DEPARTMENT OF THE INTERIOR
HUBERT WORK, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

FORTY-FOURTH ANNUAL REPORT
OF THE
DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY
TO THE
SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30
1923

WASHINGTON
GOVERNMENT PRINTING OFFICE
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Directors of the U. S. Geological Survey

CLARENCE KING, 1879–1881
JOHN WESLEY POWELL, 1881–1894
CHARLES DOOLITTLE WALCOTT, 1894–1907
GEORGE OTIS SMITH, 1907–

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FORTY-FOURTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

APPROPRIATIONS.

The direct appropriations for the work under the Geological Survey for the fiscal year 1922 comprised items amounting to $1,450,940. In addition $119,000, to be disbursed under the direction of the Public Printer, was appropriated for printing the reports of the Survey, and allotments of $8,000 and $5,050.93 for miscellaneous printing and binding and miscellaneous supplies, respectively, were made from Interior Department appropriations.

GENERAL SUMMARY.

The range of the Geological Survey's activities is shown by the following outline of the work done during the year, which is set forth in detail in the reports of the several branches. During the fiscal year 1923 the Survey

Made geologic surveys in 32 States, mapping the geology and determining the mineral resources and geologic history.

Studied ore deposits in 10 States and prepared or brought to different stages of completion 16 reports on ore deposits.

Made geologic studies in 8 States to determine the prospects of obtaining oil and gas and prepared or partly prepared 20 reports showing the results of such studies.

Made laboratory researches to determine the sources of petroleum, the mode of its formation from them, and the features of oil sands, such as texture and porosity, that are conducive to the accumulation of oil.

Published maps of Kentucky, West Virginia, and southern California showing oil and gas fields, pipe lines, and refineries, and a similar map on a smaller scale of the United States.

Examined and sampled coal beds in 9 States for the classification of lands and for the administration of the land-leasing act, as well as to guide future development, and prepared or has in preparation 6 reports on coal fields.

Made geologic examinations of sites for dams and reservoirs in 6 States in cooperation with the Reclamation Service to determine the strength, tightness, and other features of the rocks.

Continued cooperation with the Forest Service, the General Land Office, and the Indian Office in examinations of public lands, especially to determine whether they contain oil, gas, or other mineral deposits.

Assisted the United States Coal Commission by furnishing statistical records and expert advice concerning certain phases of the coal industry.

Made cooperative field studies of ore deposits, coal beds, and geologic formations in Virginia, North Carolina, Alabama, and Idaho and completed, in cooperation with the State, the manuscript of a geologic map of Arizona.

Identified thousands of fossils to determine their geologic age and thus the stratigraphic horizons or probable depths at which they were found, in order

that they may be made serviceable to drillers for oil and gas and others, as well as in general geologic research.

Mapped and examined geologically parts of the San Andreas rift zone in California to determine the occurrence of earthquakes in this zone in recent geologic time.

Published more than 40 reports on the geologic features and mineral resources of areas in different parts of the United States.

Examined the mineral resources in Alaska adjacent to the Alaska Railroad, as well as those in the Chitina Valley, in the vicinity of Fairbanks, in the Wrangell and Chandalar districts, and in the Prince William Sound region, and determined the general condition of the mining industry in the Territory.

Made a reconnaissance geologic and topographic survey of the oil fields of the Alaska Peninsula.

Prepared in part or completely reports on the Juneau and the Ketchikan districts and the Ruby-Kuskokwim region and continued revision of the geographic dictionary of Alaska.

Began, at the request of the Navy Department, the investigation of the oil resources of Naval Petroleum Reserve No. 4, on the Arctic coast of Alaska.

Published the annual report on the mineral resources of Alaska for 1920, giving an account of the investigations made and of the state of the mining industry during the year, and four advance chapters of the similar report for 1921, as well as reports on deposits of tin ore on York Peninsula, on deposits of chromite on Kenai Peninsula, and on the geology and copper deposits of the Kotsina-Kuskulana district.

Published a new map of Alaska, in four colors.

Examined and identified more than 2,000 specimens of rocks and minerals and made nearly 700 quantitative analyses of rocks and minerals for use in geologic investigations.

Continued studies of the physical and chemical character of sediments and of the principles of sedimentation, making in this study analyses of 68 samples of ocean sediments.

Made laboratory studies of the chemical changes by which copper is formed in nature.

Determined the temperature of 128 springs and geysers in Yellowstone National Park and the temperature in deep wells in Pennsylvania, Wyoming, and Oregon.

Prepared papers on isostasy and on mountain building through isostatic readjustment, on the inorganic constituents of marine invertebrates, and on sodium sulphate, and has 11 other chemical reports in various stages of preparation.

Continued the collection of the annual statistics of the mineral production in the United States and cooperated in this work with 16 States.

Issued weekly reports on the production of coal and monthly reports on the production of petroleum and cement.

Prepared special statistical reports regarding various mineral commodities for several other Government agencies, including the Senate Committee on Manufactures, the President's Conference on Unemployment, and the Fuel Distributor.

Continued to compile information showing the mineral production of other countries, especially the production of coal and petroleum.

Made topographic surveys in 22 States, completing new surveys of areas aggregating more than 13,000 square miles and resurveying areas aggregating more than 1,700 square miles.

In performing this work ran 6,413 miles of primary levels, established 1,733 permanent bench marks, occupied 102 and marked 83 triangulation stations, and ran 2,314 miles of lines of primary traverse.

Mapped areas in Hawaii aggregating 559 square miles, ran 65 miles of primary levels, and established 21 bench marks, all in cooperation with the Territory.

Made 564 linear miles of river surveys in the United States to determine stream profiles, including surveys to determine the feasibility of storing and diverting waters for use in irrigation and especially for the generation of power, and published maps showing the plan and profile of parts of Colorado River.

Prepared shaded relief maps of Ohio, West Virginia, and Grand Canyon of the Colorado and of 14 smallar areas, including a map of the country around Washington, D. C., bearing on the back a descriptive text.

Continued the compilation of the base of the United States portion of the international map of the world in cooperation with the Bureau of Public Roads.

Maintained cooperation in topographic work with the Coast and Geodetic Survey, the Forest Service, the Reclamation Service, and the Engineer Corps of the Army.

Published 73 standard topographic maps of quadrangles in the United States and 14 State maps.

Continued measurements of the flow of streams at about 1,600 stations in the United States and Hawaii to determine quantities of water available for various purposes and to provide data for use in work to be done to prevent floods, performing part of the work in cooperation with other Government organizations and with 32 States and Hawaii.

Made investigations of ground water in 16 States and in Hawaii, cooperating in this work with 6 States and Hawaii.

Published 15 reports relating to surface water, 3 reports relating to ground water, and a comprehensive report on hydroelectric power systems of California and adjacent States.

Made laboratory studies of methods of water analysis and analyzed 275 samples of waters collected at different places in the United States to determine their mineral quality so far as it may affect their use in manufacturing industries, and prepared and published a report showing the chemical character of the water of public supplies used by nearly 39,000,000 persons in 307 cities in the United States.

Continued the preparation of monthly reports showing the production of electricity and the consumption of fuel by public-utility power plants and the preparation of State maps showing the location of power stations and transmission lines used in public service, as well as reports showing the stock of coal on hand from time to time at electric public-utility plants.

Made field examinations of 14 States of lands subject to entry under the enlarged-homestead and stock-raising homestead laws.

Made field examinations of streams and lands in 14 States to enable their classification with respect to their value for water power or irrigation.

Prepared or has in preparation reports on ground water in areas in 10 States.

Reported on more than 15,000 cases arising under the administration of the public-land laws.

Classified 408,123 acres with respect to coal and 162,949 acres with respect to petroleum and increased the gross area of defined oil and gas fields by 77,989 acres.

Reported on 5,162 applications for permits, leases, or patents involving public mineral lands under the leasing laws.

Recommended the addition of 339,209 acres to the power-site reserves and the elimination of 30,119 acres.

Recommended the designation of 2,078,818 acres of land as available for settlement under the enlarged-homestead acts and the cancellation of designations involving 26,216 acres.

Recommended the designation of 2,252,469 acres of stock-raising homestead land and the cancellation of designations involving 5,755 acres.

Edited and otherwise prepared for printing 24,473 pages of manuscript, read and corrected 2,748 galley proofs and 20,628 page proofs, and prepared indexes for 55 reports covering 12,985 pages.

Prepared for reproduction in reports more than 4,000 illustrations and prepared geologic maps, structure sections, and other illustrations for 6 geologic folios.

Edited and transmitted to engraver 70 topographic maps, edited for engraving or reprint 200 topographic and other maps and profile river-survey sheets, as well as 195 maps for incorporation in reports, and read more than 600 proofs of topographic maps.

Published 482,591 copies of books and pamphlets, 3,551 copies of geologic folios, 3,000 copies of the World Atlas of Commercial Geology, 700 geologic maps, and 1,027,585 copies of topographic and other maps, a grand total of 1,519,787 publications.

Distributed 470,491 books, 8,262 geologic folios, 1,053 copies of the World Atlas of Commercial Geology, and 741,116 maps, a total of 1,220,992 copies of publications, of which 604,598 were sold.

Printed for other bureaus of the Government nearly 3,000,000 copies of maps, charts, diagrams, etc., costing about $100,000.

Maintained a photographic laboratory whose output consisted of 13,890 negatives, 671 lantern slides, 120,497 prints, and other material.

Maintained a geologic library, receiving more than 14,000 books, pamphlets, and maps, afforded facilities for more than 13,000 readers, and lent for outside use more than 7,500 books and maps.

Received nearly 340,000 letters, handled more than 1,600 packages or pieces sent by freight or express, incoming and outgoing, and sent out more than 1,400,000 pieces of mail.

MAJOR CHANGES IN ORGANIZATION.

On September 22, 1922, Congress passed an act establishing a commission to inquire fully into the facts relating to the coal industry, with the aim of obtaining advice concerning measures that might be adopted to insure a supply of coal to the industries and to the people generally throughout the country. Because of his position as Director of the Geological Survey, a bureau long and intimately connected with the mining industry, and because he had personally, both as geologist and as administrative officer, given special attention to coal and power problems, Dr. George Otis Smith was named by President Harding as one of the commissioners. This selection necessitated making a choice between the two positions, as according to law two Government positions can not be held by one person at the same time. Doctor Smith decided to accept the commissionership and resigned as Director of the Survey October 31. In reaching this decision he stated that

> The opportunity afforded a Survey representative to serve on the United States Coal Commission is not only a deserved honor to the Survey but also a desired chance to make the largest use of Survey data and personnel to the advantage of the public.

The Coal Commission expires by law September 22, 1923, and as both the President and the Secretary of the Interior desired to have Doctor Smith return and continue his effective administration of the Geological Survey after the completion of his duties as commissioner, the position of Director of the Geological Survey was not filled, but Philip S. Smith, a geologist of the Survey, who since January 11, 1915, had served during the absence of the Director as Acting Director, was continued in that capacity.

On November 16 David White completed 10 years of service as chief geologist. His contribution to the administration of the Survey was made at the expense of his own scientific work, even though he thereby increased the scientific value of the work of his associates. It seemed fair that his oft-repeated request for permission to return to his own geologic studies should be granted, not only to gratify the natural desire of an investigator who had laid aside research problems, one after another, but also to promote the advancement of the science of geology. The return of Mr. White to productive research suggests anew the sacrifice involved in the administration of scientific work. Administration by scientists is the keynote of the Survey's policy, yet the intellectual cost involved in this drafting of its best investigators must be kept down to a minimum.

W. C. Mendenhall, for more than 10 years the geologist in charge of the land-classification board, succeeded Mr. White as chief geologist. Mr. Mendenhall's 28 years' service in the Survey as assistant geologist and geologist comprised field experience extending from the

southern Appalachians to Alaska, and he brings to his new task a broad sympathy with the technical and scientific problems that will come under his direction, as well as ripe experience in administration.

Mr. Mendenhall was succeeded as chief of the land-classification board by Herman Stabler, his close associate in that branch during the last 10 years. Mr. Stabler's demonstrated capacity as a hydraulic engineer and his close personal contact with the many problems relating to the application and utilization of water, especially in its relation to the administration of the public-land laws, assures the continuance of the successful application of geologic and engineering facts and principles to public-land administration.

NECROLOGY.

Rollin D. Salisbury, geologist of the Geological Survey and head of the department of geology, University of Chicago, died at Chicago, Ill., August 15, 1922. Professor Salisbury was a distinguished figure in American geology through his personal investigations, chiefly in the field of geographic and glacial geology, and through the inspiration he gave to a host of students, many of whom are now among the ablest and soundest of the active investigators in the science of geology.

Barton F. Howe, who had been employed in gaging streams since 1919, was drowned March 3, 1923, in Delaware River near Port Jervis, N. Y., while engaged in official duties.

PUBLICATIONS.

The publications of the year comprised 153 book publications in the regular series, 133 maps, and numerous circulars, lists of publications and maps, advance statements on mineral production, and press bulletins. The total number of pages in the book and map publications was 15,130. Fifteen book publications and 207 maps were reprinted.

Brief notices of the publications in the regular series and of the new maps issued during the year are given in the following pages. These titles constitute the annual record of work accomplished—that is, completed to the extent of making the results available for use.

FORTY-THIRD ANNUAL REPORT of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1922. 82 pages, 1 plate.

A detailed account of the work of the Geological Survey during the year. The field work included geologic surveys in 32 States, topographic surveys in 21 States, and investigations of water resources in 40 States, besides work in Alaska and Hawaii. The office work included geologic studies, compilation of mineral statistics, chemical and physical researches, land classification, and the preparation of reports and maps. The Director continued to present the results of the Survey's investigations in popular language by addresses and magazine articles. More than 600,000 books and pamphlets and nearly 730,000 maps were distributed.

PROFESSIONAL PAPER 122. Copper deposits of the Tyrone district, N. Mex., by Sidney Paige. 57 pages, 10 plates, 29 text figures.

The Tyrone district is in Grant County, southwestern New Mexico. Its copper deposits consist of primary ores enriched by descending rain water and impoverished by leaching. This report describes the geology

of the district and the processes that have taken part in the formation of the deposits and contains a brief note on the prospects for additional ore bodies.

PROFESSIONAL PAPER 124. The inorganic constituents of marine invertebrates, second edition, revised and enlarged, by F. W. Clarke and W. C. Wheeler. 64 pages.

A study to determine the substances contributed to marine sediments by corals, mollusks, and other invertebrates.

PROFESSIONAL PAPER 129. Shorter contributions to general geology, 1921. 235 pages, 61 plates, 11 text figures.

Contains 10 papers on stratigraphy, paleontology, and general geology, previously published separately.

PROFESSIONAL PAPER 130. The Laramie flora of the Denver Basin, with a review of the Laramie problem, by F. H. Knowlton. 179 pages, 38 plates, 1 text figure.

Gives the results of investigations of the Laramie formation and its flora and the history of the changes of opinion in respect to beds assigned to this formation. As the final classification of some supposed Laramie areas is still uncertain this account of the flora is confined to an area about which there is little disagreement. Describes 129 forms, 74 of them as new species.

PROFESSIONAL PAPER 131–A. Additions to the flora of the Wilcox group, by E. W. Berry. 21 pages, 18 plates.

Supplements the account of the Wilcox flora published in 1916, describing numerous specimens of petrified wood which show that conifers were much more plentiful in Wilcox time (early Eocene) than had been supposed from the lack of remains of their foliage.

PROFESSIONAL PAPER 131–B. A section of the Paleozoic formations of the Grand Canyon at the Bass trail, by L. F. Noble. 73 pages, 7 plates, 4 text figures.

Although the thick series of horizontal Paleozoic beds that makes up the greater part of the wall of the Grand Canyon is broadly familiar to more people than the beds exposed in any other area in the western United States, the details of the stratigraphy are only imperfectly known. Sections of these formations have been measured at four places in the Grand Canyon National Park, and this paper gives one of these sections in detail, with notes on the other sections.

PROFESSIONAL PAPER 131–C. The shapes of beach pebbles, by C. K. Wentworth. 11 pages, 2 plates, 8 text figures.

Report of a study including measurements of more than 300 beach pebbles at two localities, to determine the shapes produced by wave abrasion.

PROFESSIONAL PAPER 131–D. A geologic reconnaissance in the Gulf Coastal Plain of Texas near the Rio Grande, by A. C. Trowbridge. 33 pages, 6 plates.

Prepared to meet the need for a map and a brief description of the formations on the Texas side of the Rio Grande, to serve as a key for important stratigraphic work in progress both in the United States and in Mexico. Contains also a short paper on new species of Eocene Mollusca from this region, by Julia Gardner.

PROFESSIONAL PAPER 131–E. Preliminary report on fossil vertebrates of the San Pedro Valley, Ariz., with descriptions of new species of Rodentia and Lagomorpha, by J. W. Gidley. 15 pages, 2 plates.

Describes fossil remains that establish the Pliocene age of the sedimentary deposits in San Pedro Valley, which had previously been considered Pleistocene.

PROFESSIONAL PAPER 131–F. Revision of the flora of the Green River formation, with descriptions of new species, by F. H. Knowlton. 52 pages, 5 plates.

The Green River formation extends for about 300 miles southward from the Wind River Mountains, Wyo., in a belt that has a maximum width of 150 miles. It is of economic interest because of its oil shales, which occur over vast areas in Wyoming, Colorado, and Utah. This paper describes the fossil plants of the formation and sets forth the conditions that prevailed during its deposition, as revealed by these plant remains.

PROFESSIONAL PAPER 131–G. Fossil plants from the Tertiary lake beds of south-central Colorado, by F. H. Knowlton. 17 pages, 4 plates.

A preliminary description of the fossil plants found in several lake-bed deposits in the San Juan Mountain region.

PROFESSIONAL PAPER 131–H. The fauna of the so-called Dakota formation of northern central Colorado and its equivalent in southeastern Wyoming, by J. B. Reeside, jr. 20 pages, 6 plates.

The fossil remains described include seven species, besides some undetermined fish scales and bones.

BULLETIN 686–Z. Structure and oil and gas resources of the Osage Reservation, Okla.—Tps. 26 and 27 N., R. 12 E., by P. V. Roundy, K. C. Heald, and G. B. Richardson. 29 pages, 6 plates, 2 text figures.

The final chapter in the series of reports on the Osage Reservation. The structure of the area covered has been worked out in detail.

BULLETIN 686. Structure and oil and gas resources of the Osage Reservation, Okla., by David White and others. 443 pages, 60 plates, 52 text figures.

A consolidation of 26 reports published at intervals between 1918 and 1922, each covering one or more townships in the Osage Reservation.

BULLETIN 707. Guidebook of the western United States; Part E, The Denver & Rio Grande Western Route, by M. R. Campbell. xi, 266 pages, 10 route maps, 96 plates, 63 text figures.

To "know America first" is a patriotic obligation, but to meet this obligation the railroad traveler needs to have his eyes directed toward the more important or essential things within his field of vision and to have much that he sees explained by what is unseen in the swift passage of the train. In this study of geography at first hand the traveler needs a handbook that will answer the questions that come to his mind so readily along the way. To meet this need the Geological Survey planned a series of guidebooks covering the chief railroad routes west of the Mississippi. Four of these guidebooks were issued in 1915 and 1916 and have been widely used; Bulletin 707 is the fifth and covers one of the finest scenic routes of the continent. The route from Denver to Salt Lake City is shown on 10 accurate maps and is described in detail, with a wealth of information concerning the geography, geology, history, and industries of this mountain region.

BULLETIN 708. High-grade clays of the eastern United States, with notes on some western clays, by H. Ries, W. S. Bayley, and others. 328 pages, 30 plates, 38 text figures.

Prior to 1917 large quantities of certain high-grade clays were imported into the United States, and when this country entered the war the problem arose whether similar clays produced in the United States could be obtained in sufficient quantity to meet a much larger demand. This report presents the results of an investigation made to throw light on this problem. The authors conclude that certain industries previously using foreign clays can dispense with them altogether and that others need much less than they had been using. The deposits described comprise clays used for white ware, paper, paint, and linoleum and refractory bond clays.

BULLETIN 709–L. Primary traverse in Virginia, 1916–1918. 100 pages, 1 plate.

BULLETIN 709–M. Triangulation in Arizona, California, and Nevada, 1915–1919. 96 pages, 1 plate.

BULLETIN 709–N. Primary traverse in South Carolina, 1917–1919. 151 pages, 1 plate.

BULLETIN 709–O. Triangulation in New Mexico and Texas, 1915 and 1917. 47 pages, 1 plate.

BULLETIN 709–P. Triangulation in Wyoming and Colorado, 1916 and 1919. 24 pages, 1 plate.

BULLETIN 709–Q. Triangulation and primary traverse in Texas, 1916–1920. 61 pages, 1 plate.

BULLETIN 709–R. Triangulation and primary traverse in North Carolina, 1918. 35 pages, 1 plate.

Seven chapters completing the bulletin on results of triangulation and primary traverse in 1916–1918, in which some later data are included.

BULLETIN 717. Sodium sulphate, its sources and uses, by Roger C. Wells. 47 pages, 13 text figures.

The recent demand for sodium sulphate for export, chiefly for use in making wood pulp for the manufacture of kraft paper, has greatly stimulated the search for deposits of the natural salt in the Western States. This bulletin has been prepared in consequence of numerous requests for information on the sources and uses of sodium sulphate. It gives a summary of the mineralogy of the principal compounds, notes on deposits in the United States and other countries, and other pertinent information.

BULLETIN 720. Economic geology of the Summerfield and Woodsfield quadrangles, Ohio, with descriptions of coal and other mineral resources except oil and gas, by D. D. Condit. 156 pages, 12 plates, 5 text figures.

Describes an area of about 462 square miles in southeastern Ohio; with special reference to its valuable coal resources, the oil and gas having already been described in preliminary reports. The well-known Pittsburgh coal bed occurs in the eastern part of this area but is as yet almost untouched by mining operations. The area contains numerous other coal beds, also some limestone, building stone, clay, and shale. The resources of each township are described separately.

BULLETIN 722. Mineral resources of Alaska; report on progress of investigations in 1920, by A. H. Brooks and others. 266, xiii pages, 3 plates, 19 text figures.

The annual report on geologic work in Alaska; contains papers on the mining industry in general, southeastern Alaska, the Salmon River district, Tuxedni Bay, the upper Kuskokwim region, and Seward Peninsula. These papers have been published separately in advance.

BULLETIN 724. Nitrate deposits in the Amargosa region, southeastern California, by L. F. Noble, G. R. Mansfield, and others. vii, 99 pages, 35 plates, 7 text figures.

During the World War the vital relation of our nitrate supply to the production of explosives and the possibility of interference with our trade connection with Chile, practically the world's sole source of nitrates, made it imperative to develop any domestic deposits that might supply the need. Many deposits of nitrates have been found in the southwestern desert country, and the search stimulated by the war brought out essentially all available evidence concerning such deposits. Attention was centered chiefly on the deposits described in this bulletin. A systematic effort was made to ascertain whether there is any substantial basis for the belief that commercially workable deposits occur in these fields, but the conclusions reached were entirely unfavorable. The quantity of nitrate that could be produced from these deposits would be very small and the cost very high. The bulletin gives in detail the evidence on which these conclusions are based.

