hand, the time and form of their publication are so uncertain that it does not seem worth while to list them at present, though some have been included in previous administrative reports.

TOPOGRAPHIC MAPS READY FOR PUBLICATION.

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

Goodnews Bay region, by R. H. Sargent; scale, 1:250,000; contour interval, 200 feet.

Lower Kuskokwim and Goodnews Bay region, by R. H. Sargent and A. G. Maddren; scale, 1:500,000; contour interval, 400 feet.

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

TOPOGRAPHIC MAPS IN PREPARATION.

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.

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

Seward-Fairbanks route; compiled; scale, 1:250,000; contour interval, 200 feet.

DIVISION OF MINERAL RESOURCES.

Further reorganization of the division of mineral resources was necessitated during the year by resignations and furloughs. Edson S. Bastin, after serving as division chief from January 1, 1919, resigned on December 24 to accept a professorship of economic geology at the University of Chicago. F. J. Katz, administrative assistant, was furloughed in September, 1919, to serve as expert special agent in charge of statistics of mines and quarries for the Bureau of the

Census. C. E. Lesher, in charge of statistical work on coal and coke, resigned in December to become statistician for the National Coal Association and later editor of the Coal Age. J. B. Umpleby, in charge of the section of foreign mineral reserves, resigned in August, 1919, to become professor of geology in the University of Oklahoma.

G. F. Loughlin, in charge of the metals section, succeeded Mr. Bastin as division chief, retaining direct supervision of the metals section. R. W. Stone continued in charge of the nonmetals section and also served as administrative assistant. F. G. Tryon assumed charge of the work on coal and coke, and Eugene Stebinger that on foreign reserves, but during Mr. Stebinger's protracted absence in South America the foreign work was supervised by B. L. Johnson.

Resignations and furloughs have also depleted the staff of specialists and clerks, and at present 17 subjects of greater or less scope are without direct supervision of geologist or engineer specialists. When the year began the division's staff included 44 such specialists, of whom 21 devoted all their time to work of the division, the rest dividing their time with the division of geology or that of chemical and physical research or the water-resources branch. At the end of the year only 25 specialists remained, of whom 16 devoted their entire time to the work of the division. The clerical force numbers 49. The intensive work during the war resulted in systematic assembling of information, and it has thus far been possible for the more experienced members of the clerical force, under supervision of the section chiefs, to supply most of the technical information requested on these subjects. This situation can continue for a time during the period of unsettled industrial conditions, but sooner or later these vacancies must be filled.

Coincident with this shrinkage in the sections handling metals and nonmetals in general, there has been necessary expansion in the section handling mineral fuels. The work on coal and coke, which expanded from a force of 6 before the war to a maximum of 450 when cooperation was effective with the Fuel Administration, has maintained a much broader scope than it had before the war, and the force now numbers 11. Weekly reports on production were continued only by the active cooperation of the National Coal Association, which supplied 4 clerks for this work; numerous special reports also were prepared for different Government bureaus and commissions.

During the strike of the bituminous miners in November and December, 1919, C. E. Lesher sat as a member of the Central Coal Committee, to which the Director General of Railroads and the Fuel Administrator intrusted the task of distributing coal during the strike. For the information of officials of the Government during that

critical period a daily bulletin on the coal supply was circulated. In addition, the section prepared many special reports on particular phases of consumption and distribution, which were used by the committee in its task of apportioning the coal available.

The agitation for an embargo on exports also laid a heavy burden on the fuel section, which was called upon to furnish information to be used in determining the policy of the United States with regard not only to restricting exports of coal but also in expediting the movement to New England and to the Northwest. With the assistance of funds furnished by the Bituminous Coal Commission a canvass of stocks in the hands of 5,500 representative consumers and an analysis of the production, by regions, and the distribution of the coal actually produced during the first six months of the year were undertaken.

The petroleum situation has shared honors with coal in its command of public attention, and the demands on the division of mineral resources have been correspondingly increasing. The monthly report showing statistics of production, shipments, and stocks has been amplified, and further development of it is in progress. Requests for information on the oil industry are received daily from all parts of the country. Before the war one specialist and four clerks handled this subject. Owing to the growing need for more and more prompt information, two new clerks have been added to work on oil statistics.

Statistics of natural gas and natural-gas gasoline, formerly compiled by one clerk under occasional supervision of the petroleum specialist, were last year placed in charge of a specialist assisted by three clerks, who devote all their time to the subject. This expansion was timely, as the work had hardly been reorganized before the declining production and necessity for conservation of natural gas, evident for some time to close students of the subject, became so serious as to attract general attention, and the Survey's increased force has been kept busy in supplying current information.

The section of foreign mineral reserves, a product of the war, was at first organized with one specialist assigned to each continent, but owing to resignations it was necessary to reorganize it into a source of general statistical, geologic, and geographic information and to assign specialists to certain timely studies. Owing to the shifting of duties as well as to the changing nature of the work, little material for publication was finished during the year, but the section has been of great service to other Government organizations, to scientific societies, and to many large companies and individual citizens seeking information on foreign mineral resources. Many mineral commodities that are produced either in this country or abroad are of decided interest to some portion of the American people, because of our dependence on or competition with the foreign products, and

the section has thus far met an urgent and continuing need. Calls on it for information are many and various. In June, for example, 48 requests were received for information on 20 different commodities, including 16 for oil (mostly in Latin America but also in Canada, India, Persia, and Abyssinia), 5 for copper (principally in Europe), 3 for phosphate rock in North Africa, and 2 for general mineral resources of Latin America, and 6 requests for foreign geologic and other maps were received. Foreign oil is at present the subject of most lively interest, and a vast amount of information on it has been compiled and analyzed.

This work is most timely when an international view of the mineral industries is superseding a national or domestic view. It is capable of expansion whenever adequate means are provided. In this connection it may be remarked that Great Britain, our chief economic competitor, has, as a result of the war, developed the Imperial Mineral Resources Bureau to conduct work similar to that of this section, but with a larger personnel, which includes many of the ablest English engineers and economists.

The present activities of the section consist principally in furnishing general information on foreign mineral deposits—work which, like that on domestic resources, consumes a great deal of time but whose results do not appear in published form; building up bibliographies and abstract files which serve as bases for research on foreign mineral deposits and which are probably already the largest reference files to literature on foreign mineral deposits in the country; compiling official statistics of mineral production in foreign countries; preparing special reports on the mineral resources of foreign countries—for example, mineral resources of Asia Minor, oil in Latin America, graphite in Latin America, silver in Mexico, phosphate rock in Morocco; preparing world oil concession maps and text; translating and abstracting important literature on oil to meet the pressing demand for such information; preparing a world atlas of commercial geology.

The World Atlas of Commercial Geology was the first large piece of work undertaken by the section of foreign mineral reserves; most of the maps on production are in proof, and preparation of the text is practically completed. The maps and text dealing with mineral reserves of Europe are about 90 per cent complete, and preliminary drafts of reserve maps of Latin America and certain countries elsewhere have been completed.

All this work is at present being carried on by three geologists, only one of whom can devote all his time to this research, two mineral geographers, a geologic aid, and five clerks—a force in marked contrast to the large bureau doing similar work in Great Britain

and hardly adequate to supply even the present calls for information, which are steadily increasing.

The scope of work conducted by the western offices of the division of mineral resources at Denver, Salt Lake City, and San Francisco has long needed expansion. Heretofore the compilation of statistics of metal and ore production and the furnishing of information and distribution of Survey publications to visitors have consumed the entire time of the statisticians in charge and their assistants. The need of prompt geologic study of new developments in mining and of other geologic work that can not be adequately attended to from the Washington office has long been felt, and a beginning to supply this need has been made by assigning J. M. Hill as resident geologist, attached to the San Francisco office. Owing to the present depleted state of the geologic staff, it is impossible to assign geologists to the other offices at present, but such assignments are urgently needed.

Cooperation with the Bureau of the Census has, as in previous census years, greatly retarded the work of this division. Comparison with the state of progress a year ago shows that whereas on July 1, 1919, returns from producers were nearly complete for all commodities and tabulation for many of them was complete or well advanced, on August 1, 1920, only a small percentage of producers' returns have been received. At the present rate of progress the work of compiling data of production for 1919 will extend into 1921 and overlap the Geological Survey's own canvass for 1920, thus delaying the reports for both years.

The preparation of statistical reports by the specialists was necessarily retarded during the war by the priority given to emergency requests for information; so that the Census cooperation, coming just as the effects of war work were being overcome, will continue to delay the preparation of reports for perhaps two years more. Although this cooperative work is intended to avoid duplication of effort, both by the Government and by the producers of mineral commodities, the methods of work in the two bureaus and the objects sought are so different that, so far as the Geological Survey is concerned, cooperation serves only to increase the amount of labor required to compile statistical data, without improving the quality of the data. It is doubtful, indeed, if the amount of extra work saved to producers by this cooperative canvass by the two bureaus is appreciable, as the schedules of the two bureaus supplement rather than duplicate each other.

Reports of the division transmitted between July 1, 1919, and June 30, 1920, included the chapters on lead, zinc, and rare metals in 1917; the summary of mineral production for that year; all the

chapters for the 1918 volume except those on coke, artificial gas, lead, and zinc; and advance chapters for 1919 on fuel briquetting, cadmium, thorium minerals, bauxite and aluminum, magnesium, platinum, and arsenic, bismuth, selenium, and tellurium, all short chapters, prepared without cooperation with the Bureau of the Census. The delayed chapters for both the 1917 and 1918 volumes were those whose authors had been called upon for a great amount of urgent work which was given precedence. The more essential data in these chapters had been published long previously in press bulletins. Several similar press bulletins giving advance figures of production in 1919 were also published.

The first "Preliminary summary of mineral resources of the United States," for 1918, was published August 7, 1919, and, as expected, has met a considerable demand for general statistical information. The final summary is necessarily the last chapter of the annual volume to be prepared, and as it is impossible to publish all the more lengthy chapters, even under the most favorable circumstances, until 11 months or more after the year which they represent, the final summary and the complete volumes must appear even later, and the preliminary summary thus serves a timely purpose. Under normal working conditions it is hoped that the preliminary summary for each year can be published by the following June 1.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

FUNDS AND ORGANIZATION.

The work of the division of chemical and physical research was continued under the usual appropriation of $40,000. Of this sum $6,000 was allotted for the examination of reported deposits of potash and nitrates under the administration of the division of geology.

The personnel of the division on June 30, 1920, comprised seven chemists, two physicists, one laboratory aid, one clerk, one laboratory assistant, and one laborer. Chase Palmer, assistant chemist, resigned October 31, 1919, to accept a position with the Southern Pacific Co. W. T. Schaller, chemist, resigned January 31, 1920, to accept a position with a sulphur company, and W. B. Hicks, chemist, resigned February 15, 1920, to join the Solvay Process Co. J. G. Fairchild, assistant chemist, was appointed by transfer from the Bureau of Chemistry and reported for duty July 1, 1919. M. A. Shoultes, laboratory aid, was reinstated October 20, 1919, after his Army service. G. V. Brown, professor of chemistry at Bucknell University, received a temporary appointment in June, 1920.

WORK IN CHEMISTRY.

The chemical work of the division is under the immediate supervision of George Steiger, chief chemist. Toward the end of the year this work had returned to a pre-war status, consisting of qualitative and quantitative analyses and mineralogic determinations of rocks and minerals. The identification by visual inspection or simple tests of specimens received by the Survey from outside sources was greatly reduced, the bulk of this work having been taken over by the division of geology. A portion of the time of R. C. Wells and W. B. Hicks and the greater part of the time of W. T. Schaller was absorbed by their duties in connection with the preparation of reports for the division of mineral resources.

The chemical analyses made during the year numbered 1,013, of which 485 were qualitative tests, 416 tests for commercial qualities, and 112 made in connection with problems of scientific research. On June 30 there were pending 9 samples for commercial valuation and 15 samples involving research.

An elaborate and critical discussion of the quality of the surface waters of the United States is in preparation by F. W. Clarke. That portion of the work treating of the waters east of Mississippi River is practically completed. Mr. Clarke has also been engaged in a discussion, on a larger scale and with greater refinement than heretofore attempted, of the composition of the crust of the earth. This work is being done in cooperation with H. S. Washington, and the report will contain more than 5,000 analyses of igneous rocks. It will require the major portion of the coming fiscal year for the completion of these two reports.

Color-standard tubes for the determination of hydrogen-ion concentrations in sea water were prepared by R. C. Wells. This work entailed an exhaustive study and the careful determination of the hydrogen-ion concentration of various dilutions of sea water. Tubes, together with certain apparatus, were furnished to the Bureau of Fisheries for the oceanographic investigations carried on by that bureau, primarily for use in the study of the water of Chesapeake Bay. In cooperation with the Interdepartmental Conference on Chemical Lime, Mr. Wells made determinations of calcium in certain samples of quicklime by seven different methods of analysis, which were carried out also by several other laboratories. The object of the work was to compare results and to select the best analytical method.

An interesting new mineral, brannerite, containing helium, was analyzed and described by Mr. Wells. The helium gas was separated, purified, and definitely identified by the spectroscope. Mr. Wells also made an extremely accurate determination of chlorine in a stand-

ard sample of sea water. This work, which was undertaken for the Bureau of Standards, required the special purification of reagents used and is comparable with atomic-weight work.

The study, together with experiments, of the effect of nitric acid on certain rocks was continued during the entire year, as were also experiments on the effect of carbonic acid on Indiana limestone. This work was done by Mr. Steiger in cooperation with G. F. Loughlin. Mr. Steiger also made a series of experiments on the dehydration of gypsum, selenite, and alunogen. E. S. Larsen conducted a microscopic study of the minerals in their various degrees of hydration. These three studies require experimentation extending over long periods of time and will be continued during the coming year.

A method for the determination of sulphur in the form of sulphide in the presence of carbonates in water was devised by J. G. Fairchild, and details for its successful application to practical work were perfected and will shortly be published in the Journal of the American Chemical Society.

A number of analytical methods were tested during the year to determine whether they might profitably be applied to the work of the laboratory.

WORK IN PHYSICS.

The physical laboratory is in charge of C. E. Van Orstrand, physical geologist. Apart from minor investigations which were made for the immediate use of geologists, investigations in this laboratory were conducted on the diffusion of solids (in cooperation with F. P. Dewey, of the Treasury Department), deep earth temperatures, the construction of mathematical tables, and the determination of pore space in rocks.

The experiments on the diffusion of solids require a long time, and the studies have continued through several years. Observations of deep earth temperatures were made from time to time by Mr. Van Orstrand. It is planned to extend these observations to the principal oil fields in the United States, where the ardent search for new oil reserves is stimulating boring to much greater depths than heretofore, thus affording unprecedented opportunities for such observations. Reports of progress have been published by Mr. Van Orstrand, who is also continuing the preparation of his tables of the probability integral.

The examination of the composition of oil sands, the size and shapes of the grains, and the pore space has been carried on by A. F. Melcher, who visited oil fields in Texas, Kansas, and Wyoming for the field inspection of outcropping sands and the collection of samples from the productive zones penetrated by the drill. These investigations concern the rate of production and longevity of the sands, as

well as the problem of more complete ultimate extraction of the oil in the sands.

Considerable progress has been made in the computation of the exponential function by M. A. Shoultes, who also has assisted in all the experimental work of the physical laboratory.

REPORTS PUBLISHED OR IN PREPARATION.

In addition to the papers already mentioned, the following reports by members of the division have been published or are in course of preparation:

By F. W. Clarke, The data of geochemistry, 4th ed. (U. S. Geol. Survey Bull. 695); Report of the International Committee on Atomic Weights for 1919–20 (Am. Chem. Soc. Jour., December, 1919); Recalculation of atomic weights (Nat. Acad. Sci. Mem.); Inorganic constituents of marine invertebrates (revision and enlargement of U. S. Geol. Survey Prof. Paper 102). By George Steiger and E. S. Larsen, Griffithite, nontronite, and alumogen. By E. S. Larsen, J. T. Pardee, and George Steiger, Bementite (Am. Jour. Sci.). By R. C. Wells, Determination of carbon dioxide in sea water at Tortugas, Fla. (Carnegie Inst. Year Book 18); Studies of purchasing power; An unusual deposit of aragonite from sea water (Washington Acad. Sci. Jour., May 4, 1920); Zirconium sulphate of exact composition; Note on "brannerite" (Franklin Inst. Jour., June, 1920); Sodium and sodium compounds in 1918 (Mineral Resources); The salt error of cresol red. By R. C. Wells and F. L. Hess, Brannerite, a new uranium mineral (Franklin Inst. Jour., February, 1920). By J. G. Fairchild, Notes on mineral sulphide water analyses. By H. D. Miser and J. G. Fairchild, Hausmannite in the Batesville district, Ark. (Washington Acad. Sci. Jour., May, 1920). By J. S. Diller, J. G. Fairchild, and E. S. Larsen, High-grade talc for gas burners. By W. B. Hicks, Potash in 1918 (Mineral Resources); Potash resources of Nebraska (U. S. Geol. Survey Bull. 715–I); Refined potassium salts in 1918 (U. S. Geol. Survey Press Bulletin). By W. T. Schaller, reports on mica and on thorium and rare-earth minerals in 1918 (Mineral Resources). By E. T. Erickson, in cooperation with K. C. Heald, Tests to detect small quantities of oil and bitumen (U. S. Geol. Survey Press Bulletin). By C. E. Van Orstrand, Tables of the exponential function and of the circular sine and cosine to radian argument (Nat. Acad. Sci. Mem. 5, vol. 14, 1920); Deepest well in the world (U. S. Geol. Survey Press Bulletin, July, 1919); Deep earth temperatures of the globe. By A. F. Melcher, Determination of pore space in oil and gas sands (Am. Inst. Min. Met. Eng. Bull., April, 1920).

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch during the year was as follows:

Chief geographer, R. B. Marshall, to September 30, 1919; chief topographic engineer, C. H. Birdseye, since October 1, 1919.

Atlantic division, Frank Sutton, geographer, in charge.

Central division, W. H. Herron, geographer, in charge.

Rocky Mountain division, T. G. Gerdine, geographer, in charge.

Northwestern division, T. G. Gerdine and G. R. Davis, geographers, in charge.
Pacific division, G. R. Davis, geographer, in charge.
Computing section, E. M. Douglas, geographer, in charge.
Section of inspection and editing, W. M. Beaman, topographic engineer, in charge.
Section of cartography, A. F. Hassan, draftsman, in charge.

PERSONNEL.

During the fiscal year 25 members of the topographic branch who had held commissions in the Engineer Officers' Reserve Corps were reinstated in their former positions, including 14 topographic engineers, 2 topographers, and 9 assistant topographers; at the end of the year 17 others had not requested reinstatement from the Army. The technical force was also increased by transfers and reinstatements and was reduced by resignations and transfers. With these changes the corps now includes 1 chief topographic engineer, 9 geographers, 64 topographic engineers, 6 topographers, 40 assistant topographers, 25 junior topographers, 1 map editor, 1 map reviser, 1 computer, and 9 draftsmen—a total of 157. During the year 3 topographic engineers, 1 topographer, 2 assistant topographers, and 3 junior topographers were on furlough. Nine members of the permanent force were on furlough during the year for work in Haiti and Santo Domingo. In addition, 50 technical field assistants were employed during the whole or a part of the fiscal year. The clerical force comprises 13 clerks of various grades.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 69 published maps; Bulletin 709–A, Triangulation and primary traverse in Maryland, Delaware, and West Virginia, 1916–1918; and Bulletin 709–B, Primary traverse in Florida, 1917. These publications are noticed on page 21. The manuscript for a revised edition of Bulletin 226, Boundaries of the United States, to be issued under a new number, was transmitted for publication.

APPROPRIATIONS.

The total appropriations for topographic surveys for the fiscal year 1920 were as follows:

Topographic surveys	$325,000.00
Statutory salaries	9,200.00
Special funds for military mapping (contributed by War Department)	260,000.00
	594,200.00

COOPERATION.