BULLETIN 725. Contributions to economic geology (short papers and preliminary reports), 1921; Part I, Metals and nonmetals except fuels. 452 pages, 19 plates, 67 text figures.

A consolidation of papers previously published separately, describing chromite in California, Oregon, Washington, Montana, Pennsylvania, Maryland, and North Carolina; manganese in Montana, Utah, Oregon, Washington, and Oklahoma; tungsten in California, Nevada, Oregon, Utah, Arizona, and New Mexico; pyrite in South Carolina; tin in New Mexico; gold, silver, lead, and zinc in Nevada; and gold, silver, copper, lead, and zinc in Arizona.

BULLETIN 726. Contributions to economic geology (short papers and preliminary reports), 1921; Part II, Mineral fuels. 332 pages, 54 plates, 52 text figures.

The annual bulletin on investigations of mineral fuels. Contains papers on lignite in North Dakota and oil in Oklahoma, Utah, New Mexico, and Texas. These papers were published separately in advance.

BULLETIN 727. Potash in the Greensands of New Jersey, by G. R. Mansfield. 154 pages, 10 plates, 6 text figures.

Describes a belt of greensand marl extending across New Jersey from Sandy Hook to Delaware River. In this belt the greensands contain potash in the mineral glauconite. It is estimated that the quantity of potash that could be mined from the greensands by open-pit methods would be enough to supply the needs of the United States for nearly a thousand years at the rate of importation for the five years 1910–1914. If underground mining should become practicable the available quantity of potash would be enormously increased. The development of a potash industry based on these greensands depends on the ability of the manufacturers to compete with other producers of potash, both foreign and American.

BULLETIN 728. The occurrence and uses of peat in the United States, by E. K. Soper and C. C. Osbon. 217 pages, 18 plates, 32 text figures.

A report intended to show the method of formation, distribution, quantity, and quality of the peat found in the United States, to indicate the uses for which it is best suited, to point out the possibilities offered by

the commercial utilization of peat, and to serve as a guide for future investigations. Peat is used in the United States chiefly in agriculture, and this use probably offers greater possibilities in this country than in any other.

BULLETIN 729. Oil shale of the Rocky Mountain region, by Dean E. Winchester. 204 page, 18 plates, 4 text figures.

The racing world demand for oil is bringing nearer the time when the easily extractable petroleum must be supplemented by oil obtained from oil shale by heating. Immense deposits of oil shale occur in the Western States, and much has already been done toward placing the American oil-shale industry on a firm basis, but the industry is still in its early stages, and much more chemical and engineering research is needed to assure success. This bulletin presents the available information concerning the oil shale of the Rocky Mountain region, gives results of distillation tests and a brief description of shale oil, and contains a bibliography of about 1,000 books and articles on oil shale.

BULLETIN 730–C. The shapes of pebbles, papers by C. K. Wentworth. 24 pages, 2 plates, 17 text figures.

Two brief papers on studies undertaken in an attempt to establish criteria for distinguishing pebbles according to their origin and thus throwing light on their history.

BULLETIN 730–D. Physiographic provinces and sections in western Oklahoma and adjacent parts of Texas, by N. M. Fenneman. 34 pages, 3 plates, 2 text figures.

Describes a part of the interior plains of the United States, particularly an area just east of the High Plains.

BULLETIN 730. Contributions to the geography of the United States, 1922. 144 pages, 18 plates, 44 text figures.

The first volume of a new series to be published by the Geological Survey as papers become available. Contains five papers that were published separately in 1922 on the physiography of certain areas in Colorado, Arizona, Oklahoma, and Texas and on a study of the shapes of pebbles.

BULLETIN 731. Bibliography of North American geology for 1919–20, by J. M. Nickles. 284 pages.

Lists and indexes over 2,100 publications on the geology of North America, Panama, and Hawaii. A continuation of the series of bibliographies, which now cover the years 1732–1920.

BULLETIN 732. Geology and ore deposits of Shoshone County, Idaho, by J. B. Umpleby and E. L. Jones, jr. 162 pages, 16 plates, 8 text figures.

Shoshone County includes the famous Coeur d'Alene district, the most productive mining district in Idaho and one of the great lead-silver districts of the world. This district, which was described in Professional Paper 62, issued in 1908, has undergone rapid development in the last 15 years, and the present bulletin gives the results of an investigation that throws new light on the origin of the deposits and offers a better basis for intelligent exploration in adjacent areas.

BULLETIN 733. Geology of the York tin deposits, Alaska, by Edward Steidtmann and S. H. Cathcart. 136 pages, 12 plates, 23 text figures.

The York region is the source of nearly all the tin produced in the United States, which, although the world's leading consumer of tin, yields less than one-half of 1 per cent of the world's production. This report describes the deposits in detail and lays emphasis on the study of the origin of the lode deposits, with a view of aiding in the search for tin in this region.

BULLETIN 734. Deposits of manganese ore in the Batesville district, Ark., by H. D. Miser, with a chapter on the mining and preparation of the ores by W. R. Crane. 284 pages, 17 plates, 26 text figures.

Another contribution to the inventory of the country's manganese resources resulting from the increased demand and reduced foreign supply during the war. Preliminary reports on this district were published in 1918 and 1920, and the present bulletin gives in detail the information collected. The Batesville deposits have been worked at times since 1849.

BULLETIN 735–D. Silver enrichment in the San Juan Mountains, Colo., by E. S. Bastin. 65 pages, 19 text figures.

Report on part of a topical study of the enrichment of silver ores in many districts. Concludes that although some of the ores in the San Juan region owe their richness in silver to downward enrichment by percolating solutions, some of the primary ores are rich enough to be profitably mined.

As the primary ores extend to greater depth than the enriched ores, this conclusion offers encouragement to deep mining.

BULLETIN 735–E. Primary native silver ores near Wickenburg, Ariz., and their bearing on the genesis of the silver ores of Cobalt, Ontario, by E. S. Bastin. 25 pages, 14 text figures.

The silver ores of a mine near Wickenburg are of peculiar interest to economic geologists because their principal silver mineral—native silver—is primary, whereas most occurrences of native silver are unquestionably the products of downward enrichment. In some of their associations the Wickenburg ores resemble the famous silver ores of Cobalt, Ontario. This paper sets forth conclusions reached in regard to these ores in the course of a study of silver enrichment in many mining camps of the western United States. The results favor the hypothesis that the rich native silver ores of the Cobalt district are also primary.

BULLETIN 735–F. General features of the brown hematite ores of western North Carolina, by W. S. Bayley. 56 pages, 3 plates, 10 text figures.

The continuous production of brown iron ore in North Carolina during the last five years has attracted attention to the State as a possible source of supply when the demand for such ore becomes more pressing. This paper outlines the general conclusions derived from a study of the ores.

BULLETIN 735–G. General features of the magnetite ores of western North Carolina and eastern Tennessee, by W. S. Bayley. 66 pages, 6 text figures.

The magnetite deposits described have yielded about 1,500,000 tons of iron ore, and some of them were worked as early as 1802 to supply ore for use in Catalan forges. The paper contains maps of the magnetite areas and analyses of the ores.

BULLETIN 735–H. Peridotite dikes in Scott County, Ark., by H. D. Miser and C. S. Ross. 10 pages, 1 plate, 2 text figures.

Describes an occurrence of peridotite on which considerable money has been spent in prospecting and making analyses in the hope of finding diamonds or other minerals of value, but without success. The authors conclude that even if diamonds occur here they could not be recovered economically.

BULLETIN 735–I. Diamond-bearing peridotite in Pike County, Ark., by H. D. Miser and C. S. Ross. 48 pages, 8 plates, 3 text figures.

Describes an area in southwestern Arkansas in which several thousand diamonds have been produced since 1906. The diamonds are found in peridotite, an igneous rock that occurs in several forms, both intrusive and effusive. The paper includes a comparison of the Arkansas area with the diamond fields of South Africa.

BULLETIN 735–J. The Los Burros district, Monterey County, Calif., by J. M. Hill. 26 pages.

Notes on a small district that has produced about $90,000 worth of gold.

BULLETIN 736–B. Oil and gas prospects in and near the Crow Indian Reservation, Mont., by W. T. Thom, jr. 19 pages, 1 plate.

Report on an examination made to determine the prospect of obtaining oil and gas in the Crow Reservation. Concludes that although the structure in the parts of the reservation that have not yet been drilled does not warrant enthusiasm, nevertheless the reservation affords a much better chance to the wildcatter than many other areas in Montana.

BULLETIN 736–C. Geology of the Wiles area, Ranger district, Tex., by C. E. Dobbin. 15 pages, 2 plates, 5 text figures.

Describes an area of 36 square miles in the southeastern part of Stephens County, Tex., with special reference to the geologic features that are related to the occurrence of oil and gas.

BULLETIN 736–D. The Osage oil field, Weston County, Wyo., by A. J. Collier. 42 pages, 5 plates, 1 text figure, 1 insert.

High-grade oil in commercial quantities was discovered in the fall of 1919 near the flag station of Osage, Wyo., and within a year a town of 1,500 persons had grown up and $3,000,000 had been spent in developing the field. This report describes the field and concludes that although it will probably never be a great producer of oil, it will yield a moderate quantity for many years.

BULLETIN 736–E. Geology of the Ranger oil field, Tex., by Frank Reeves. 64 pages, 5 plates, 2 text figures.

Report on one of the most productive oil fields discovered in the United States during the last five years. Describes the geology of the region and the oil and gas development and gives recommendations for drilling.

BULLETIN 736–F. Possibility of finding oil in laccolithic domes south of the Little Rocky Mountains, Mont., by A. J. Collier and S. H. Cathcart. 8 pages, 2 text figures.

Describes the geology of a number of small areas where the rock beds have been arched upward into small domes that probably afford the most favorable conditions for the accumulation of oil within the general region where they occur.

BULLETIN 736–G. The Brooks, Steen, and Grand Saline salt domes, Smith and Van Zandt counties, Tex., by Sidney Powers and O. B. Hopkins. 65 pages, 4 plates, 2 text figures.

The known salt domes in the United States are confined to the Coastal Plain in Texas and Louisiana. This paper describes three domes in Texas and discusses the possibility of finding oil in them. Little is known of the nature of salt domes, and this paper is a contribution to their study.

BULLETIN 736–H. Stratigraphy of the El Dorado oil field, Ark., as determined by drill cuttings, by James Gilluly and K. C. Heald. 8 pages, 1 plate.

Report on a problem undertaken by the Geological Survey in order to facilitate development in the El Dorado field and furnish a guide to oil operators prospecting in surrounding territory.

BULLETIN 737. Manganese deposits of east Tennessee, by G. W. Stose and F. C. Schrader. 164 pages, 30 plates, 45 text figures.

Gives in detail the information obtained in a survey that was one of the projects undertaken in the country-wide investigation of sources of manganese during the World War. The work was done in cooperation with the Geological Survey of Tennessee. All the operating mines and nearly all the prospects and known deposits of manganese ore in the eastern part of the State were visited. Although the demand for manganese has decreased since the war, the facts here recorded form a useful addition to the inventory of the country's mineral wealth.

BULLETIN 738. The commercial granites of New England, by T. N. Dale. 504 pages, 34 plates, 96 text figures.

A revised and abridged combination of six bulletins by the same author on the granites of the several New England States, with considerable new information. The aim has been to present the subject in both its economic and its general scientific aspects and to make the scientific part intelligible to the general reader. The bulletin contains also statistics of production, a bibliography, and a glossary of technical terms.

BULLETIN 739–A. The Alaskan mining industry in 1921, by Alfred H. Brooks. 68 pages.

A summary showing that the mining industry was more prosperous in 1921 than in 1920, though owing to the low price of copper the value of the total mineral output showed a large decrease. The report gives statistics covering many years for most of the districts.

BULLETIN 739–B. Mineral deposits of the Wrangell district, southeastern Alaska, by A. F. Buddington. 25 pages, 1 plate, 4 text figures.

The only mineral deposits in the Wrangell district that have passed the prospecting stage yield gold and garnet, but numerous other minerals of possible economic value occur in the district. The deposits are described briefly in this report.

BULLETIN 739–C. Recent investigations of petroleum in Alaska; papers by S. R. Capps, F. H. Moffit, A. H. Brooks, and G. C. Martin. 69 pages, 2 plates, 4 text figures.

Contains papers on oil in the Cold Bay district of Alaska Peninsula and the Iniskin Bay district of Cook Inlet, a note on an oil seepage near Anchorage, and a paper on a supposed oil seepage in the Nenana coal field that is not derived from oil but is a tar distilled from burning coal beds.

BULLETIN 739–D. The occurrence of metalliferous deposits in the Yukon and Kuskokwim regions, Alaska, by J. B. Mertie, jr. 17 pages.

Presents in condensed form some generalizations and deductions regarding the distribution and occurrence of mineral deposits in interior Alaska, to serve primarily as a guide to the prospector.

BULLETIN 740. Mica deposits of the United States, by D. B. Sterrett. 354 pages, 29 plates, 96 text figures.

A compilation of the Geological Survey's available information on mica deposits in the United States. Gives a comprehensive review of the mica resources of the country and describes in detail many of the mines and prospects. Contains a short bibliography and sections on the geology and mineralogy of mica.

BULLETIN 741. The Jarbidge mining district, Nev., with a note on the Charleston district, by F. C. Schrader. 92 pages, 20 plates, 19 text figures.

Ore was discovered in the Jarbidge district in 1910, and the Geological Survey published a reconnaissance report on the district in 1912. The present report is supplemental to the earlier one and aims to bring it as nearly as possible up to date, containing much new material on the geology and ore deposits. The bulletin contains also a short description of the adjacent Charleston district.

BULLETIN 742. Chromite of Kenai Peninsula, Alaska, by A. C. Gill. 55 pages, 4 plates.

During the World War about 2,000 tons of chromite was mined at Claim Point, on Kenai Peninsula. This report describes the deposits at that place and at Red Mountain, 16 miles to the northeast.

BULLETIN 743. Geology of the Oatman gold district, Ariz., a preliminary report, by F. L. Ransome. 62 pages, 12 plates, 7 text figures.

The recent discovery of ore by diamond drilling in the Oatman district has led to renewed activity in prospecting and to a demand for information concerning the geology of the district. To meet this demand in some measure the present preliminary report has been prepared. The general features of the geology of the district and the occurrence of the ore deposits are set forth, and the author gives such practical conclusions as have so far been reached.

BULLETIN 745. The Kotsina-Kuskulana district, Alaska, by F. H. Moffit and J. B. Mertie, jr. 159 pages, 19 plates, 8 text figures.

The work of the Geological Survey in Alaska comprises, first, topographic and geologic reconnaissance surveys that determine the general distribution and geologic occurrence of mineral deposits, and, second, detailed investigations in areas where the deposits are of sufficient promise to justify the work. In areas of copper deposits it is particularly desirable to have full geologic information before installing the large plants that are necessary to mine and concentrate the ores. Reconnaissance surveys of the Kotsina-Chitina copper belt were completed about 20 years ago. The present report sets forth the results of a detailed examination of the area. It contains a complete analysis of the economic problems relating to the ore deposits and is a noteworthy contribution to knowledge of the geology.

BULLETIN 751–A. Continuity of some oil-bearing sands of Colorado and Wyoming, by W. T. Lee. 26 pages, 6 plates, 3 text figures.

Deals with the correlation of stratified rocks in the lower part of the Cretaceous system and its bearing on the discovery of oil and gas. Attempts to clarify the stratigraphic problems by showing the continuity of beds through areas where they have been known under different names.

WATER-SUPPLY PAPER 463. Surface water supply of the United States, 1917; Part XII, North Pacific drainage basins, B, Snake River basin; G. C. Baldwin, G. L. Parker, and F. F. Henshaw, district engineers. 168 pages, 2 plates.

One of the annual reports giving results of stream gaging.

WATER-SUPPLY PAPER 469. Surface waters of Wyoming and their utilization, by Robert Follansbee. 341 pages, 1 map.

Records of stream flow in Wyoming have been collected by the United States Geological Survey and the State engineer since 1894. These records have served as a basis for the development of irrigation and power and for the adjudication of water rights, and they are constantly becoming more valuable in connection with the utilization of the surface waters. The published records are scattered through Federal and State reports, many of which are out of print. Numerous other records given have never been published. This paper sets forth the essential facts regarding the surface-water supply and its use as a basis for investigation leading to the future development of the State's resources.

WATER-SUPPLY PAPER 473. Surface water supply of the United States, 1918, Part III, Ohio River basin; A. H. Horton and C. G. Paulsen, district engineers. 120 pages, 2 plates.

WATER-SUPPLY PAPER 478. Surface water supply of the United States, 1918, Part VIII, Western Gulf of Mexico basins; G. A. Gray and C. E. Ellsworth, district engineers. 106 pages, 2 plates.

WATER-SUPPLY PAPER 479. Surface water supply of the United States, 1918, Part IX, Colorado River basin; Robert Follansbee, C. C. Jacob, A. B. Purton, and C. E. Ellsworth, district engineers. 194 pages, 2 plates.

WATER-SUPPLY PAPER 480. Surface water supply of the United States, 1918, Part X, The Great Basin; C. C. Jacob, A. B. Purton, H. D. McGlashan, F. F. Henshaw, G. C. Baldwin, and Robert Follansbee, district engineers. 277 pages, 2 plates.

WATER-SUPPLY PAPER 482. Surface water supply of the United States, 1918, Part XII, North Pacific slope drainage basins; A, Pacific basins in Washington and upper Columbia River basin; G. L. Parker and W. A. Lamb, district engineers. 178 pages, 2 plates.

WATER-SUPPLY PAPER 483. Surface water supply of the United States, 1918, Part XII, North Pacific drainage basins; B, Snake River basin; G. C. Baldwin, G. L. Parker, A. B. Purton, and F. F. Henshaw, district engineers. 176 pages, 2 plates.

WATER-SUPPLY PAPER 484. Surface water supply of the United States, 1918, Part XII, North Pacific slope drainage basins; C, Lower Columbia River basin and Pacific slope drainage basins in Oregon; F. F. Henshaw and G. L. Parker, district engineers. 140 pages, 2 plates.

Seven of the annual reports giving results of stream gaging.

WATER-SUPPLY PAPER 486. Water powers of the Cascade Range, Part IV; Wenatchee and Entiat basins, by G. L. Parker and Lasley Lee. 80 pages, 9 plates, 3 text figures.

The fourth of a series of reports prepared under a cooperative agreement with the Washington State Board of Geological Survey. Describes an area in the central part of the State, on the east slope of the Cascade Range, in Chelan County. Gives analyses and summaries that indicate the power resources of the area and show the relative value of chosen sections of the river systems. Outlines a scheme of power projects that will be consistent with the highest ultimate development in the region.

WATER-SUPPLY PAPER 488. The floods in central Texas in September, 1921, by C. E. Ellsworth. 60 pages, 8 plates, 5 text figures.

Report on a series of floods that caused the loss of at least 224 lives and damage to property amounting to more than $10,000,000. Contains numerous diagrams and maps and gives a concise account of previous floods in this general area.

WATER-SUPPLY PAPER 490–C. Routes to desert watering places in the lower Gila region, Ariz., by C. P. Ross. 49 pages, 7 plates, 1 text figure.

WATER-SUPPLY PAPER 490–D. Routes to desert watering places in the Papago country, Ariz., by Kirk Bryan. 123 pages, 10 plates, 1 text figure.

The third and fourth in the series of "desert guides" for the southwestern region of the United States. Each contains three large relief maps showing roads and watering places, a general description of the region, suggestions for desert travel, detailed road logs, and an index of watering places.

WATER-SUPPLY PAPER 493. Hydroelectric power systems of California and their extensions into Oregon and Nevada, by F. H. Fowler. 1,326 pages, 73 plates, 50 text figures.

California was one of the first States to utilize hydroelectric energy, the first plant in the State having been put into operation more than 30 years ago. Since that time the installation of hydroeletric plants and the extension of long-distance transmission systems in California have kept well abreast of the best current practice in electrical engineering. The most important phases of this development have been described in numerous articles and technical works, but these are widely scattered, and the need of a comprehensive work on the existing developments has led to the compilation of the present volume. This book contains a vast amount of first-hand information on the history, markets, electric systems, finances, and rates of each of the operating hydroelectric companies in the State and shows the general conditions under which they have attained their present stage of development. It thus represents an economic as well as an engineering study.

WATER-SUPPLY PAPER 495. Geology and ground-water resources of Sacramento Valley, Calif., by Kirk Bryan. 297 pages, 19 plates, 10 text figures.

The Great Valley of California, of which Sacramento Valley forms the northern half, is comparable with the valleys of the Ganges and the Nile in fertility, climate, and character of drainage system but is much more sparsely populated. Its more intensive development depends primarily on water. Until recently the growing of wheat and barley by dry farming has been the chief agricultural industry, but immense land holdings are being

subdivided, irrigation systems are being constructed, and small farm units, intensive cultivation, and high-priced crops are transforming the agricultural life of the valley. This development involves the use of both surface water and ground water. The present paper sets forth the available information on the ground-water resources of the valley, gives notes on well and pumping problems, and discusses the several subdivisions of the valley in detail.

WATER-SUPPLY PAPER 496. The industrial utility of public water supplies in the United States, by W. D. Collins. 63 pages, 1 plate, 1 text figure.

The effects of mineral constituents on the value of water have a familiar illustration in the difficulty of using soap with water that is "hard." Such effects are troublesome in many industrial plants, such as commercial laundries, bleaching and dyeing works, and plants for the manufacture of soft drinks, food products, chemicals, and numerous other articles. Foaming, corrosion, and scale caused by the use of bad water in steam boilers necessitate large and continuous expenditures to prevent disaster. This paper gives analyses of water in public supplies at 287 places in the United States, each of which has a population of more than 25,000. These analyses were made by well-established methods and are undoubtedly accurate, and the samples were as representative as any that could be obtained. The paper also contains notes on the treatment of the water to improve its quality for industrial use.

WATER-SUPPLY PAPER 500. Contributions to the hydrology of the United States, 1921. 74 pages, 4 plates, 17 text figures.

Contains three papers on Coeur d'Alene Lake, Idaho, irrigation near Gage, Okla., and run-off in the Rocky Mountain region. These papers had been previously published separately.

WATER-SUPPLY PAPER 504. Surface water supply of the United States, 1919–20, Part IV, St. Lawrence River basin; W. G. Hoyt, C. C. Covert, and C. H. Pierce, district engineers. 192 pages, 2 plates.

WATER-SUPPLY PAPER 507. Surface water supply of the United States, 1919–20, Part VII, Lower Mississippi River basin; Robert Follansbee and R. C. Rice, district engineers. 52 pages, 2 plates.

WATER-SUPPLY PAPER 508. Surface water supply of the United States, 1919–20, Part VIII, Western Gulf of Mexico basins; C. E. Ellsworth, district engineer. 140 pages, 2 plates.

Three of the annual progress reports giving results of stream gaging.

MINERAL RESOURCES OF THE UNITED STATES, 1919; Part I, Metals. 964 pages, 5 plates, 10 text figures.

A consolidation of the chapters on the several metals issued separately at different dates between June, 1920, and January, 1922, with an introduction and general summary covering metals and nonmetals. The statistics reflect the reaction from intensive production for war purposes and the unsettled state of industry in general in 1919.

MINERAL RESOURCES OF THE UNITED STATES, 1919; Part II, Nonmetals. 569 pages, 23 text figures.

The annual statistical volume on nonmetallic mineral resources—a consolidation of chapters published separately at intervals between August, 1920, and April, 1922. Owing to the delay in obtaining some of the figures a few of the customary chapters are omitted, but the complete figures are to be given in later volumes.

MINERAL RESOURCES OF THE UNITED STATES, 1920. 6 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1921. 53 advance chapters.

MINERAL RESOURCES OF THE UNITED STATES, 1922. 4 advance chapters.

GEOLOGIC FOLIO 214. Raton-Brilliant-Koehler, N. Mex.-Colo., by W. T. Lee. 17 pages of folio text, 9 maps, 1 structure-section sheet, 1 sheet of coal sections, 12 plates, 21 text figures.

The three quadrangles described in this folio lie mainly in New Mexico. They constitute the central part of the coal-producing area known as the Raton Mesa region and are in the transitional zone between the typical Great Plains and the mountains. These quadrangles cover an area of 717 square miles, five-sixths of which lies within a single land grant and contains few roads or settlements. This folio describes the geography of the Great Plains province and treats the geology of the three quadrangles in detail. The principal economic resource of this area is coal, and the folio gives numerous graphic sections of coal beds and analyses to show the quality of the coal, which has a high heating value.

TOPOGRAPHIC AND OTHER MAPS as indicated below. (The maps marked * were also published with a green overprint showing woodland areas.)

Alaska.

Map of the Territory in four colors: Scale, 1 inch=39.5 miles. Size, 35½ by 51 inches.

New map on same scale as the Geological Survey's wall map of the United States, showing many special features, such as the boundaries of the judicial divisions (printed in red) and the Government railroad from Seward to Fairbanks, also parts of Yukon and British Columbia.

Arizona and Utah.

Plan and profile of Colorado River, Lees Ferry, Ariz., to mouth of Green River, Utah; San Juan River, mouth to Chinle Creek, Utah; and certain tributaries: Scale, 1 inch=½ mile; contour interval on land 20 feet, on river surface 5 feet; vertical scale of profiles, 1 inch=20 feet. Size, 21 by 27 inches. 22 sheets (16 plans, 6 profiles).

These sheets give the results of special surveys and investigations in Utah and Arizona, made in cooperation with the Southern California Edison Co., to ascertain the feasibility of storage and diversion of the waters of Colorado River. The plan sheets show the topography of a belt of country along Colorado River for 216 miles and along San Juan River for 133 miles, and the profile sheets show the slope of the stream.

California.

Academy: Scale, 1 inch=½ mile; contour interval, 5 and 25 feet. Latitude, 36° 52′ 30″ to 37°; longitude, 119° 30′ to 119° 37′ 30″.

Map of part of Fresno County, in the hilly zone between San Joaquin Valley and the foothills of the Sierra Nevada. The area contains little level land and is rather rugged in a small way. Its southwest corner lies in San Joaquin Valley at only 430 feet above sea level, but several hills in the northern part reach altitudes of 1,600 feet or more. The area is poorly watered and sparsely settled.

Biola: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 45′ to 36° 52′ 30″; longitude, 120° to 120° 7′ 30″.

Map of parts of Fresno and Madera counties, near the center of San Joaquin Valley. The area lies in an alluvial plain whose surface descends from 265 feet above sea level in the northeast corner to 210 feet in the southwest corner. San Joaquin River crosses its center in a sinuous trench one-eighth to one-fourth mile wide and 20 feet deep, lying within another trench half a mile wide and 25 feet deep. The area south of the river is irrigated by ditches, most of which follow low alluvial ridges built by distributaries of the river during floods.

Chaney Ranch: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 120° 30′ to 120° 37′ 30″.

Map of part of Fresno County, on the southwest side of San Joaquin Valley. Nearly all the area is a flat alluvial slope, which descends from 450 feet above sea level at the base of the foothills in the southwest corner to 265 feet in the northeast corner. Little Panoche Creek, from which some of the southwestern part of the area is irrigated, flows northeastward on an alluvial ridge that it has built up.

Dos Palos: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 52′ 30″ to 37°; longitude, 120° 37′ 30″ to 120° 45′.

Map of parts of Merced and Fresno counties, in the southwestern part of San Joaquin Valley. The southern two-thirds of the area is an alluvial apron 215 to 115 feet above sea level, merging into the flood plain of San Joaquin River at 105 to 115 feet in the northeastern part. The area contains no permanent streams but is crossed by two irrigation canals, from which ditches distribute water.

Firebaugh: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 45′ to 36° 52′ 30″; longitude, 120° 22′ 30″ to 120° 30′.

Map of an area in Fresno and Madera counties, near the middle of San Joaquin Valley. The northeastern part is in the flood plain of San Joaquin

River, 140 to 160 feet above sea level, and is traversed by the meandering trench, 15 to 20 feet deep, of the river and by flood channels, some of which are occupied by irrigation canals. The southeastern part is a gentle alluvial slope that rises from 150 feet above sea level near the river to 255 feet in the southwest corner and is almost wholly unsettled.

Fresno: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 119° 45′ to 119° 52′ 30″.

Map of part of Fresno County, in the eastern part of San Joaquin Valley, including in the northeast corner most of the city of Fresno. The surface has little relief and descends southwestward from 305 feet above sea level in the northeast corner to 245 feet in the southwest corner. Low alluvial ridges built by streams from the foothills traverse the northern half of the area. In the southern half a number of small ponds and playas are in shallow northwestward-trending depressions.

Friant: Scale, 1 inch=½ mile; contour interval, 5 and 25 feet. Latitude, 36° 52′ 30″ to 37°; longitude, 119° 37′ 30″ to 119° 45′.

Map of an area in Fresno and Madera counties, at the northeast margin of San Joaquin Valley. The southwestern part, 350 to 400 feet above sea level, is a broad alluvial apron at the base of the foothill country, which is rolling and rises in a few summits to 1,500 feet or more. San Joaquin River emerges from a canyon above Friant and flows in a flat-bottomed valley 150 feet below the general level of the alluvial apron.

Kearney Park: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 119° 52′ 30″ to 120°.

Map of part of Fresno County, in San Joaquin Valley between San Joaquin and Kings rivers. The nearly flat valley plain slopes from 265 feet above sea level in the northeast corner to 210 feet in the southwest corner. There are no permanent streams, but much of the area is traversed by irrigation ditches, and there are a few intermittent ponds.

Kerman: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 120° to 120° 7′ 30″.

Map of part of Fresno County, in San Joaquin Valley, a few miles south of the river. The surface slopes southwestward away from San Joaquin River and toward Kings River, from 240 feet above sea level in the northeast corner to 180 feet in the southwest corner. There are no permanent streams, but a few intermittent ponds lie in shallow depressions.

Little Panoche: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 45′ to 36° 52′ 30″; longitude, 120° 37′ 30″ to 120° 45′.

Map of part of Fresno County, in the southwestern part of San Joaquin Valley. The southwest corner lies on the slope of the Panoche Hills—foothills of the Diablo Range—at 1,000 feet above sea level. The general surface descends northeastward from about 650 feet at the base of the hills to 175 feet in the northeast corner. The area contains no permanent streams and is almost uninhabited.

Oil and gas fields of the State of California: Scale, 1 inch=8 miles.

The productive oil and gas fields, the main pipe lines, and the oil refineries are shown by distinctive colors and symbols.

Parks Bar: Scale 1 inch=½ mile; contour interval, 5 and 25 feet. Latitude, 39° 7′ 30″ to 39° 20′; longitude, 121° 7′ 30″ to 121° 22′ 30″.

Map of an area in Yuba and Nevada counties, mainly in the valley of Yuba River, near the point where it emerges from the foothills of the Sierra Nevada. Above The Narrows the river flows in a winding V-shaped gorge, 700 feet deep, between hills that stand 1,100 to 1,400 feet above sea level. Below The Narrows the valley is 100 to 300 feet deep with steep walls.

*Pozo: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 35° 15′ to 35° 30′; longitude, 120° 15′ to 120° 30′.

Map of part of San Luis Obispo County, in the heart of the Coast Ranges. The La Panza Range crosses the center of the area from northwest to southeast. Nearly the whole area is mountainous; the summits range from 1,700 feet above sea level in the northern part to 3,700 feet or more in the highest peaks of the La Panza Range. The main valleys are cut down to only 1,200 feet above sea level.

Pozo Farm: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 52′ 30″ to 37°; longitude, 120° 22′ 30″ to 120° 30′.

Map of an area in San Joaquin Valley in Madera and Fresno counties. The surface is extremely flat, the total difference of altitude being only 35 feet in the entire area of 60 square miles. San Joaquin River flows northwestward in a channel to which it is confined in some places by low levees, though in others it meanders slightly on a flood plain that is intersected by small channels and dotted with intermittent ponds.

*Preston Peak: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 41° 30′ to 42°; longitude, 123° 30′ to 124°.

Map of parts of Del Norte and Siskiyou counties, in the Klamath Mountains, which occupy the entire area. Many summits reach altitudes of 5,000 to 6,500 feet, and Preston Peak, in the northeastern part, stands 7,310 feet above sea level. The valleys of the main streams are several thousand feet deep, and Klamath River crosses the extreme southwest corner at an elevation of less than 100 feet above sea level.

Round Mountain: Scale, 1 inch=½ mile; contour interval, 5 and 25 feet, changing on the 550-foot contour. Latitude, 36° 45′ to 36° 52′ 30″; longitude, 119° 30′ to 119° 37′ 30″.

Map of an area in Fresno County, on the northeast side of the San Joaquin Valley. The greater part is occupied by an upland, whose sloping surface is rather rough on a small scale, rising from 350 feet above sea level in the southwest corner to 500 feet in the northeast corner. Along the east side many small knobs and a few larger buttes rise 100 to 400 feet above the upland.

Sanger: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 119° 30′ to 119° 37′ 30″.

Map of part of Fresno County, in the eastern part of San Joaquin Valley, whose general surface descends from 410 feet above sea level in the northeast corner to 315 feet in the southwest corner. It is crossed by low, irregular southwestward-trending alluvial ridges, built by flood distributaries of Kings River, which enters the eastern part in a great bend and flows in a shallow trench in a flood plain 2 miles wide, bounded by an irregularly cuspate scarp 25 feet high.

*Sawyers Bar: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 41° to 41° 30′; longitude, 120° to 120° 30′.

Map of parts of Siskiyou, Trinity, and Humboldt counties, in the Salmon Mountains, which occupy the entire area and reach altitudes of 7,000 to 8,000 feet above sea level. Thompson Peak, near the southeast corner, stands 8,936 feet above sea level. The main valleys are 4,000 feet or more deep, and Klamath River just enters the western margin at an altitude of only 500 feet above sea level.

* Seiad: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 41° 30′ to 42°; longitude, 123° to 123° 30′.

Map of part of Siskiyou County, in the Klamath Mountains, which occupy the entire area. Many summits reach altitudes of 6,000 to 7,500 feet, and Red Mountain, in the southeastern part, stands 8,317 feet above sea level. Klamath River flows in a tortuous gorge 2,000 to 4,000 feet deep. The Salmon Mountains, in the southern part, bear traces of former glaciation, especially a number of small lakes in cirques.

Tufts Ranch: Scale, 1 inch=½ mile; contour interval, 5 feet. Latitude, 36° 37′ 30″ to 36° 45′; longitude, 120° 22′ 30″ to 120° 30′.

Map of an area in Fresno County, in the southwestern part of San Joaquin Valley. The whole area lies on a flat alluvial slope that descends from 340 feet above sea level in the southwest corner to 175 feet in the northeast corner.

Colorado.

*Conejos: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 37° to 37° 30′; longitude, 106° to 106° 30′.

Map of parts of Conejos, Rio Grande, Alamosa, and Archuleta counties, mainly in the eastern foothills of the San Juan Mountains. The western part is a mountainous plateau that stands 11,000 to 12,000 feet above sea level and is trenched by the canyons of Conejos River and Alamosa Creek, which are cut down below 9,000 feet. East of the mountains the surface falls abruptly to San Luis Valley, 7,500 feet above sea level. Where the streams emerge into the valley they split into distributaries and are tapped by irrigation canals.

Paradox Valley: Scale, 1 inch=2 miles, contour interval, 100 feet. Latitude, 38° to 38° 30′; longitude, 108° 30′ to 109°.

Map of parts of Montrose and San Miguel counties, mainly in the San Miguel Plateau. The general surface, which lies 5,700 to 7,000 feet above sea level, includes mesas whose flat summits are 7,000 feet or more above sea level; broad, shallow basins whose surface slopes gently from all sides toward the center; canoe-shaped valleys with steep walls facing inward; and ridges with steep slopes toward the valleys and gentle slopes toward the basins. Some peaks reach altitudes of 8,000 feet. The northeast corner lies on the Uncompahgre Plateau at altitudes of 8,800 to 9,800 feet. Dolores River crosses the area in a highly meandering course, flowing on a flood plain across the valleys and in a canyon 500 to 1,300 feet deep through the mesas and ridges.

State map: Scale, 1 inch=8 miles.

Base map of the State of Colorado in two colors. It shows county and township boundaries, location and names of all towns, most of even the smaller settlements, and the railroads (in black), also the rivers and many of the smaller streams and water features (in blue).

Connecticut.

[See Massachusetts, Rhode Island, and Connecticut.]

District of Columbia.

[See Maryland, Virginia, and the District of Columbia.]

Georgia.

Harlem: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 33° 15′ to 33° 30′; longitude, 82° 15′ to 82° 30′.

Map of an area in McDuffie, Columbia, Jefferson, Richmond, Warren, Glascock, and Burke counties, at the inner margin of the Coastal Plain and partly on the Piedmont Upland. The general upland surface descends from nearly 600 feet above sea level in the northwest corner to 400 feet in the southeast corner.

Illinois.

[See also Wisconsin and Illinois.]

* Barrington: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° to 42° 15′; longitude, 88° to 88° 15′.

Map of parts of Cook, Lake, McHenry, and Kane counties, in the Lake Plains. The general altitude is between 700 and 900 feet above sea level. Nearly the whole area is occupied by a morainal belt of Wisconsin drift, consisting of an intricate assemblage of knolls and ridges, undrained hollows, and small formless valleys. Most of the surface is poorly drained, many of the hollows being occupied by small ponds or swamps, but Fox River crosses the northwest corner.

* Carbondale: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 37° 30′ to 37° 45′; longitude, 89° to 89° 15′.

Map of parts of Williamson, Union, Jackson, and Johnson counties. The northern part, which lies in the Prairie Plains, is a rolling plain 400 to 460 feet above sea level, cut by broad, shallow valleys 50 feet deep. The central and southern part, lying in the northern part of the Shawneetown Hills, is moderately hilly, the summits standing 600 to 860 feet above sea level. The streams in the southern part are unobstructed and are rapidly eating their way into the divide, but the larger streams in the northern part flow in crooked courses on the silt that fills their valleys.

* Joliet: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 41° 30′ to 41° 45′; longitude, 88° to 88° 15′.

Map of part of Will, Du Page, and Cook counties, in the northeastern part of the State. The general surface slopes gently from 790 feet above sea level in the northeast corner to 640 feet in the southwest corner and is crossed by several old glacial drainage channels 50 feet deep, with flat, somewhat marshy bottoms. Des Plaines River flows in the largest of these valleys, which is also traversed by the Chicago Drainage Canal, the Illinois and Michigan Canal, and several railroads. The eastern side of the area is occupied by hills left by the glaciers, and the western part is mainly a gently rolling plain.

Iowa.

* Fort Dodge: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 30′ to 42° 45′; longitude, 94° to 94° 15′.

Map of parts of Webster and Humboldt counties, in the north-central part of the State. The greater part is a rolling prairie country that lies about 1,150 feet above sea level and is traversed by a few shallow valleys, in many of which the streams have been confined to artificial channels. Des Moines River flows southward across the western part in a sinuous trench 100 feet deep and half a mile wide, bordered in part by bluffs and in part by slopes on which one or two faint terraces are developed.

* Lehigh: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 15′ to 42° 30′; longitude, 94° to 94° 15′.

Map of an area in Webster County, in the north-central part of the State. Most of the area lies on a rolling prairie upland that stands 1,080 to 1,180 feet above sea level. Des Moines River flows southeastward across the northern part in a meandering trench 150 feet deep, whose steep walls are furrowed by gullies. The tributaries descend to the river through similar steep-walled trenches, some of which extend back 2 or 3 miles. Much of the upland surface is so nearly level that the natural drainage is poor. This condition has been improved by ditching, which has produced the angular courses of many of the small streams.

Kansas.

State map: Scale, 1 inch=16 miles. Base map of Kansas, printed in black only. Similar to base map of Colorado. (See p. 18.)

Kentucky.

Electric generating stations and transmission lines used in public service in the State of Kentucky in 1921: Scale, 1 inch=8 miles.

The hydroelectric generating stations, the fuel-consuming generating stations, the stations combining these two sources of power, the substations, the switching stations, the distributing companies, and the primary transmission lines are shown by distinctive symbols, printed in red, on the United States Geological Survey's base map of Kentucky.

Oil and gas fields of the State of Kentucky: Scale, 1 inch=8 miles. Similar to map of California. (See p. 16.)

Maine.

* Brassua Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 45° 30′ to 45° 45′; longitude, 69° 45′ to 70°.

Map of parts of Somerset and Piscataquis counties, in the Moosehead Plateau, whose general surface stands 1,300 feet above sea level but is cut by valleys 100 to 200 feet deep. Misery Ridge, which crosses the southern part from northeast to southwest, reaches an altitude of 2,047 feet, and the summit of Squaw Mountain, in the southeast corner, 2,720 feet. Brassua Lake lies near the center, and a part of Moosehead Lake occupies the northeast corner. The two outlets of Moosehead Lake enter from the east and unite in Indian Pond, which drains southward through Kennebec River.

Lafayette National Park: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 13′ to 44° 30′; longitude, 68° 09′ to 68° 28′.

Map of an area in Hancock County, comprising parts of the Mount Desert, Bar Harbor, and Swan Island quadrangles and including the whole of Mount Desert Island and a number of surrounding islands and a part of the neighboring mainland. Shows the position and outline of the new Lafayette National Park. The most conspicuous topographic feature is the mountain range of Mount Desert Island, several summits of which stand more than 1,000 feet above sea level and the highest (Mount Cadillac) reaches 1,532 feet. The range is crossed by deep gorges holding lakes and by the deep cleft of Somes Sound. On the back of the map is printed an outline description and explanation of the geology of the island.

* Moosehead Lake: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 45° 30′ to 45° 45′; longitude, 69° 30′ to 69° 45′.

Map of an area in Piscataquis and Somerset counties, on the Moosehead Plateau, including the south-central part of Moosehead Lake. The lake, whose surface lies 1,028 feet above sea level, occupies a very irregular hollow in a rugged plateau that stands 1,150 feet above sea level. Above this plateau rise low mountains, the best known of which (Mount Kineo, 1,806 feet) forms a peninsula projecting into the lake from the eastern shore. The southwest corner lies on the northeastern slope of Squaw Mountain at an altitude of 2,700 feet. The lake is dotted with many islands, the largest of which are semimountainous, Sugar Island rising nearly 500 feet above the water surface.

State map: Scale 1 inch=16 miles.

Base map of Maine, printed in black. Similar to base map of Colorado. (See p. 18.)

Maryland and Virginia.

Rockville (new edition): Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° to 39° 15′; longitude, 77° to 77° 15′.

Map of part of Montgomery and Howard counties, Md., and Fairfax County, Va., in the Piedmont Upland just north of Washington. The upland surface slopes southeastward from 720 feet above sea level in the northwest corner of the area to 340 feet in the southeast corner, and is cut by flaring valleys about 200 feet deep. A part of the gorge of Potomac River above Great Falls is shown in the southwest corner.

Maryland, Virginia, and the District of Columbia.

Washington and vicinity (road map): Scale, 1 inch=4 miles. Latitude, 38° 30′ to 39° 30′; longitude, 76° 3′ to 77° 30′.

Shaded relief map of part of Maryland and Virginia, with the District of Columbia near the center of the area. Baltimore is near the northeast corner of the area, Annapolis on the eastern margin, and Frederick in the northwest corner. On the south the area extends just beyond Quantico, Va., and La Plata, Md. The main through roads and other improved roads are shown by red overprint, and the quality of the roads is indicated. On the back of the sheet is an interesting description of the country around Washington, in which the chief features of geographic, geologic, and historic interest are briefly considered.

Massachusetts, Rhode Island, and Connecticut.

State map: Scale, 1 inch=16 miles.

Base map, printed in black. Similar to base map of Colorado. (See p. 18.)

Michigan.

*Durand: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 45′ to 43°; longitude, 83° 45′ to 84°.

Map of an area in Genesee, Shiwassee, and Livingston counties, on the Thumb Upland. The general surface slopes from about 900 feet above sea level in the southeast corner to 750 feet in the northwest corner and is broken by irregular morainal ridges and hills, some of which stand 100 feet above the general surface. The Flint moraine crosses the northern part, and several less distinct and partly coalescent moraines cross the southern part. A number of swamps and ponds in the southeast corner occupy ice-block holes in the Portland moraine.

* Flint: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 43° to 43° 15′; longitude, 83° 30′ to 83° 45′.

Map of parts of Genesee, Tuscola, and Saginaw counties, on the northwestern slopes of the Thumb Upland, whose general surface slopes gently from 850 feet above sea level in the southeast corner to 650 feet in the northwest corner. There are several morainal belts made up of knolls 10 to 80 feet high, among which there are small undrained hollows containing ponds and bogs. Flint River and other streams flow in trenches 30 to 60 feet deep.

* Holly: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° 45′ to 43°; longitude, 83° 30′ to 83° 45′.

Map of parts of Genesee, Oakland, and Livingston counties, on the northwestern slope of the Thumb Upland, whose general surface slopes from 1,050 feet above sea level in the southeast corner to 800 feet in the northwest corner. The area is crossed by morainal belts, which include many knolls that stand 100 to 200 feet above the general level, interspersed with broad, flat areas and hollows, many of which are swampy or contain ponds.

* Schoolcraft: Scale, 1 inch=1 mile; contour interval, 10 feet. Latitude, 42° to 42° 15′; longitude, 85° 30′ to 85° 45′.

Map of parts of Kalamazoo and St. Joseph counties, near the western margin of the Thumb Upland, whose general surface there lies 850 to 900 feet above sea level. In the western part are several morainal belts consisting of groups of knolls 10 to 60 feet high, among which are small ponds and undrained hollows. The rest of the area is a poorly drained rolling plain. Numerous shallow depressions hold small lakes, some of which have no surface outlets.

Mississippi.

* Meridian: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 32° 15′ to 32° 30′; longitude, 88° 30′ to 88° 45′.

Map of part of Lauderdale County, in the Coastal Plain near the eastern boundary of the State. The general surface stands 500 to 550 feet above sea level and is cut by irregular valleys 100 feet deep with flat bottoms half a mile to a mile wide. In the southeastern part an irregular belt of low hills reaches altitudes of more than 600 feet. The upland is so much cut by ravines and small valleys that there is little level land except in the flat valley bottoms.