Cooperation has been maintained in 21 States and 1 Territory, which contributed the following amounts:

Arizona	$1,620.07
California	31,354.45
Colorado	327.35
Hawaii	802.61
Idaho	4,562.74
Illinois	19,157.17
Indiana	1,323.40
Iowa	1,714.63
Kentucky	12,889.26
Maine	2,480.94
Michigan	14,297.67
Mississippi	1,819.33
Missouri	4,228.28
New York	14,949.52
North Dakota	1,499.97
Pennsylvania	11,046.92
Texas	11,168.34
Vermont	2,702.04
Virginia	4,714.02
West Virginia	15,038.82
Washington	11,577.85
Wisconsin	21,262.39
	190,537.77

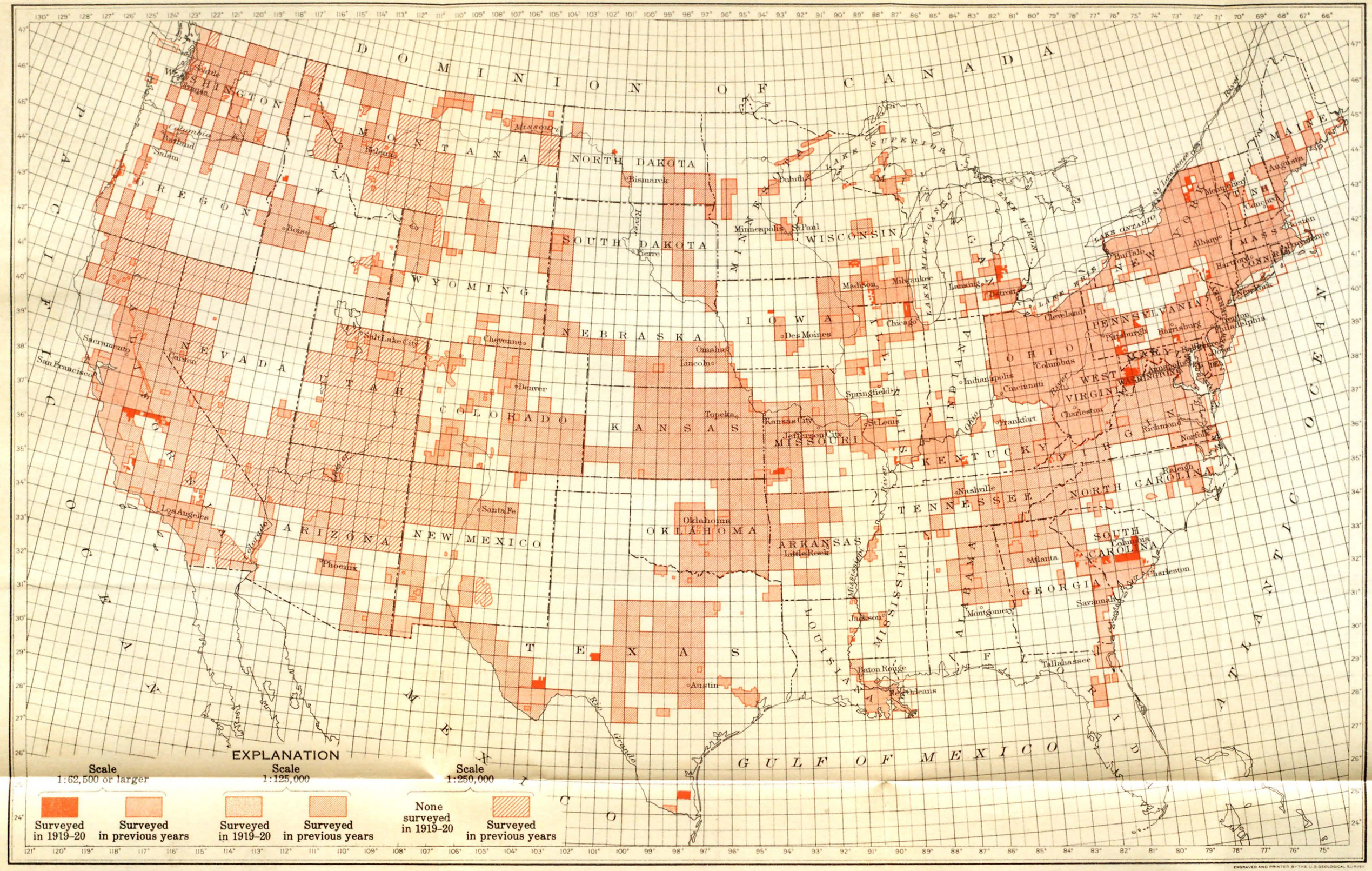
Of the State cooperative contributions reported in the Fortieth Annual Report ($102,476.10), $28,458.47 was not expended prior to July 1, 1919, and remained available for expenditures during the fiscal year ending June 30, 1920. This amount is included in the figures given above.

In addition, an allotment of $2,500 was made by the Illinois State Department of Public Works and Buildings for work on the Illinois road map, and an allotment of $2,500 by the National Park Service for mapping a part of the floor of the Yosemite National Park; neither of these was met by Survey funds. The Bureau of Public Roads allotted $5,800, with the understanding that an equal amount would be expended from Survey funds after July 1, 1920, and six draftsmen, who were employed in compiling road maps, were detailed to that Bureau from March 1 to the end of the fiscal year.

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1920, distinguished as to scale, etc., is shown on Plate II.

As shown in the following table, the new area mapped was 11,178 square miles, making the total area surveyed to date in the United States 1,301,136 square miles, or 42.9 per cent of the entire country.



EXPLANATION

Scale 1:62,500 or larger		Scale 1:125,000		Scale 1:250,000	
Surveyed in 1919–20	Surveyed in previous years	Surveyed in 1919–20	Surveyed in previous years	None surveyed in 1919–20	Surveyed in previous years

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

AREAS COVERED BY TOPOGRAPHIC SURVEYS MADE BY UNITED STATES GEOLOGICAL SURVEY PRIOR TO JULY 1, 1920

AND THE SCALE EMPLOYED FOR EACH AREA

Scale $\frac{1}{14000000}$

100 0 100 200 300 400 500 Miles

In addition, 1,214 square miles of resurvey was completed, making the total area of surveys during the year 12,392 square miles.

In connection with these surveys, 4,788 linear miles of primary levels were run, making 282,950 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,242 permanent bench marks were established. In addition, 10 linear miles of river surveys were run.

Triangulation stations to the number of 161 were occupied and 170 were permanently marked. Primary traverse lines aggregating 3,628 miles were run, in connection with which 399 permanent marks were set.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1919, to June 30, 1920.

State.	New area mapped July 1, 1919, to June 30, 1920.	Total area mapped to June 30, 1920.	Percentage of total area of State mapped to June 30, 1920.
	Sq. miles.	*Sq. miles.*	
Alabama	.....	19,192	37.0
Arizona	100	70,236	62.0
Arkansas	.....	21,494	40.3
California	1,532	124,880	78.8
Colorado	67	51,047	49.1
Connecticut	.....	4,965	100.0
Delaware	.....	2,370	100.0
District of Columbia	.....	70	100.0
Florida	.....	4,716	8.0
Georgia	162	24,835	41.9
Idaho	256	28,452	33.7
Illinois	694	17,601	31.0
Indiana	.....	3,609	10.0
Iowa	129	12,045	21.4
Kansas	.....	64,159	78.0
Kentucky	218	18,383	45.2
Louisiana	.....	8,366	17.2
Maine	.....	10,297	31.1
Maryland	.....	12,327	100.0
Massachusetts	.....	8,266	100.0
Michigan	861	10,219	17.6
Minnesota	.....	7,354	9.0
Mississippi	74	2,200	4.6
Missouri	.....	36,913	53.1
Montana	47	58,558	40.0
Nebraska	.....	27,117	35.0
Nevada	.....	51,141	46.2
New Hampshire	102	4,235	45.3
New Jersey	.....	8,224	100.0
New Mexico	.....	42,588	34.7
New York	678	45,341	92.1
North Carolina	.....	18,876	36.0
North Dakota	87	9,901	14.0
Ohio	.....	41,040	100.0
Oklahoma	.....	39,908	57.0
Oregon	333	25,568	26.4
Pennsylvania	779	26,008	58.8
Rhode Island	.....	1,248	100.0
South Carolina	1,849	13,675	44.1
South Dakota	.....	19,032	25.0
Tennessee	.....	21,283	50.6
Texas	1,615	74,999	28.1
Utah	6	69,031	82.0
Vermont	268	4,844	50.6
Virginia	69	35,819	84.0
Washington	563	31,027	44.8
West Virginia	.....	24,170	100.0
Wisconsin	644	13,419	23.9
Wyoming	45	30,088	31.0
Total United States (exclusive of Alaska)	11,178	1,301,136	42.9
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 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 and in miscellaneous computations.

J. H. Renshawe, geographer, was engaged during the year in preparing relief maps of parts of southern California, southwestern Arizona, the southern Appalachian region, the Grand Canyon National Park, and Alaska.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

The section of inspection in the topographic branch and the section of topographic-map editing in the publication branch were consolidated February 26, 1920, into the section of inspection and editing of topographic maps and placed under the administrative and technical control of the topographic branch. W. M. Beaman, previously in charge of the section of inspection, was designated topographic engineer in charge of the new section, which has general supervision of the office preparation, inspection, and editing of all topographic maps. The work of this section is described under "Publication branch" (pp. 162–163).

CARTOGRAPHY.

The compilation of the United States portion of the international map of the world, under the immediate supervision of A. F. Hassan, was resumed March 1, in order to complete, as early as possible, base maps on the scale of 1:500,000 for all the States. Prior to that date the cartographic force was engaged in inking the original military topographic maps and military information data and in finishing the Arizona portion of the international map, which was undertaken in cooperation with the State of Arizona the previous year. The force completed 30 topographic maps, 31 military-information tracings, and the base map of Arizona. The compilation of base maps was carried to the following percentages of completion: California, 45 per cent; Colorado, 65 per cent; Coastal Plain area of Texas, 85 per cent; Nebraska, 45 per cent; North Dakota, 95 per cent; South Dakota, 65 per cent. Maps of this series have been published for 35 States.

ATLANTIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Georgia, Maine, Mississippi, New Hampshire, New York, Penn-

sylvania, South Carolina, Vermont, Virginia, and West Virginia. This work comprised the completion of the survey of 18 quadrangles and 2 special areas and the resurvey of 5 quadrangles, in addition to which 12 quadrangles were partly surveyed and 3 were partly resurveyed. Primary triangulation and primary traverse were carried on by seven parties in Maine, Mississippi, New York, Pennsylvania, Virginia, and West Virginia.

Topographic surveys in Atlantic division from July 1, 1919, to June 30, 1920.

State.	Contour interval.	For publication on the scale of—			Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		1:62,500.		1:20,000 (new).		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
		New.	Resurvey.								
	Feet.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*		*Miles.*			
Georgia	10,20	162			162						
Maine						87	24			8	
Mississippi	20	74			74			158	32		
New Hampshire	20	102			102						
New York	20	678			678	235	62	197	21		
Pennsylvania	20	779			779	321	104	260	9		
South Carolina	10	1,849			1,849	129	31				
Vermont	20	268			268	110	31				
Virginia	2,10 50		23	69	92	194	45	229	21		
West Virginia	50		944		944	367	110	36	11	18	14
		3,912	967	69	4,948	1,443	407	880	94	26	14

Georgia.—In cooperation with the War Department, the survey of the Appling, Dearing, and Rocky Ford quadrangles, in Bulloch, Columbia, Jenkins, Lincoln, McDuffie, Richmond, Screven, and Wilkes counties, Ga., was completed, the total area mapped being 119 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet.

Georgia-South Carolina.—In cooperation with the War Department, the survey of the Augusta quadrangle, in Burke and Richmond counties, Ga., and Aiken and Columbia counties, S. C., was completed, and that of the Warrenville quadrangle, in Richmond County, Ga., and Aiken County, S. C., was continued, the total area mapped being 155 square miles, 43 square miles in Georgia and 112 square miles in South Carolina, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Water Power Commission allotted $5,000 and the United States Geological Survey allotted an equal amount. For the control of the Farmington quadrangle 87 miles of primary levels were run and 24 permanent bench marks established, and for the control of the Brassua Lake and Moosehead quadrangles 8 triangulation stations were occupied.

Mississippi.—For beginning cooperative topographic surveys in Mississippi during the fiscal year 1920–21 the State Geological Survey allotted $20,000 and the United States Geological Survey allotted an equal amount. In order that field work might be taken up immediately, this money was made available in the spring of 1920. For the control of the Doloroso, Forest, Morton, and Pelahatchie quadrangles 158 miles of primary traverse were run and 32 permanent marks set.

Mississippi-Louisiana.—In addition to the cooperative work the survey of the Natchez quadrangle, in Adams and Jefferson counties, Miss., and Catahoula County, La., was continued, the total area mapped being 74 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. All the area mapped was in the State of Mississippi.

New Hampshire.—In cooperation with the War Department the survey of the Suncook quadrangle, in Hillsboro, Merrimack, and Rockingham counties, N. H., was completed, the total area mapped being 102 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

New York.—For the continuation of cooperative topographic surveys in New York the State engineer and surveyor allotted $15,000 and the United States Geological Survey allotted an equal amount. The survey of the Cranberry Lake and Nicholville quadrangles, in Franklin, Hamilton, Herkimer, and St. Lawrence counties, was completed, and that of the Childwold and White Lake quadrangles, in Franklin, St. Lawrence, and Sullivan counties, was begun, the total area mapped being 673 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Childwold, Nicholville, Livingston Manor, and White Lake quadrangles, 227 miles of primary levels were run and 60 permanent bench marks established, and for the control of the Livingston Manor and White Lake quadrangles 124 miles of primary traverse were run and 9 permanent marks set. (See also Pennsylvania-New York.)

Pennsylvania.—For the continuation of cooperative topographic surveys in Pennsylvania the State Topographic and Geologic Survey allotted $25,000 and the United States Geological Survey allotted an equal amount. The survey of the Confluence and Meyersdale quadrangles, in Fayette and Somerset counties, was completed, and that of the Altoona, Hanover, New Florence, and Stahlstown quadrangles, in Adams, Blair, Cambria, Center, Clearfield, Fayette, Indiana, Somerset, Westmoreland, and York counties, was begun, the total area mapped being 730 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Altoona, Confluence, Hanover, New Florence, and Philipsburg quadrangles 254 miles of primary levels were run and 88 permanent bench

marks established, and for the control of these quadrangles and the Tyrone and Stahlstown quadrangles 173 miles of primary traverse were run and 3 permanent marks set.

Pennsylvania-New York.—The survey of the Damascus and Long Eddy quadrangles, in Pike and Wayne counties, Pa., and Delaware and Sullivan counties, N. Y., was begun, the total area mapped being 54 square miles (49 square miles in Pennsylvania and 5 square miles in New York), for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles 75 miles of primary levels were run, 18 permanent bench marks established, 160 miles of primary traverse run, and 18 permanent marks set.

South Carolina.—In cooperation with the War Department the survey of the Bamberg, Bowman, Chicora, Eutawville, Manning, Mayesville, and Orangeburg quadrangles, in Bamberg, Barnwell, Berkeley, Calhoun, Clarendon, Dorchester, Lee, Orangeburg, Sumter, and Williamsburg counties, S. C., was completed, and that of the Moncks Corner and Williston quadrangles, in Aiken, Barnwell, and Berkeley counties, was continued, the total area mapped being 1,737 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these quadrangles 129 miles of primary levels were run and 31 permanent bench marks established.

Vermont.—For the continuation of cooperative topographic surveys in Vermont the State geologist allotted $3,000 and the United States Geological Survey allotted an equal amount. The survey of the Lincoln Mountain and Montpelier quadrangles, in Addison, Chittenden, Lamoille, and Washington counties, was completed, the total area mapped being 268 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Montpelier, Bolton, and Hyde Park quadrangles 110 miles of primary levels were run and 31 permanent bench marks established.

Virginia.—In cooperation with the War Department the survey of Camp A. A. Humphreys, in Arlington and Fairfax counties, Va., was completed, the total area mapped being 57 square miles, for publication on the scale of 1:20,000, with a contour interval of 10 feet. For the control of this area 150 miles of primary levels were run, 36 permanent bench marks established, and 160 miles of primary traverse run.

In cooperation with the War Department the survey of the Big Bethel Reservoir, in Elizabeth City, Warwick, and York counties, was completed, the total area mapped being 12 square miles, for publication on the scale of 1:20,000, with a contour interval of 2 feet.

For the continuation of cooperative topographic surveys in Virginia the State geologist allotted $2,544.10 and the United States Geological Survey allotted an equal amount. For the control of the Chatham quadrangle 69 miles of primary traverse were run and 21 permanent marks set.

Virginia-Kentucky.—In cooperation with the State of Virginia the resurvey of the Big Stone Gap quadrangle, in Lee, Scott, and Wise counties, Va., and Harlan County, Ky., was begun, the total area mapped being 23 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The area mapped was all in Virginia. For the control of this quadrangle 44 miles of primary levels were run and 9 permanent bench marks established, all in Virginia.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the State geologist allotted $18,750 and the United States Geological Survey allotted an equal amount. The resurvey of the Davis, Elk Garden, Maysville, Onego, and Petersburg quadrangles, in Grant, Hardy, Mineral, Pendleton, and Randolph counties was completed, and that of the Moorefield quadrangle, in Hardy and Hampshire counties, was begun, the total area mapped being 929 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Keyser, Maysville, Moorefield, Onego, and Petersburg quadrangles 367 miles of primary levels were run and 110 permanent bench marks established, and for the control of the Elk Garden and Keyser quadrangles 36 miles of primary traverse were run and 11 permanent marks set. For the control of the Alderson, Clintonville, Lobelia, Richwood, Simmonsville, and White Sulphur Springs quadrangles 13 triangulation stations were occupied, 9 of which were permanently marked.

West Virginia-Virginia.—In cooperation with the State of West Virginia, the resurvey of the Ronceverte quadrangle, in Greenbrier and Monroe counties, W. Va., and Allegheny and Craig counties, Va., was begun, the total area mapped being 15 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Ronceverte and Pearisburg quadrangles five triangulation stations were occupied and marked.

OFFICE WORK.

The drafting of the following sheets was completed: Appling, Bascom, Brooklet, Cumberland Island, Dearing, Glennville, Hephzibah, Millen, Pembroke, Rocky Ford, Stapleton, Statesboro, Ga.; Augusta, Clarks Hill, Ellenton, Greens Cut, Peeples, Ga.-S. C.; Suncook, N. H.; Cranberry Lake, Nicholville, N. Y.; Camp Bragg, N. C.; Meyersdale, Pa.; Aiken, Bamberg, Bowman, Camp Jackson,

Lodge, Manning, Maysville, Orangeburg, Ridgeville, St. George, Summerville, S. C.; Memphis, Tenn.-Ark.; Lincoln Mountain, Montpelier, Vt.; Ivor, McKenney, Homeville, Lawrenceville, Wise, Va.; Arringdale, Boykins, Holland, White Plains, Va.-N. C.; Davis, Elk Garden, Greenland Gap, W. Va.

Progress in the drafting of additional sheets was made as follows: Warrenville, Ga.-S. C., 66 per cent; Childwold, N. Y., 10 per cent; Confluence, Pa., 53 per cent; Chicora, S. C., 20 per cent; Eutawville, S. C., 45 per cent; Talatha, S. C., 50 per cent; Williston, S. C., 65 per cent; Coeburn, Va., 53 per cent.

Primary-level circuits were adjusted for the following quadrangles: Camp Hancock, Hephzibah, Ga.; Allendale, Augusta, Clarks Hill, Greens Cut, Hilltonia, Peeples, Robbins, Shirley, Ga.-S. C.; Childwold, N. Y.; Confluence, Hanover, Meyersdale, Tobyhanna Military Reservation (Pocono quadrangle), Pa.; Bowman, Chicora, Manning, Moncks Corner, Rimini, S. C.; Bolton, Montpelier, Vt.; Coeburn, Camp A. A. Humphreys, Hampton, Va.; Maysville, Onego, Petersburg, W. Va.