Missouri.

* Chillicothe: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45′ to 40°; longitude, 93° 30′ to 93° 45′.

Map of parts of Livingston and Grundy counties, near the southern margin of the Dissected Till Plains. The general upland surface lies 900 to 960 feet above sea level and is much cut by ravines and small valleys, which descend to the broad flat-bottomed valleys of Grand and Thompson rivers. The flood plains of these rivers lie 680 to 720 feet above sea level and contain numerous cut-off meanders and small oxbow lakes.

* Gallatin: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 30° 45′ to 40°; longitude, 93° 45′ to 94°.

Map of parts of Daviess, Caldwell, Livingston, and Grundy counties, in the southwestern part of the Prairie Plains. The generally rolling surface lies between 750 and 1,000 feet above sea level and is crossed by the broad alluvial valley of Grand River, a stream that meanders irregularly on a flood plain in which there are several oxbow lakes.

Nevada.

State map: Scale, 1 inch=8 miles.

Base map of Nevada, in one color (black). Similar to base map of Colorado. (See p. 18.)

New Hampshire and Vermont.

State map: Scale, 1 inch=16 miles.

Base map of New Hampshire and Vermont, printed in black. Similar to base map of Colorado. (See p. 18.)

New Mexico.

State map: Scale, 1 inch=8 miles.

Base map of New Mexico, in two colors. Similar to base map of Colorado. (See p. 18.)

Tyrone district: Scale, 1:24,000 or 1 inch=2,000 feet; contour interval, 25 feet.

Map of small area in Grant County lying between the Little Burro Mountains on the northeast and the Big Burro Mountains on the southwest. The Continental Divide crosses as a rather inconspicuous ridge from one mountain group to the other. The area is mainly hilly and ranges in altitude from 5,700 feet above sea level in the gulches to 8,000 feet at the summit of the Big Burro Mountains. The Tyrone mining district is situated in the northeastern part.

New York.

* Childwold: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 15′ to 44° 30′; longitude, 74° 30′ to 74° 45′.

Map of part of St. Lawrence and Franklin counties, in the northwestern Adirondacks. The general surface, which lies 1,600 feet above sea level, is cut by shallow valleys and interrupted by low, rocky hills. Mount Matumbla, in the southeast corner, stands 2,700 feet above sea level. The area has been heavily glaciated and is poorly drained, much of the surface being swampy and dotted with ponds.

* Livingston Manor: Scale, 1 inch=1 mile; contour level, 20 feet. Latitude, 41° 45′ to 42°; longitude, 74° 45′ to 75°.

Map of parts of Sullivan and Delaware counties, in the southern part of the Catskill Plateau, whose general surface stands 2,100 feet above sea level but is so much cut by deep valleys that it is scarcely recognizable. The northeastern part is occupied by the foothills of the Catskill Mountains, and the summit of Rattle Hill, near the northeast corner, is 2,600 feet above sea level. Ponds and small swamps occupy hollows in the upland surface, and there is little level land outside of narrow strips of flood plain in the main valleys, which are 500 feet or more deep and have generally steep sides.

* Stark: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 44° 15′ to 44° 30′; longitude, 74° 45′ to 75°.

Map of part of St. Lawrence County, in the northwestern part of the Adirondack Plateau, whose general surface stands 1,500 to 1,600 feet above sea level in the southeast corner and descends to 1,100 feet in the northwest corner. Numerous small mountains rise a few hundred feet above the plateau, and the summit of Baldface Mountain reaches an altitude of 1,860 feet. There are few well-defined valleys, but the streams wander about between the hills, and much of the low ground is occupied by swamps and small ponds.

* White Lake: Scale, 1 inch=1 mile: contour interval, 20 feet. Latitude, 41° 30′ to 41° 45′; longitude, 74° 45′ to 75°.

Map of part of Sullivan County, in the Allegheny Plateau, whose general surface lies 1,300 to 1,500 feet above sea level and is cut by valleys 300 to 500 feet deep. Delaware River crosses the extreme southwest corner in a trench 600 feet deep. The rather rough upland surface is not well drained, and the hollows are occupied by numerous swamps and ponds.

New York and Pennsylvania.

* Damascus: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° 30′ to 41° 45′; longitude, 75° to 75° 15′.

Map of parts of Wayne and Pike counties, Pa., and Sullivan County, N. Y., in the Pocono Plateau, whose general upland surface descends from 1,800 feet above sea level in the northwestern part to 1,200 feet in the southeastern part. Delaware River flows southward across the eastern part in a sinuous trench 400 to 600 feet deep. Small lakes and swamps occupy many of the hollows in the surface of the upland.

* Long Eddy: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° 45′ to 42°; longitude 75° to 75° 15′.

Map of parts of Delaware and Sullivan counties, N. Y., and Wayne County, Pa., in the Pocono Plateau, whose general upland surface stands 1,600 to 1,800 feet above sea level. The northern part is occupied by hills whose summits stand 2,200 to 2,300 feet above sea level and which are outliers of the Catskill Plateau. Delaware River flows southeastward in a meandering trench 800 to 1,000 feet deep, and the East Branch of the Delaware flows southwestward across the northwest corner in a similar but somewhat deeper trench.

North Dakota.

* Garrison: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 47° 30′ to 47° 45′; longitude, 101° 15′ to 101° 30′.

Map of an area in McLean and Mercer counties, in the Missouri Plateau section of the Great Plains. The general surface of the plateau lies between 1,800 and 2,000 feet above sea level and is dissected by a few small valleys 100 to 200 feet deep. The northeastern part is occupied by a glacial moraine, in the hollows of which are many small ponds, most of them intermittent. Missouri River crosses the southwest corner in a sweeping curve, flowing in a valley 2 miles wide, with bluffs where the river flows close to the valley walls.

Ohio.

Shaded relief map of the State: Scale, 1 inch=6 miles. Size, 39½ by 43 inches.

The relief shading brings out well the general topographic character of the different parts of the State and the major differences in their topography. The larger physiographic divisions, especially the Allegheny Plateau and the Erie Plain, are easily distinguishable.

Oregon.

Elmira: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 44° to 44° 15′; longitude, 123° 15′ to 123° 30′.

Preliminary map of a partly surveyed area in Lane County, at the southwestern margin of the Willamette Valley. Only the east side of the quadrangle, lying in the valley at 300 to 400 feet above sea level, has been surveyed. The most prominent features of the district are several buttes, of which the largest (Richardson Butte) stands 812 feet above sea level.

* Monroe: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 44° 15′ to 44° 30′; longitude, 123° 15′ to 123° 30′.

Incomplete map of parts of Benton and Lane counties, on the west side of the Willamette Valley, whose nearly level surface here is 250 to 300 feet above sea level and is traversed by several abandoned channels of Long Tom River, some of them containing oxbow lakes.

Pennsylvania.

[See also New York and Pennsylvania.]

*Altoona: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 30′ to 40° 45′; longitude, 78° 15′ to 78° 30′.

Map of an area in Blair, Cambria, Clearfield, and Center counties, partly in the Allegheny Plateau and partly in the Appalachian Ranges, the two physiographic provinces being separated by the bold escarpment of the Allegheny Front, which crosses from southwest to northeast. The Allegheny Front is crowned by an irregular ridge—the Allegheny Mountains—whose chief summits stand 2,500 to 2,600 feet above sea level. Northwest of this ridge the upland surface ranges from 1,800 to 2,400 feet above sea level and is cut by valleys 500 to 1,000 feet deep. Southeast of the ridge the surface descends abruptly to a much dissected shelf, 1,700 to 1,800 feet above sea level, and then gradually to the valley of Little Juniata River, 900 to 1,000 feet above sea level. Southeast of this valley it rises again to 2,500 feet in the zigzag range of Brush Mountain, in the southeastern part. The city of Altoona is in the valley of Little Juniata River, which is also traversed by the main line of the Pennsylvania Railroad. The principal State highways across the quadrangle are distinguished by a red overprint.

* Confluence: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45′ to 40°; longitude, 79° 15′ to 79° 30′.

Map of an area in Somerset and Fayette counties, near the eastern side of the Allegheny Plateau, which is much cut by valleys, some of them more than 1,000 feet deep, so that little of the original plateau surface remains. The area is crossed diagonally near its center by Laurel Hill, whose chief summits stand 500 feet above the plateau, and the highest point in the quadrangle, on Boardman Ridge, in the southeast corner, is 3,000 feet above sea level. At Confluence, in the southern part, Youghiogheny River is joined by Casselman River and Laurel Hill Creek.

* Donegal: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° to 40° 15′; longitude, 79° 15′ to 79° 30′.

Map of an area in Westmoreland, Fayette, and Somerset counties, near the east side of the Allegheny Plateau. The western part is crossed from north to south by Chestnut Ridge, whose chief summits stand 2,200 to 2,400 feet above sea level, and the southeast corner is crossed by Laurel Ridge, whose chief summits stand more than 2,900 feet above sea level.

* Hanover: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 39° 45′ to 40°; longitude, 76° 45′ to 77°.

Map of parts of York and Adams counties, in the Piedmont Upland. The general upland surface of the southeastern half lies 700 to 800 feet above sea level, is cut by valleys 100 to 200 feet deep, and is traversed by interrupted ridges 100 feet higher. The central part is crossed by a valley 1 to 3 miles wide whose general surface lies 400 to 600 feet above sea level. Northwest of the valley are the Pigeon Hills, whose chief summit, 1,220 feet above sea level, is one of the highest points of the Piedmont Upland in Pennsylvania. The northwestern part lies in the rolling Gettysburg Plain, 500 to 600 feet above sea level. The Lincoln Highway crosses the northern part of the area, as shown by red overprint.

* Lock Haven: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15; longitude, 77° 15′ to 77° 30′.

Map of parts of Clinton, Lycoming, and Center counties, mainly in the Appalachian Ranges. The northwest corner lies on the Allegheny Plateau, whose surface stands about 1,900 feet above sea level and is deeply cut by southeastward-descending ravines. Southeast of the plateau is Bald Eagle Valley, the northwestern part of which is occupied by a shelf, 2 to 3 miles wide, whose very irregular surface lies 1,000 to 1,200 feet above sea level. The southeastern part of the valley is the trench of Bald Eagle Creek and the West Branch of Susquehanna River and has a flat bottom a mile or so wide and 550 feet above sea level. The southern half is occupied by interlocking mountain ranges. Some of the valleys are broad and canoe-shaped; others are narrow and linear. The crests of the chief ranges stand 1,900 to 2,000 feet above sea level, and the highest point of Big Mountain reaches 2,300 feet.

*New Florence: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 15′ to 40° 30′; longitude, 79° to 79° 15′.

Map of parts of Westmoreland, Indiana, Cambria, and Somerset counties, near the eastern margin of the Allegheny Plateau, whose general surface stands 1,400 to 1,600 feet above sea level and is crossed by Laurel Hill and Chestnut Ridge, which stand 1,000 to 1,200 feet above the plateau. Conemaugh River and Blacklick Creek flow westward in trenches 400 to 1,100 feet deep and cut through Chestnut Ridge in deep V-shaped gorges. The gorge of Conemaugh River is followed by the Pennsylvania Railroad between Johnstown and Blairsville intersection.

*Philipsburg: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 40° 45′ to 41°; longitude, 78° to 78° 15′.

Map of parts of Center and Clearfield counties, mainly in the eastern margin of the Allegheny Plateau, whose general surface is 1,700 to 2,100 feet above sea level and across which Moshannon Creek flows northeastward in a tortuous trench 200 to 500 feet deep. The plateau is bounded on the southeast by the ridge of the Allegheny Mountains, whose chief summits stand 2,200 to 2,400 feet above sea level. Southeast of the mountains the surface descends abruptly about 1,000 feet to Bald Eagle Valley, along which Bald Eagle Creek flows in a trench 100 feet deep and southeast of which the nearly straight ridge of Bald Eagle Mountain rises to 1,800 feet.

* Pocono: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15′; longitude, 75° 15′ to 75° 30′.

Map of parts of Monroe, Wayne, and Pike counties, in the Pocono Plateau. The northwestern half is on the plateau, whose surface lies generally 2,000 feet above sea level and is broken here and there by low swells and knobs but rises to 2,236 feet on Hardwood Ridge, at the northern margin. There are no deep valleys, and the depressions of the surface are nearly all occupied by swamps or ponds. The southeastern half is on the irregular escarpment by which the surface descends abruptly from the level of the plateau to less than 800 feet in the southeast corner. Two steam railroads climb the escarpment but follow devious courses to make the ascent. The terminal moraine of the Wisconsin drift crosses the southern

part; it is poorly developed where it ascends the escarpment but forms a ridge nearly 100 feet high across the plateau.

* Williamsport: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 41° to 41° 15′; longitude, 77° to 77° 15′.

Map of parts of Lycoming, Union, Clinton, and Center counties, in the Appalachian Ranges. The West Branch of Susquehanna River crosses the northern part in a flat-bottomed valley a mile or so wide and 520 feet above sea level. Most of the area is occupied by zigzag mountain ranges, separated partly by broad, canoe-shaped valleys and partly by narrow, linear valleys. The crests of the main ranges stand 1,800 to 2,000 feet above sea level, and the crest of South White Deer Range reaches 2,140 feet in one place.

Rhode Island.

[See Massachusetts, Rhode Island, and Connecticut.]

Texas.

*Altuda: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° 15′ to 30° 30′; longitude, 103° 15′ to 103° 30′.

Map of part of Brewster County, at the northeastern margin of the Mexican Highland. The Glass Mountains, whose chief summits stand 6,000 to 6,500 feet above sea level, occupy the central and eastern parts, and the Del Norte Mountains extend into the southwest corner. The rest of the area is occupied by broad slopes that descend from 4,700 feet above sea level at the foot of the mountains to 4,000 feet or less in the main valleys, which are drained by intermittent streams.

*Armstrong: Scale, 1 inch=1 mile; contour interval, 5 feet. Latitude, 26° 45′ to 27°; longitude, 97° 45′ to 98°.

Map of parts of Kennedy, Brooks, and Hidalgo counties, in the Coastal Plain. The area is a nearly flat plain which descends very gently from 64 feet above sea level in the northwest corner to 15 feet above sea level near the southeast corner. Its surface is pitted by small, irregular depressions, 5 to 10 feet deep, many of which contain intermittent ponds. Knolls 15 to 25 feet high stand here and there, and in the eastern part are several areas of sand dunes. All the surface forms seem to be due to the work of the wind. The area contains no streams.

Barnhart: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 31° to 31° 15′; longitude, 101° to 101° 15′.

Map of an area in Irion and Crockett counties, on the northeastern margin of the Edwards Plateau. The southwestern part lies on the plateau, at an altitude of 2,600 to 2,700 feet, and several outliers stand at the same altitude in the northern part. The remainder is occupied by the broadly flaring, nearly flat-bottomed valleys, 200 to 300 feet deep, of several intermittent streams that flow to the Middle Fork of Concho River.

Big Lake: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 31° to 31° 15′; longitude, 101° 15′ to 101° 30′.

Map of parts of Reagan, Crockett, and Irion counties, in the Edwards Plateau, on the divide between Colorado River and the Rio Grande. The general surface of the plateau stands a little more than 2,700 feet above sea level and is cut by broad, shallow valleys 100 to 200 feet deep. The main divide, which is on the flattest part of the plateau, is in places poorly defined. Big Lake, a shallow temporary lake near the west side, has no outlet.

Fort Stockton: Scale, 1 inch=1 mile; contour interval, 25 feet. Latitude, 30° 45′ to 31°; longitude, 102° 45′ to 103°.

Map of part of Pecos County, nearly on the divide between Pecos River and the Rio Grande. The general surface is a rolling plain, descending from 3,300 feet above sea level in the southwest corner to 2,700 feet in the northeast corner. Several small mesas with precipitous sides stand 150 to 200 feet above the plain, and the summit of Twelvemile Mesa, in the southwest corner, is 3,722 feet above sea level.

* Hess Canyon: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 30° 15′ to 30° 30′; longitude, 103° to 103° 15′.

Map of part of Brewster and Pecos counties, in the trans-Pecos country. The northern half is occupied by the Glass Mountains, whose chief summits stand 5,800 feet or more above sea level. The southern half is occupied mainly by a sloping plain, whose surface descends from about 4,500 feet

above sea level at the base of the mountains to 4,150 feet near the margin of the area. In the southeastern part several irregular ridges stand 200 to 500 feet above the plain.

State of Texas. Scale, 1 inch=8 miles.

Base map of Texas, in four sheets, printed in two colors. Similar to base map of Colorado. (See p. 18.)

United States.

Oil and gas field of the United States: Scale, 1 inch=40 miles.

A revised edition of the map showing the oil and gas fields of the United States. The map shows by distinctive colors and symbols the oil and gas fields, the areas that have produced some oil and gas, the trunk pipe lines, and the refineries.

Utah.

[See also Arizona and Utah.]

Profile map of Weber River above Coalville and of East Canyon Creek from mouth to Taylor Creek, Utah. Six sheets.

Profile map of Provo River from Utah County line to Charleston and above Heber; North Fork of Provo River; Diamond Creek above Spanish Fork; American Fork; and Hobble, Sixth Water, Payson, Santaquin, and Salt creeks, Utah. Ten sheets.

Profile map of Cottonwood, Little Cottonwood, and Mill creeks, tributary to Jordan River, Utah. Four sheets.

State map: Scale, 1 inch=8 miles.

Base map of the State of Utah in one color (black). Similar to base map of Colorado. (See p. 18.)

Vermont.

[See New Hampshire and Vermont.]

Virginia.

[See also Maryland and Virginia; Maryland, Virginia, and the District of Columbia; West Virginia and Virginia.]

*Chatham: Scale 1 inch=1 mile; contour interval, 20 feet. Latitude, 36° 45′ to 37°; longitude, 79° 15′ to 79° 30′.

Map of part of Pittsylvania County, in the Piedmont Upland, whose general surface is 600 to 800 feet above sea level and is crossed by several northeastward-trending ridges that stand 200 to 400 feet higher. The surface is intricately cut by ravines and small valleys, some of which are 200 to 300 feet deep. The area is crossed from north to south by the main line of the Southern Railway.

Washington.

* Colockum Pass: Scale, 1 inch=2 miles; contour interval, 50 feet. Latitude, 47° to 47° 15′; longitude, 120° to 120° 30′.

Map of parts of Kittitas, Grant, and Douglas counties, mainly in the Wenatchee Mountains, whose south end occupies most of the area. The chief summits stand 3,800 to 6,350 feet above sea level. At the eastern base of the mountains is a sloping bench, 1,500 to 2,000 feet above sea level, across which Columbia River flows southward in a trench 1,000 feet deep and 1 to 2 miles wide. In the southwestern part the surface falls abruptly to Kittitas Valley, a broad basin lying 1,700 to 2,500 feet above sea level.

* Lake Crescent: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 48° to 48° 15′; longitude, 123° 45′ to 124°.

Map of an area in Clallam County, on the south shore of Juan de Fuca Strait, at the north base of the Olympic Mountains, whose foothills cross the southern part in several eastward-trending ranges and reach altitudes of 4,500 to 5,000 feet. Lake Crescent lies between two of these ranges.

* Pysht: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 48° to 48° 15′; longitude, 124° to 124° 15′.

Map of a part of Clallam County, situated between the northern base of the Olympic Mountains and the Strait of Juan de Fuca. The southern half is occupied by several eastward-trending mountain ranges, some peaks of which reach altitudes of 3,500 feet or more above sea level. Soleduck River flows westward between two of the ranges, meandering on a flood plain a mile or more in width. North of the mountains, bordering the strait, it is a hilly country that lies less than 1,100 feet above sea level. down to which the valleys of Pysht and Clallam rivers have been cut.

Sultan: Scale, 1 inch=2 miles; contour interval, 100 feet. Latitude, 47° 30′ to 48°; longitude, 121° 30′ to 122°.

Map of an area in King and Snohomish counties, at the western base of the Cascade Range. The eastern half, which is in the foothills of the Cascade Range, is rough, and many summits within it stand more than 5,000 feet above sea level. Preacher Mountain, in the extreme southeast corner, attains an altitude of 5,930 feet. Several streams flow westward from the mountains in gorges 3,000 feet or more in depth. A striking feature of the mountainous tract is the number of small lakes, some of them more than 4,000 feet above sea level, in ancient glacial cirques, most of which are at the heads of hanging valleys. The western half of the area, which lies in the Puget trough, consists chiefly of two sets of mesas, one set lying 400 to 600 feet and the other set 1,000 to 1,200 feet above sea level. The individual mesas are separated by valleys, some of them a mile wide and flat-floored, lying mainly less than 200 feet above sea level, and are broken in places by bold hills, some of which rise more than 2,000 feet above sea level. Evidences of glaciation are abundant, and the drainage of the western part, in particular, has been developed largely on a glaciated surface.

West Virginia.

Electric generating stations and transmission lines used in public service in the State of West Virginia in 1921. Scale, 1 inch=8 miles. Similar to map of Kentucky. (See p. 19.)

Oil and gas fields of the State of West Virginia: Scale, 1 inch=8 miles. Similar to map of California. (See p. 16.)

* Waiteville: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 37° 15′ to 37° 30′; longitude, 80° 15′ to 80° 30′. (Only the part of the area that lies in West Virginia is shown.)

Map of an area in Monroe County, in the southeastern part of the State, among the Appalachian Ranges. Potts Mountain, along whose crest runs the State boundary, stands 2,900 to 3,900 feet above sea level, and Peters Mountain, in the northwest corner, reaches 4,045 feet in one summit. Between the two ranges the valley of Potts Creek, in which Waiteville is situated, lies between 1,900 and 2,100 feet above sea level.

West Virginia and Virginia.

* Wardensville: Scale, 1 inch=1 mile; contour interval, 50 feet. Latitude, 39° to 39° 15′; longitude, 78° 30′ to 78° 45′.

Map of an area in Hampshire and Hardy counties, W. Va., and Frederick and Shenandoah counties, Va., among the Appalachian ranges, several of which cross the area. The crests of the nearly even-topped ranges stand 2,000 to 2,900 feet above sea level, and the summit of Paddy Mountain, in the southeast corner, reaches 3,025 feet. The main valleys are cut down to less than 1,000 feet above sea level, and parts of the valleys of North River and Lost or Cacapon River have flat floors half a mile to a mile wide. At a point about 3 miles above Wardensville, Lost River, in crossing from one valley to another, flows underground for nearly 2 miles.

Wisconsin.

* Blue Mounds: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 43° to 43° 15′; longitude, 89° 45′ to 90°.

Map of parts of Iowa, Dane, and Sauk counties, in the Driftless Area. The area mapped is mainly an upland lying 1,100 to 1,200 feet above sea level and much cut by small valleys 100 feet deep. The Blue Mounds,

in the southeastern part, stand conspicuously above the upland, the western mound reaching an altitude of 1,716 feet. The upland is broken in the northern part by the valley, 3 miles wide, of Wisconsin River. Part of this valley is swampy, and the remainder is occupied by outwash terraces and sand dunes.

* New Glarus: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 42° 45′ to 43°; longitude, 89° 30′ to 89° 45′.

Map of an area in Dane and Green counties, most of it in the Driftless Area. The upland surface lies 1,100 to 1,200 feet above sea level and is cut by broadly flaring valleys 100 to 250 feet deep. The terminal moraine of the Wisconsin drift crosses the northeast corner, through Verona, and the eastern edge is occupied by the western marginal fringe of the Illinoian drift. The valleys of the main streams, which flow southeastward, are partly blocked by outwash of Illinoian drift, and the streams wander about on marshy plains half a mile to 2 miles in width.

Wisconsin and Illinois.

* Monroe: Scale, 1 inch=1 mile; contour interval, 20 feet. Latitude, 42° 30′ to 42° 45′; longitude, 89° 30′ to 89° 45′.

Map of an area lying chiefly in Green County, Wis., but just extending into Stephenson County, Ill. The quadrangle is situated in an upland, whose surface lies 1,000 to 1,100 feet above sea level and is cut by many ravines and valleys, those of the principal streams being 200 feet deep. Most of the quadrangle is covered with a thin sheet of glacial drift, but the northwestern part lies in the Driftless Area.

GEOLOGIC BRANCH.

SCOPE AND ORGANIZATION OF WORK.

The field covered by the research activities of the geologic branch is practically coextensive with the field covered by the science of geology. The work of this branch and that of the State geological surveys, the geologic faculties of the universities, some of the great endowed research institutions, and a relatively few individuals of exceptional enthusiasm and initiative together constitute the contributions that are being made to-day toward the development of this phase of natural science in the United States. In general, a spirit of cooperation pervades these groups of investigators, so that the work of each supplements that of the others. By coordinating activities, combining facilities, funds, and personnel, and exchanging information and experience through cooperation, the sum total of progress made is greatly increased.

In performing its part in this common work the geologic branch makes investigations in many of the departments of geology, although in none of them can it begin to fill the field, nor can it undertake independently or even aid many types of research that should be pursued. In others its participation is most meager because of the limitations in funds and personnel which it shares with many other research institutions. Nevertheless, many phases of geology, including paleontology, glaciology, mineralogy, petrography, physiography, mineral chemistry, and physics, and combinations of these utilized in economic studies are represented in its activities and in its staff specialists, and the results of the work appear in its publications.

The work of the branch on mineral resources combines statistical inquiry with a certain amount of direct study of the geologic environment of the products studied, so that production and development can be interpreted in terms of geology and in the light which geologic

studies throw on the magnitude of known sources of these products, and the possibilities of new sources and reserves. Mere statistics of production without this vivifying geologic interpretation made possible by the union of geologists and statisticians are relatively barren. It is a matter of regret that funds and personnel are not sufficient to carry this principle throughout the work on mineral resources.

The work of the division of chemistry and physics is, in a general sense, supplementary to that of the division of geology, in that its researches are directed to the chemical and physical aspects of geologic problems.

The organization of the branch has been a natural growth, adapted and fitted to the functions performed, and has not been materially changed for years. The three major subdivisions represent the most distinct fields into which these functions fall—geology, chemistry and physics, and mineral resources, each represented by an organization unit called a division.

The general organization throughout the fiscal year has been as follows:

Geologic branch:
David White, chief geologist until November 15, 1922.
W. C. Mendenhall, chief geologist from November 16, 1922, to June 30, 1923.
Division of geology: Sidney Paige, geologist, acting in charge.
Division of chemistry and physics: George Steiger, chief chemist, acting in charge.
Division of mineral resources: G. F. Loughlin, geologist in charge.

BRANCH FUNDS.

The act making appropriations for the Department of the Interior for the fiscal year ending June 30, 1923, carried the following items, from which the work of the geologic branch is supported:

Geologic surveys	$300,000
Scientific assistants (geologists, paleontologists, and chemist)	20,700
Mineral resources	125,000
Chemical and physical researches	40,000

In addition, geologic field work necessary in the classification of mineral lands was done by the aid of the appropriation made to the Survey for land classification, at a total cost of $33,650. This is a decrease of $52,000 in the amount available for geologic surveys and of $5,100 in the amount available for land-classification work by comparison with the preceding fiscal year.

The special geologic and economic training represented in the branch personnel continue to be made available to other organizations, State and Federal, through cooperation, usually by assignment of members of the branch staff to the special problems involved, either wholly at the expense of the organization that requires the work done or on a cost-sharing basis. The Department of Justice, the Office of Indian Affairs, the Forest Service, the Reclamation Service, the Coal Commission, and a number of States thus received the benefit of the specialized training available in the branch. The cost to the cooperating organizations, in the form of salaries assumed or field expenses borne, was about $15,000 for the fiscal year.

The gross total of funds available to the branch for the fiscal year, including direct appropriations, funds for land classification, and cooperative funds, was thus $534,350.

DIVISION OF GEOLOGY.

ORGANIZATION AND PERSONNEL.

The division of geology as at present organized includes the 10 sections indicated below. It also exercises technical supervision over the section of geologic-map editing, a part of the publication branch.

Geology of metalliferous deposits: F. L. Ransome, geologist in charge.
Paleontology and stratigraphy: T. W. Stanton, geologist in charge.
Glacial geology: W. C. Alden, geologist in charge.
Geology of iron and steel metals: E. F. Burchard, geologist in charge.
Coastal Plain investigations: L. W. Stephenson, geologist in charge.
Areal geology: Sidney Paige, geologist in charge.
Geology of nonmetalliferous deposits: G. R. Mansfield, geologist in charge.
Petrology: E. S. Larsen, jr., geologist in charge.
Geology of oil and gas fields: K. C. Heald, geologist in charge.
Geology of coal fields: M. R. Campbell, geologist in charge until January 31, 1923; W. T. Thom, jr., geologist in charge from February 1 to June 30, 1923.

In addition to the adminstrative organization, the division includes two important advisory committees—the committee on geologic names, T. W. Stanton, chairman, and the physiographic committee, M. R. Campbell, chairman. These committees consider in detail all problems falling within their respective fields and advise the chief geologist of their findings as a basis for administrative action.

At the beginning of the fiscal year the staff of the division included 123 geologists of various grades. During the year there were two resignations, one death, and four additions to the staff, so that the number of employees of this group at the end of the year was 124. Five draftsmen and seven preparators of fossils and skilled laborers were also attached to the division. In the clerical force there were three separations and one accession during the year, and the number employed at the end of the year was 30.

The most important change in personnel within the division during the year was the relief of M. R. Campbell, at his own request, of administrative responsibility for the section of coal-field geology, after 16 years of most efficient and productive service. Mr. Campbell will now be able to devote more energy to personal research and especially to physiographic work.

DIVISION FUNDS.

The total funds available for the work of the division for the fiscal year were as follows:

Geologic surveys	$300,000
Repayments (on account of work done for other Government establishments or other Geological Survey units)	8,674
Classification of lands	33,650
Scientific assistants	17,700
Search for potash deposits (from appropriation for chemical and physical researches)	5,342
	365,366

The expenditure of these funds may be classified by subjects approximately as follows:

Economic geology of metalliferous deposits	$55,608
Economic geology of nonmetalliferous deposits	12,902
Economic geology of fuels (oil, gas, coal)	83,067
Scientific researches not directly connected with economic geology (paleontology, glaciation, Coastal Plain formations, etc.)	106,168
Supervision, administration, salaries of clerical, technical, and skilled-labor forces, purchase and repair of instruments, office supplies, etc	107,621
	365,366

Of the amounts available for geologic work, approximately $65,000 was used directly for field expenses, including the search for potash. About 88 per cent of this amount was expended west of the one hundredth meridian, and about 12 per cent east of it.

COOPERATION.

Cooperation with States and Federal agencies in the solution of problems involving geology has been continued. Examples of cooperative work of this character during the year are the preparation of a geologic map of Arizona, in cooperation with the Arizona Bureau of Mines and Geology; examinations of the Deep River coal field of North Carolina, the Brushy Mountain coal field of Virginia, the brown iron ores of western Tennessee, and the Cretaceous formations in Alabama, in cooperation with the geological surveys of those States; a study of the geology and ore deposits of the Pend Oreille region and of reported platinum deposits in Idaho, in cooperation with the Idaho Bureau of Mines and Geology; examinations of dam and reservoir sites along the lower Colorado River and in Idaho, Oregon, and New Mexico, for the Reclamation Service, and of certain lands proposed for purchase under the Appalachian forest reserve act for the Forest Service.

The determinations of fossils sent in from various parts of the United States, the West Indies, and Central and South America and of the position of the rocks from which they came, by the paleontologists of the Survey, is a cooperative service of great usefulness especially appreciated by the State geological surveys and by the oil industry.

GENERAL REVIEW OF THE YEAR.

Few permanent changes in the technical force have been made during the year. The universities, many of which have adjusted their operations to the altered economic situation in the United States by increased budgets, promise to displace the mining industries as the chief source of losses from the trained staff of the Survey.

Many projects that were interrupted by the war have since been brought to completion, but the completion of others has been made difficult by loss of personnel. Emphasis, however, continues to be laid on the completion of projects already begun, though with so many demands for new and important studies of great prospective value to science and to the mining industry, and with reduced funds

and reduced personnel, the progress made in completing work on hand is discouragingly slow.

Among the papers published during the year that represent researches of interest to the mining world are the following:

Silver enrichment in the San Juan Mountains, Colo. (Bull. 735–D).
Copper deposits of the Tyrone district, N. Mex. (Prof. Paper 122).
Geology and ore deposits of Shoshone County, Idaho (Bull. 732).
Geology of the Oatman district, Ariz. (Bull. 743).
Nitrate deposits in the Amargosa region, Calif. (Bull. 724).
High-grade clays of the eastern United States (Bull. 708).
Potash in the greensands of New Jersey (Bull. 727).
Manganese deposits of east Tennessee (Bull. 737).
Manganese deposits of the Batesville district, Ark. (Bull. 734).
Mica deposits of the United States (Bull. 740).
Oil shale of the Rocky Mountain region (Bull. 729).

A series of important papers on oil fields and on problems connected with oil development was also issued. Worthy of mention among these is the brief paper on the continuity of some oil-bearing sands of Colorado and Wyoming (Bull. 751–A), which has been well received by geologists engaged in oil development. Another of the geologic guidebooks that have proved so valuable to teachers and travelers was published, covering the Denver & Rio Grande Western route (Bull. 707), and several paleontologic and stratigraphic papers that represent definite advances in our knowledge of earth history and development were issued. Numerous reports, both economic and noneconomic, are awaiting publication.

Work in most of the fields of geology is of necessity carried on less extensively than before the war, owing to decreased funds, depleted staff, and increased field costs, yet systematic work is continued and researches that promise significant results are under way. Distinct progress has been made by C. Whitman Cross and his associates in the study of the San Juan Mountain region in southern Colorado. This area is geologically unique and has had a long and complex volcanic and physiographic history whose main events are now well understood. The research has been complicated and has often been interrupted, but the results will probably form as valuable a single contribution to the understanding of geologic processes as the Survey has yet made.

Another important research long under way, whose results were delivered in manuscript form toward the end of the fiscal year, is the study of the geology, geography, and mineral resources of southeastern Idaho by G. R. Mansfield. The complex structure and stratigraphy of this region have been satisfactorily worked out, and the report will no doubt be of great interest to students of tectonics and of geologic history. This region contains some of the most valuable rock phosphate beds of the West, so that the work done is of economic value also.

A continuing project of promise is the detailed study of the San Andreas rift in southern California being made by L. F. Noble as the Survey's part of a series of cooperative earthquake studies under the auspices of the Seismological Society of America. The Carnegie Institution and the Coast and Geodetic Survey are each carrying on coordinated parts of this work.

Special studies of the physical and chemical properties of sediments and of the fundamental principles of sedimentation have been

continued by T. W. Vaughan and a group of associates within and without the Survey.

The Survey's oil work has been active throughout the year, and a number of reports have been published and others submitted for publication. Numerous general studies that should be made for the benefit of the oil industry can not be undertaken for lack of funds and men, but researches are under way on the materials that constitute the source of petroleum and on the manner in which it was formed from these sources, on the porosity and texture of the reservoir rocks, on microscopic faunas as an aid in identifying and correlating beds, and on the cap-rock material of salt domes. The preparation of oil and gas field maps and of State geologic maps continues, as well as the usual areal and structural geologic mapping of selected districts.

Detailed studies of coal fields for the classification of coal lands and for the administration of the leasing act, as well as to guide future development, were resumed toward the end of the year on a somewhat larger scale than in recent years.

WORK OF THE DIVISION BY STATES.

ALABAMA.

Field work.—Charles Butts visited the Bessemer, Vandiver, Montevallo, and Columbiana quadrangles, Ala., to collect additional information for the revision of the geologic folios on these quadrangles, and to review the question of the identification of the Straven coal beds at the request of the State geologist. Field studies to establish the boundaries of the Cretaceous formations in connection with the preparation of a geologic map of Alabama were made by L. W. Stephenson and C. W. Cooke. E. F. Burchard examined the brown iron ores of the Russellville district.

Office work.—The Bessemer-Vandiver and Columbiana-Montevallo folios were revised by Charles Butts, who also prepared a description of the geology of the Alabama coal fields to be incorporated in a bulletin of the Bureau of Mines, containing analyses of coal from Alabama. C. W. Cooke continued work on his report on the upper Eocene and Oligocene formations of southern Alabama and western Florida, transmitted a paper on the correlation of the Vicksburg group for publication in "Shorter contributions to general geology," and prepared a geologic section for use in making a model of part of Alabama.

ARIZONA.

Field work.—F. L. Ransome, assisted by H. A. C. Jenison, finished field work in the Oatman gold district, Ariz. C. P. Ross completed field studies on the geology and ore deposits of the Christmas quadrangle and the Aravaipa and Stanley mining districts. Waldemar Lindgren under special agreement investigated mining districts in Yavapai County. N. H. Darton completed geologic studies in connection with the preparation of a geologic map of Arizona, in cooperation with the Arizona Bureau of Mines. H. E. Gregory and L. F. Noble made some reconnaissance stratigraphic investigations on the north side of the Grand Canyon, in the region of the Kanab and Kaibab plateaus. F. L. Ransome studied geologic problems of the Boulder Canyon and Black Canyon dam sites for the Reclamation Service, and H. A. C. Jenison examined the possible economic resources of the reservoir sites involved in proposed reclamation projects.

Office work.—F. L. Ransome completed and transmitted a preliminary report on the Oatman district, continued the preparation of the detailed report on the geology and ore deposits of that district, and revised the Ray geologic folio. He also completed a report for the Reclamation Service on the Boulder Canyon and Black Canyon dam sites and presented before the National Academy of Sciences an illustrated account of ancient high-level potholes along Colorado River. The geologic map of Arizona, with descriptive text, was completed

by N. H. Darton and transmitted to the Arizona Bureau of Mines. C. P. Ross prepared and submitted for publication reports on the ore deposits in the vicinity of Christmas (Saddle Mountain and Banner mining districts) and on the Stanley and Aravaipa districts and revised his report on the lower Gila region. E. S. Bastin, under contract, completed and submitted for publication a report on the origin of certain rich silver ores near Chloride and Kingman. Reports on proposed dam sites on Colorado and San Juan rivers were prepared by H. D. Miser. A geologic description to accompany the Grand Canyon National Park folder was prepared by L. F. Noble for the National Park Service. G. H. Girty, Edwin Kirk, and T. W. Stanton studied and reported on Carboniferous, Cambrian, Devonian, and Mesozoic fossils.

Publications.—Issued: Bulletins 735–E, 743; Professional Papers 131–B, 131–E. In press: Geologic Folio 217 (Ray).

ARKANSAS.

Office work.—A report on the stratigraphy of the El Dorado oil field, Ark., by James Gilluly and K. C. Heald, was completed and submitted for publication. Maps, illustrations, and descriptive text covering the DeQueen and Caddo Gap quadrangles were revised and put in shape for publication as a professional paper by H. D. Miser, who also prepared a summary of the manganese ore reserves of the State in connection with a report on the manganese reserves of the United States.

Publications.—Issued: Bulletins 734, 736–H, 735–H, 735–I; press notice on geology of the El Dorado oil field.

CALIFORNIA.

Field work.—J. M. Hill made some field studies of the silver deposits at Randsburg, Calif., and did some reconnaissance work in several mining camps in the copper belt of Plumas County. W. S. W. Kew continued his work on the geology of the oil fields of southern Los Angeles County, nearly completing the mapping of the Fernando quadrangle. F. E. Matthes continued field work in the upper San Joaquin basin in connection with a report on the physiographic and glacial history of the basin. He also spent some time in reconnaissance work on the physiography of the foothills of the Sierra Nevada. L. F. Noble devoted several weeks to field work on the San Andreas rift.

Office work.—L. F. Noble continued the preparation of a report on nitrate in the Mohave Desert, the valley of Colorado River, and adjacent regions and spent several days on office work relating to the San Andreas rift. J. M. Hill completed a reconnaissance report on the gold deposits of the Los Burros district, Monterey County, and did some work on a report on the Randsburg silver district. Work was continued by F. E. Matthes on a report on the origin of the Yosemite Valley. He also prepared a paper on hanging valleys of the Yosemite region and has in progress a report on the physiography of the upper San Joaquin basin. J. S. Diller revised his report on the Lassen Volcanic National Park. W. H. Dall and Edwin Kirk prepared reports on fossil material from the State. G. R. Mansfield prepared a press report on nitrates in southeastern California. W. S. W. Kew continued the preparation of reports on the upper Santa Clara River (Soledad Canyon) district, on the faults of southern California, and on the San Pedro Hills, Los Angeles County, and the compilation of a geologic map of southern California. He revised his report on the oil and gas resources of the Los Angeles-Ventura district and prepared a paper on the geology of the San Gabriel Mountains, which he read before the Geological Society of America at Berkeley. Mr. Kew also prepared a paper entitled "A geologic time scale for a part of southern California," for presentation at the meeting of the American Association of Petroleum Geologists in Denver.

Publications.—Issued: Bulletins 724, 735–J; press notice on nitrate in southeastern California; oil and gas map of California.

COLORADO.

Field work.—J. B. Reeside, jr., accompanied a topographic party mapping the canyon of Green River, Colo., and examining dam and reservoir sites along the stream for the development of power and for irrigation. J. D. Sears, assisted by James Gilluly and W. H. Bradley, did geologic mapping in Moffat County.

Some details of structure that may have a bearing on the accumulation of oil were mapped. J. B. Eby began field work in the eastern Yampa coal field, doing detailed mapping between Craig and Hayden. G. F. Loughlin made a brief visit to the Leadville district to obtain data for the completion of a report on the district.

Office work.—C. W. Cross, E. S. Larsen, C. S. Ross, and Kirtley Mather continued preparation of reports on the geology of the San Juan region. F. H. Knowlton submitted a paper on the Animas flora as a shorter contribution to general geology. G. F. Loughlin continued the revision of the Leadville monograph. E. S. Larsen made some progress on his report covering the geology of the San Cristobal quadrangle. J. D. Sears and W. H. Bradley prepared and submitted a paper on the relations of the Wasatch and Green River formations in northwestern Colorado and completed a report on the geology and oil and gas prospects of a part of Moffat County, Colo., and southern Sweetwater County, Wyo. J. B. Reeside, jr., completed a report on the Cretaceous and Tertiary formations of the west side of the San Juan Basin of Colorado and New Mexico. A report by W. T. Lee on the correlation of the oil-bearing rocks of eastern Wyoming and Colorado was prepared and published. Paleontologic reports on material from Colorado were made by T. W. Stanton, G. H. Girty, and W. H. Dall.

Publications.—Issued: Bulletins 707, 729, 735–D, 751–A; Professional Papers 130, 131–F, 131–G, 131–H; Geologic Folio 214; press notice announcing publication of Bulletin 751–A. In press: Bulletin 718, "Geology and ore deposits of the Creede district, Colo."

DISTRICT OF COLUMBIA.

Field work.—C. K. Wentworth continued field studies of the terrace gravels of the Coastal Plain in the District of Columbia and vicinity.

Office work.—Papers were prepared and presented by L. W. Stephenson, Laurence La Forge, C. K. Wentworth, and E. W. Berry, discussing the geologic section exposed in the excavation for the new Walker Hotel. C. K. Wentworth submitted a report on the Coastal Plain terrace gravels, including those of the District. The publications of the year included a shaded road map of the country around Washington, bearing on the back a historical and geologic text.

FLORIDA.

Field work.—A reconnaissance examination of the Government phosphate lands in Florida was made by G. R. Mansfield and G. W. Holland to procure data for land classification.

Office work.—T. W. Vaughan studied fossil Foraminifera from the Eocene and Oligocene formations of the Coastal Plain of Florida. Work on a report on the upper Oligocene formations of Florida and southern Alabama was continued by C. W. Cooke, who also prepared a paper on the Flint River formation in Florida and adjacent States. Julia Gardner completed and submitted the final draft of Parts I and II of a report on the Mollusca of the Alum Bluff formation of Florida and continued the preparation of Part III. W. C. Mansfield prepared a paper entitled "A contribution to the late paleontology of northeastern Florida."

GEORGIA.

Field work.—C. W. Cooke and L. W. Stephenson did supplementary field work on the Cretaceous, Tertiary, and Quaternary formations of Georgia and made brief examinations of the oil and gas possibilities in the vicinity of Fort Valley, with T. M. Prettyman, of the State Survey.

Office work.—A paper on the Flint River formation, a new division of the Vicksburg group, was prepared by C. W. Cooke. Some work was done by Laurence La Forge on a bulletin on the physical geography of Georgia.

IDAHO.

Field work.—Dam sites on the King Hill project, Idaho, were examined for the Reclamation Service by F. C. Calkins. In cooperation with the State of Idaho, the field study of the geology and ore deposits of the region adjacent to Talache and the south arm of Lake Pend Oreille was continued by Edward

Sampson and J. L. Gillson. Field work in the Portneuf and Paradise Valley quadrangles, with special reference to the study of the phosphate lands, was begun by G. R. Mansfield.

Office work.—Preparation of a joint report by Edward Sampson and J. L. Gillson on the geology and ore deposits in the vicinity of Lake Pend Oreille has been in progress. G. R. Mansfield completed and transmitted for publication a report on the geography, geology, and mineral resources of part of southeastern Idaho. He also prepared for outside publication a paper on the structure of the Rocky Mountains in Idaho and Montana. Paleontologic material from various formations was studied and reported on by T. W. Stanton, G. H. Girty, W. H. Dall, and Edwin Kirk. F. H. Knowlton studied specimens and began the preparation of descriptions of plants from beds supposed to be interbedded with the Columbia lava of Idaho and Washington. A short paper on possible oil in Idaho was written by K. C. Heald and was published in the Bulletin of the American Association of Petroleum Geologists.

Publications.—Issued: Bulletin 732.

ILLINOIS.

Field work.—Frank Leverett made field examinations along the southern border of the Kansan and Nebraskan glacial drift sheets in Missouri and Illinois.

Office work.—A cooperative bulletin on the Equality and Shawneetown quadrangles, Illinois, to be published by the State, was completed by Charles Butts.

KANSAS.

Office work.—A paper on the drift of Missouri and Kansas was prepared by Frank Leverett for presentation at the meeting of the Geological Society of America at Ann Arbor, Mich.