Geographic positions were computed for the following quadrangles: Altamaha, Broxton, Dates, Leliaton, Lumber City, Macon, Meriwether, Perrys Mills, Stillmore, Wilcox, Ga.; Doloroso, Miss.; Alton, Gilmanton, Mount Pawtuckaway, Suncook, N. H.; Damascus, Livingston Manor, Long Eddy, White Lake, N. Y.; Accident, Altoona, Birmingham, Confluence, Damascus, Hanover, Long Eddy, New Florence, Stahlstown, Uniontown, Pa.; Bamberg, Batesburg, Bowman, Bonneau, Branchville, Chapin, Chicora, Edmund, Elloree, Eutawville, Fort Motte, Hopkins, Indiantown, Kingstree, Lexington, Manning, Orangeburg, Ridgeville, Rimini, St. George, Seivern, Summerville, Sumter, Woodford, S. C.; Barre, Bolton, Royalton, Waitsfield, Vt.; Big Stone Gap, Camp A. A. Humphreys, Va.; Alderson, Callaghan, Clintonville, Elk Garden, Keyser, Lobelia, Maysville, Moorefield, Onego, Orkney Springs, Pearisburg, Petersburg, Richwood, Ronceverte, Simmonsville, White Sulphur Springs, W. Va.

CENTRAL DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, and Wisconsin. The work comprised the completion of the survey of 9 quadrangles and the resurvey of 2, in addition to which 12 quadrangles were partly surveyed. Primary traverse was carried on by seven parties in Illinois, Indiana, Kentucky, Michigan, and Wisconsin.

Topographic surveys in central division from July 1, 1919, to June 30, 1920.

State.	Contour interval.	For publication on scale of 1:62,500.		Total area surveyed.	Primary levels.		Primary traverse.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Illinois	10, 20	694	.....	694	328	91	379	32
Indiana	.....	.....	.....	.....	.....	.....	225	18
Iowa	10	129	.....	129	67	17	.....	.....
Kentucky	20	218	.....	218	202	56	281	45
Michigan	5, 10	861	.....	861	301	59	768	60
Missouri	10	.....	247	247	65	23	.....	.....
Wisconsin	20	644	.....	644	514	142	737	73
	.....	2,546	247	2,793	1,477	388	2,390	228

Illinois.—For the continuation of cooperative topographic surveys in Illinois the Department of Registration and Education allotted $15,394.49 and the United States Geological Survey allotted an equal amount. The survey of the Barrington and Vermont quadrangles, in Cook, Fulton, Kane, Lake, and McHenry counties, was completed, and that of the Carbondale and Dongola quadrangles, in Jackson, Johnson, Pulaski, Union, and Williamson counties, was begun, the total area mapped being 528 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. For the control of the Barrington, Carbondale, Dongola, Joliet, and Mound City quadrangles 252 miles of primary levels were run and 71 permanent bench marks established, and for the control of the Annawan, Alexis, Barry, Buda, Camp Grove, Carbondale, Galesburg, Hannibal, Joliet, Liberty, Marion, Marshall, Mendon, Merom, Moonshine, Monmouth, Mount Sterling, Oilfield, Oquawka, Quincy, and Yorkville quadrangles 379 miles of primary traverse were run and 32 permanent marks set.

Illinois-Wisconsin.—In cooperation with the State of Illinois the survey of the Grays Lake quadrangle, in Lake and McHenry counties, Ill., and Kenosha County, Wis., was begun, the total area mapped being 166 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of this area 76 miles of primary levels were run and 20 permanent bench marks established.

Indiana.—For cooperative topographic surveys in Indiana the State geologist allotted $1,323.40 and the United States Geological Survey allotted an equal amount. For the control of the Heltonville and Oolitic quadrangles 225 miles of primary traverse were run and 18 permanent marks set.

Iowa.—For the continuation of cooperative topographic surveys in Iowa the State Geological Survey allotted $1,750 and the United

States Geological Survey allotted an equal amount. The survey of the Lehigh quadrangle, in Webster County, was begun, the total area mapped being 129 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Lehigh and Dakota quadrangles 67 miles of primary levels were run and 17 permanent bench marks established.

Kentucky.—For the continuation of cooperative topographic surveys in Kentucky the Commissioner of Geology and Forestry allotted $12,943.60 and the United States Geological Survey allotted an equal amount. The survey of the Alvaton and Glenmore quadrangles, in Allen, Butler, Edmonson, Simpson, and Warren counties, was begun, the total area mapped being 172 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles 202 miles of primary levels were run and 56 permanent bench marks established, and for the control of these areas and the Bethpage, Lucas, Mammoth Cave, Salmons, and Temple Hill quadrangles 222 miles of primary traverse were run and 35 permanent marks set.

Kentucky-Illinois.—The survey of the Golconda quadrangle, in Livingston and Crittenden counties, Ky., and Pope and Hardin counties, Ill., was completed, the total area mapped being 46 square miles (all in Kentucky), for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Kentucky-Tennessee.—For the control of the Adolphus and Buck Lodge quadrangles 59 miles of primary traverse were run and 10 permanent marks set.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted $14,370 and the United States Geological Survey allotted an equal amount. The survey of the Burt, Rives Junction, Springport, and Stockbridge quadrangles, in Calhoun, Eaton, Genesee, Ingham, Jackson, Livingston, Saginaw, Shiawassee, and Washtenaw counties, was completed, and that of the Durand and Flint quadrangles, in Genesee, Livingston, Saginaw, Shiawassee, and Tuscola counties, was begun, the total area mapped being 861 square miles, for publication on the scale of 1:62,500, with contour intervals of 5 and 10 feet. For the control of the Burt, Durand, Flint, and Holly quadrangles 301 miles of primary levels were run and 59 permanent bench marks established. For the control of the Armada, Avoca, Berkshire, Butman, Croswell, Forestville, Freeland, Hicky, Highwood, Marlette, Mayville, Melvin, Sanford, Shepherd, and Vassar quadrangles 768 miles of primary traverse were run and 60 permanent marks set.

In addition to the cooperative mapping done in Michigan a survey comprising 16 square miles along Flint River was made for the city engineer of Saginaw, in connection with the flood problems of the

Saginaw River basin. For the control of this area 80 miles of primary levels were run and 15 permanent bench marks established.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted $5,000 and the United States Geological Survey allotted an equal amount. The resurvey of the Sarcoxie and Stotts City quadrangles, in Jasper and Lawrence counties, was completed, the total area mapped being 247 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Braymer, Dearborn, Gower, Gallatin, Plattsburg, Polo, and Winston quadrangles 65 miles of primary levels were run and 23 permanent bench marks established.

Wisconsin.—For the continuation of cooperative topographic surveys in Wisconsin the State geologist allotted $15,000 and the United States Geological Survey allotted an equal amount. The survey of the Kendall and Mauston quadrangles, in Juneau and Monroe counties, was completed, and that of the Mazomanie, Monroe, New Glarus, and Upson quadrangles, in Dane, Green, Iowa, Iron, and Sauk counties, was begun, the total area mapped being 644 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Upson, Mellen, Browntown, Monroe, Brodhead, New Glarus, Bibon, Superior, Rockmont, Brule, Iron Ore River, Cusson, Blanchardville, and Birch Lake quadrangles 514 miles of primary levels were run and 142 permanent bench marks established, and for the control of the Upson, Mellen, Three Lakes, New Glarus, Bibon, Birch Lake, Ashland, Moquah, Morse, Monico, Elcho, Antigo, Eland, Caroline, Hortonville, Appleton, Suamico, and Robbins quadrangles 737 miles of primary traverse were run and 73 permanent marks set.

OFFICE WORK.

The drafting of the following sheets was completed: Vermont, Ill.; Burt, Rives Junction, Springport, Stockbridge, Mich.; Sarcoxie, Stotts City, Mo.; Kendall, Mauston, Wis.

Progress in the drafting of additional sheets was made as follows: Barrington, Ill., 60 per cent; Dongola, Ill., 36 per cent; Grays Lake, Ill.-Wis., 24 per cent; Lehigh, Iowa, 50 per cent; Glenmore, Ky., 8 per cent; Durand, Mich, 25 per cent; Flint, Mich., 50 per cent; Mazomanie, Wis., 52 per cent; Monroe, Wis., 15 per cent; New Glarus, Wis., 15 per cent; Upson, Wis., 35 per cent.

Primary-level circuits were adjusted for the following quadrangles: Barrington, Dongola, Joliet, Ill.; Grays Lake, Ill.-Wis.; Dakota, Lehigh, Iowa; Alvaton, Glenmore, Ky.; Burt, Durand, Flint, Holly, Imlay City, Lapeer, Schoolcraft, Mich.; Ashland, Bibon, Birch Lake, Blanchardville, Brodhead, Browntown, Brule, Ironwood, Kendall, Mellen, Monroe, New Glarus, Rockmont, Tomah, Upson, Wis.

Geographic positions were computed for the following quadrangles: Buda, Barrington, Desplaines, Elgin, Highwood, Joliet, Liberty, Marshall, McHenry, Merom, Moonshine, Oilfield, Quincy, Yorkville, Ill.; Grays Lake, Ill.-Wis.; Heltonville, Oolitic, Ind.; Dakota, Lehigh, Iowa; Alvaton, Glenmore, Lucas, Mammoth Cave, Salmons, Temple Hill, Ky.; Adolphus, Bethpage, Buck Lodge, Ky.-Tenn.; Alger, Algonac, Almont, Armada, Avoca, Bay City, Burt, Beaver Lake, Berkshire, Butman, Cass City, Crosswell, Durand, Flint, Forestville, Freeland, Hicky, Highwood, Holly, Imlay City, Ithaca, Lapeer, Loomis, Marlette, Mayville, Melvin, Merrill, Mount Clemens, Mount Forest, Nolan, Port Huron, Saginaw, St. Charles, Sanford, Sebewaing, Seymour Lake, Shepherd, Tyre, Vassar, Mich.; Antigo, Appleton, Ashland, Bibon, Birch Lake, Blanchardville, Browntown, Caroline, Clam Lake, Cross Plains, Eland, Elcho, Hortonville, Iron Ore River, Ironwood, Mellen, Monico, Monroe, Moquah, Morse, New Glarus, Odanah, Port Wing, Robbins, Seymour, State Line, Suamico, Three Lakes, Upson, Wis.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Colorado, North Dakota, Texas, and Wyoming. The work comprised the completion of the survey of six quadrangles and one special area, in addition to which four quadrangles and one special area were partly surveyed. Primary triangulation and primary traverse were carried on by six parties in Colorado and Texas.

Topographic surveys in Rocky Mountain division from July 1, 1919, to June 30, 1920.

State.	Contour interval.	For publication on the scale of—				Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		1:12,000	1:31,680	1:62,500	1:125,000		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Colorado.	20,100	2	.....	.....	65	67	125	34	.....	.....	10	8
North Dakota	20	.....	.....	87	.....	87	22	5	.....	.....	.....	.....
Texas....	5,25,50	.....	89	1,526	.....	1,615	1,078	296	203	50	92	104
Wyoming	100	.....	.....	.....	45	45	.....	.....	.....	.....	.....	.....
	.....	2	89	1,613	110	1,814	1,225	335	203	50	102	112

Colorado.—The mapping of the Kerber Creek mining district, in Saguache County, Colo., was begun, the total area mapped being 2 square miles, for publication on the scale of 1:12,000, with a contour

interval of 20 feet. This work was done in cooperation with the State geologist of Colorado, who allotted $1,000, the United States Geological Survey furnishing the services of an experienced topographic engineer and the necessary instruments.

In addition to this cooperative mapping the survey of the Conejos quadrangle, in Alamosa, Conejos, and Rio Grande counties, was begun, the total area mapped being 65 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area 125 miles of primary levels were run and 34 permanent bench marks established, and 10 triangulation stations were occupied, 8 of which were marked.

North Dakota.—For beginning cooperative topographic surveys in North Dakota the State Geological Survey allotted $1,500 and the United States Geological Survey allotted an equal amount. The survey of the Garrison quadrangle, in McLean County, was begun, the total area mapped being 87 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 22 miles of primary levels were run and 5 permanent bench marks established.

Texas.—In cooperation with the War Department the survey of the Marathon, Monument Spring, Salt Lakes, and Tarida Ranch quadrangles, in Cameron, Hidalgo, Brewster, and Willacy counties, Tex., was completed, and that of the Marathon No. 1 quadrangle, in Brewster County, was begun, the total area mapped being 1,136 square miles, for publication on the scale of 1:62,500, with contour intervals of 5 and 50 feet. For the control of these areas and that of the Alice No. 1, Alice No. 3, Big Spring, Fort Stockton Nos. 1, 2, 3, and 4, Free No. 3, Hebbronville, Katherine No. 2, Loma Chata Nos. 3 and 4, Marathon No. 2, Midkiff, Pato Nos. 3 and 4, Rankin, Robstown, Sanderson Nos. 2 and 3, San Ygnacio, and Stiles quadrangles 826 miles of primary levels were run and 226 permanent bench marks established, and for the control of the Katherine Nos. 1 and 2, Padre Island No. 3, Salt Lakes, and Tarida Ranch quadrangles 203 miles of primary traverse were run and 50 permanent marks set. For the control of the Alice Nos. 1, 3, and 4, Fort Stockton Nos. 1, 2, 3, and 4, Free Nos. 1, 2, 3, and 4, Loma Chata Nos. 1 and 4, Marathon, Marathon Nos. 1 and 2, Monument Spring, Pato No. 3, Sanderson Nos. 1, 2, 3, and 4, and Stiles quadrangles 64 triangulation stations were occupied and 83 marked.

For the continuation of cooperative topographic surveys in Texas the Bureau of Economic Geology and Technology allotted $9,455, to be used in the survey of the Sawyer Nos. 1, 2, 3, and 4 quadrangles, the United States Geological Survey giving credit to the State for cooperation on the Marathon, Monument Spring, Salt Lakes, and Tarida Ranch quadrangles, which were mapped in cooperation with the War

Department. The survey of the Sawyer No. 4 quadrangle, in Crockett, Iron, and Reagan counties, was completed and that of Sawyer No. 3 quadrangle, in Crockett and Reagan counties, was begun, the total area mapped being 390 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 the Sawyer Nos. 1 and 2 quadrangles 184 miles of primary levels were run, 45 permanent bench marks established, and 28 triangulation stations occupied, 21 of which were marked.

The State Board of Water Engineers allotted $4,000 and the United States Geological Survey allotted an equal amount. The survey of the San Saba project, in San Saba County, was completed, the total area mapped being 89 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of this area 68 miles of primary levels were run and 25 permanent bench marks established.

Wyoming.—The survey of the Afton quadrangle, in Lincoln County, Wyo., was completed, the total area mapped being 45 square miles, for publication of the scale of 1:125,000, with a contour interval of 100 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Marathon, Monument Spring, Salt Lakes, Tarida Ranch, Tex.; Afton, Wyo.

Progress in the drafting of additional sheets was made as follows: Garrison, N. Dak., 5 per cent.

Primary-level circuits were adjusted for the following quadrangles: Big Spring, Crane, Fort Stockton Nos. 1, 2, 3, and 4, Free No. 3, Garden City, Katherine No. 4, Marathon Nos. 1, 2, and 3, Midkiff, Ozona, Salt Lakes, Sanderson Nos. 1 and 2, Sawyer No. 3, Stiles, Tex.

Geographic positions were computed for the following quadrangles: Animas Peak, Antelope, Avis, Big Hatchet Peak, Cienega Springs, Dog Mountains, Hachita, Hermanas, Hope, Orange, Playas, Pratt, Queen, Victorio, Walnut Wells, N. Mex.; Crane, Dove Mountain, Fort Stockton, Free, Hood Springs, Longfellow, Marathon, Sanderson, Santiago Peak, Sawyer No. 3, Stiles, Tex.; Como Ridge, Difficulty, Hanna, Leo, Saddleback Hills, Wyo.

NORTHWESTERN DIVISION.

FIELD WORK.

Summary.—During the year topographic mapping was carried on in Idaho, Montana, Oregon, and Washington. The work included the completion of the survey of five quadrangles, in addition to which six were partly surveyed. In addition, a profile survey was made of a portion of one river, the distance traversed being 10 linear miles.

Primary triangulation and primary traverse were carried on by two parties in Idaho and Washington.

Topographic surveys in northwestern division from July 1, 1919, to June 30, 1920.

State.	Contour interval.	For publication on scale of—		Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		1:62,500	1:125,000		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*			
Idaho	50,100	111	145	256	53	14	.....	.....	20	11
Montana	100	.....	47	47	.....	.....	.....	.....	.....	.....
Oregon	25,50	333	.....	333	143	27	.....	.....	.....	.....
Washington	50,100	.....	563	563	126	18	136	22	.....	.....
	.....	444	755	1,199	322	59	136	22	20	11

Idaho.—For the continuation of cooperative topographic surveys in Idaho the Bureau of Mines and Geology allotted $1,190 and the United States Geological Survey allotted an equal amount. The survey of the Seven Devils quadrangle, in Adams County, was begun, the total area mapped being 111 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area 53 miles of primary levels were run and 14 permanent bench marks established, and for the control of the Avery, Bovill, Fernwood, Kendrick, and Washington Creek quadrangles 20 triangulation stations were occupied, 11 of which were marked.

In addition to the cooperative topographic mapping in Idaho, the survey of the Custer quadrangle, in Custer County, was completed, the total area mapped being 145 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Montana.—The mapping of the Drummond 30-minute quadrangle, in Granite, Missoula, and Powell counties, Mont., was completed, the total area mapped being 47 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Oregon.—In cooperation with the War Department, the survey of the Cottage Grove and Waldport quadrangles, in Lane and Lincoln counties, Oreg., was completed and that of the Alsea No. 3, Reedsport, and Scottsburg No. 2 quadrangles, in Douglas and Lane counties, was begun, the total area mapped being 333 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet. For the control of the Alsea Nos. 2 and 3, Scottsburg Nos. 1, 3, and 4, and Waldport quadrangles 143 miles of primary levels were run and 27 permanent bench marks established.

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 survey of the Walla Walla quadrangle, in Columbia and Walla Walla counties, was completed, and that of the Sultan and Trinidad quadrangles, in Douglas, King, Kittitas, and Snohomish counties, was begun, the total area mapped being 563 square miles, for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet. For the control of the Sultan quadrangle 126 miles of primary levels were run, 18 permanent bench marks established, 136 miles of primary traverse run, and 22 permanent bench marks set.

A plan and profile survey of a portion of Nooksack River was made, the distance traversed being 10 linear miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Custer, Idaho; Drummond, Mont.; Cottage Grove, Waldport, Oreg.; Pysht, Walla Walla, Wickersham, Wash.

Progress in the drafting of additional sheets was made as follows: Seven Devils, Idaho, 48 per cent; Alsea No. 3, Oreg., 40 per cent; Lake Crescent, Wash., 90 per cent; Sultan, Wash., 33 per cent; Trinidad, Wash., 40 per cent.

Primary-level circuits were adjusted for the following quadrangles: Seven Devils, Idaho; Sultan, Wash.

Geographic positions were computed for the following quadrangles: Bovill, Kendrick, Seven Devils, Washington Creek, Idaho; Sultan, Wash.

PACIFIC DIVISION.

FIELD WORK.

Summary.—During the season topographic mapping was carried on in Arizona, California, and Utah. The work included the completion of the survey of 14 quadrangles and 2 special areas, in addition to which 8 quadrangles and 1 special area were partly surveyed. Primary triangulation and primary traverse were carried on by two parties in California.

Topographic surveys in Pacific division from July 1, 1919, to June 30, 1920.

State.	Contour interval.	For publication on the scale of—						
		1:4,800	1:12,000	1:21,120	1:24,000	1:31,680	1:62,500	1:125,000
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*
Arizona	5,10	.....	11	.....	25	64	.....	.....
California	2,4,5 / 50,100	3	.....	.....	.....	828	198	503
Utah	50	.....	.....	6	.....	.....	.....	.....
	.....	3	11	6	25	892	198	503

Topographic surveys in Pacific division from July 1, 1919, to June 30, 1920—Con.

State.	Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		Distance run.	Bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Sq. mi.	*Miles.*		*Miles.*			
Arizona	100						
California	1,532	321	53	19	5	13	33
Utah	6						
	1,638	321	53	19	5	13	33

Arizona.—The United States Reclamation Service, in cooperation with the State of Arizona, allotted $4,000 and the United States Geological Survey allotted an equal amount for special surveys and investigations in Arizona to ascertain the feasibility of the storage and diversion of the waters of Gila River below San Carlos and the irrigation of lands in the proposed San Carlos project; the storage and diversion of waters of Gila and San Francisco rivers in the vicinity of Red Rock and Alma, N. Mex., and irrigation of lands therefrom in the State of Arizona. For this purpose 100 square miles of topographic mapping was completed, for publication on the scales of 1:12,000, 1:24,000, and 1:31,680, with contour intervals of 5 and 10 feet.

California.—In cooperation with the War Department the survey of the Nipomo quadrangle, in San Luis Obispo County, Calif., was completed and that of the Avenal and La Panza quadrangles, in San Luis Obispo and Santa Barbara counties, was begun, the total area mapped being 198 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

For the continuation of cooperative topographic surveys in California the State Department of Engineering allotted $14,000 for work in San Joaquin Valley and the United States Geological Survey allotted an equal amount. In addition to this, the State allotted $7,500, which was not met by Survey funds. The survey of the Academy, Bridge, Carrisalito Springs, Charleston School, Dos Palos, Friant, Gregg, Kentucky Well, Madera, No. 18, Oxalis, Pozo Farm, and Sheep Ranch quadrangles, in Fresno, Madera, and Merced counties, was completed and that of the Kings River, Laguna Seca Ranch, No. 22 and No. 23 quadrangles, in Fresno and Merced counties, was begun, the total area mapped being 828 square miles, for publication on the scale of 1:31,680, with a contour intervals of 5 feet. For the control of the Academy, Arburnas, Carrisalito Springs, Charleston School, Clovis, Friant, Kings River, Laguna Seca Ranch, Malaga, No. 21, No. 22, No. 27, Reedley special, Sanger, Selma, Squaw Valley,

Sultana, and Wahtoke quadrangles 303 miles of primary levels were run and 48 permanent bench marks established, and for the control of the Arburnas, Carrisalito Springs, Chaney Ranch, Charleston School, Cierva Hills, Helm, Kerman, Monocline Ridge, No. 23, No. 24, No. 25, No. 26, No. 28, No. 29, No. 31, No. 32, Oil City, Ora, San Joaquin, Tranquillity, Tumey Hills, and Wheatville quadrangles 13 triangulation stations were occupied and 33 marked.

In addition to the cooperative topographic mapping, the survey of the Hinkley and Trimmer quadrangles, in Fresno and San Bernardino counties, was begun, the total area mapped being 503 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Corrections in the field were made on the Preston Peak, Sawyers Bar, and Seiad quadrangles.

The survey of the floor of the Yosemite Valley was begun for the National Park Service, the total area mapped being 3 square miles, for publication on the scale of 1:4,800, with contour intervals of 2 and 4 feet. For the control of this area 18 miles of primary levels were run and 5 permanent bench marks established, 19 miles of primary traverse run, and 5 permanent marks set.

Hawaii.—For cooperative topographic surveys in the Territory of Hawaii the Governor of Hawaii allotted $25,000 and the United States Geological Survey allotted an equal amount. No topographic mapping was accomplished under this agreement, as A. O. Burkland, topographic engineer, who has been placed in immediate charge of this work, did not sail for Hawaii until the middle of June.

Utah.—The survey of the Cottonwood special extended area, in Utah County, Utah, was completed, the total area mapped being 6 square miles, for publication on the scale of 1:21,120, with a contour interval of 50 feet. In addition to this work, plan and profile surveys and a survey of reservoir sites and canals in Salt Lake County, for drainage for Mill Creek and Cottonwood Creek in Utah, were begun, 22 square miles of topographic mapping being completed.

OFFICE WORK.

The drafting of the following topographic maps was completed: Oatman special, Ariz.; Bonanza, Bonita Ranch, Bridge, Carbona, Carrisalito Springs, Charleston School, Dos Palos, Daulton, Friant, Gregg, Gilroy Hot Springs, Gonzales, Kentucky Well, Madera, Metz, Nipomo, Oxalis, Pozo, Pozo Farm, Yosemite Valley, Volta, Calif.; Cottonwood special extended, Utah.

Progress in the drafting of additional sheets was made as follows: Hollister, Calif., 95 per cent; Los Banos, Calif., 90 per cent; Mount Boardman, Calif., 45 per cent; Santa Rita Bridge, Calif., 90 per cent; Trimmer, Calif., 81 per cent.

Primary-level circuits were adjusted for the following quadrangles: Yosemite and thirty-four 7½-minute quadrangles in San Joaquin Valley, Calif.

Geographic positions were computed for the following quadrangles: Oatman special, Ariz.; Avenal, Bonanza, Carrisalito Springs, Center School, La Panza, Nipomo, Ortigalito, Panoche, Pozo, Tumey Hills, and Yosemite National Park (Muir Woods extension) (boundary and area computations), survey of boundaries of additions to Muir Woods National Monument, Calif.; Rochester special, Nev.

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 five divisions:

Division of surface water, John C. Hoyt, hydraulic engineer, in charge.
Division of ground water, O. E. Meinzer, geologist, in charge.
Division of quality of water, W. D. Collins, chemist, in charge.
Division of power resources, A. H. Horton, hydraulic engineer, in charge.
Division of enlarged and stock-raising homesteads, H. C. Cloudman, classifier, in charge.

PERSONNEL.

During the year the technical force was reduced 54 by resignations, death, or transfers, and was increased 52 through reinstatements of men from military service and new appointments—a net reduction of 2. At the end of the year the force consisted of 1 chief hydraulic engineer, 19 hydraulic engineers, 25 engineers, 25 assistant engineers, 13 junior engineers, 2 geologists, 4 associate geologists, 3 junior chemists, 4 classifiers, 14 assistant classifiers, and 6 junior classifiers, a total of 116. Of this number, 1 hydraulic engineer and 3 assistant engineers are on furlough, and 1 hydraulic engineer, 13 engineers, 2 assistant engineers, 2 junior engineers, 1 classifier, and 1 assistant classifier are employed occasionally.

In the clerical force there were 10 separations and 16 accessions, and at the end of the year the force numbered 38.

ALLOTMENTS.

The appropriation for gaging streams was $175,000. The cooperative funds made available by State allotments, amounting to $173,380, have been increased in some States and decreased in others, making necessary corresponding adjustments of this work.

The appropriation for examination of lands under the stock-raising homestead law enacted December 29, 1916, was $175,000.

Allotments of appropriations, water-resources branch.

For gaging streams:			
General administration		$17,741.33	
Land-classification board		7,000.00	
Map editing		288.17	
Branch administration		6,500.00	
Computations		12,000.00	
Reviewing manuscripts		1,915.00	
Inspection		1,000.00	
			$46,444.50
Surface water:			
New England:			
Connecticut	$1,600.00		
Maine	850.00		
New Hampshire	1,000.00		
Vermont	900.00		
Massachusetts	2,125.00		
		6,475.00	
New York		4,975.00	
Pennsylvania		645.33	
Middle Atlantic States		800.00	
South Atlantic States		5,975.00	
Tennessee		1,890.00	
Texas		4,875.00	
Upper Mississippi River:			
Wisconsin	$3,375.00		
Minnesota	300.00		
Iowa	1,700.00		
Illinois	1,500.00		
		6,875.00	
Colorado, Wyoming, and New Mexico		7,375.00	
Montana	$4,625.00		
North Dakota	300.00		
		4,925.00	
Great Basin:			
Utah	$4,875.00		
Nevada	2,500.00		
		7,375.00	
Idaho:			
Outside of Snake River basin	$3,875.00		
Snake River basin	1,000.00		
		4,875.00	
Oregon		4,875.00	
Washington		4,875.00	
California		4,975.00	
Hawaii:			
At Honolulu	$4,000.00		
At Washington	800.00		
		4,800.00	
Kansas		3,500.00	
Arizona		3,000.00	
			83,085.33

For gaging streams—Continued.		
Ground water:		
General	$16,600.00	
Coastal Plain	1,400.00	
		$18,000.00
Quality of water		7,850.00
Power resources		14,000.00
General supplies		600.00
Contingent		5,020.17
		175,000.00
For enlarged and stock-raising homesteads:		
Field work	$89,495.00	
Land-classification board	56,500.00	
General administration	14,844.00	
Branch administration	8,000.00	
Contingent	6,161.00	
		175,000.00

Of the total appropriations, 80 per cent was allotted for work in public-land States.

COOPERATION.

State.—The following amounts were expended by several States from cooperative allotments:

Alabama		$175
Arizona		2,985
California:		
State engineer	$11,355	
State Water Commission	9,395	
City of San Francisco	2,335	
San Bernardino, Riverside, and Orange counties	3,000	
		26,085
Colorado		500
Connecticut		1,005
Georgia		535
Hawaii		26,200
Idaho:		
Outside of Snake River basin	$9,685	
Snake River basin	1,470	
		11,155
Illinois		3,620
Iowa:		
State Geological Survey	$655	
State Highway Commission	2,340	
		2,995
Kansas		4,010
Kentucky		250
Maine		4,290
Massachusetts		2,450
Minnesota		610
Montana		3,425

Nevada		$2,510
New Hampshire		1,560
New York:		
State engineer	$2,500	
Conservation Commission	9,995	
		12,495
North Carolina		415
North Dakota		575
Oregon		5,700
Pennsylvania		25,780
South Dakota		180
Tennessee		490
Texas		10,280
Utah		4,735
Vermont		1,060
Washington		6,190
West Virginia		355
Wisconsin		6,245
Wyoming		4,520
		173,380

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

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 authorization by the Office of Indian Affairs, stream gaging was continued on the Menominee, Crow, Fort Hall, Yakima, Colville, Quinault, Klamath, Warm Springs, Gila River, Western Shoshone, Walker River, and Uinta Indian reservations.

National Park Service.—Streams in the Yosemite 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, was continued in cooperation with the Forest Service.

Investigations were made for the Forest Service in connection with the purchase of lands in Cutts Grant, N. H.

Stream gaging in the Uncompahgre National Forest was done by the Forest Service, which was reimbursed by the Geological Survey.

Weather Bureau.—River gages were installed, checked, and repaired for the Weather Bureau in connection with flood warnings in Florida, Texas, and California.

General Land Office.—An investigation was made of water-power sites in the Coos Bay wagon-road grant, Oreg., in cooperation with the General Land Office.

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 14 reports and 3 separate chapters. Titles and brief summaries of these publications are given on pages 25–29. At the end of the year 21 reports were in press and 13 manuscripts were awaiting editorial examination.

GENERAL SUMMARY.

Investigations of surface streams have been continued by maintaining gaging stations in 39 States and in Hawaii and Alaska. Cooperation with States and other Federal organizations has made possible the large amount of work in progress. Thirty-two cooperating States (including Hawaii) have contributed $173,380 for work in these States, and the Indian Office, National Park Service, Forest Service, and Reclamation Service have also contributed largely to the study of the flow of particular streams.

Ground-water investigations have been in progress in 14 States and in the Dominican Republic and Hawaii. The Hawaiian project is a very important one because of the great value of ground water in these islands for municipal, irrigation, and military supplies. The work was made possible by funds supplied by the Territorial government and the city of Honolulu and not included in the above statement.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of 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.

Investigations made during the war in cooperation with the United States Fuel Administration were discontinued in part after the signing of the armistice. However, the statistical studies and the mapping of the transmission lines and electric-power generating plants of public-utility companies have been continued.

DIVISION OF SURFACE WATER.

ORGANIZATION.

The work of the division of surface water 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 18 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, Journal Building, Albany, N. Y.
Pennsylvania: O. W. Hartwell, Telegraph Building, Harrisburg, Pa.
Middle Atlantic and Ohio River: G. C. Stevens, Washington, D. C.
South Atlantic and eastern Gulf: W. E. Hall, Post Office Building, Atlanta, Ga.
Tennessee: W. R. King, Customhouse, Nashville, Tenn.
Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffices, Kimball Building, Chicago, Ill., and Ames, Iowa.
Kansas: R. C. Rice, Federal Building, Topeka, Kans.
Upper Missouri River: W. A. Lamb, Montana National Bank Building, Helena, Mont.
Rocky Mountain: Robert Follansbee, New Post Office Building, Denver, Colo.
Great Basin: A. B. Purton, Federal Building, Salt Lake City, Utah.
Idaho: C. G. Paulsen, Idaho Building, Boise, Idaho.
Snake River basin: G. C. Baldwin, Federal Building, Idaho Falls, Idaho.
Washington: G. L. Parker, Federal Building, Tacoma, Wash.
Oregon: F. F. Henshaw, Post Office Building, Portland, Oreg.
California-Arizona: H. D. McGlashan, Customhouse, San Francisco, Calif.; suboffices, Federal Building, Los Angeles, Calif., and Tucson, Ariz.
Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.
Hawaii: James E. Stewart, 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. (See Pl. III.) 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 conferences of the engineers.

At the end of the year 1,349 gaging stations were being maintained, including 76 in Hawaii; 174 stations were discontinued and 272 new stations established during the year. Records for about 190 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.

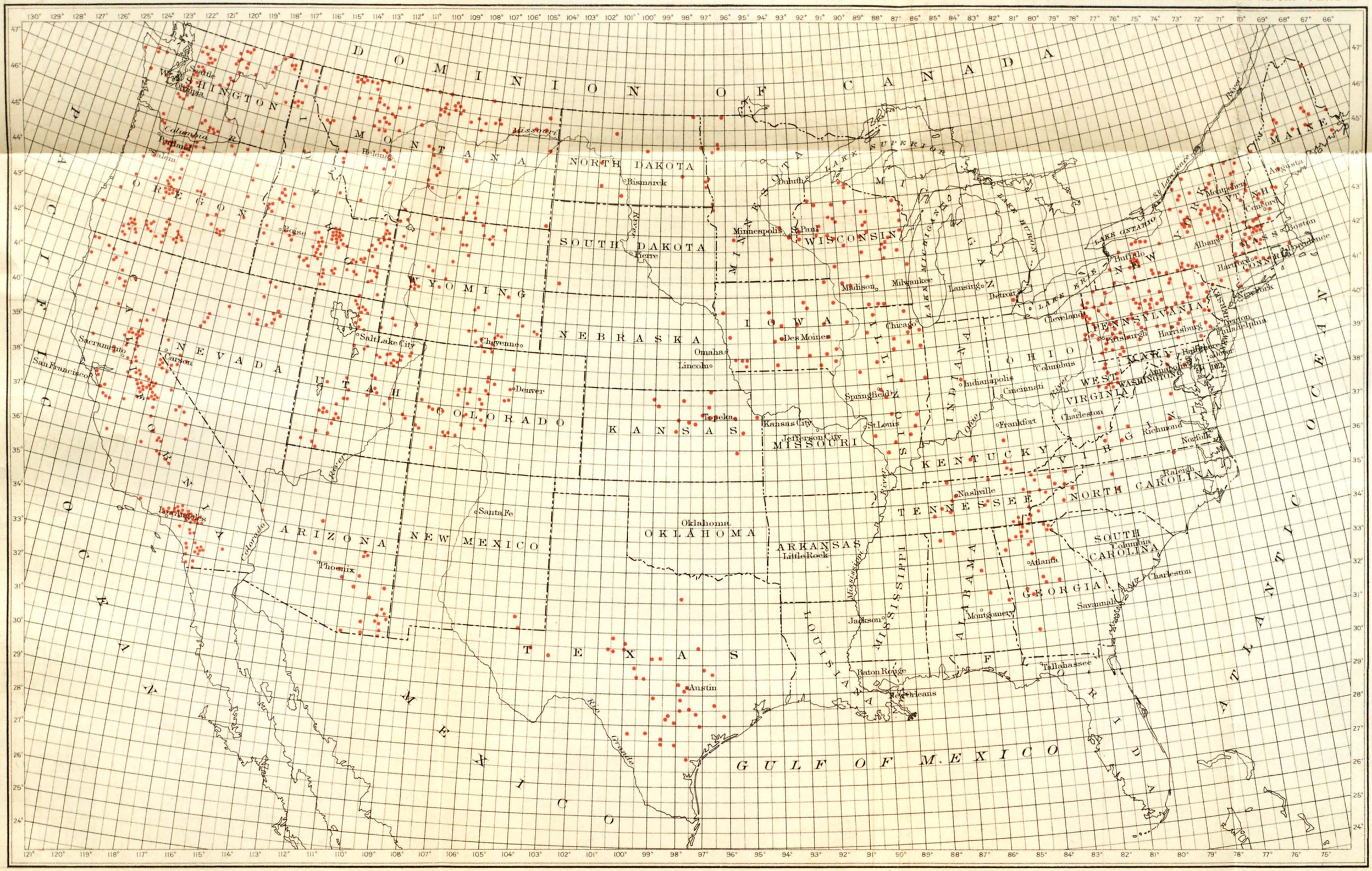
Gaging stations and cooperating parties for the year ended June 30, 1920.

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	....	2	....	1	....	4	.....	3	2	.....
Arizona	....	1	....	4	2	....	....	19	....	1	4	23	10	4	336	59
California	....	....	26	1	....	2	4	148	36	35	104	148	9	22	1,124	326
Colorado	3	2	14	....	....	1	....	13	2	3	1	37	2	8	124	13
Connecticut	....	....	....	....	....	....	....	5	....	3	2	6	4	.....	32	1
Florida	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....	2
Georgia	....	....	....	....	....	3	....	7	....	13	1	22	1	1	41	8
Idaho	....	4	4	14	....	2	....	68	1	171	60	204	63	9	1,369	189
Illinois	....	....	....	....	....	....	....	23	1	1	2	23	.....	1	78	.....
Indiana	....	....	....	....	....	....	....	....	....	1	....	1	.....	.....	1	.....
Iowa	....	....	....	....	....	5	....	22	....	5	6	26	3	1	143	10
Kansas	....	....	....	....	....	1	....	15	....	....	1	16	5	.....	77	8
Kentucky	....	....	....	....	....	1	....	4	....	....	....	5	1	.....	5	.....
Maine	....	....	....	....	....	....	....	16	....	2	2	16	3	3	80	2
Maryland	3	....	....	....	....	....	....	....	....	....	....	3	.....	.....	4	.....
Massachusetts	....	....	....	....	....	....	....	17	....	....	....	17	1	.....	68	.....
Michigan	....	....	....	....	....	....	....	....	....	1	....	1	.....	1	.....	.....
Minnesota	....	....	....	....	3	2	....	5	....	....	....	10	4	1	38	.....
Montana	8	49	4	7	....	....	....	27	....	3	....	98	12	2	385	62
Nevada	....	1	....	3	....	1	....	22	....	4	9	22	1	6	78	1
New Hampshire	....	....	....	....	....	....	....	12	....	7	7	12	2	.....	46	.....
New Jersey	1	....	....	....	....	....	....	....	....	....	....	1	.....	.....	1	.....
New York	....	....	....	....	1	4	....	60	2	11	18	60	6	2	280	51
North Carolina	....	....	....	....	....	1	....	5	....	3	....	9	2	1	24	4
North Dakota	....	....	....	....	....	....	3	9	....	....	....	12	.....	1	12	.....
Ohio	....	....	....	....	2	....	....	....	....	....	....	2	.....	.....	4	.....
Oklahoma	....	....	....	....	....	....	....	....	....	....	....	....	....	3	.....	.....
Oregon	....	4	1	9	....	3	....	14	22	39	....	92	13	11	253	59
Pennsylvania	....	....	....	....	9	....	....	87	1	4	14	87	87	.....	263	5
South Dakota	....	....	....	....	....	....	....	1	....	....	....	1	.....	.....	1	.....
Tennessee	....	....	....	....	....	8	....	20	....	6	11	23	7	.....	49	4
Texas	....	1	....	....	....	3	....	39	5	4	13	39	.....	3	325	535
Utah	....	1	....	4	....	....	....	58	2	14	21	58	.....	52	400	70
Vermont	....	....	....	....	....	....	....	9	....	2	2	9	2	2	25	2
Virginia	2	....	....	....	....	1	....	....	....	2	....	5	.....	.....	8	2
Washington	2	1	5	12	....	....	1	7	12	34	1	73	12	8	394	45
West Virginia	....	....	....	....	6	1	....	12	....	....	7	12	1	.....	28	.....
Wisconsin	....	....	....	2	2	....	....	44	....	14	17	45	2	3	216	4
Wyoming	....	8	5	....	....	1	2	42	....	8	15	51	5	7	150	.....
Hawaii	....	....	....	....	....	....	....	76	1	25	26	76	14	19	571	80
	19	72	59	56	25	41	10	909	85	417	344	1,349	272	174	7,035	1,547

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 in 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 1920:



STREAM-GAGING STATIONS MAINTAINED BY UNITED STATES GEOLOGICAL SURVEY JUNE 30, 1920

Scale 1/14000000

100 0 100 200 300 400 500 Miles

ENGRAVED AND PRINTED BY THE U.S.GEOLOGICAL SURVEY

Number of water-supply papers containing results of stream measurements, 1899–1920.