KENTUCKY.

Field work.—E. O. Ulrich spent several days in central Kentucky gathering faunal and stratigraphic data.

Office work.—Some progress was made on the preparation of a geologic folio on the Shawneetown and Equality quadrangles by Charles Butts. E. O. Ulrich continued studies of Trenton and Cincinnatian faunas and notes on stratigraphic sections in middle Tennessee and central Kentucky, with the primary purpose of preparing a report (jointly with R. S. Bassler) on the stratigraphy and fossil faunas of middle Tennessee. Results of these studies were incorporated in a paper delivered before the Paleontological Society at Ann Arbor in December. K. C. Heald reviewed and transmitted the oil and gas map of Kentucky and prepared a press bulletin announcing its publication. Plant remains collected by David White from the Devonian rocks of eastern Kentucky were found by Taisia Stadnichenko, chemist at Vassar College, to be richly bituminous. They are described in a paper entitled "Some mother plants of petroleum in the Devonian black shales," read before the Association of Economic Geologists and printed in Economic Geology.

Publications.—Issued: Map of oil and gas fields of Kentucky.

LOUISIANA.

Office work.—M. I. Goldman studied salt-dome cap rocks and made preliminary microscopic examinations of a salt-dome core from Sulphur, La. E. W. Berry, T. W. Stanton, and Julia Gardner studied fossil collections from Louisiana.

MAINE.

Field work.—Laurence La Forge and F. J. Katz made brief inspections in the Portland quadrangle, Maine, in connection with the Portland geologic folio, which is in preparation.

Office work.—Arthur Keith continued work on the contour map of Maine for the New England geographic handbook.

MARYLAND.

Field work.—David White and W. T. Thom, jr., did some stratigraphic work on the Mount Savage fire-clay deposits and on the coal measures of Georges Creek coal basin, Maryland and West Virginia. Some rock samples were collected for determinations of gravity. Work in Carroll County was continued by Miss A. I. Jonas for the Maryland Geological Survey. C. K. Wentworth made studies of Coastal Plain gravels and terraces in Maryland.

MISSISSIPPI.

Office work.—L. W. Stephenson completed two cooperative reports on the State of Mississippi, one on the geology, to be published by the State Survey, and one on the ground waters, for publication by the United States Geological Survey.

MISSOURI.

Field work.—Frank Leverett made field examinations along the southern border of the Kansan and Nebraskan glacial drift sheets in Missouri and western Illinois. E. O. Ulrich, assisted by R. D. Mesler, did stratigraphic work and made paleontologic collections in the Eminence and Potosi quadrangles, Mo., and C. E. Siebenthal did some field work in the Wyandotte quadrangle.

Office work.—E. O. Ulrich reported upon Ozarkian fossils for the Missouri State Survey. W. T. Thom, jr., prepared a text on the geology of the coal formations of Missouri, to be published in a Bureau of Mines technical paper on analyses of Missouri coals. A paper on the drift of Missouri and Kansas was prepared by Frank Leverett for presentation at the meeting of the Geological Society of America at Ann Arbor, Mich.

MONTANA.

Field work.—C. E. Dobbin and J. B. Reeside, jr., studied the Fox Hills sandstone and the Lance formation and their relations in southeastern Montana, southwestern North Dakota, and northwestern South Dakota. H. A. C. Jenison made field studies of manganese ore deposits in western Montana. K. C. Heald and W. W. Rubey mapped the structure of the Ingomar dome. R. S. Knappen, assisted by G. F. Moulton and H. H. Charles, completed field mapping in the northern Big Horn Basin. Frank Reeves, assisted by M. N. Bramlette and M. I. Goldman, continued areal and economic work in Blaine and Chouteau Counties. C. E. Dobbin, assisted by J. E. Hoffmeister and A. H. Redfield, mapped the areal geology and workable lignite beds in McCone County and began with several assistants systematic mapping of the Gangue River and Armells Creek coal fields. W. C. Alden studied the Tertiary (?) and Pleistocene bench gravels in Yellowstone Valley and tributaries and the associated glacial phenomena in the western part of the State. A. J. Collier, assisted by W. W. Boyer and Ralph Lusk, mapped the Kevin-Sunburst area and adjacent parts of the Sweetgrass arch.

Office work.—W. C. Alden continued the preparation of his report on the Cenozoic history of eastern Montana, prepared a paper on the physiographic development of the northern Great Plains, and wrote a popular article on Sun River canyon, a note for Science on the rate of movement of glaciers in Glacier National Park, and a brief report on Grasshopper Glacier, near Cooke, for the National Park Service. J. T. Pardee continued work on a report on glaciation and the origin of gold-bearing gravels in the Pioneer region and completed a report on the geology and ground water of Townsend Valley for the water-resources branch. Work on his final report on the geology and oil and coal resources of the Crow Indian Reservation was continued by W. T. Thom, jr., who also assembled material for a map showing the geologic structure of the Dakota sandstone in Montana and revised his paper on the relation of deep-seated faults to surface structural features of central Montana, which was published by the American Association of Petroleum Geologists. A report on the geology and oil and gas possibilities of the faulted area south of the Bearpaw Mountains, by Frank Reeves, was transmitted for publication. Mr. Reeves also presented a paper on geological structure of the Bearpaw Mountains at a meeting of the Geological Society of Washington. A press notice and sketch structure map of the Kevin-Sunburst district were prepared by

A. J. Collier, who also continued work on his report on the geology of the Fort Belknap Indian Reservation and the Little Rocky Mountains. He presented a paper on the geology of the Little Rocky Mountains before the Geological Society of Washington. R. S. Knappen and G. F. Moulton made some progress on a report on the geology and oil possibilities of the northern Big Horn Basin. Mr. Moulton completed the maps and text for a press notice on oil and gas prospects north of the Pryor Mountains. C. E. Dobbin completed a report on the geology and coal resources of parts of Garfield, McCone, and Dawson counties, and began the preparation of a paper on the Lance and Fort Union formations of the Missouri River valley for outside publication. G. R. Mansfield completed a paper on the structure of the Rocky Mountains in Idaho and Montana and transmitted it for publication in the Bulletin of the Geological Society of America.

Publications.—Issued: Bulletins 736–B, 736–F; Press notice, "Results of an examination by a Government geologist on the Kevin-Sunburst oil field, Mont."

NEVADA.

Field work.—H. G. Ferguson, assisted by S. H. Cathcart, continued field study and geologic mapping of the Tonopah and Hawthorne quadrangles, Nev. Lewis G. Westgate, assisted by Carle H. Dane, began field work in the Pioche mining district. F. L. Ransome, assisted by H. A. C. Jenison, made a study of the geologic problems of the Boulder and Black Canyon dam sites for the Reclamation Service. D. F. Hewett completed field work in the Goodsprings quadrangle.

Office work.—H. G. Ferguson and S. H. Cathcart began a joint preliminary report on the geology and mineral resources of the Tonopah quadrangle. F. C. Schrader prepared a revised report on the Jarbidge district and has in preparation a report on the ore deposits of the Carson Sink region. Adolph Knopf completed and transmitted a report on the geology and ore deposits of the Rochester district. D. F. Hewett prepared a paper on the structure of the Spring Mountain Range for the meeting of the Geological Society of America at Ann Arbor, Mich. He also reported on alum deposits near Fallon and carnotite in southern Nevada, and prepared a brief report on pickeringite near Fallon and a press notice on ground water in the Piute Valley. T. W. Stanton, G. H. Girty, W. H. Dall, and Edwin Kirk studied and reported on fossil material from various formations.

Publications.—Issued: Bulletin 741; press notice on ground water in the Piute Valley. In press: "Geology and ore deposits of the Manhattan district" (Bulletin 723).

NEW MEXICO.

Office work.—J. D. Sears revised his report on the Gallup-Zuni coal field, N. Mex., and transmitted it for publication. H. G. Ferguson continued the preparation of his final report on the geology and ore deposits of the Mogollon district. At the request of the Reclamation Service E. S. Larsen prepared a report on the geology of the drainage area of the Rio Grande in northern New Mexico. W. T. Lee completed the revision of his report on the coal resources of the Raton district. J. B. Reeside, jr., prepared data on the subsurface geology in San Juan Basin in Colorado and New Mexico, and worked on a paper on the Cretaceous and Tertiary formations of the western part of the basin.

Publications.—Issued: Geologic Folio 214; Prof. Paper 122.

NEW YORK.

Office work.—Some progress was made by L. M. Prindle on the geologic maps and manuscripts for the Berlin-Greylock and Hoosick-Bennington folios. David White spent some time in study of spores in Devonian black shale from New York to ascertain facts to be set forth in a paper on the mother plants of petroleum in the Devonian black shale.

NORTH CAROLINA.

Field work.—L. W. Stephenson and C. W. Cooke did supplemental field work on Cretaceous, Tertiary, and Quaternary formations in North Carolina in connection with reports being prepared by Mr. Cooke. M. R. Campbell and

K. K. Kimball examined the Deep River coal field in cooperation with the State and made a reconnaissance examination of a reported coal field in Montgomery County.

Office work.—W. S. Bayley spent some time revising a manuscript on magnetite iron ores of western North Carolina and eastern Tennessee, prepared in cooperation with the two State geological surveys. G. R. Mansfield revised a report on the origin of the Brown Mountain lights, published as a press notice. A report on the Deep River coal field was completed by M. R. Campbell and K. K. Kimball and transmitted to the State for publication. A paper on the Ore Knob copper mine of North Carolina was prepared by C. S. Ross. W. C. Mansfield studied fossil collections from North Carolina.

Publications.—Issued: Bulletins 735–F, 735–G.

NORTH DAKOTA.

Field work.—C. E. Dobbin, accompanied by J. B. Reeside, jr., visited localities important for a general study of the Fox Hills sandstone and Lance formation in southeastern Montana, southwestern North Dakota, and northwestern South Dakota.

Office work.—W. T. Thom, jr., prepared a press notice on the oil and gas possibilities of northwestern North Dakota.

Publications.—Issued: Press notice on oil and gas possibilities in northwestern North Dakota.

OHIO.

Office work.—W. T. Thom, jr., prepared a press notice announcing the publication of a report by D. D. Condit on the economic geology of the Summerfield and Woodsfield quadrangles, Ohio. M. R. Campbell prepared a report on the geology of the Ohio coal fields, for the Bureau of Mines.

Publications.—Issued: Bulletin 720; press notice announcing Bulletin 720

OKLAHOMA.

Field work.—A. F. Melcher visited the Burbank oil field, Okla., to continue his studies of the porosity of samples of rock from oil fields. K. C. Heald did some field mapping in sec. 11, T. 24 N., R. 6 E., Osage County, and prepared a map and report covering this work for the Office of Indian Affairs. C. E. Siebenthal examined mines in the Wyandotte quadrangle.

Office work.—K. C. Heald wrote press notices announcing the publication of Bulletin 736–A and Bulletin 686–Z. A manuscript for a bulletin on the geology of the Bristow quadrangle, Creek County, Okla., with reference to petroleum and natural gas, by A. E. Fath, was revised by Mr. Heald and transmitted for publication. A. F. Melcher determined the pore space and diameter of grains in samples of oil sand from the Burbank field. P. V. Roundy and G. H. Girty completed a paper on the Glenn formation of Oklahoma. H. D. Miser began the compilation of data for a geologic map of Oklahoma. C. S. Ross prepared a paper on the evidence of slumping preserved in Pennsylvanian beds of Oklahoma for publication in the Journal of Geology.

Publications.—Issued: Bulletins 686–Z, 686, 730–D.

OREGON.

Field work.—F. C. Calkins made a field examination on dam sites on the Umatilla project, Oreg., for the Reclamation Service. W. S. W. Kew made a field examination of the geology of Ashland and vicinity, with reference to the oil-shale deposits and oil possibilities.

Office work.—J. S. Diller prepared a brief supplementary paper on the engulfment of Mount Mazama. W. S. W. Kew reported on the deposits of oil shale near Ashland.

PENNSYLVANIA.

Field work.—Examinations were made in the Honeybrook, Phoenixville, Coatesville, and West Chester quadrangles, Pa., by Florence Bascom and G. W. Stose and in the New Holland and Lancaster quadrangles by A. I. Jonas and Mr. Stose. Mr. Stose also spent some time in Adams County and Chester Valley on work for the State Survey. Charles Butts carried on field work in the

Bellefonte, Hollidaysburg, and Huntingdon quadrangles, in connection with the preparation of geologic folios on these quadrangles. G. B. Richardson examined coal fields in the Somerset and Windber quadrangles. David White made field studies of the Mercer group in several counties and collected fossil plants in connection with an investigation of the relations of that group in western Pennsylvania and the Brookville group farther east.

Office work.—A. I. Jonas and E. B. Knopf continued work on the Quarryville-McCalls Ferry report. Miss Jonas completed a brief paper on the Quarryville quadrangle for a bulletin to be published by the State Survey of Pennsylvania. G. B. Richardson, K. K. Kimball, and A. A. Baker devoted some time to work on the report covering the geologic structure and coal, oil, and gas conditions in the New Kensington quadrangle. Florence Bascom completed her portions of the Coatesville-West Chester, Honeybrook-Phoenixville, Reading-Boyertown, and Quakertown-Doylestown geologic folios. G. W. Stose gave some time to the preparation of maps, text, etc., to be used in the two first-named folios, of which he is joint author. Miss Jonas contributed a short report on the diabase of the Quakertown and Doylestown quadrangles to be incorporated in the folio covering those quadrangles. Charles Butts completed the revision of the Hollidaysburg-Huntingdon folio. A paper on the crystalline schists of Pennsylvania and Maryland was submitted by Mrs. Knopf for publication in the American Journal of Science. Miss Jonas and Mr. Stose prepared a paper on the Ordovician overlap of the Piedmont in Pennsylvania and Maryland for presentation at the meeting of the Geological Society of America.

SOUTH CAROLINA.

Field work.—L. W. Stephenson and C. W. Cooke made field studies of the Coastal Plain terraces in South Carolina.

Office work.—C. W. Cooke resumed work on his report on the geology of the Coastal Plain of South Carolina. L. W. Stephenson identified and prepared a list of Cretaceous fossils from Mars Bluff, Peedee River, for use in Mr. Cooke's report. J. B. Reeside, jr., prepared a paper on *Eutrephoceras sloani*, a new nautiloid cephalopod from the Eocene of South Carolina, to be published by the United States National Museum.

SOUTH DAKOTA.

Field work.—C. E. Dobbin, accompanied by J. B. Reeside, jr., made a trip through southeastern Montana, southwestern North Dakota, and northwestern South Dakota, visiting localities important for a general study of the Fox Hills sandstone and Lance formation. Sidney Paige did some additional field work in connection with the preparation of his report on the Homestake mine.

Office work.—The Black Hills folio text, by Sidney Paige and N. H. Darton, was subjected to final revision. Sidney Paige's report on the geology in the vicinity of Lead, S. Dak., and its bearing on the Homestake mine was transmitted for publication. He presented a paper on the Homestake mine at the meeting of the Geological Society of America at Ann Arbor.

TENNESSEE.

Field work.—E. F. Burchard began field work on the brown iron ores of west-central Tennessee in cooperation with the Tennessee Geological Survey. Mr. Burchard, C. W. Cooke, and L. W. Stephenson examined the Coastal Plain formations along the Tennessee-Mississippi boundary with State Geologist W. A. Nelson.

Office work.—W. S. Bayley revised the manuscript of a report on the magnetite ores of eastern Tennessee and western North Carolina prepared in cooperation with the two State surveys. D. F. Hewett prepared a paper on the relation of manganese oxide deposits of Virginia and Tennessee to peneplains, for unofficial publication. E. O. Ulrich made studies of Trenton and Cincinnatian faunas and their stratigraphic relations in middle Tennessee and central Kentucky for a report (with R. S. Bassler) on the stratigraphy and fossil faunas of middle Tennessee. Some of the results of these studies were incorporated in a paper delivered before the Paleontological Society at Ann Arbor. The report on the geology and ore deposits of the Ducktown mining district, by W. H. Emmons and F. B. Laney, has been submitted for publication as a professional paper. H. D. Miser prepared a paper on iron ore on a peneplain in

the Waynesboro quadrangle, which was read at the New York meeting of the Society of Economic Geologists. Charles Butts prepared a report on a marble belt in the vicinity of Knoxville.

Publications.—Issued: Bulletins 735–G, 737.

TEXAS.

Field work.—H. W. Hoots continued field work in western Texas in connection with explorations for potash salts until September, 1922, when W. B. Lang assumed this task. Julia Gardner continued her work on the Midway and Wilcox formations of the State, examining collections at the University of Texas, Austin, in cooperation with the State Bureau of Economic Geology and Technology.

Office work.—G. R. Mansfield completed a paper on the potash field in western Texas, which was published in Industrial and Engineering Chemistry, May, 1923. Julia Gardner continued her work on her part of the final report on southwestern Texas. L. W. Stephenson began a report on the formations of the Gulf series between Colorado River and the Rio Grande. K. C. Heald wrote a press notice on the Wiles area and one announcing Bulletin 736–G. P. V. Roundy worked on a report on the microscopic fauna of the lower Bend of Texas. This report is designed particularly for the guidance of oil-company paleontologists.

Publications.—Issued: Professional Paper 131–D; Bulletins 730–D, 736–E, 736–G.

UTAH.

Field work.—E. M. Spieker, assisted by J. B. Eby in 1922 and A. A. Baker in 1923, made a detailed examination of the geology and coal resources of portions of the Wasatch Plateau between Salina and Price River canyons, Utah. R. C. Moore, in connection with coal-classification work in southern Utah, mapped geologically a large area north of Colorado River from Paria Creek eastward. H. E. Gregory and L. F. Noble made a reconnaissance from Kanab Creek eastward to connect with Mr. Moore's work. J. B. Reeside, jr., accompanied a topographic party making a survey of Green River with reference to reservoir sites for power and reclamation projects.

Office work.—H. D. Miser, Sidney Paige, and K. W. Trimble prepared a report on the Rainbow Natural Bridge for outside publication. A report by C. R. Longwell, H. D. Miser, R. C. Moore, Kirk Bryan, and Sidney Paige, entitled "Rock formations in the Colorado Plateau of southeastern Utah and northern Arizona," was submitted for publication. Mr. Miser brought nearly to completion a report on the structure of the San Juan Canyon and adjacent areas. He also prepared administrative reports on the geologic aspects of engineering problems along San Juan and Colorado rivers in southeastern Utah. Frank R. Clark submitted a report under contract on the economic geology of the Sunnyside and Wellington quadrangles. E. M. Spieker prepared a map and reports for the land-classification branch on work done in the Wasatch Plateau coal field in 1922 and a paper on the geology of the coal fields of Utah to accompany the report of the Bureau of Mines on the analyses of Utah coals. F. C. Calkins made some progress on a report on the general geology of the Cottonwood district. R. C. Moore spent several days on maps and a report on land classification in southern Utah. F. L. Hess prepared and transmitted a paper on ilsemannite at Ouray. J. B. Reeside, jr., completed a paper on the geology of the Green River valley between Green River, Wyo., and Green River, Utah.

Publications.—Issued: Professional Paper 131–F.

VERMONT.

Office work.—L. M. Prindle continued the preparation of the folio covering the Hoosick and Bennington quadrangles, Vt. Arthur Keith submitted a report on the stratigraphy of northwestern Vermont for outside publication.

VIRGINIA.

Field work.—David White and J. B. Eby worked in the Wise County coal field, Va., revising and correcting geologic boundaries of Pennsylvanian and Mississippian rocks on the south side of Powell Mountain. G. F. Loughlin examined stone available for construction work on the Government reservation at

Quantico and vicinity. Charles Butts examined, in cooperation with the State Survey, reported occurrences of oil at Rose Hill. C. K. Wentworth examined Coastal Plain gravels and terraces. M. R. Campbell and K. K. Kimball mapped the structure, areal geology, and coal outcrops of the Price Mountain district, near Blacksburg, in cooperation with the State Survey. E. O. Ulrich studied Upper Cambrian, Ozarkian, Canadian, and Ordovician formations in the Appalachian Valley. He also obtained some information regarding Clinton and Devonian beds.

Office work.—W. C. Mansfield continued the preparation of a report on the Miocene stratigraphy of Virginia. J. B. Eby completed his report on the coal resources of Wise County, prepared in cooperation with the State Survey, and submitted it to the State for publication. G. W. Stose contributed a chapter for this report on the Big Stone Gap area. Mr. Eby also prepared a paper on the possibilities of oil and gas occurrence in southwestern Virginia, showing the relation of isocarbs to faulting. This paper was presented in March, 1923, at the meeting of the American Association of Petroleum Geologists in Shreveport, La. W. T. Lee completed a report on the geography of the Coastal Plain of Virginia for the State Survey. M. R. Campbell prepared a description of the Virginia coal fields for the Bureau of Mines. Charles Butts prepared a press report with map covering his investigations of the oil well and the geology of the surrounding area at Rose Hill. D. F. Hewett prepared a paper on the relation of the manganese oxide deposits of Virginia and Tennessee to peneplains, for unofficial publication.

WASHINGTON.

Office work.—F. H. Knowlton continued the study of fossil plants from Spokane, Wash., interbedded with Columbia lava. J. T. Pardee completed an introduction to a report by Mr. Knowlton on these plants.

WEST VIRGINIA.

Field work.—David White and W. T. Thom, jr., collected rock samples for determinations of gravity and did stratigraphic work on the coal measures of the Georges Creek basin in Maryland and West Virginia.

Office work.—J. B. Eby wrote a report on the geology and coal formations of West Virginia for inclusion in the Bureau of Mines technical paper on analyses of West Virginia coal. G. H. Girty prepared a paper on the Chester group of West Virginia for the Tucker County report of the State Survey and worked on a paper on the fauna of the Greenbrier limestone.

Publications.—Issued: Map of oil and gas fields of West Virginia.

WISCONSIN.

Field work.—Frank Leverett studied the glacial drift sheets north of the Driftless Area and investigated the pre-Wisconsin drift sheets and associated deposits.

Office work.—E. O. Ulrich prepared a paper entitled "Table of the geological formations in Wisconsin" and submitted it to the Wisconsin Geological Survey.

WYOMING.

Field work.—C. R. Longwell, W. W. Rubey, Alexander Stepanoff, and H. W. Hoots made field studies in Crook and Weston counties, Wyo., as part of a detailed study of the oil possibilities of the Black Hills rim. A. J. Collier, assisted by W. W. Boyer, mapped the Golden Eagle gas field, northwest of Thermopolis, and a number of structural features in the vicinity of Casper. J. B. Reeside, jr., accompanied an engineering party mapping the Green River canyon from Green River, Wyo., to Green River, Utah. J. D. Sears and W. H. Bradley completed field mapping in Sweetwater County, an extension of the project covering Moffat County, Colo., and began a detailed study of the Baxter Basin. Mr. Bradley, assisted by Carle H. Dane, examined deposits of oil shale in the vicinity of Steamboat Mountain, Sweetwater County.

Office work.—J. D. Sears and W. H. Bradley completed a report on the geology and oil and gas prospects of a part of Moffat County, Colo., and southern Sweetwater County, Wyo., and another on the relations of the Wasatch and Green River formations in northwestern Colorado and southern Wyoming.