Year.	I North Atlantic slope (St. John River to York River).	II South Atlantic and eastern Gulf (James to the Missis-sippi).	III Ohio River.	IV St. Lawrence River and Great Lakes.	V Hudson Bay and upper Missis-sippi River.	VI Missouri River.	VII Lower Missis-sippi River.	VIII Western Gulf of Mexico.	IX Colorado River.	X Great Basin.	XI Pacific slope in Cali-fornia.	XII North Pacific slope basins.		
												Pacific slope in Washing-ton 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] 169, 173	174	176, [s] 177	176, [r] 177	177	178	178	[t] 177, 178
1906.....	[n] 201, [o] 202, [p] 203	[p] 203, 204	205	206	207	208	[k] 205, 209	210	211	212, [r] 213	213	214	214	214
1907–8....	241	242	243	244	245	246	247	248	249	250, [r] 251	251	252	252	252
1909.....	261	262	263	264	265	266	267	268	269	270, [r] 271	271	272	272	272
1910.....	281	282	283	284	285	286	287	288	289	290	291	292	292	292
1911.....	301	302	303	304	305	305	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
1919.....	501	502	503	504	505	506	507	508	509	510	511	512	513	514
1920.....	521	522	523	524	525	526	527	528	529	530	531	532	533	534

[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 WATER.

GENERAL FEATURES.

The division of ground water investigates the waters that lie below the surface—their occurrence, quantity, quality, and head, their recovery through wells and springs, and their utilization for domestic, industrial, irrigation, and public supplies, and at watering places for live stock and desert travelers. Each year ground-water surveys are made of selected areas where the problems of water supply are most urgent, and the results are published in water-supply papers or other reports. These papers generally include maps showing the ground-water conditions in the areas surveyed. The work is planned with a view eventually to cover the entire country. The investigations relating to quality of water are made in cooperation with the division of quality of water; the surveys in the Atlantic Coastal Plain and in the West Indies are under the supervision of the chief of the section of Coastal Plain investigations, of the geologic branch. The fiscal year 1919–20 was largely devoted to completing the investigations that had been interrupted by the war.

Many projects involving large expenditures for drilling wells to develop water supplies are considered each year by the United States Government, especially by the War and Navy departments. The ground-water division is called upon to furnish information and advice on a large part of these projects.

One of the most important projects undertaken during the year was a survey of the Hawaiian Islands, in which ground water is of great value for municipal, irrigation, and military supplies and on some plantations for the fluming of sugar cane. The recovery and conservation of this water involve problems of much practical importance. The work was begun through the initiative of Prof. H. E. Gregory with funds supplied by the Territorial government and the city of Honolulu.

A comprehensive paper on ground water in the United States, with a discussion of principles, is being prepared by O. E. Meinzer. By the end of the year Part I of this paper, which relates to the occurrence of ground water, was practically completed and Part II, which relates to the origin, circulation, and quantity of ground water, was begun. Each part is to be published as a water-supply paper.

A study of the relation of sea water to ground water along the seacoasts was made by J. S. Brown, who is preparing a report on this subject.

A. J. Ellis continued his work as specialist on mineral waters for the division of mineral resources and, with the aid of Miss B. H.

Stoddard, prepared the report on production of mineral waters in the United States in 1919.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee.

WORK BY STATES.

Arizona.—A paper entitled "Geology and water resources of the Gila and San Carlos valleys in the San Carlos Indian Reservation, Ariz.," by A. T. Schwennesen, was published as Water-Supply Paper 450–A.

Two guides to watering places were completed for the region lying west of Phoenix, Tucson, and Nogales and south of Parker and Wickenburg. These guides are to be published as Water-Supply Papers 490–C and 490–D.

A reconnaissance report on the geography, geology, and hydrology of the lower Gila region, extending, roughly, from Phoenix to Yuma and Parker, was prepared by C. P. Ross and is to be published as a water-supply paper. A brief paper by Mr. Ross on the geology of the region was transmitted to the geologic branch for publication as a contribution to general geology.

A reconnaissance report on the geography, geology, and hydrology of the Papago country, which lies west of Santa Cruz River and south of the Gila, was nearly completed by Kirk Bryan during the year. It is to be published as a water-supply paper. A brief paper on erosion and sedimentation in the Papago country, by Mr. Bryan, was transmitted to the geologic branch for publication as a contribution to geography.

California.—Four reports on ground water in California were published during the year, covering the San Jacinto and Temecula basins; the western slope of San Diego County: Lanfair Valley; and Pahrump, Mesquite, and Ivanpah valleys. These reports (Water-Supply Papers 429, 446, 450–B, and 450–C) are noticed on pages 26–28.

Of the two guides to desert watering places transmitted in the previous fiscal year, the one on the Salton Sea region (Water-Supply Paper 490–A) was in press at the end of the year. The guide to the Mohave Desert region will be published as Water-Supply Paper 490–B.

A compilation of the Geological Survey's records of water levels in wells in southern California, by F. C. Ebert, was completed and at the end of the fiscal year was ready to be sent to the printer. It is to be issued as Water-Supply Paper 468.

A reconnaissance report on the geography, geology, and hydrology of the Salton Sea region, by J. S. Brown, was transmitted for publication.

A report on Santa Clara Valley was completed by W. O. Clark and at the end of the fiscal year was with the chief of the division for examination and criticism. Measurements of seepage losses from Coyote River and of water levels in wells in Santa Clara Valley were continued during the year.

Additional field work was done during the year in the Mohave region by D. G. Thompson, who is preparing a comprehensive paper on the geography, geology, and hydrology of the region. Mr. Thompson also made a field investigation of the recent developments and ground-water prospects in Antelope Valley, primarily for the information of the Federal Land Bank at Berkeley, Calif.

Water-level measurements were made in selected wells in southern California that have been under observation for a period of years. Many additional observation wells were selected, and seepage measurements were made with a view to obtaining precise data on the intake and discharge of the ground-water reservoirs on which the citrus-fruit industry largely depends. This work is under the immediate direction of F. C. Ebert, hydraulic engineer in the surface-water division.

The large amount of ground-water work in California is made possible through financial cooperation of the State Department of Engineering.

Connecticut.—Three reports relating to areas in Connecticut were in press at the end of the year: "Ground water in the Meriden area," by G. A. Waring (Water-Supply Paper 449); "Ground water in the Southington-Granby area," by H. S. Palmer (Water-Supply Paper 466); and "Ground water in the Norwalk, Suffield, and Glastonbury areas," by H. S. Palmer (Water-Supply Paper 470).

During the year field work was done by J. S. Brown in 18 towns in the New Haven area, and a report on this area was in preparation. In connection with this work Mr. Brown made a special study of the relation of sea water to ground water along the coast and is preparing a paper on this subject.

All ground-water work in Connecticut is done in cooperation with the State Geological and Natural History Survey, H. E. Gregory, superintendent.

Florida.—An investigation of ground water available for the public supply of Miami, Fla., was made by C. P. Ross, and the results were embodied in a brief report that was transmitted to the Florida State Board of Health.

At the request of the United States Public Health Service an investigation of the ground-water conditions on Sea Horse Key, North Key, and Snake Key, in the vicinity of the town of Cedar Keys, Fla., was made by J. S. Brown. A report based on this investigation was transmitted to the Public Health Service.

Hawaii.—Two important ground-water investigations were begun in the Hawaiian Islands, one in the vicinity of Honolulu, by H. S. Palmer, and one in the Kau district, on the Island of Hawaii, by W. O. Clark and L. F. Noble. The investigation in the vicinity of Honolulu is being made for the purpose of advising the city authorities as to the best methods for developing additional ground-water supplies for the city waterworks, especially with respect to the availability of high-level supplies that could be recovered by gravity flow from infiltration tunnels. The investigation in the Kau district relates to the discovery of additional high-level supplies for fluming sugar cane. At the beginning of the work, in February and March, Mr. Meinzer spent seven weeks in field work in the islands to study the ground-water conditions and prospects and to plan the methods of field work. He also made a reconnaissance, with G. K. Larrison, water-supply engineer in the War Department, of the ground-water conditions on the Island of Oahu with reference to the needs of the Army and Navy. Before returning he addressed the Honolulu Chamber of Commerce on the development and conservation of the city's available water supply.

Idaho.—An investigation of the prospects of obtaining additional water supplies for live stock in the Targhee National Forest, Idaho, by drilling wells was made by D. G. Thompson in response to a request from the United States Forest Service. A report based on this investigation was transmitted to the Chief Forester.

Maryland.—The ground-water conditions in the vicinity of Suitland, Md., were examined by O. E. Meinzer, and a brief report on the subject was transmitted to the Secretary of the Interior.

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 eastern Montana, which was begun in a previous year, was continued by A. J. Ellis. Mr. Ellis spent a few weeks in field work in Musselshell County to supplement the work previously done and made much progress in the preparation of a report on that county. He also had in preparation a paper on ground water in the region south of Yellowstone River.

An investigation of the ground-water conditions in the vicinity of Helena was made by D. G. Thompson, and a report thereon was transmitted to the Helena Commercial Club. Information on the ground-water conditions in this region was also furnished to the United States Public Health Service for use in connection with a water supply for a hospital at Fort Harrison.

Nevada.—A report on ground water in Pahrump, Mesquite, and Ivanpah valleys, by G. A. Waring, was published as Water-Supply

Paper 450–C. These valleys lie partly in Nevada and partly in California.

A report on exploratory drilling for water and use of ground water for irrigation in Steptoe Valley, Nev., by W. O. Clark and C. W. Riddell, was sent to the printer for publication as Water-Supply Paper 467.

Exploratory drilling for water was continued by the State engineer. For this work the United States Geological Survey furnished the drilling equipment which had been used in exploratory drilling in Steptoe Valley.

North Dakota.—For several years H. E. Simpson has been engaged on a comprehensive investigation of ground water in North Dakota for the State geological survey. Near the end of this fiscal year arrangements were made whereby the Federal Survey will furnish assistance, so that the report on this investigation can be promptly completed .

Oklahoma.—A brief paper by D. G. Thompson on ground water for irrigation in the vicinity of Gage, Okla., was transmitted to be published as Water-Supply Paper 500–A. It is based on field work done in the previous year.

South Carolina.—The survey of the ground-water resources of the Coastal Plain of South Carolina was continued in cooperation with the section of Coastal Plain investigations by C. W. Cooke, under the direction of T. W. Vaughan.

Texas.—The work in Texas was carried on in cooperation with the section of Coastal Plain investigations. The field of study included the central and western parts of the Coastal Plain province.

Virginia.—A brief investigation of ground-water conditions in the vicinity of McLean, Va., was made by C. P. Ross, and the results were transmitted to the Secretary of the Interior.

Dominican Republic.—In connection with the work which the United States Geological Survey is doing in the Dominican Republic (see p. 87), C. P. Ross prepared a paper on ground-water prospects in Monte Cristi Valley, with special reference to developing water supplies for irrigation. This paper is based on field work done chiefly in the previous year. It was transmitted to the chief of the section of Coastal Plain investigations.

DIVISION OF QUALITY OF WATER.

The principal work of the quality of water division consists of making analyses of surface and ground waters and interpreting such analyses to determine the suitability of the waters, so far as mineral content is concerned, for domestic and industrial uses. During the year 349 samples of water were analyzed and classified, and calculations and classifications have also been made on about 200 analyses

made elsewhere for use in reports on the quality of the water in different parts of the United States. In addition to the study of the water resources of the United States certain investigations have also been made on the water resources of Haiti and the Dominican Republic. The sections on quality of water in five manuscripts were reviewed during the year.

DIVISION OF POWER RESOURCES.

The work of the division of power resources, which during the fiscal year 1919 was conducted largely in cooperation with the Bureau of Conservation and the Bureau of Mineral Statistics of the United States Fuel Administration, was discontinued in part after the signing of the armistice. The collection of statistics of the production of electric power by public-utility companies and of fuel consumed in producing such power and the mapping of transmission lines and electric-power generating plants of public-utility companies have been continued because of their importance in connection with the pressing problem related to the country's supply of energy and with the conservation of fuels. Miss Bessie B. Borst has been in charge of the section of power statistics, and Guy D. Thomas has directed the section of mapping.

Monthly statistical reports were issued during the fiscal year for March, April, July, October, January, February, and March. Beginning with January, 1920, reports will be issued for each month. It requires about two months to prepare the data of any month for publication.

As estimated from the monthly reports for February, March, April, July, October, and January, the production of electricity in the calendar year 1919 by electric public-utility plants was about 39,000,000,000 kilowatt-hours, 62 per cent of which was produced by fuels and the remainder by water power. The fuels consumed comprised 35,000,000 tons of coal, 11,000,000 barrels of oil, and 21.7 million M cubic feet of gas.

As a basis for the reports of the production of electricity, public-utility companies are requested to submit monthly reports of electricity generated by water power or fuel power and the amount of fuel consumed in generating the electricity reported, if fuel is used. Any concern selling all or a part of the electricity it produces is considered a public utility.

Card indexes of the names and addresses of companies engaged in generating electricity for public use have been maintained and kept up to date and now include about 6,200 companies, of which 1,050 distribute purchased electricity and 1,106 are electric railway companies. These companies operate approximately 5,500 power plants, of which about 4,300 whose generating capacity is 100 kilo-

watts or more are requested to submit monthly reports of their production of electricity and consumption of fuel. Reports are received from plants representing about 90 per cent of the capacity of all the public-utility plants. The output and fuel consumption of plants which do not submit reports are estimated from the best information available.

In preparing the maps showing the location of the power stations and transmission lines used in public service, proof maps were first made from the best information available. Sections of these proof maps were sent to the different companies with the request that the data in regard to their companies shown on the maps be corrected or revised as far as necessary. The companies were also requested to submit information in regard to the characteristics of their transmission lines. From the information submitted final maps, embodying the corrections submitted by different companies, have been prepared. These maps will be published as plates in water-supply papers, which will contain in tabular form information in regard to the equipment of the power stations and the chief characteristics of the transmission lines. Water-Supply Paper 494, Generation and transmission of electric power in the State of New York, was in the editor's hands at the end of the fiscal year. The manuscript of a similar water-supply paper, covering the New England States, has also been practically completed. The preparation of maps of Pennsylvania and New Jersey is in progress.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

During the season of 1919 field work in the examination of lands applied for under the enlarged and stock-raising homestead laws was begun immediately after the passage in July of the act making appropriation for the work during the fiscal year. A force of 32 classifiers of various grades, including 5 assigned from the land-classification board, was engaged in active field work. This force was mostly divided into parties of two or three men, although a number of men worked singly.

During this season applications which were made under the stock-raising homestead law and which were pending in the land districts of the following States were examined: North Dakota, all districts; South Dakota, all districts except a small part of the Timber Lake district; Kansas, all of western part; New Mexico, Durango, Roswell, and Las Cruces districts and about half of the Santa Fe district; Colorado, all districts except a few remote areas; Wyoming, Cheyenne, and Douglas districts, one-fourth of the Evanston district, four-fifths of the Buffalo district, and three-fourths of the Sundance district; Montana, two-thirds of the Miles City district;

Idaho, Hailey district and all but a small part of the Blackfoot district; Oregon, practically all of The Dalles district north of the south line of T. 12 S.; Nevada, all districts.

Field work in the examination of lands applied for under the stock-raising homestead law was begun, for the season of 1920, late in April, and of lands applied for under the enlarged-homstead law early in June. By resignations from the service and by death the force available for field work at the beginning of the season was reduced to 21 men, which includes two men assigned from the land-classification board.

Field examinations of applications pending under the stock-raising homestead law were completed by the end of the fiscal year in the Lemmon and Timber Lake districts, South Dakota; in northwestern Oklahoma; and in the Santa Fe district, New Mexico; and were in progress in the Miles City, Lewistown, Bozeman, Havre, and Helena districts, Montana; the Sundance district, Wyoming; The Dalles district, Oregon; and the Sacramento and Susanville districts, California.

Field examinations of entries under the enlarged-homestead law have been made during the year or were in progress at the end of the year in North Dakota, South Dakota, Montana, Colorado, Wyoming, Idaho, Nevada, Arizona, and California.

Under instructions from the First Assistant Secretary of the Interior an examination was made during July, August, and September of the character of the lands proposed to be included in the Modoc National Forest by the act approved March 3, 1919.

LAND-CLASSIFICATION BOARD.

ORGANIZATION AND PERSONNEL.

The technical work of the land-classification board falls naturally into two major classes, corresponding to the classes of resources with which it deals. These are mineral classification and hydrographic classification, the latter being construed to include the agricultural classification required to be made, as the irrigability of the lands classified is either the chief element or an important secondary element in agricultural classification.

The board is therefore, for administrative purposes, organized into two divisions, the division of mineral classification and the division of hydrographic classification, and the latter division includes three sections, each dealing with an appropriate type of work. At the end of the fiscal year the organization and personnel were as follows:

Chief of board, W. C. Mendenhall, geologist.
Chief engineer and assistant chief of board, Herman Stabler.
Secretary of board, Elsie Patterson.

Division of mineral classification, R. W. Howell, geologist (on furlough); C. D. Avery, mining engineer; N. W. Bass, assistant classifier.

Division of hydrographic classification: Power section, R. W. Davenport and B. E. Jones, hydraulic engineers; N. J. Tubbs, engineer; D. J. Guy, assistant engineer. Irrigation section, J. F. Deeds, engineer; F. J. Sopp, W. N. White, and E. E. Jones, classifiers; C. E. Nordeen, assistant topographer. Grazing section, A. E. Aldous and G. W. Holland, classifiers; J. G. Mathers, assistant engineer; W. L. Hopper and R. O. Helland, assistant classifiers.

The total number of persons on the regular staff of the board at the end of the year was 60. In addition to this regular force, from 20 to 25 classifiers on the rolls of the water-resources branch were amalgamated with the land-classification board staff during the office season in connection with the stock-raising homestead classifications.

The difficulties that all the Government offices encounter in maintaining a staff under present conditions are well illustrated by the fact that although the number employed at the end of the year was approximately the same as at the beginning, there had been 17 separations and 18 additions to the force during the year, a turnover of nearly 30 per cent.

SCOPE AND CHARACTER OF THE WORK.

The land-classification board is charged under the present Survey organization with the task of applying the results of the studies of field problems by the field branches to the administration of the laws affecting the use and disposition of lands and mineral resources, public and reserved. In the fulfillment of this task it utilizes the results that have been accumulated by the Survey during the 40 years and more of its existence, calls for special field examinations by the geologic, topographic, and water-resources branches, when needed, and prepares from the resulting data reports applicable to the particular purpose in view. Thus it supplies to the Department of the Interior and to a minor extent to other departments the facts and the interpretation of the facts necessary to the administration of a variety of complex laws dealing with natural resources. It has prepared and recommended the executive withdrawals temporarily suspending the operation of the coal-land laws until the lands affected could be examined, properly classified, appraised, and restored to entry and purchase at the appraised prices. Similarly it has recommended the creation of the oil, phosphate, and potash reserves until Congress could enact appropriate laws for the disposition of these minerals. It has initiated the placing of public lands valuable for the development of water power in reserves that prevented their acquisition under the homestead and selection laws and has had important duties in facilitating the use of such lands under the laws providing for water-power development. It has drafted

the orders and with the aid of the geologists of the geologic branch it has selected the lands set aside as oil and oil-shale reserves for the use of the Navy in the future. On the basis of information already available or obtained through field examinations by the water-resources branch it has made the classifications required by the enlarged and stock-raising homestead laws. It furnishes to the Land Office and to the Indian Office reports on the character of lands sought under the public-land laws or the laws providing for the disposition of Indian lands.

Its problems are therefore diversified, involving geologic, agricultural, economic, engineering, and semilegal phases, and its staff necessarily includes specialists in geology, engineering, and agriculture, some of whom in addition have a certain amount of training in land law.

As the work done is primarily that of applying the results of scientific and economic researches to the administration of the public-land laws, the character of this work necessarily varies with the enactment of new measures.

Two laws, long awaited, that definitely affect the work of the board were enacted during the first half of 1920. These are the so-called mineral lands leasing act of February 25, 1920 (41 Stat., 437), and the water-power act of June 10, 1920 (41 Stat., 1063). The first of these laws repeals the coal-land laws in force since 1873 and the old placer act as applied to oil and gas, phosphate, and oil shale and substitutes a general leasing law as a means of developing these minerals. The necessity of fixing sale prices on public coal lands therefore ceases, and the oil and phosphate lands locked up in reserves are opened for development. But the new laws are complex and impose certain new duties upon the Geological Survey which fall primarily upon the land-classification board. Among these are the determination of the "known geologic structures of the producing oil or gas fields" and the division of coal, phosphate, and oil-shale lands into appropriate leasing units.

The water-power act provides for its administration by a body called the Federal Power Commission. Certain functions heretofore performed by the land-classification board, such as the consideration of applications and preparation of permits for the development of water power on lands under the jurisdiction of the Interior Department, are among the functions of the new commission. The relations to the commission of other duties concerned with water-power classification that in the past have devolved upon the board can not be determined until the commission's organization is completed and the respective functions of the Government entities involved are determined.

FUNDS.

As during previous years, the work of the board in 1919–20 was supported by allotments made from certain specific Survey appropriations. These allotments were as follows:

Enlarged and stock-raising homesteads	$56,500
Geologic surveys	22,500
Topographic surveys	8,000
Gaging streams	7,000
	94,000

Congress, however, in the sundry civil act approved June 5, 1920, by a change in the phraseology of the item for the examination and classification of lands and by an increase in the appropriation itself, made independent provision for the classification work for the next fiscal year.

SUMMARY OF WORK OF CLASSIFICATION.

During the year 24,158 acres were classified as to their coal content, 6,449 acres as coal land, and 17,709 acres as noncoal land. As this work was in greater part a revision of earlier classifications the net result was to reduce the total area classified as coal land by 5,144 acres and to increase the total area classified as noncoal land by 16,343 acres. During the year 525,726 acres of coal lands were restored to entry and but 2,797 acres withdrawn.

No oil, potash, or phosphate lands were withdrawn during the year, but 954 acres were classified as nonoil land and restored to unrestricted entry, and 89 acres were eliminated from a potash reserve in California.

Nine "known geologic structures of producing oil or gas fields" were defined toward the end of the year and thus segregated for leasing under the new leasing act of February 25, 1920.

There were no additional classifications of oil-shale lands.

A moderate amount of adjustment of areas included in power-site reserves was made on the basis of new information. An additional area of 62,854 acres of lands valuable for power was withdrawn, and an aggregate area of 40,966 acres, found to be without material value for power purposes, was released from withdrawal. These operations resulted in increasing the area of power-site reserves from 2,565,727 to 2,587,615 acres.

The total area of former Oregon-California Railroad grant lands designated as power-site lands was increased to 141,653 acres, an addition of 380 acres to the area so designated on June 30, 1919. At the end of the year 764,438 acres of land in Arizona and 196,400 acres in New Mexico were included in areas designated as valuable for water-

power purposes under the enabling acts of those States. The change during the year in the areas so designated consists in a reduction of 4,600 acres in the area for New Mexico as a result of redescription in accordance with official survey of land unsurveyed when originally designated. The area in outstanding reservoir withdrawals was increased to 83,693 acres as the result of the withdrawal of 1,714 acres in Wyoming as sites needed for control of water supply.

Operations under the stock-raising homestead laws were an especially noteworthy feature of the classification work of the year. An increase of 54,310,468 acres in lands designated as stock-raising lands, from 20,181,868 to 74,492,336 acres, was the result of a strenuous effort to keep pace with the demands for entry of lands for homesteads to be devoted primarily to stock raising.

Additional areas of 4,583,577 acres were designated as nonirrigable under the enlarged-homestead acts, and 421,337 acres found to have been improperly classified were excluded from designations previously made. The total area remaining so designated at the end of the year is 292,959,481 acres. Of this area, 545,034 acres in Idaho, an increase of 28,797 acres, and 1,503,014 acres in Utah, an increase of 78,740 acres, are classified under the nonresidence provisions of the act as being without domestic water supply sufficient to make continuous residence possible.

The area in public water reserves was increased to 239,283 acres as the result of the addition of 14,367 acres to the area previously so classified and the elimination of 765 acres.

An area of 57,600 acres was designated under the Nevada groundwater reclamation act toward the end of the year.

CORRESPONDENCE.

During the year 34,596 letters and applications of various sorts were received by the land-classification board, about 22 per cent more than the number for the preceding fiscal year. In addition, about 3,000 copies of miscellaneous correspondence from different bureaus were sent to the board for its information and files; this correspondence is made up largely of General Land Office letters to its local officers and of reports on the character of lands by its inspectors and agents, copies of decisions rendered by the Department of the Interior, and Reclamation Service withdrawals and restorations.

Within the year 15,934 letters and reports were prepared in the board. This is an increase of 3.5 per cent over the output for the preceding fiscal year.

For the working days of the year these figures show a daily average of 112 pieces for the incoming correspondence and of 52 for the outgoing.

COOPERATION WITH GENERAL LAND OFFICE.

The cooperation with the General Land Office, under which reports are submitted by the Survey containing information as to the mineral value and water resources of lands for which applications under the public-land laws have been filed, was continued during the year. Similar cooperation exists with the Office of Indian Affairs.

The Survey also furnished to the General Land Office reports on the feasibility of irrigation projects and proposed power developments under the terms of the general cooperative plan between the two bureaus. Closely related to this cooperation is the duty of the Survey to classify land under the enlarged and stock-raising homestead acts and to advise the General Land Office as to appropriate action on applications for land which has been classified. A type of cases not heretofore received consists of applications under the ground-water reclamation act applicable to Nevada only. In these cases, as in enlarged homestead and stock-raising cases, the Survey classifies the land and gives appropriate advice to the General Land Office.

The number of cases requiring such action which have been received and the number considered by the Survey are set forth in the following summary:

General summary of cooperative cases.

Class.	Pending June 30, 1919.	Received during year.	Disposed of during year.	Pending June 30, 1920.	Gain or loss.
Mineral character only:					
General Land Office requests for information	430	816	317	929	−499
General Land Office field-service reports	444	1,158	845	757	−313
Applications for classification as to mineral	56	88	92	52	+4
Applications for mineral permits	59	84	79	64	−5
Applications for mineral leases	.....	2	.....	2	−2
	989	2,148	1,333	1,804	−815
Water resources only:					
General Land Office requests for information	5	8	7	6	−1
General Land Office field-service reports	12	10	12	10	+2
Cases in national forests	2	12	14	.....	+2
Applications for reclassification as to water resources	16	81	68	29	−13
Applications for rights of way	38	164	171	31	+7
Lists under Carey Act	.....	2	2	.....	.....
Irrigation-project reports	3	37	22	18	−15
Petitions under enlarged-homestead acts	4,121	2,780	3,770	3,131	+990
Applications under stock-raising homestead act	19,721	18,398	23,664	14,455	+5,266
Applications under ground-water reclamation act	.....	127	25	102	−102
	23,918	21,619	27,755	17,782	+6,136
Mineral character and water resources:					
General Land Office requests for information	1,972	3,576	3,528	2,020	−48
General Land Office field-service reports	252	285	223	314	−62
General Land Office requests for information as to water resources, accompanied by field-service reports as to mineral character	76	99	69	106	−30
Indian Office requests for information	7	16	9	14	−7
	2,307	3,976	3,829	2,454	−147
Grand total	27,214	27,743	32,917	22,040	+5,174

MINERAL CLASSIFICATION.

LEGAL CHANGES.

The character of the classification work required in the administration of the public-land laws was fundamentally changed as to the most important group of nonmetalliferous minerals, through the approval by the President on February 25, 1920, of the act entitled "An act to promote the mining of coal, phosphate, oil, oil shale, gas, and sodium on the public domain" (41 Stat., 437). This act is a leasing act. Under it the Government disposes of the minerals which it owns, as private owners have long disposed of them, not in fee at a nominal flat price but by lease on a royalty basis.

The prime object of the withdrawal policy initiated by the Executive and sanctioned by Congress in the act of June 25, 1910 (36 Stat., 847), namely, to reserve the mineral withdrawn until Congress could pass appropriate laws for their disposition—has thus been accomplished. The mineral reserves are subject to the new law, and the necessity of withdrawals, except occasionally and for special purposes, ceases. The immediate task is to render the leasing act effective by prompt and efficient administration.

The functions of the Geological Survey in the administration of the leasing act—functions exercised primarily through the land-classification board—are to furnish the technical geologic information and the information on relations to production required to administer the law. This type of mineral classification will in the future displace much of that required in the past. Indeed, partly in anticipation of the passage of the new law, partly because most of the coal land needed for immediate development had been appraised and was available for purchase, partly because most of the known public oil and gas and phosphate lands were reserved, and partly because of the Survey's loss of scientific personnel to private industry, there has been relatively little activity in mineral-classification work during the year.

COAL.

Withdrawals and restorations.—Only 2,797 acres of coal lands were withdrawn for classification during the year, and 525,726 acres were restored as a result of classification. Nearly all the lands restored this year, as during the previous fiscal year, were in the lignite area of North Dakota, where all coal lands are appraised at the minimum price. All withdrawn coal lands are rendered available for development through leasehold by the act of February 25, 1920.

Coal withdrawals and restorations, fiscal year 1919–20, in acres.

	Outstanding June 30, 1919.	New withdrawals, 1919–20.	Restorations, 1919–20.	Outstanding June 30, 1920.
Arizona	141,945			141,945
California	17,643			17,643
Colorado	4,500,511		7,004	4,493,507
Idaho	4,761			4,761
Montana	10,612,032	2,797	1,906	10,612,923
Nevada	83,833			83,833
New Mexico	5,585,208			5,585,208
North Dakota	10,902,615		516,176	10,386,439
Oregon	4,361			4,361
Utah	5,313,836			5,313,836
Washington	824,074		640	823,434
Wyoming	2,437,723			2,437,723
	40,428,542	2,797	525,726	39,905,613

Classifications and appraisals.—The end of the fiscal year may be regarded as the end of the period of classifications and appraisals under the old coal-land laws (Rev. Stat., 2347–2352), which have governed the disposition of public coal lands for nearly half a century. Prior to 1906 coal lands had been sold at the minimum price permitted by statute, regardless of the quantity, quality, or accessibility of the coal they contained. Since that year a systematic policy of classification and appraisal has been in effect, and under this policy nearly 30,000,000 acres of coal lands have been classified and appraised at nearly $1,000,000,000, about 75,000,000 acres have been classified as noncoal land, and nearly 40,000,000 acres, largely coal land, remained withdrawn, awaiting definite classification and appraisal, at the date of the passage of the leasing act, February 25, 1920.

Area and valuation of coal lands, June 30, 1920.

State.	Appraised coal land outstanding June 30, 1919.	Valuation of appraised coal land outstanding June 30, 1919.	Coal land appraised, 1919–20.			Increase and decrease of appraised areas, 1919–20.	Appraised coal land outstanding June 30, 1920.	Valuation of appraised coal land outstanding June 30, 1920.
			Total coal land appraised.	Coal land reclassified as noncoal land.	Reappraisals.			
	Acres.		*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	
Arkansas	60,715	$1,473,762					60,715	$1,473,762
California	7,720	585,086					7,720	585,086
Colorado	2,881,494	195,531,620	3,643			+3,643	2,885,137	196,199,767
Idaho	4,603	89,624					4,603	89,624
Montana	5,783,336	137,410,916	1,446	2,796	7,117	−1,350	5,781,986	137,560,696
Nevada	6,803	126,830					6,803	126,830
New Mexico	666,205	16,392,111		8,777		−8,777	657,428	16,198,951
North Dakota	11,409,769	199,382,266	80			+ 80	11,409,849	199,383,866
Oregon	7,195	174,843					7,195	174,843
South Dakota	244,874	2,711,462					244,874	2,711,462
Utah	1,069,871	45,101,333					1,069,871	45,101,333
Washington	1,866	38,520	840			+ 840	2,706	88,360
Wyoming	7,238,635	387,820,153	440	20	554	+ 420	7,239,055	387,794,213
	29,383,086	986,838,526	6,449	11,593	7,671	−5,144	29,377,942	987,488,793

Classification of coal and noncoal land June 30, 1920, in acres.

State.	Classification outstanding June 30, 1919.		Net results of classification, 1919–20.		Classification outstanding June 30, 1920.		
	Coal.	Noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.
Arizona		42,492		+ 60		42,552	42,552
Arkansas	60,715	70,038			60,715	70,038	130,753
California	8,720	228,502			8,720	228,502	237,222
Colorado	3,366,473	9,357,490	+3,643	+ 3,521	3,370,116	9,361,011	12,731,127
Idaho	4,603	8,272,256			4,603	8,272,256	8,276,859
Montana	5,897,805	21,804,357	−1,350	+ 1,590	5,896,454	21,805,947	27,702,402
Nevada	6,803	2,428			6,803	2,428	9,231
New Mexico	684,157	3,753,000	−8,777	+10,877	675,380	3,763,877	4,439,257
North Dakota	11,409,769	2,847,354	+ 80		11,409,849	2,847,354	14,257,203
Oregon	17,444	1,062,095			17,444	1,062,095	1,079,539
South Dakota	244,874	6,961,357			244,874	6,961,357	7,206,231
Utah	1,087,992	3,307,091			1,087,992	3,307,091	4,395,083
Washington	149,426	1,584,849	+ 840	+ 275	150,266	1,585,124	1,735,390
Wyoming	7,413,504	15,491,090	+ 420	+ 20	7,413,924	15,491,110	22,905,034
	30,352,285	74,784,399	−5,144	+16,343	30,347,140	74,800,742	105,147,883

Land classified as coal and noncoal land, fiscal year 1919–20, in acres.

State.	Reclassification.		New classification.		Total classification.			Net increase or decrease of coal and noncoal areas.	
	Previous noncoal, now coal.	Previous coal, now noncoal.	Coal.	Noncoal.	Coal.	Noncoal.	Total.	Coal.	Noncoal.
Arizona				60		60	60		+ 60
Colorado			3,643	3,521	3,643	3,521	7,164	+3,643	+ 3,521
Montana	1,366	2,796	80	160	1,446	2,956	4,402	−1,350	+ 1,590
New Mexico		8,777		2,100		10,877	10,877	−8,777	+10,877
North Dakota			80		80		80	+ 80	
Washington			840	275	840	275	1,115	+ 840	+ 275
Wyoming		20	440		440	20	460	+ 420	+ 20
	1,366	11,593	5,083	6,116	6,449	17,709	24,158	−5,144	+16,343

OIL.

During the year no additions were made to the petroleum reserves heretofore created under the authority of the withdrawal act. The curtailment of field investigations because of the loss of scientific personnel, the fact that the greater part of the public lands believed to contain oil were already withdrawn, and the hope of the early enactment of legislation that would open the reserves to development—a hope realized by the approval of the leasing act February 25, 1920—all contributed to this result. One restoration of 954 acres was made in Montana in a withdrawn area which had been tested

by drilling and had proved barren. The status of withdrawals for the year is indicated by the following table:

Oil withdrawals and restorations, fiscal year 1919–20, in acres.

State.	Withdrawals outstanding June 30, 1919.	Restorations, 1919–20.	Withdrawals outstanding July 1, 1920.
Arizona	230,400	.....	230,400
California	1,257,229	.....	1,257,229
Colorado	222,977	.....	222,977
Louisiana	467,030	.....	467,030
Montana	1,351,891	954	1,350,937
North Dakota	84,894	.....	84,894
Utah	1,962,787	.....	1,962,787
Wyoming	1,181,626	.....	1,181,626
	6,758,834	954	6,757,880

Immediately after the President's signature of the leasing act thousands of applications for leasing permits were initiated either by posting notices on the ground or by filing the applications in the local land offices. Procedure under the new law, however, was not defined until the approval of the regulations (General Land Office Circular 672), March 11, 1920, and these regulations were not printed and available for general distribution until several weeks later. Meantime a well that indicated the existence of a producing field containing high-grade oil had been brought in on Musselshell River near Mosby, Mont., in what is known as the Cat Creek anticline, in a region that had been partly studied and mapped by the Survey but had not been withdrawn and therefore was open to agricultural entry and selection under several nonmineral-land laws. In order to prevent those nonmineral entries and to segregate the land in the proved area for disposal under the new oil-leasing law, four townships in Montana (T. 15 N., Rs. 29 and 30 E.. and T. 14 N., Rs. 30 and 31 E., Montana meridian), containing 91,802 acres, were classified on March 15, 1920, as mineral lands valuable as a source of petroleum and natural gas. This action has been justified by the later development of at least two additional wells with an initial daily capacity of 2,000 or 3,000 barrels of high-grade oil.

In the division among the bureaus of the Department of the administrative functions to be performed under the oil sections of the leasing act, the Geological Survey is required to determine the relations to geologic structure of lands applied for under permit or lease. The law provides that leases only, except under the relief sections of the act, may be granted for lands within any "known geological structure of a producing oil or gas field" and that prospecting permits only may be issued for lands outside producing "structures." Furthermore, only one lease may be issued to one applicant on any one such producing "structure" and only one permit to one applicant

on a single nonproducing "structure." All applications are referred to the land-classification board for a determination of their compliance with these provisions. As rapidly as the necessary information can be collected, the "known structures of producing fields" are defined, and township diagrams indicating their boundaries are transmitted through the Commissioner of the General Land Office to the local land offices, where they become a matter of public record for the guidance of applicants. This work was under way at the end of the fiscal year, nine "structures" of producing fields, with an area of 120,533 acres, having been defined before June 30, 1920, as follows:

State.	Field.	Area (acres).
Montana	Cat Creek	47,205
Wyoming	Dry Piney	2,559
Do	Mule Creek	1,527
Do	Lance Creek	10,736
Do	Thornton	1,274
Do	Rock Creek	4,354
Do	Salt Creek	34,398
Do	Big Sand Draw	7,393
Do	Hamilton dome	11,087
		120,533

The nonproducing "structures" within which prospecting permits may be issued are not formally defined, but individual reports are rendered upon each application. A few such applications had been received from the General Land Office at the close of the year.

POTASH.

Since October 2, 1917, a leasing act for potash (40 Stat., 297) has been in effect similar in principle to the general leasing act for nonmetalliferous minerals. The work of the Geological Survey on the classification of potash lands since October 2, 1917, has consisted primarily in reporting on the propriety of issuing potash permits and leases under this act. These reports are recommendations, favorable or adverse, based upon geologic conditions in the area applied for and, in the case of permits, upon the possibility that the mineral sought may be found by proper prospecting methods. If a lease is applied for, the evidence as to discovery of a deposit that offers a reasonable probability of successful commercial development is analyzed.

Under the stimulus of the high prices prevailing during and immediately after the war, many potash prospecting permits were applied for in the western desert basins. With the decline of prices that followed the cessation of hostilities and the gradual resumption of imports, this activity has diminished. Nevertheless, 71 applications were received during 1919–20, as compared with 150 during the preceding year. During the year 175 reports were rendered upon applications, and at the end of the year 55 were awaiting action.

Applications for potash prospecting permits, 1919–20.

Pending July 1, 1919	59
Received during year	71
Acted on during year	75
Pending June 30, 1920	55

PHOSPHATE.

Practically all the valuable phosphate deposits on public lands being reserved under the authority of the withdrawal act pending the enactment of legislation for their development, no additional withdrawals were recommended during the year. These reserves, like those containing coal, oil or gas, oil shale, and sodium, are now open to lease under the act of February 25, 1920.

The areas that were withdrawn at the time of the passage of the leasing act are as follows:

	Acres.
Florida	119,737
Idaho	1,015,717
Montana	287,883
Utah	302,465
Wyoming	998,592

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 acts of June 25, 1910 (36 Stat., 847, 855, 858), and August 24, 1912 (37 Stat., 497). On July 1, 1919, the area included in withdrawals was 2,565,727 acres. During the year 62,854 acres were withdrawn and 40,966 acres previously included in power-site reserves were restored to entry. Accordingly, on June 30, 1920, the total area withdrawn in connection with water power was 2,587,615 acres.

Power sites withdrawn, restored to entry, and outstanding, fiscal year 1919–20, in acres.