D. F. Hewett worked on the text and illustrations of a report on the geology and resources of Oregon Basin, in the Meeteetse and Grass Creek quadrangles, Wyo., with particular reference to coal. C. R. Longwell and W. W. Rubey completed a press notice, accompanied by a contour map, of the Pump Creek anticline, near the Osage field. J. R. Reeside, jr., wrote a report on the geology of the Green River canyon from Green River, Wyo., to Green River, Utah. A. J. Collier prepared a press notice, map, and illustrations covering five domes in the Bates Hole district, Natrona County.

Publications.—Issues: Bulletins 736–D, 751–A.

EUROPE, ASIA, AND AFRICA.

Office work.—David White prepared a joint report with H. C. Morris, of the Department of Commerce, on progress in oil development in Europe, Asia, and Africa, which was presented before the American Institute of Mining and Metallurgical Engineers in February, 1923.

HAITI.

Office work.—W. P. Woodring, assisted by J. S. Brown and W. S. Burbank, continued work on the report on the geology of the Republic of Haiti, the expenses of which were borne by the Haitian Government. A report on the mineral deposits of Haiti was prepared by W. S. Burbank.

HAWAII.

Office work.—W. H. Dall completed and reviewed the monograph of Hawaiian marine Mollusca.

DIVISION OF MINERAL RESOURCES.

In the division of mineral resources the year was characterized chiefly by additional activities and changes imposed by the situation in the coal industry and was marked further by the completion of the delayed annual reports on mineral fuels for the years 1919, 1920, and 1921, so that at the end of the fiscal year all work was again "current." The division suffered further losses in its technical personnel, but these losses were partly offset by transfers within the Survey and by the fact that the funds thus freed were used to increase the clerical force by one permanent employee and several temporary employees. Thus, although the losses were serious, they made it possible to expedite the routine work on the longer statistical tasks, particularly the annual coal and petroleum canvasses, and to devote more of the division's funds to field canvasses on the coal industry than during the preceding year.

Despite the gain thus indicated, however, the inadequacy of personnel and funds was keenly felt. The section of nonmetals particularly suffered from lack of technically trained supervisors or specialists on at least 10 subjects, although it has been fortunate in obtaining by assignment the services of G. R. Mansfield as specialist on phosphate rock, potash, and nitrates as successor to the specialist who resigned more than a year ago. Through inability to handle certain subjects as they should be handled the Survey is not only gradually losing ground in these fields but is becoming less able to serve the Government or individuals with complete and up-to-date information and with reliable judgment.

Eight separations in the division's force occurred during the year—four resignations, two retirements, and two transfers. Five of these separations were among the clerical force and have been offset

by transfer from other divisions and new appointments. Three separations occurred in the technical force. E. G. Sievers resigned July 7, 1922, as specialist on natural gas and derived products. Mr. Sievers's place has not been filled, but his work has been added to that of the petroleum specialist, to whom has been given one additional permanent clerk. On December 31, 1922, Charles G. Yale, statistician in charge of the San Francisco branch office since 1903, retired. Mr. Yale was an authority on the metal-producing industry of the Pacific Coast States, regularly contributed creditable papers to the Survey's publications, and had been eminently successful in maintaining cordial relations with the mining public. He was succeeded by J. M. Hill, geologist. F. G. Tryon was transferred November 16, 1922, to the United States Coal Commission, the connection between the Survey's work on coal and coke statistics and the commission's work thus being established advantageously to both offices. Mr. Tryon is expected to return to the Survey on completing his assignment with the Coal Commission, and his place is being partly filled temporarily by F. J. Katz. For most of the year Mr. Katz was in charge of the division, relieving G. F. Loughlin, whose services were required primarily for geologic work.

The available office space has been even more crowded than heretofore, owing to the growth of records and files in current use and to the increase in the desk space needed for temporary clerks and for the clerks working in connection with the United States Coal Commission and the Federal fuel distributor's inquiries. The specialists accommodated in the space provided for the division and section chiefs have, as heretofore, been obliged to share their offices with two or more clerks and on account of congestion are hindered in their work and in properly caring for persons who call at the Survey for information.

Public interest during the year centered largely in the work on fuels. Weekly reports were prepared and issued on the country's production of coal and monthly reports on the production of petroleum and cement. The petroleum section of the division, in addition to doing its routine work and catching up with delayed work, prepared a large amount of statistical material on the production, stocks, and prices of crude oil for the use of the Senate Committee on Manufactures in its investigations relating to the cost of gasoline. The coal section carried on and brought up to date its usual work. It also assisted the President's unemployment conference in studies of fluctations in the coal industry and of coal marketing. While the great strike was in force it prepared for distribution, chiefly to Federal and State officials, daily reports on coal production and shipments and semiweekly statements for the use of the President and Cabinet. It also rendered assistance to the Federal fuel distributor's office and, in cooperation with the Bureau of the Census, undertook for that office five canvasses of consumers' stocks of coal, on which reports have been issued. These extraordinary undertakings necessitated the assignment of Mr. Katz to the coal-statistics section and consequent postponement of his regular work on nonmetals.

Work on metals continued as in recent years with slight additional tasks in compilation of producer lists for the Bureau of Internal Revenue and for the Senate Commission on Gold and Silver Inquiry.

Work of the nonmetals section was reduced to essential routine statistical inquiries and compilations.

Cooperation with the Bureau of the Census in the field of the division's regular statistical inquiries was restricted to a few subjects covered in the 1921 biennial census of manufactures, as outlined in the Director's report of a year ago.

Cooperation with the State geological surveys continued as heretofore. The number of cooperating States during the fiscal year was 16.

The work of the western offices continued in the main as usual. Besides the statistical work of the San Francisco office Mr. Hill had opportunity for a small amount of geologic field work in California. The demand on the office for statistical work required additional clerical help for a period of two months. At the Salt Lake City office C. N. Gerry acted in charge for about six months, while V. C. Heikes was engaged in the study of supplies of arsenic. During part of that time Mr. Heikes was at Birmingham, Ala., where he was in close touch with agriculturists and others interested in the problem of obtaining arsenic.

The section of foreign mineral reserves continued to supply timely information on foreign mineral production, reserves, and developments, especially on oil. A large amount of statistical and bibliographic material was added to its files. Toward the end of the year the work of the section was reorganized and reduced in order to expedite the preparation of atlases showing fuel reserves.

Progress in compilation of the annual chapters of Mineral Resources of the United States compares favorably with recent years. Part I of the volume for 1921 was sent to the printer in June. The final chapter of Part II, on coal, was sent to the printer in March. During the year 30 chapters of the volume for 1921 were transmitted, including a chapter on foreign mineral production, which is new to the series, and 25 chapters of the volume for 1922. Those for 1922 still incomplete include subjects that involve handling a large number of producers' reports and can not be completed earlier without more prompt cooperation from the producers; also some of the minor reports on nonmetals, which the chief of the section could not prepare because of other duties but on which the statistical work is practically complete. The preliminary summary of mineral resources in 1922 was transmitted March 31 and published August 15, 1923; the corresponding summary for 1921 was transmitted April 1 and published September 14, 1922. As for the year preceding, most of the reports for 1922 have been much curtailed, primarily to keep within the reduced printing fund, also because the scope of many of them has become so stabilized that much of the discussion of the statistical tables is no longer necessary, and partly because in the absence of specialists assigned to certain subjects only statistical material was available for publication.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The work of the division of chemical and physical research was carried on under an appropriation of $3,000 for the salary of one chemist and a lump-sum appropriation of $40,000 for laboratory

expenses, the salaries of chemists, physicists, and assistants, and expenses incident to the search for potash. The field expenses in the search for potash were approximately $5,500. The personnel comprised 14 persons and remained without change during the entire year. George Steiger, chief chemist, acted as chief of the division and also directed the work of the chemical laboratory. C. E. Van Orstrand directed the work of the physical laboratory.

The division is charged with the responsibility of aiding the study of geologic processes by conducting researches in chemistry, physics, and mineralogy, by making chemical analyses of rocks, minerals, ores, and waters, and by carrying out physical measurements and observations in both field and laboratory.

WORK IN CHEMISTRY.

The section of chemistry has continued a service to the public in identifying 2,085 specimens sent in by persons from all parts of the country. Most of the specimens were identified by simple inspection. Quantitative analyses numbered 673 and were made mainly for use in geologic investigations.

A paper on the evolution and disintegration of matter was prepared by F. W. Clarke for publication. This paper is an elaborate discussion of the evolution of the elements from nebula to planet, including a discussion of the reverse process of stellar disintegration and a discussion of the average composition of the earth.

Supplemental experiments were made on the effect of nitric acid on granite by George Steiger. Mr. Steiger also examined the pebble-phosphate workings of Polk County, Fla., and prepared a brief report on that industry. After a study of conditions to be satisfied a method for the analysis of sediments was outlined by Mr. Steiger and J. G. Fairchild. During the year the method was practically applied, with satisfactory results, to the analysis of 68 bottom samples from the Bay of Maine and from the vicinity of Samoa.

An exhaustive study of the chemical changes by which metallic copper may be formed in nature, with particular reference to the Lake Superior region, was begun by R. C. Wells, who visited the mines early in the year for the purpose of collecting samples and who later prepared and read a paper on the subject before the Ann Arbor meeting of the Geological Society of America in December, 1922. At this meeting Mr. Wells also read a paper on the flocculation of colloids before the conference on sedimentation. Mr. Wells finished revision of the manuscript on sodium sulphate, which was published as Bulletin 717. An address on the chemistry of the sea was given by Mr. Wells before the Chemical Society of Washington.

A wax from the Elko oil shale was separated and studied by E. T. Erickson, who also studied bituminization in cannel coal and made a careful investigation, including laboratory experiments, to show the nature of the hydrocarbons of a submerged forest found in excavating for a new hotel at Washington, D. C.

W. T. Schaller investigated a number of rare and unusual minerals and described one new species, argentojarosite. He continued the study of uranium and vanadium minerals and of pegmatites and prepared a paper on this subject and examined in the field pegmatites in North Carolina, Maryland, and Pennsylvania. The silicic acid derived from the mineral gillespite was further studied in conjunction with X-ray spectra. Field studies were made of copper-cobalt minerals in Maryland, graphite and quartz in North Carolina, crystallized turquoise in Virginia, and the zeolite region in New Jersey. Measurements of openings in ordinary laboratory screens again demonstrated the wide variance in size of holes in screens of certain mesh. Mr. Schaller also assisted and partly supervised E. P. Henderson in the inspection and identification of many specimens of minerals, rocks, and ores.

Field work in the search for potash is described in the report of the division of geology. There was a decided decrease in the number of samples received for assay owing to the fact that a number of wells now being put down with the core drill in order to obtain more reliable samples have not yet reached the salt dome. R. K. Bailey determined necessary conditions for flame tests for potash, including tests of the limits of error.

WORK IN PHYSICS.

C. E. Van Orstrand made observations of temperature in 128 springs and geysers in Yellowstone National Park. A report on these observations, entitled "Temperatures in some springs and geysers in Yellowstone National Park," has been submitted to the American Geophysical Union for publication with other papers on thermal springs. The preparation of the extended paper on deep earth temperatures of the globe was continued at intervals throughout the year. Observations of deep earth temperatures were made in Pennsylvania, Wyoming, and Oregon. A paper on "Apparatus for the measurement of temperatures in deep wells by means of maximum thermometers" is ready for publication. A patent has been granted on one of the machines used in measuring the depths to which thermometers are lowered into deep wells. Two papers dealing with the subject of isostasy were completed. The first, "Notes on isostasy," was published in the Bulletin of the Geological Society of America as an appendix to the paper by W. T. Lee on "Building of the southern Rocky Mountains." A second paper, "Some phases of the resistance of the earth's material to changes," was prepared as a contribution to the general subject of mountain building on the basis of isostatic adjustment.

A. F. Melcher continued the general study of the texture of oil and gas sands in various parts of the United States. With the assistance of M. A. Shoultes and of J. G. Douglas, a student of Johns Hopkins University, he completed determinations of the pore space of 200 samples of oil and gas sands. Mr. Shoultes also assisted in the determination of the diameter of grains of 40 samples. In connection with this work a special study is being made of the Hickman sand in the Burbank field, Okla., with the object of ascertaining the variations in diameter of the grain in different parts of the field, and also of establishing a relation between porosity and initial production. A report on the texture of oil and gas sands with relation to production is nearly completed. K. C. Heald cooperated in some of the field work. In addition to assisting in the experimental and computational work of the laboratory Mr. Shoultes conducted heating tests of oil shales and of solids in process of diffusion.

A number of papers prepared for publication, both official and for private journals, were reviewed by various members of the division.

ALASKAN MINERAL RESOURCES BRANCH.

The personnel of the Alaska force included, on July 1, 1922, 1 chief Alaskan geologist, 4 geologists, 2 topographers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist on monthly salary, and 1 geologist and 2 geologic aids on per diem salaries; and on June 30, 1923, 1 chief Alaskan geologist, 6 geologists, 2 topographers, 1 cadastral engineer, 1 draftsman, and 4 clerks on annual salaries, 1 assistant geologist and 1 junior topographer on monthly salaries, and 2 geologists, 1 assistant geologist, and 1 geologic aid on per diem salaries.

The Alaska field season extends from May to October, and the subsequent office work required to complete the results of field investigations usually extends to the beginning of the next field season. The period covered therefore does not coincide with the fiscal year, but as appropriations for work on Alaska are made available immediately, field work may be done until the end of a fiscal year on two appropriations simultaneously. In a region so remote as Alaska, however, and in projects that do not conform to the fiscal period, it is necessary to report by projects, not by periods. The accompanying statement therefore shows the work done during the field season of 1922, as defined above, and gives such notes on the projects for the field season of 1923 as were available at the time the report was prepared.

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The funds available included an appropriation of $75,000 for 1922–23, an unexpended balance of $5,430, and an allotment of $2,000 from the appropriation for the classification of public lands. The appropriation of 1923–24, amounting to $75,000, became available January 24, 1923, and an allotment of $75,000 was made from funds of the Navy Department April 3, 1923, for special work in Navy petroleum reserve No. 4, but these items are not included in the fiscal analyses attached. Expenditures for the field season of 1922 were as follows:

Approximate distribution of funds for investigations in Alaska, field season 1922.

General investigations, geology and mineral resources	$9,600
Southeastern Alaska	5,400
Copper River	8,400
Alaska Railroad	4,200
Alaska Peninsula	24,850
Yukon Basin	7,580
Map compilation	5,200
Collecting mineral statistics	3,100
Allotted for field work, 1923	14,100
	82,430

Approximate allotments of Alaska funds to different kinds of surveys and investigations, field season 1922.

Special investigations of geology and mineral resources	$10,700
Reconnaissance geologic surveys	23,630
Reconnaissance topographic surveys	14,000
Map compilation	4,100
Collecting mineral statistics	2,400
Administration, including clerical salaries, miscellaneous expenses, etc	7,500
Office of Director	6,000
Allotted for field work, 1923	14,100
	82,430

Allotments of Alaska funds for salaries and field expenses, field season 1922.

Scientific salaries	$28,400
Field expenses	24,430
Miscellaneous expenses, including clerical salaries, etc	9,500
Office of Director	6,000
Allotted for field work, 1923	14,100
	82,430

The following table shows the progress of investigations in Alaska and the annual grants of funds since systematic surveys were begun in 1898 but does not include surveys made during the field season of 1923. A varying amount is spent each year on special investigations that yield results which can not be expressed in terms of area. Since 1918 the reduction of the annual appropriation and the increased cost of all field work have not permitted extensive geologic and topographic surveys.

Progress of surveys in Alaska, 1898–1922.

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	80,000	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	75,000	.....	3,500	.....	.....	1,200	.....	.....	.....	.....	.....
1919	75,000	.....	2,700	.....	.....	2,300	.....	.....	.....	19	.....
1920	75,000	.....	1,480	.....	.....	770	.....	.....	.....	19	.....
1921	75,000	.....	2,130	150	.....	300	205	.....	.....	.....	.....
1922	75,000	.....	4,000	.....	.....	4,300	.....	.....	.....	.....	.....
	1,956,189	73,200	115,095	5,657	51,680	156,900	3,936	462	74	.....	.....
Percentage of total area of Alaska	.....	12.48	19.63	0.96	8.81	26.76	0.67	.....	.....	.....	.....

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

Field season of 1922.—Alfred H. Brooks, chief Alaskan geologist, was engaged in office work until June 12, 1922, when he joined an expedition to the northern Pacific under the auspices of the Department of Commerce, investigating the geology and mineral resources in the coastal regions of Alaska, the adjacent islands, and portions of the coast of Siberia. His office time was divided between geologic studies, preparation of the annual progress report and press bulletin, mineral statistics, field plans, the assembling of data on the geology of the Point Barrow region, and administrative and routine matters.

G. C. Martin did no field work in the summer of 1922 and was engaged throughout the year in geologic studies of the Alaska Mesozoic formations and in administrative duties as acting chief Alaskan geologist during Mr. Brooks's absence.

Philip S. Smith, from June 14 to September 13, made geologic investigations of areas adjacent to the Alaska Railroad.

Fred H. Moffit was engaged in a revision and extension of the reconnaissance geologic mapping of the Chitina Valley.

J. B. Mertie, jr., continued reconnaissance geologic mapping of parts of the Rampart and Fairbanks quadrangles and collected mineral statistics in the vicinity of Fairbanks.

Geologic mapping and investigation of the mineral resources of the Wrangell district were continued by A. F. Buddington.

A reconnaissance topographic and geologic survey of the oil fields of Alaska Peninsula was made by a double party in charge of R. H. Sargent. Mr. Sargent was accompanied by W. R. Smith, geologist. The second party in this general region was under the leadership of R. K. Lynt, accompanied by A. A. Baker, geologist.

C. Arthur Hollick was employed for seven months in continuing his studies of the Alaska Tertiary fossil plants.

James McCormick was employed for six months in the revision of the "Geographic dictionary of Alaska." John B. Torbert was engaged in Alaska cartographic work throughout the year, and E. B. Hill, assistant topographic engineer, was engaged in work on Alaska maps for about two months.

Miss Lucy M. Graves, chief clerk, has continued to carry much of the clerical administration of the branch and has acted as chief during the absence of the chief and acting chief Alaskan geologists. The details of collecting statistics of the mineral production of Alaska have been in the hands of T. R. Burch.

Field season of 1923.—Alfred H. Brooks left Washington June 21, 1923, to make certain inquiries in Seattle and carry on some investigations in the vicinity of Juneau, Alaska.

A. F. Buddington is continuing a geologic reconnaissance survey and study of the mineral resources of the Wrangell district.

S. R. Capps, on furlough since April 16, 1922, returned May 1, 1923, and resumed the preparation of his report on the geology and mineral resources of the region tributary to the Alaska Railroad. In June, 1923, he took over administrative charge of the branch as acting chief Alaskan geologist. In the later part of the summer he will continue the investigation of the geology and mineral resources of the country along the Alaska Railroad.

G. C. Martin, after a comparative study of some of the oil districts in California, is making geologic and petroleum investigations in the Alaska Peninsula.

J. B. Mertie, jr., is extending the geologic reconnaissance survey and study of the mineral resources of the Chandalar district and adjacent regions of Alaska.

F. H. Moffit is making geologic surveys and investigating the copper deposits of Prince William Sound region.

Sidney Paige, in charge of three combined geologic and topographic parties, is surveying Naval Petroleum Reserve No. 4, on the Arctic coast of Alaska. The scientific personnel of his party comprises Wm. T. Foran and James Gilluly, geologists; E. C. Guerin, cadastral engineer; and Gerald FitzGerald, topographer.

R. K. Lynt, accompanied by W. R. Smith, geologist, is extending geologic and topographic surveys in the Cold Bay region.

R. H. Sargent, accompanied by K. F. Mather, geologist, is making a geologic and topographic reconnaissance survey of the Douglas River-Katmai region.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

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

Chief topographic engineer, C. H. Birdseye.

Atlantic division, topographic engineer in charge, Frank Sutton.

Central division, topographic engineer in charge, W. H. Herron.

Rocky Mountain division, topographic engineer in charge, Glenn S. Smith. (In the absence of Mr. Birdseye Mr. Smith acted as chief topographic engineer.)

Pacific division, topographic engineer in charge, T. G. Gerdine.

Division of West Indian surveys, topographic engineer in charge, Glenn S. Smith.

Computing section, topographic engineer in charge, E. M. Douglas.

Section of inspection and editing, topographic engineer in charge, W. M. Beaman.[1]

[1] Mr. Beaman was on duty with the Brazilian Centennial Exposition at Rio de Janeiro from August 16, 1922, to May 31, 1923, and during that time L. S. Leopold was in charge of the section.

Section of cartography, draftsman in charge, A. F. Hassan.
Map information office, topographic engineer in charge, J. H. Wheat.
Section of relief maps, geographer in charge, J. H. Renshawe.
Section of photographic mapping, topographic engineer in charge, T. P. Pendleton.[2]

PERSONNEL.

The technical force was increased by the appointment of 10 junior topographers, 1 phototopographic engineer, 4 draftsmen, 1 temporary computer, and 4 temporary draftsmen and the reinstatement and transfer of 1 topographic engineer, 4 assistant topographic engineers, 2 junior topographers, and 3 draftsmen. The force was reduced by 1 death, 9 resignations, and 5 transfers. With these changes the corps now includes 1 chief topographic engineer, 4 topographic engineers in charge of divisions, 4 geographers, 75 topographic engineers, 2 topographers, 41 assistant topographic engineers, 30 junior topographers, 1 phototopographic engineer, 1 map editor, 2 map revisers, 1 computer, and 14 draftsmen, a total of 176. During the year 12 topographic engineers, 3 assistant topographic engineers, and 6 junior topographers were on furlough. In addition, 21 technical field assistants were employed during the whole or a part of the year. The clerical force comprises 12 clerks of various grades, one of whom is a temporary employee.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consisted of 71 new standard topographic maps, 9 new State maps, and 42 river plans and profiles; 2 State maps completely revised are in press. Advance photolithographic editions were printed for 95 new topographic maps now in process of engraving and final publication, and 68 photolithographs were printed of new topographic maps, for which publication has not yet been otherwise provided. Additional publications were a shaded relief map of Ohio; maps of the Lafayette National Park, Maine, and the Jeptha Knob area, Kentucky; and a road map of Washington, D. C., and vicinity.

The remaining advance chapters of Bulletin 709, giving results of triangulation and primary traverse for 1916–1918, prepared for publication in 1920, were published during the year.

Manuscript for a bulletin giving level results in California for 1896–1922 has been transmitted for publication.

APPROPRIATIONS.

The Federal appropriations for topographic surveys for the fiscal year 1923 were as follows:

Topographic surveys	$325,000.00
Salaries, scientific assistants	9,200.00
Special funds for military mapping (contributed by War Department)	34,629.11
	368,829.11

[2] Mr. Pendleton was on leave without pay from the beginning of the fiscal year to May 1, 1923, and during that time J. H. Wheat was in charge of the section.

COOPERATION.