	Withdrawals outstanding June 30, 1919.	New withdrawals, 1919–20.	Restorations, 1919–20.	Withdrawals outstanding June 30, 1920.
Alabama	120			120
Alaska	81,015	10,000		91,015
Arkansas	22,354			22,354
Arizona	295,848	6,360		302,208
California	288,894	4,152		293,046
Colorado	277,136	12,111	22,793	266,454
Idaho	258,473	1,925	2,007	258,391
Michigan	1,240			1,240
Minnesota	12,309			12,309
Montana	164,431	789	8,579	156,641
Nevada	27,543			27,543
Nebraska	761			761
New Mexico	62,602	2,970		65,572
Oregon	422,744	16,714	7,112	432,346
Utah	448,698	6,880	475	455,103
Washington	113,248	888		114,136
Wyoming	88,311	65		88,376
	2,565,727	62,854	40,966	2,587,615

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 such of the revested lands as are found to be chiefly valuable for water-power sites. The total area classified as power-site lands under the provisions of the act was 141,273 acres on June 30, 1919. During the year 380 acres additional were classified as power-site lands, making a total of 141,653 acres so designated.

The act of February 26, 1919 (40 Stat., 1179), also revested in the United States title to certain lands in Oregon known as the Coos Bay wagon-road grant, which has been held by the Southern Oregon Co., and provides for the classification of these lands in the manner described in the act of June 9, 1916, as above referred to. These lands have been examined by an engineer of the Geological Survey and carefully studied to determine their power value, but no lands have yet been designated.

On July 1, 1919, designations had been made of 764,438 acres of land valuable for water power in Arizona and of 201,000 acres of such land in New Mexico, under the provisions of the enabling acts of those States. During the year, owing to a modification of water-power designation No. 1, New Mexico No. 1, in order to conform the description of a portion of the lands described therein to the official plat, the area designated was reduced 4,600 acres, leaving 196,400 acres designated. The area designated in Arizona remained unchanged.

In general, such of the designated lands as were not otherwise withdrawn have also been included in power-site reserves under appropriate acts of Congress.

Application for reclassification.—At the beginning of the fiscal year 16 applications for the reclassification of lands included in power-site reserve were awaiting action, and during the year 81 were received, making a total of 97 cases. Action was taken on 68, leaving 29 cases 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 certain administrative duties in connection with applications for rights of way over the public lands for purposes related to the development, transmission, and use of power. Such applications, when received in proper form at the General Land Office, are transmitted to the Geological Survey for the 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 after such con-

sideration the approval of an application is found to be compatible with the public interest, a draft of an appropriate agreement is prepared, together with a report and recommendations addressed to the Secretary of the Interior reciting 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 and used, the tenure of the site, and the rights of way limits, with a view to the proper protection of the public interest as regards the most beneficial utilization of the resources involved, adequate service, reasonable rates, and a fair return to investors.

The act of Congress approved June 10, 1920 (41 Stat., 1063), known as the Federal water-power act, expressly repeals "all acts or parts of acts inconsistent with this act." It appears in view of the general scope and purpose of this water-power act that no further action on applications under the earlier acts, in so far as they cover the same subject matter, should be initiated. Accordingly, it is thought appropriate to include in this report a brief summary of the work already done by this board under the regulations of January 6 and March 1, 1913.

The following table shows the number of applications for rights of way which have been received for consideration and reported on in each calendar year from 1912 to 1919, inclusive, and for 1920 until June 30, also the number pending June 30, 1920. In this table "(1901)" and "(1911)" refer to the acts of February 15, 1901, and March 4, 1911, respectively.

Applications for rights of way over power sites, 1912–1920.

Received.

	1912[a]	1913[a]	1914	1915	1916	1917	1918	1919	1920	Total.
Preliminary permit	11	20	11	8	5	6	2	5	3	71
Final permit	3	9	4	5	5	9	3	3	3	44
Transmission line (1901)	5	5	8	6	6	10	7	8	1	56
Transmission line (1911)	5	5	2	6	5	9	10	9	2	53
Not classified	2	3	.....	.....	.....	.....	.....	.....	1	6
	26	42	25	25	21	34	22	25	10	230

[a] The figures for 1912 and 1913 include several applications previously filed and resubmitted for consideration under new regulations.

Reported on.

Preliminary permit	11	20	10	7	5	4	2	3	.....	62
Final permit	2	9	4	3	3	5	1	1	2	30
Transmission line (1901)	5	5	7	6	4	9	6	7	1	50
Transmission line (1911)	5	5	2	6	5	9	10	9	1	52
Not classified	2	3	.....	.....	.....	.....	.....	.....	.....	5
	25	42	23	22	17	27	19	20	4	199

Applications for rights of way over power sites, 1912–1920—Continued.

Pending June 30, 1920.

	1912	1913	1914	1915	1916	1917	1918	1919	1920	Total.
Preliminary permit	.....	.....	1	1	.....	2	.....	2	3	9
Final permit	1	.....	.....	2	2	4	2	2	1	14
Transmission line (1901)	.....	.....	1	.....	2	1	1	1	.....	6
Transmission line (1911)	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Not classified	.....	.....	.....	.....	.....	.....	.....	.....	1	1
	1	.....	2	3	4	7	3	5	6	[a]31

[a] Twenty original applications and 11 applications for reconsideration or for final permits in pursuance of preliminary permit previously issued.

The status of the applications reported on, as shown by the Survey records of July 1, 1920, is as follows:

Preliminary permits:		
Rejected or abandoned	33	
Term lapsed	10	
Final permit applied for or issued	11	
In effect	5	
		59
Final permits:		
In effect	23	
Rejected, revoked, or abandoned	5	
		28
Transmission line (1901):		
In effect	41	
Rejected, revoked, or abandoned	9	
		50
Transmission line (1911):		
In effect	47	
Rejected	3	
		50
Special cases rejected		5

Besides the cases listed above there are 7 cases (3 preliminary permits, 2 final permits, and 2 grants) reported out of the Geological Survey, concerning which final action by the Department either has not been taken or has not been reported to the Geological Survey.

In general, applications for rights of way over power sites have been received at an average rate of about 25 a year. The time of consideration of individual applications has of course varied widely. Including the time taken for obtaining additional data from applicants and reports from the different bureaus concerned, the average time between the date of filing in the local land office and the date of the Geological Survey report has been approximately 10 months. As hereinbefore noted, many of the applications for preliminary permits listed in the table for the years 1912 and 1913 had been under consideration previous to those years. When submitted for consideration under the new regulations, they were found to lack certain essential information. The failure of many of the applicants to supply this information resulted in their rejection, as shown above. Applications for preliminary and final permits, not including cases

pending when the Federal water-power act was approved, involved the following total power capacity:

	Capacity in horsepower.	
	Total.	Apportioned to Interior Department lands.
Preliminary permits	385,000	285,000
Final permits	155,000	65,000
	540,000	350,000

Grants under the act of 1911 and permits under the act of 1901 include over 1,000 miles of transmission-line right of way over vacant Interior Department lands. These transmission lines are practically all constructed, but only a small proportion of the power development authorized has been completed.

A large number of permits were issued by the Secretary of the Interior under the act of February 15, 1901, prior to the issuance of the current regulations, and the permittees have not been required to comply with the later regulations. These early permits involve an estimated capacity of 400,000 horsepower and some 450 miles of transmission line. The complete status of these permits is not available in the records of the Geological Survey.

Pursuant to the instructions of the Secretary, dated August 24, 1916 (45 L. D., 326), 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 upon for detailed reports of the operations or developments of their power systems during the calendar year 1919. The reports show that during the year the permittees and grantees generated or transmitted over their systems 3,100,000,000 kilowatt-hours of electric energy. Of this amount 85 per cent was generated by water power. The operating expenses for companies generating 100,000,000 kilowatt-hours or more per year (88 per cent hydro, 12 per cent steam), including taxes and allowances for depreciation, average 6 mills per kilowatt-hour sold. The average sale price of all electric energy sold by the same companies was 12 mills per kilowatt-hour, an increase of 10 per cent over the price in 1918. The energy sold amounts on an average to 77 per cent of the energy generated for companies having extensive distribution systems and an output of over 100,000,000 kilowatt-hours.

Power output of permittees and grantees, 1916–1919.

Year.	Number reporting.	Kilowatt-hours.
1916	26	1,200,000,000
1917	32	2,000,000,000
1918	51	3,200,000,000
1919	57	3,100,000,000

During the year favorable reports were made to the Secretary of the Interior on 10 applications for final permits and 1 application for preliminary power permit under the act of February 15, 1901, and 14 applications for grants under the act of March 4, 1911. Of these 25 cases 3 are called applications for reconsideration in the table below.

Several applications involving extensions of time under permits and grants, modifications of stipulations, and approvals of transfers of permits and grants have been considered and reports on them made 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 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 1919–20.

	Pending June 30, 1919.	Received, 1919–20.	Acted on, 1919–20.	Pending June 30, 1920.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 14, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 990), etc.	7	15	17	5
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc.	7	90	91	6
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1235, 1253), etc.	22	20	22	20
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.	2	39	41	0
Total number of applications for original consideration	38	164	171	31
Additional applications for reconsideration	16	16	21	11

During the year one Carey Act segregation list was received, and a report on it was forwarded to the General Land Office. One case of this type was submitted by the General Land Office for reconsideration during the year, and the case was returned with appropriate supplemental report.

At the beginning of the year three cases were pending awaiting reports to the General Land Office under the instructions from the Secretary of the Interior of March 15, 1913, relative to irrigation projects whose water rights or shares of stock are presented as evidence of compliance with the requirements of the desert-land act, or reports as to the feasibility from an engineering and economic standpoint of applications under the irrigation-district law of August 11, 1916 (39 Stat., 506). During the year 37 new cases were received and reports were submitted to the General Land Office in 22 cases, leaving 18 cases pending June 30, 1920. One case of this type submitted for reconsideration was pending at the beginning of the year, and 9 additional cases were received during the year. Three of these cases were acted upon, leaving 7 pending at the end of the fiscal year.

RESERVOIR WITHDRAWALS.

One withdrawal in connection with water-storage reservoir-site investigations has been made during the year. This withdrawal embraces two reservoir sites in Wyoming said to be valuable in connection with the control of general water-supply conditions in Bear River valley, Utah.

Reservoir withdrawals outstanding June 30, 1920.

	Acres.
Arizona	23,040
Colorado	1,728
Montana	9,080
North Dakota	1,569
Oregon	10,619
Washington	35,943
Wyoming	1,714
	83,693

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 made during the fiscal year in conjunction

with data obtained previously, action based on Survey classifications has been taken in nearly all cases, the general exceptions being those involving lands within the exterior limits of irrigation projects requiring further investigations.

Action on petitions under the enlarged-homestead acts, fiscal year 1919–20.

State.	Pending June 30, 1919.	Received, 1919–20.	Total.	Action taken, 1919–20.						
				All designated.	Part designated.	Refused.	Recalled.	Total.	Pending June 30, 1920.	Cases reconsidered.
Arizona	44	146	190	16	.....	2	16	34	156	5
Arkansas	1	.....	1	.....	.....	.....	.....	.....	1	.....
California	317	138	455	275	4	2	4	285	170	19
Colorado	564	620	1,184	492	12	11	9	524	660	45
Idaho	405	238	643	313	7	111	24	455	188	60
Kansas	15	45	60	8	.....	1	1	10	50	.....
Michigan	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minnesota	1	.....	1	1	.....	.....	.....	.....	1	.....
Montana	883	492	1,375	792	13	14	41	860	515	134
Nebraska	1	1	2	1	.....	.....	.....	1	1	.....
Nevada	40	10	50	24	.....	11	1	36	14	.....
New Mexico	329	252	581	222	3	2	7	234	347	17
North Dakota	152	71	223	95	9	7	2	113	110	16
Oklahoma	.....	2	2	.....	2	.....	.....	2	.....	.....
Oregon	166	100	266	201	15	2	3	221	45	11
South Dakota	232	56	288	119	4	3	1	127	161	8
Utah	467	186	653	297	6	49	11	363	290	25
Washington	197	74	271	186	5	20	3	214	57	21
Wyoming	307	349	656	259	4	12	15	290	366	44
	4,121	2,780	6,901	3,301	84	247	138	3,770	3,131	405

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, 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 pros-

pective entrymen. In consequence, general designations of large areas are made only rarely.

Enlarged-homestead designations, fiscal year 1199–20, in acres.

State.	Outstanding July 1, 1919.	Designations, 1919–20.	Cancellations, 1919–20.	Outstanding June 30, 1920.
Arizona	25,489,483	10,880	4,040	25,496,323
California	8,415,241	410,495	.....	8,825,736
Colorado	28,778,359	419,075	5,160	29,192,274
Idaho:				
Secs. 1–5 and 7	10,319,499	206,540	24,907	10,501,132
Sec. 6	516,237	28,957	160	545,034
	10,835,736	235,497	25,067	11,046,166
Kansas	548,754	23,720	.....	572,474
Montana	50,665,905	492,125	600	51,157,431
Nevada	46,304,756	81,702	2,960	46,383,498
New Mexico	31,519,989	639,774	.....	32,159,763
North Dakota	11,910,717	32,125	.....	11,942,842
Oregon	18,938,987	641,148	2,400	19,577,735
South Dakota	15,901,760	174,795	348,170	15,728,385
Utah:				
Secs. 1–5 and 7	7,684,195	215,080	32,180	7,867,095
Sec. 6	1,424,274	79,340	600	1,503,014
	9,108,469	294,420	32,780	9,370,109
Washington	5,566,658	466,205	160	6,032,703
Wyoming	24,812,426	661,616	.....	25,474,042
	288,797,241	4,583,577	421,337	292,959,481

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 is reasonably required to support a family.

Although the field force was materially reduced, greater progress was made in the classification of lands under this act than in previous years. This progress was effected largely by the use of the accumulated field data collected during the period the law has been in operation. Toward the end of the fiscal year the work had reached such a stage that general designations of lands other than those individually applied for was possible, and several million acres were designated in this manner.

The area designated during the fiscal year, 54,312,588 acres, was more than two and one-half times the total designated prior to July 1, 1919, and although the number of cases closed was somewhat less

than in the previous year, a material reduction was made in the number of cases pending. Since the law became effective 81,713 applications for designation have been received, of which 67,258 have been acted upon.

Stock raising homestead designations, fiscal year 1918–19, in acres.

State.	Outstanding July 1, 1919.	Designations, 1919–20.	Cancellations, 1918–19.	Outstanding June 30, 1920.
Arizona	291,120	2,151,950		2,443,070
Arkansas	240			240
California	365,380	3,896,586		4,261,966
Colorado	2,674,964	2,800,757	40	5,475,681
Idaho	445,389	2,418,425		2,863,814
Kansas	57,604	31,070		88,674
Michigan		320		320
Montana	2,401,790	5,977,437		8,379,227
Nebraska	38,648	56,760		95,408
Nevada	28,980	102,039		131,019
New Mexico	5,083,090	17,670,063		22,753,153
North Dakota	191,418	110,441		301,859
Oklahoma	22,481			22,481
Oregon	1,040,907	4,283,134	320	5,323,721
South Dakota	1,782,525	4,415,582		6,198,107
Utah	52,410	511,950		564,360
Washington	207,536	123,758		331,294
Wyoming	5,497,386	9,762,316	1,760	15,257,942
	20,181,868	54,312,588	2,120	74,492,336

Stock raising homestead petitions, fiscal year 1919–20.

State.	Pending June 30, 1919.	Received, 1919–20.	Total.	Action taken, 1919–20.					Pending June 30, 1920.	Reconsidered cases.
				All designated.	Part designated.	Refused.	Recalled.	Total.		
Arizona	438	405	843	241	3	11	54	309	534	355
Arkansas	1	2	3	1				1	2	
California	1,751	682	2,433	1,161	25	51	23	1,260	1,173	285
Colorado	2,036	2,502	4,538	2,860	64	92	73	3,089	1,449	233
Idaho	2,273	761	3,034	1,875	152	210	60	2,297	737	248
Kansas	61	40	101	57	1	2		60	41	
Michigan		4	4	1				1	3	
Montana	3,142	3,172	6,314	2,426	44	161	286	2,917	3,397	248
Nebraska	81	112	193	141	1			142	51	1
Nevada	123	85	208	112	14	13	8	147	61	13
New Mexico	2,104	2,159	4,263	1,946	47	53	15	2,061	2,202	1,624
North Dakota	236	124	360	229	17	18	4	268	92	40
Oklahoma	40	51	91			1		1	90	3
Oregon	2,002	1,216	3,218	2,344	120	168	10	2,642	576	251
South Dakota	1,466	1,081	2,547	2,004	18	47	34	2,103	444	167
Utah	1,230	228	1,458	757	40	9	4	810	648	101
Washington	396	237	633	255	9	8	4	276	357	20
Wyoming	2,341	5,537	7,878	5,138	47	61	34	5,280	2,598	384
	19,721	18,398	38,119	21,546	602	905	609	23,664	14,455	3,973

PUBLIC WATER RESERVES.

Withdrawals of tracts containing watering places located in regions largely devoid of sources of water supply for stock grazing on surrounding open public range were continued during the year, and restorations from such withdrawals were also made. These re-

serves are created under the act of June 25, 1910 (36 Stat., 847), as amended by section 10 of the act of December 29, 1916 (39 Stat., 862), in order that control of the water on the land withdrawn may be retained in the Government. Efforts of private individuals to develop and protect the water supply on such lands from damage and pollution, however, will be encouraged by granting special privileges to such individuals through the issuance of permits under the act of February 15, 1901 (31 Stat., 790).

Areas amounting to 14,367 acres were included in public water reserves during the year, and 765 acres were eliminated from such reserves on the basis of information obtained through field examination by the General Land Office and the Survey.

Public water reserves withdrawn, restored to entry, and outstanding, fiscal year 1919–20, in acres.

State.	Withdrawals outstanding July 1, 1919.	New withdrawals, 1919–20.	Restorations, 1919–20.	Withdrawals outstanding June 30, 1920.
Arizona	13,826	335	160	14,001
California	56,034	3,812	85	59,761
Colorado	1,900	.....	.....	1,900
Idaho	7,040	3,600	.....	10,640
Montana	7,284	440	.....	7,724
Nevada	4,833	2,020	.....	6,853
New Mexico	3,361	2,680	.....	6,041
Oregon	11,744	640	.....	12,384
South Dakota	240	.....	.....	1,240
Utah	34,867	720	.....	35,587
Washington	800	120	.....	920
Wyoming	83,752	.....	520	83,232
	225,681	14,367	765	239,283

GROUND-WATER RECLAMATION IN NEVADA.

The ground-water reclamation act of October 22, 1919 (41 Stat., 293), authorizes the issuance of permits to citizens of the United States or associations of such citizens, giving the exclusive right to conduct explorations within the limit of 2,560-acre tracts of a certain type of land in Nevada for the purpose of obtaining a water supply for irrigation from wells. The act provides that land covered by these permits shall have been designated by the Secretary of the Interior as nonmineral, nontimbered, and not known to be susceptible of successful irrigation at a reasonable cost from any source of water supply. Instructions were issued March 19, 1920, directing the preparation of the orders of designation in the Geological Survey, and the furnishing of appropriate advice to the Commissioner of the General Land Office in all cases involving applications for permits under this act. An area of 57,600 acres had been designated under the terms of this act at the end of the year.

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 28,700 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,664 galley proofs and 20,251 page proofs were read and corrected. Indexes were prepared for 40 publications, covering 8,044 pages. The publications of the year are listed and abstracted on pages 12–30.

At the end of the fiscal year seven 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 2,440, including 251 miscellaneous maps, 288 photographs, 388 diagrams and sections, 1,308 paleontologic drawings, and 205 miscellaneous illustrations. The illustrations transmitted to accompany manuscripts numbered 783, to be reproduced by chromolithography, photolithography, halftone engraving, zinc etching, the four-color process, and cuts already engraved. The number of proofs received and examined was 801. At the end of the year material for illustrating 57 separate reports and chapters is on hand, 21 of which are 10 to 90 per cent completed. The number of reports now on hand for which illustrations are to be completed is greater than at the end of any previous year. During the year an unusual number of large and difficult illustrations have received attention, such as the maps that accompany two reports on desert watering places.

DIVISION OF DISTRIBUTION.

Editions of 153 new books and pamphlets, 30 reprinted books and pamphlets, 2 new geologic folios, 4 new geologic maps, 69 new or revised topographic maps, and 114 reprinted topographic maps, making a total of 372 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 621,649 books and pamphlets, 7,208 folios, 323 geologic maps, and 711,872 topographic and other maps, a grand total of 1,341,052.

The division distributed 621,132 books, 17,954 folios, and 898,388 maps, a total of 1,537,474, of which 12,117 folios and 707,252 maps were sold. The total amount received and deposited in the Treasury as the result of sales of map publications was $43,977.08, including $42,723.73 for topographic and geologic maps and $1,253.35 for geologic folios. The division received and answered 107,774 letters.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

The publication of geologic folios was resumed during the year. Two folios were completed and published, Nos. 209 and 210. (See pp. 29–30.) The maps of Folio 211 (Elkton-Wilmington, Md., Del., Pa.) were printed, and the text reached the stage of page proof. Some of the maps of Folio 212 (Syracuse-Lakin, Kans.) were printed. The maps of Folio 213 (New Athens-Okawville, Ill.) reached the stage of stone proof. Progress was made in the engraving of the large geologic map of the Black Hills (S. Dak.) folio and of the three maps of the Brilliant-Raton-Koehler (N. Mex.-Colo.) folio.

The maps of Part I of the World Atlas of Commercial Geology (72 in all) were well advanced; about half of them were completed, one-fourth were in color proof, and the drawings for the remainder were completed.

During the year G. W. Stose, geologist in charge of the section, edited the maps and illustrations for 42 reports other than folios.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

The number of topographic maps in progress in the office (exclusive of engraving and printing) ranged from 52 in November to 113 in March; the monthly average was 77. During the year 92 topographic maps were completely drafted and approved, and 84 of them were sent to the engraving division for advance-sheet photolithography; 84 maps were edited for engraving, 119 maps or sheets were edited as illustrations for 25 Survey reports, and corrections on 178 maps were edited for reprints. Engraved proof was read on 61 new topographic maps and corrections to 65 reprints. Index maps for 12 State circulars were revised. During the year 69 new topographic maps were published (58 engraved on copper and 11 printed by three-color photolithography), and at the end of the year 83 maps were in process of engraving and printing, and 62 maps were on hand in the section for completion of drafting or inspection and editing. A new class of topographic publications (for War Department distribution only) comprised 6 large special maps for artillery use in the Army, reproduced by engraving on copper and photolithography, mostly on the scale of 1 : 10,000, copy for which was prepared and reproduction proof read by this section.

The section continued in direct charge of the preparation of reports giving confidential military information to the War Department, of which 61 were transmitted during the year. Progress on reports not yet transmitted and mostly awaiting printing of base maps represents an equivalent of 15 reports.

W. M. Beaman spent September and October in a field inspection of topographic parties in the central, northwestern, and Pacific divisions. L. S. Leopold was detailed to the National Park Service from September to December, inclusive, for topographic field work in Yosemite Valley, Calif. James McCormick was designated February 28 as the representative of the Geological Survey on the United States Geographic Board, in place of R. B. Marshall, resigned.

An average of 16 employees were engaged in the work of the section for the year.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND FOLIOS.

During the fiscal year 58 new topographic maps were engraved and printed, 9 new topographic war maps were photolithographed and printed in black and colors, 1 new topographic map of Willamette Valley, Oreg. (sheet 9), was photolithographed and printed in black and colors, and 1 new State map, Arizona, scale 1:500,000, was photolithographed and printed in black only, making a total of 69 new maps printed and delivered.

Corrections were engraved on the plates of 164 maps, of which 106 were for reprint editions, 35 were in hand for printing, and 23 were corrected for other purposes. Seven photolithographic State maps were corrected and reprinted, and one topographic map in hand at the beginning of the year was completed.

Of the new and reprinted maps 183 editions, amounting to 711,872 copies, were printed and delivered to the map room. This is a decrease of 177 editions and 233,421 copies from the preceding year.

Two new geologic folios (see pp. 29–30) were published during the year, one more than last year. The editions of these folios amounted to 7,208 copies, an increase of 3,335 copies over the preceding year, Extra geologic maps of these folios amounting to 323 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING.

The following war work was done for different branches of the War Department and for other branches of the Government: For the office of the Chief of Staff, 266 grained zinc plates bearing the transferred work of the Carta de la República Mexicana, United States map showing coal regions, weekly statistical reports 130 to 148 (530 pages); for the office of the Director of Air Service, outline map of the United States; on order of the office of the Chief of Ordnance, 3 large position mirrors were ruled in centimeter squares; for the Federal Board of Vocational Education, editions of 7 forms,

25 charts, 17 diagrams, blue prints, rectigraphs, bromide enlargements, and miscellaneous photographic work; for the Bureau of War Risk Insurance, a large amount of photographic work, including editions of 443 pages of reports and organization charts; for the Treasury Department (War Loan Organization), 300,000 maps of New Europe; for the Bureau of Mines, under appropriations for argon-gas investigations, lantern slides, blue prints, and miscellaneous photographic work. Miscellaneous war work was also done for the Constructing Quartermaster (Harwood's Mill Water Development), Chemical Warfare Service (Edgewood Arsenal), General Service Schools (Fort Leavenworth, Kans.), Engineer Map Reproduction Plant, Washington Barracks, D. C., United States Shipping Board, Director of Americanization, and United States Grain Corporation. The following war work was done through the topographic branch: Thirty-six special engraved and photolithographed military maps; maps of Fort Omaha balloon field (1 sheet), Camp Jackson (4 sheets), Camp Abraham Eustis (1:20,000 scale), Camp Bragg (8 sheets), Camp Hancock (1 sheet), and Camp Knox (4 sheets). Work was continued during the year on the World Atlas of Commercial Geology.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual reports of the governor of Alaska, the governor of Hawaii, the Surgeon General (United States Navy), the Commissioner General of Immigration, the Director of National Parks, the War Department (vol. 1), the Board of Regents of the Smithsonian Institution, the Department of the Interior (Indian Affairs and Territories), vol. 2, and the Director of the United States Geological Survey; reports on preliminary examination of Lorain Harbor, Ohio, Hillsboro River, Fla., Tangipahoa River, Fla., and Black Bay of Biloxi, Miss. (H. Docs. 254, 256, 257, and 258, 66th Cong., 1st sess.); final report of Gen. John J. Pershing (H. Doc. 626, 66th Cong., 2d sess.); report on protection of Galveston, Tex. (H. Doc. 693, 66th Cong., 2d sess.); report on Gila River flood control (S. Doc. 436, 65th Cong., 3d sess.); War Department, War Documents 951, 968, 988, 990, Tariff books for Washington-Alaska military cable and telegraph system, Occasional Papers 58 (The evolution of the art of fortification, Engineer School, United States Army); Navy Department, Ordnance Pamphlet 378, Inspection Bulletin 2, Inspection districts under the Bureau of Construction and Repair, Compilation of data on foreign countries for use of the fleets, and Compilation of military data (maps of Mexico); Bureau of Ethnology Bulletin 73; Bureau of Mines Bulletins 64, 98, and Technical Paper 155; Department of Commerce, Special Publication 63; American Nautical Almanac, 1921 and 1922; American Ephemeris and Nautical Almanac, 1920, 1921, and 1923; Geological

Survey Bulletins 656, 661, 686–B, 686–C, 686–D, 686–E, 686–F, 686–G, 686–H, 686–J, 686–K, 686–L, 686–T, 686–U, 686–V, 686–W, 691–B, 691–C, 691–E, 691–G, 691–H, 697, 704, 711–B, 711–C, 711–F, 711–G, 711–H, 712–E, 713, 716–A, 716–B, Professional Papers 115, 116, 125–B, Water-Supply Papers 447, 450–A, 450–C, 490–B, 490–C, 490–D; Mineral Resources, 1918, chapters on peat, manganese and manganiferous ores, and asphalt and allied substances, pamphlet on preparation of illustrations for reports of the United States Geological Survey. In addition the following separate illustrations were printed and delivered to the Government Printing Office: For the War Department, 43 instruction charts, maps and diagrams for final report of Gen. John J. Pershing; for the Navy Department, organization chart, Bureau of Supplies and Accounts, plans for navy yards and stations, Chart IV (logarithmic scale); for the National Park Service, panoramic view of Mount Rainier National Park, sketch map of Yosemite National Park, maps for rules and regulations for five national parks, maps for seven circulars giving general information regarding national parks; for the Forest Service, protractor forms; for the National Forest Reservation Commission, maps showing progress of purchase of eastern national forests; for the General Land Office, maps of Oregon-California Railroad lands, one Indian reservation, one camp and military reservation, mineral survey plat sheet, Form 4–675–b (township plat), posters advertising sale of public lands, and plats of 7 town sites; for the Office of Farm Management, base and outline maps of the United States by counties and States, and maps of South America; for the Bureau of Animal Industry, maps showing quarantine for Texas fever of cattle; for the Bureau of Entomology, maps showing spread of the Mexican cotton-boll weevil, and maps showing areas quarantined for the gypsy moth and brown-tail moth; for the Department of State (International Joint Commission), maps showing water supply of St. Mary and Milk rivers; for the Alaskan Engineering Commission, industrial map of Fairbanks section, Alaska, and maps showing construction of Government railroads in Alaska; for the Superintendent of Documents, maps of the United States by counties; for the Department of Justice, diagrams for use in case of the United States v. the Steel Corporation; for the Bureau of the Census, maps showing birth and death registration areas; for the Department of the Interior, maps of the Hawaiian Islands; for the Bureau of Education, maps of Alaska showing public schools and reindeer stations; for the Bureau of Mines, gasoline-blending chart.

The following work was done for other bureaus and departments: For the Department of the Interior, graphic chart, bromide enlargements, rectigraph prints, and miscellaneous photographic work; for the Reclamation Service, 37 maps of projects, 40 farm-unit plats of

projects, 3 town-site plats of projects, 3 supplemental plats of projects, 6 maps of Idaho and Oregon, 62 standard designs, diagrams, forms, and tracings, map showing location of projects, log sheet, transportation slips, progress chart, travel-order blank, discharge tables, lantern slides, and miscellaneous photographic work; for the General Land Office, 1,438 township plats, 527 mineral plats, plats of 3 town sites, 13 State maps showing enlarged-homestead areas, map showing survey of boundary line between Oklahoma and Texas, and miscellaneous photographic work; for the Bureau of Mines, map of Hewitt oil field, charts, diagrams, blue prints, lantern slides, and miscellaneous photographic work; for the Alaskan Engineering Commission, maps showing Government railroads in Alaska, map of Fairbanks district, progress map, statement forms, and miscellaneous photographic work; for the Office of Indian Affairs, maps of 4 Indian reservations, map showing Indian reservations west of Mississippi River, lantern slides, bromide enlargements, and miscellaneous photographic work; for the National Park Service, 12 automobile-guide maps, 1 automobile tour map, map showing proposed enlargement of Crater Lake National Park, map showing proposed Roosevelt National Park in relation to the Yosemite National Park, map showing national park-to-park highways in the western United States, automobile wind-shield stickers for 14 national parks, fire-warning signs, park signs, labels, bromide enlargements, lantern slides, rectigraphs, and miscellaneous photographic work; for the Bureau of Standards, editions of 455 pages of technical manuscript, millimeter ruling, forms, diagrams, and miscellaneous photographic work; for the Forest Service, maps of 59 national forests, 14 proclamation maps of national forests, 26 maps for atlas folios, 7 recreation maps of national forests, 140 homestead-entry plats, triangulation record, allotment-estimate sheets, forms, diagrams, and other miscellaneous work.

Miscellaneous work was also done for the Department of Commerce, Interstate Commerce Commission, Department of Labor, Bureau of Entomology, Weather Bureau, States Relations Service, Bureau of Public Roads, Post Office Department, Hydrographic Office, St. Elizabeth's Hospital, Bureau of Foreign and Domestic Commerce, Coast and Geodetic Survey, International Boundary Commission, and Commission of Fine Arts.

This work for other branches of the Government included many reprint editions and amounted to about $125,000, 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 State engineer and surveyor, Albany, N. Y.; Electrical World, New York City; A. Hoen & Co., Baltimore, Md.; Dominican Topographic Survey; J. B. Lyon Co., Albany, N. Y.; Snyder & Black, New York City; J. C. Hoyt, water-resources

branch, United States Geological Survey; John W. Hallowell, Assistant to the Secretary, Department of the Interior; Tennessee State Geological Survey, Nashville, Tenn.; University of Wisconsin, Madison, Wis.; American National Red Cross, Detroit, Mich.; and Topographic Engraving Co., Washington, D. C.; and the money received in payment for the work, amounting to $482.18, was turned into the Treasury of the United States to be credited to miscellaneous receipts. On requisition of the Government Printing Office, 228 transfer impressions were made and shipped to contracting printers. Under cooperative agreements transfer impressions were furnished without charge to the State geological surveys of Wisconsin, Illinois, Virginia, and West Virginia. Transfer impressions were also furnished to the water-resources branch, Treasury Department, Massachusetts Institute of Technology, and Griffin & Co., London, England.

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, 3,524,689 copies were printed. Including topographic maps and geologic folios, a grand total of 4,243,769 copies were printed and delivered during the year, an increase of nearly 10 per cent over the number in the previous year.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 10,210 negatives, of which 1,147 were wet, 2,596 dry, 378 paper, 5,221 field negatives developed, and 868 lantern slides; 2,979 negatives made for photolithographers; 3,905 zinc plates; 231 zinc etchings; 109 celluloids; and 45,946 prints, of which 25,920 were maps and diagrams, 18,022 photographs for illustrations, and 2,004 rectigraphs. In addition 1,359 prints were mounted, and 93 lantern slides were colored.

ADMINISTRATIVE BRANCH.

During the year up to June 12, in addition to his technical work as one of the specialists in the division of mineral resources and as geologist, Philip S. Smith served as administrative geologist and, during the absence of the Director, as acting Director. After June 12 Mr. Smith was engaged on geologic investigations in Alaska and the duties of the administrative geologist and acting Director were performed by Marius R. Campbell. Henry C. Rizer served throughout the year as chief clerk.

EXECUTIVE DIVISION.

The work of the executive division, in charge of G. E. Mitchell, was of the same general character as during the fiscal year 1919.

Mails, files, and records.—During the year 163,343 pieces of mail, including 2,193 registered, were opened and referred; in addition 157,136 letters were received direct by the other divisions, making a total of 320,479, an increase of 4 per cent compared with 1919. Remittances received for Survey publications numbered 22,679 and aggregated $45,109.94, an increase of 52 per cent in number of letters and of $21,092.57 in amount compared with 1919.

The recording, referring, checking, mailing, and filing of correspondence required the services of 10 clerks. The number of letters mailed through the division was 121,980, a decrease for the year of 6 per cent. This number does not include the outgoing registered mail, which numbered 11,022 pieces, nor 180,107 pieces of letter mail sent direct from other divisions. The total for the Survey was therefore 313,109, a decrease of 21 per cent for the year. This decrease in outgoing mail can be accounted for by the fact that during the year a large part of the correspondence of the division of mineral resources was carried on in cooperation with the Bureau of the Census.

Personnel.—The roll of Secretary's appointees numbered 966 at the end of the fiscal year, 1 less than at the end of 1919. The total number of changes in the personnel was 1,217, which included 266 appointments, 267 separations (6 deaths), 643 promotions, and 41 miscellaneous changes.

During the year 17,247 days of annual leave and 5,101 days of sick leave were granted, being 73 per cent of the amount of annual leave and 21½ per cent of the amount of sick leave which is permissible under the law; 13,730 days of leave without pay were also granted.

Freight and express.—During the year 1,860 pieces of freight and express were handled, 832 outgoing and 1,028 were incoming.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT.

The cost of the work and material used in the division of scientific equipment during the year was $26,399.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given on pages 169 and 170.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1920.[a]

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$31,020.00		$31,020.00	$26,800.89	$4,219.11
Salaries, scientific assistants	29,900.00		29,900.00	29,899.99	.01
Skilled laborers, etc	15,080.00		15,080.00	15,080.00	
Gaging streams, etc	175,000.00	$28,009.06	203,009.06	191,245.08	11,763.98
Chemical and physical researches	40,000.00	160.84	40,160.84	33,884.42	6,276.42
Preparation of illustrations	18,280.00	15.00	18,295.00	18,228.40	66.60
Mineral resources of the United States	110,000.00	324.00	110,324.00	104,960.79	5,363.21
Geologic maps of the United States	118,000.00	123,115.49	241,115.49	198,880.38	42,235.11
Books for the library	2,000.00		2,000.00	1,400.89	599.11
Topographic surveys	325,000.00	267,827.77	592,827.77	582,120.43	10,707.34
Geologic surveys	347,073.50	2,910.96	349,984.46	331,760.67	18,223.79
Mineral resources of Alaska	75,000.00	650.00	75,650.00	63,116.17	12,533.83
Enlarged and stock-raising homesteads	175,000.00	513.92	175,513.92	166,127.23	9,386.69
	1,461,353.50	423,527.04	1,884,880.54	1,763,505.34	[b] 121,375.20

[a] In addition to these appropriations $125,000 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, 1920.

Appropriation.	Total.	Salaries and wages.	Transportation of persons and things.	Provisions; subsistence and support of persons.	Forage; subsistence and support of animals.	Printing, engraving, lithographing, etc.
Salaries, office of Director	$26,800.89	$26,800.89				
Salaries, scientific assistants	29,899.99	29,899.99				
Skilled laborers, etc	15,080.00	15,080.00				
Gaging streams, etc	191,245.08	150,744.04	$9,190.25	$8,527.89	$23.90	$583.64
Chemical and physical researches	33,884.42	25,865.33	561.96	1,030.32		
Preparation of illustrations	18,228.40	17,933.33	.31			
Mineral resources of the United States	104,960.79	98,107.81	1,414.53	2,000.44		
Geologic maps of the United States	198,880.38	152,534.60	69.27	89.60		
Books for the library	1,400.89					
Topographic surveys	582,120.43	360,733.70	29,397.49	109,051.02	13,770.52	1,047.14
Geologic surveys	331,760.67	281,259.14	9,495.45	16,274.18	2,626.14	
Mineral resources of Alaska	63,116.17	47,878.48	6,426.21	4,455.04	169.59	
Enlarged and stock-raising homesteads	166,127.23	117,151.11	5,956.44	20,168.15		
	1,763,505.34	1,323,988.42	62,511.91	161,596.64	16,590.15	1,630.78

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1920—Continued.

Appropriation.	Special and miscellaneous service.	Materials; miscellaneous supplies, etc.	Stationery, drafting, etc., supplies.	Equipment (including live stock).	Maintenance, operation, and repair of passenger-carrying vehicles.	Hire of motor-propelled and horse-drawn passenger-carrying vehicles.
Gaging streams, etc	$5,888.78	$1,298.41	$1,157.60	$12,301.69	$993.43	$535.45
Chemical and physical researches	570.54	1,211.17	321.61	3,128.65	1,119.84	75.00
Preparation of illustrations	183.34	9,96	82.66	18.80	.....	.....
Mineral resources of the United States	1,935.34	6.59	201.66	1,128.73	.....	165.69
Geologic maps of the United States	3,087.74	10,406.80	27,855.33	4,837.04	.....	.....
Books for the library	.....	.....	.....	1,400.89	.....	.....
Topographic surveys	29,208.51	5,062.45	1,844.89	23,010.10	6,852.55	2,142.06
Geologic surveys	8,152.74	795.58	1,041.41	7,538.75	2,818.72	1,758.56
Mineral resources of Alaska	2,714.41	237.37	296.31	938.76	.....	.....
Enlarged and stock-raising homesteads	1,367.79	45.02	671.17	16,006.32	4,694.93	66.30
	53,109.19	19,073.35	33,472.64	70,309.73	16,479.47	4,743.06

LIBRARY.

The accessions of books, pamphlets, and maps numbered 13,644 items. The recorded loans were 6,403 books and 133 maps, not including those used by 11,358 readers who consulted the library in person. The catalogue was increased by the addition of 5,340 cards. In accordance with the cooperative cataloguing arrangement 572 title entries were furnished to the Library of Congress for printing, the proof reading for which involved 105 galleys.

The books collated and prepared for the binder numbered 971. The letters and other papers translated from foreign languages for other divisions of the Survey numbered 148.

The bibliography of North American geology for 1918 was published as Bulletin 698. The bibliography for 1919 and 1920 is in preparation. Work on the cumulated bibliography of North American geology has progressed steadily, but no date can be set for publication.

The library contains practically all the important scientific and technical publications treating of the subjects included in the Survey's work, as well as the necessary guides, bibliographic aids, and reference books.

INDEX.

D.

E.

N.