Cooperation has been maintained in 22 States and 1 Territory, which contributed the following amounts:

California	$46,851.80	Pennsylvania	$26,973.84
Connecticut	1,728.81	South Dakota	5,033.50
Hawaii	22,328.11	Tennessee	3,696.27
Idaho	174.27	Texas	15,545.21
Illinois	27,832.47	Utah	8,934.90
Iowa	1,985.67	Vermont	2,999.79
Kentucky	17,082.95	Virginia	2,850.18
Louisiana	14,518.42	Washington	7,582.82
Maine	6,692.28	West Virginia	20,093.64
Mississippi	5,446.43	Wisconsin	14,194.51
Missouri	15,828.36		
New York	14,400.92		286,302.44
Oregon	3,527.29		

In addition, work was executed as follows: Base-map work for the land-classification branch, cost, $7,500; work for the Reclamation Service, $5,914.06; base-map work for the Coal Commission, $4,285.86; base-map work for the Forest Service, $2,026.95; work for the Bureau of Immigration, $19.33; work for the International Boundary Commission, $5.20; work for the National Park Service, $2,856; field surveys for the Navy Department, $544.07; work for the Office of Public Buildings and Grounds, $19.20; base-map work for the Bureau of Education, $126.16. The total amount available from these sources was $23,296.83.

The total amount expended from all sources for the work of the topographic branch was $678,428.38.

SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1923, distinguished as to scale and date, is shown on Plate I.

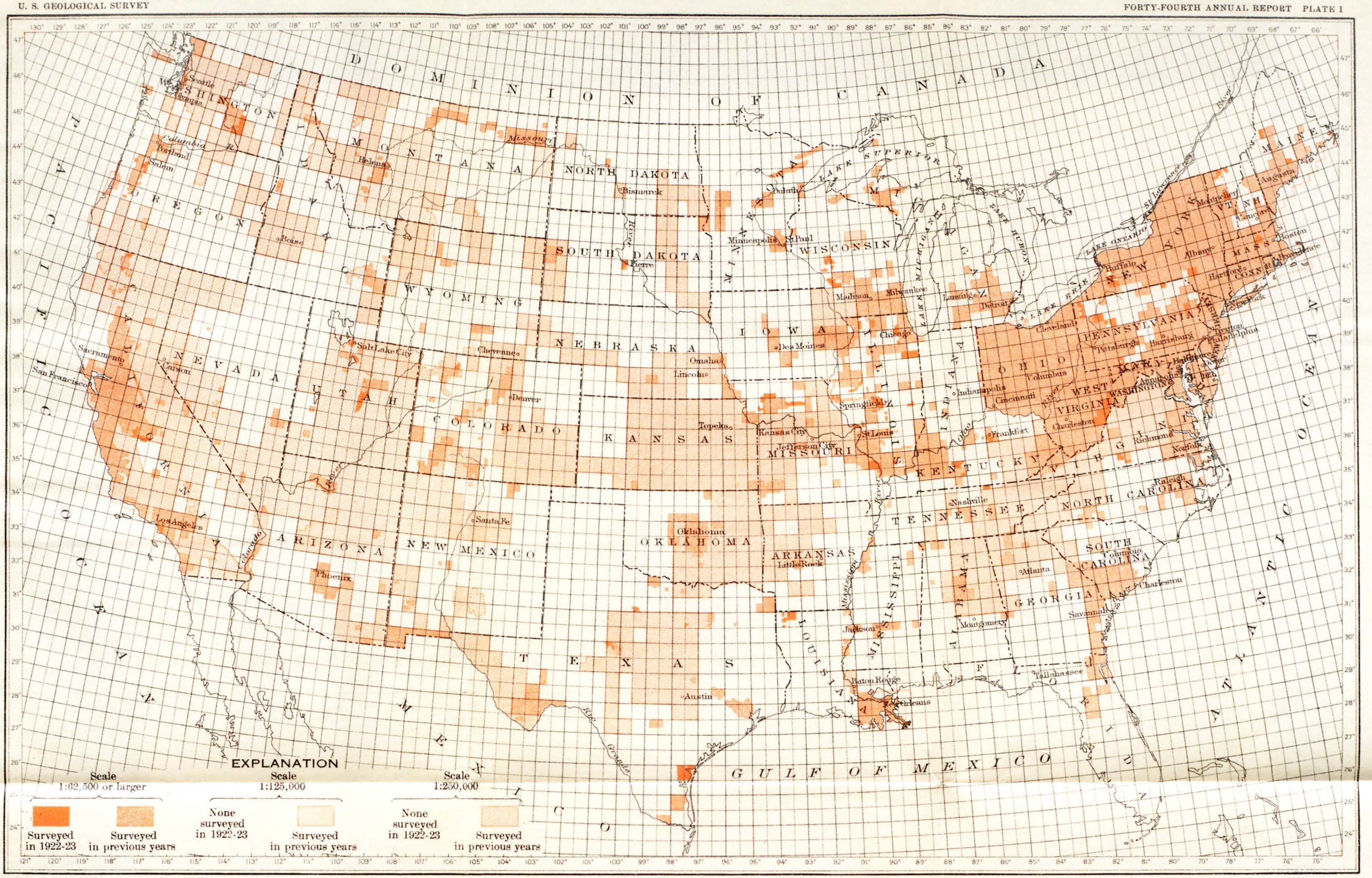
As shown in the following table, the new area mapped was 13,129 square miles, making the total area surveyed to date in the continental United States, exclusive of Alaska, 1,232,041 square miles, or 40.7 per cent of the entire country. In addition, 1,710 square miles of resurvey was completed, making the total area of surveys during the year 14,839 square miles. River surveys amounting to 564 linear miles were also made.

In connection with these surveys 6,413 linear miles of primary levels were run, making 297,194 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,733 permanent bench marks were established.

Triangulation stations to the number of 102 were occupied and 83 were permanently marked.

Primary traverse lines aggregating 2,314 miles were run, in connection with which 484 permanent marks were set.

In addition, 559 square miles of topographic mapping was completed in Hawaii and 65 miles of primary levels were run and 21 bench marks established.



AREAS COVERED BY TOPOGRAPHIC SURVEYS MADE BY UNITED STATES GEOLOGICAL SURVEY PRIOR TO JULY 1, 1923

AND THE SCALE EMPLOYED FOR EACH AREA

Scale $\frac{1}{14000000}$

100 0 100 200 300 400 500 Miles

A. HOEN & CO. LITH. BALTIMORE.

Present condition of topographic surveys of the United States and new area surveyed July 1, 1922, to June 30, 1923.

State.	New area mapped July 1, 1922, to June 30, 1923.	Total area mapped to June 30, 1923.	Percentage of total area of State mapped to June 30, 1923.	State.	New area mapped July 1, 1922, to June 30, 1923.	Total area mapped to June 30, 1923.	Percentage of total area of State mapped to June 30, 1923.
	Sq. miles.	*Sq. miles.*			*Sq. miles.*	*Sq. miles.*	
Alabama	.....	19,192	37.0	New Jersey	.....	8,224	100.0
Arizona	.....	55,429	48.7	New Mexico	.....	40,412	32.9
Arkansas	.....	21,494	40.3	New York	1,094	47,828	97.2
California	1,012	121,074	76.5	North Carolina	.....	18,876	36.0
Colorado	224	51,358	49.4	North Dakota	.....	10,017	14.1
Connecticut	.....	4,965	100.0	Ohio	.....	41,040	100.0
Delaware	.....	2,370	100.0	Oklahoma	.....	39,908	57.0
District of Columbia	.....	70	100.0	Oregon	351	26,255	27.2
Florida	.....	4,716	8.0	Pennsylvania	1,898	30,825	68.3
Georgia	.....	24,835	41.9	Rhode Island	.....	1,248	100.0
Idaho	14	28,586	33.9	South Carolina	.....	13,675	44.1
Illinois	1,886	22,300	39.4	South Dakota	134	19,243	24.8
Indiana	18	3,627	10.0	Tennessee	132	21,552	51.3
Iowa	109	12,495	22.3	Texas	1,028	78,341	29.5
Kansas	.....	64,159	78.0	Utah	553	16,855	19.8
Kentucky	696	19,893	48.9	Vermont	410	5,700	59.6
Louisiana	444	8,810	18.2	Virginia	240	36,512	85.7
Maine	291	11,135	33.7	Washington	715	32,719	47.3
Maryland	.....	12,327	100.0	West Virginia	.....	24,170	100.0
Massachusetts	.....	8,266	100.0	Wisconsin	562	15,168	27.1
Michigan	.....	11,153	19.2	Wyoming	.....	30,088	30.7
Minnesota	.....	7,354	8.7				
Mississippi	119	3,881	8.3	Total continental United States (exclusive of Alaska)	13,129	1,232,041	40.7
Missouri	1,199	39,813	57.3				
Montana	.....	41,590	28.5				
Nebraska	.....	27,117	35.0	Hawaii	559	2,975	46.1
Nevada	.....	41,141	37.5				
New Hampshire	.....	4,235	45.3				

Topographic surveys from July 1, 1922, to June 30, 1923.

State.	Contour interval.	For publication on scale of—				Total area surveyed.		
		1:20,000.	1:24,000.	1:31,680.	1:62,500.	New.	Resurvey.	Total.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
California	5	.....	402	610	.....	1,012	.....	1,012
Colorado	20,50	.....	.....	94	130	224	.....	224
Idaho	50	.....	.....	.....	14	14	.....	14
Illinois	10,20	.....	.....	.....	1,886	1,886	.....	1,886
Indiana	10	.....	.....	.....	18	18	.....	18
Iowa	20	.....	.....	.....	109	109	.....	109
Kentucky	20	.....	.....	.....	696	696	.....	696
Louisiana	20	.....	.....	.....	444	444	.....	444
Maine	20	.....	.....	.....	291	291	.....	291
Massachusetts	10	46	.....	.....	.....	.....	46	46
Mississippi	5,10,20	.....	61	.....	58	119	.....	119
Missouri	10,20	.....	163	.....	1,036	1,199	.....	1,199
New York	20	.....	.....	.....	1,094	1,094	.....	1,094
Oregon	5,20,25,50	.....	.....	130	221	351	.....	351
Pennsylvania	20	.....	.....	.....	1,898	1,898	.....	1,898
South Dakota	20	.....	.....	.....	134	134	.....	134
Tennessee	20	.....	.....	.....	132	132	.....	132
Texas	5,20	.....	76	.....	952	1,028	.....	1,028
Utah	1,5,50	.....	187	366	.....	553	.....	553
Vermont	20	.....	.....	.....	410	410	.....	410
Virginia	20	.....	.....	.....	240	240	.....	240
Washington	25	.....	.....	.....	715	715	.....	715
West Virginia	50	.....	.....	.....	1,664	.....	1,664	1,664
Wisconsin	20	.....	.....	.....	562	562	.....	562
	.....	46	889	1,200	12,704	13,129	1,710	14,839
Hawaii	10,50	.....	.....	559	.....	559	.....	559

Topographic surveys from July 1, 1922, to June 30, 1923—Continued.

State.	Levels.		Primary traverse.		Triangulation.	
	Distance run.	Permanent bench marks.	Distance run.	Permanent marks.	Stations occupied.	Stations marked.
	Miles.		*Miles.*			
California	457	103	115	18	51	34
Connecticut	488	150				
Idaho					15	15
Illinois	779	221	325	68		
Iowa			173	34		
Kentucky	329	80	258	71		
Louisana	746	217	479	134		
Maine	183	42				
Massachusetts	134	24	125	29		
Mississippi	153	45				
Missouri	245	75	120			
New York	311	67	274	42		
Ohio			160	13		
Oregon		8				
Pennsylvania	274	96				
Rhode Island	8					
South Dakota	386	125				
Tennessee	287	64				
Texas	529	131	201	54		
Utah	368	74			26	25
Vermont	158	43			2	3
Virginia	81	27				
Washington	200	54			8	6
West Virginia	69	13				
Wisconsin	228	74	84	21		
	6,413	1,733	2,314	484	102	83
Hawaii	65	21				

GENERAL OFFICE WORK.

Computations for vertical and horizontal control were made and the results were copied and catalogued by the computing section. The section of relief maps prepared shaded relief maps of Colorado and West Virginia; Grand Canyon of Colorado River; Asheville and vicinity and Brown Mountain district, N. C.; Teapot Dome, Wyo.; and parts of Pennsylvania, northern New Mexico, and the San Juan Mountains, Colo., as well as of the following quadrangles: Altoona, Milton, Tyrone, and Philipsburg, Pa., and Clintonville, Hanging Rock, Ronceverte, and White Sulphur Springs, W. Va. The section of photographic mapping was engaged in miscellaneous work in connection with the utilization of Air Service photographs in topographic mapping. The map-information office was engaged in indexing and cataloguing the map data available in the several Federal departments and a number of non-Federal organizations and in furnishing miscellaneous map information to the public.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

The section of inspection and editing of topographic maps continued to supervise the office preparation of all topographic maps and to inspect and edit them before reproduction; it also edited a number of maps submitted by other Survey branches and Government bureaus.

The number of Survey topographic maps in progress in the topographic branch (exclusive of those being engraved and printed) ranged from 145 in August to 192 in January; the monthly average was 174.

An average of 14 employees were engaged in this section for the year.

W. M. Beaman was designated as the representative of the topographic branch of the Survey at the exhibit of military maps and mapping held jointly with the Corps of Engineers and the Military Intelligence Division, United States Army, at the Brazilian Centennial Exposition in Rio de Janeiro. While on this duty Mr. Beaman was furloughed without pay from the Survey from August 16 to May 31 and reported to the Brazilian Centennial Commission. During his absence L. S. Leopold was acting chief of the section.

James McCormick divided his time between representing the Survey on the United States Geographic Board and on similar special investigations and a revision of the "Geographic dictionary of Alaska."

The work of this section is described further under "Publication branch" (p. 82).

SECTION OF CARTOGRAPHY.

The compilation of the base of the United States portion of the international map of the world was continued during the year with the cooperation of the Bureau of Public Roads. The Texas portion of this map, in course of compilation the previous year, was completed, and the Arizona and Oregon portions were completely revised, as was the Montana portion, which was partly revised the previous year. Maps of this series have been prepared for 47 States.

Other map projects included the preparation for the Air Service, United States Army, of an air-navigation map of central California and strip maps of the territory from Dayton, Ohio, to Wheeling, W. Va., and from Wheeling, W. Va., to Washington, D. C. Other strip maps for air navigation were in course of preparation; a map of Fayette County, Tenn., was redrafted for the State; the road map of Illinois was revised for the State; and several graphs and charts were prepared for the Federal Board for Vocational Education. One employee was detailed in charge of drafting for the Coal Commission, and another was engaged for a short period in map work for Porto Rico.

ATLANTIC DIVISION.

FIELD WORK.

Connecticut.—In cooperation with the Connecticut State Highway Commission for control of new work, 488 miles of primary levels were run and 150 permanent bench marks established. In addition, the United States Coast and Geodetic Survey ran 278 miles of precise levels and set 241 permanent bench marks, the work being paid for by the Geological Survey.

Maine.—In cooperation with the Maine State Water Power Commission, the survey of the Long Pond quadrangle was completed, and that of the Burnham quadrangle was begun.

Massachusetts.—The resurvey of Camp Devens and vicinity was begun, the total area mapped being 46 square miles, for publication on the scale of

1:20,000, with a contour interval of 10 feet. For the control of this area 134 miles of primary levels were run, 24 permanent bench marks established, 125 miles of primary traverse run, and 29 permanent marks set. This work was done for the War Department.

New York.—In cooperation with the State engineer of New York, the survey of the Andes, Ellicottville, Randolph, and Walton quadrangles was completed, and that of the Chafee, Colden, and Franklinville quadrangles was begun. At the request of the Bureau of Yards and Docks, Navy Department, the survey of a proposed hospital site for the Veterans' Bureau near Liberty, N. Y., was completed. The cost of the work was paid by the Navy Department.

Pennsylvania.—In cooperation with the Pennsylvania State Bureau of Topographic and Geological Survey, the survey of the Mauch Chunk, Milton, Mount Union, Oil City, Reynoldsville, Stoddartsville, and Tionesta quadrangles was completed, and that of the Berlin, Brookville, Cambridge Springs, Meadville, and Towanda quadrangles was begun.

Pennsylvania-New Jersey.—In cooperation with the Pennsylvania State Bureau of Topographic and Geological Survey, the survey of the Bushkill quadrangle was begun. The area mapped was all in Pennsylvania.

Rhode Island.—For the control of Block Island 8 miles of primary levels were run. This work was done for the War Department.

Tennessee.—At the request of the Engineer Corps of the Army, 202 miles of primary levels were run along Tennessee River and 56 permanent bench marks were set, to be used by the Corps in the investigation of the Tennessee River basin.

Tennessee-Kentucky.—In cooperation with the Tennessee State geologist, the survey of the Lillydale quadrangle was completed and that of the Byrdstown quadrangle was begun. The area mapped was all in Tennessee.

Vermont.—In cooperation with the Vermont State geologist, the survey of the Barre quadrangle was completed and that of the Corinth quadrangle was begun. In addition, the survey of the Franklin Pond quadrangle was completed and that of the Irasburg and Montgomery quadrangles was begun. This work was done for the War Department.

Virginia.—In cooperation with the State geologist of Virginia, the survey of the Callands quadrangle was completed.

Virginia-North Carolina.—In cooperation with the State geologist of Virginia, the survey of the Danville quadrangle was begun. The area mapped was all in Virginia.

West Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Durbin, Horton, Lobelia, Marlinton, and Mingo quadrangles was completed.

West Virginia-Virginia.—In cooperation with the State geologist of West Virginia, the resurvey of the Cass, Hightown, Spruce Knob, and Warm Springs quadrangles was completed. The area mapped was all in West Virginia.

OFFICE WORK.

The drafting of 22 sheets was completed, and that of 9 sheets was begun. Primary-level circuits were adjusted for 26 quadrangles. Geographic positions were computed for 22 quadrangles.

CENTRAL DIVISION.

FIELD WORK.

Illinois.—In cooperation with the Illinois Department of Registration and Education, the survey of the Essex, Geneva, Glenarm, Kankakee, Liberty, Oregon, and Taylorville quadrangles was completed and that of the Assumption, Cornland, Elgin, Harvel, Marion, Morrisonville, Petersburg, and Yorkville quadrangles was begun. In addition, the survey of projects Nos. 4, 5, 12, 13, 14, and 15 was completed, the total area mapped being 317 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. This work was done in such a manner as to be available for future incorporation in regular topographic maps.

Illinois-Indiana.—In cooperation with the State of Illinois, the survey of the Momence quadrangle was completed.

Iowa.—In cooperation with the Iowa State Geological Survey, the survey of the Melcher quadrangle was completed.

Kentucky.—In cooperation with the Kentucky Geological Survey, the survey of the Frankfort, Mammoth Cave, and Leitchfield quadrangles was completed and that of the Cub Run, Horse Branch, and Waddy quadrangles was begun.

Missouri.—In cooperation with the Missouri State geologist the survey of the Cape Girardeau, Perryville, Polo, and Winston quadrangles was completed and that of the Ford City, Gilman City, Maysville, Pattonsburg, and Plattsburg quadrangles was begun. In addition a survey was made along certain highway routes in Linn, Macon, and Livingston counties, 163 square miles being completed on the scale of 1:24,000, with a contour interval of 10 feet. This work was done in such a manner as to be available for future incorporation in regular topographic maps. A plan and profile survey was made of Gasconade River from Arlington to Rich Fountain, the sketching extending to the top of the bluffs along the river and up all tributaries 100 feet above the elevation of the river for a distance of 53 miles from the initial point. In connection with this project 36 miles of levels were run and 14 bench marks established.

Missouri-Illinois.—In cooperation with the State of Missouri the survey of the Altenburg quadrangle was completed and that of the Alton and Bonfils quadrangles was begun. The area mapped was all in Missouri.

Ohio.—In preparation for the revision of the maps of the East and West Columbus quadrangles 160 miles of primary traverse were run and 13 permanent marks set.

Wisconsin.—In cooperation with the State geologist of Wisconsin the survey of the Black River Falls, Galesville, La Farge, North Bend, Pigeon Falls, and Viroqua quadrangles was begun. In addition the survey of highway projects Nos. A_3 and B_1 was completed and that of highway projects Nos. C_1, C_2, and D_1 was begun. This work was arranged in such a manner as to be incorporated without adjustment into regular maps of quadrangles of which the areas surveyed are a part.

OFFICE WORK.

The drafting of 26 sheets was completed and that of 16 sheets was begun. Primary-level circuits were adjusted for 41 quadrangles. Geographic positions were computed for 66 quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

Colorado.—The survey of the Elkhead No. 3 quadrangle was begun.

Colorado-Utah.—The Geological Survey made special surveys and investigations to ascertain the feasibility of storing and diverting the waters of Green River for irrigation and for the generation of power. These surveys extended from Green River, Wyo., to Green River, Utah. In this connection surveys were made of Yampa River from its mouth to Cross Mountain reservoir site. In this work 306 miles of river traverse and 94 square miles of topographic mapping (67 square miles along Green River and 27 square miles along Yampa River) were completed, for publication on the scale of 1:31,680, with a contour interval of 20 feet. This work was done for the land-classification branch and in cooperation with the Utah Power & Light Co.

Idaho.—In cooperation with the Forest Service triangulation was extended over the Idaho National Forest, 15 stations being occupied and 15 marked.

Idaho-Oregon.—In cooperation with the State Bureau of Mines and Geology of Idaho and the State Bureau of Mines and Geology of Oregon, the survey of the He Devil quadrangle was continued.

Louisiana.—In cooperation with the Department of Conservation of Louisiana, the survey of the Sarepta quadrangle was completed and that of the Bossier and Plain Dealing quadrangles was begun.

Mississippi.—In cooperation with the Mississippi Geological Survey, the survey of the Pelahatchee quadrangle was completed. In addition, a plan and profile survey of Pearl and Strong rivers was made to ascertain the feasibility of water-power development. In connection with this work 17 miles of river traverse and 61 square miles of topographic mapping were completed, for publication on the scale of 1:24,000, with contour intervals of 5, 10, and 20 feet. For the control of this area 153 miles of primary levels were run and 45 permanent bench marks were established. At the request of the Bureau of Yards and Docks, Navy Department, a proposed hospital site for the

Veterans' Bureau near Gulfport, Miss., was surveyed. The cost of the work was paid by the Navy Department.

South Dakota.—In cooperation with the State geologist of South Dakota, the survey of the Pierre quadrangle was completed.

Texas.—In cooperation with the Texas Bureau of Economic Geology and Technology, the survey of the Aransas Pass, Corpus Christi, Driscoll, Oso Creek, and Robstown quadrangles was completed. In cooperation with the State Board of Water Engineers, the survey of the Breckenridge reservoir site, the Bronte reservoir site, and the Fort Worth reservoir site was completed.

Utah.—In cooperation with Box Elder, Salt Lake, Tooele, Utah, and Weber counties, Utah, and the United States Reclamation Service, the survey of these counties was begun, the total area mapped being 187 square miles. For the control of these projects 368 miles of primary levels were run, 74 permanent bench marks established, and 26 triangulation stations occupied, 25 of which were permanently marked. This work was done to aid in planning irrigation and drainage systems, and the results will be incorporated in regular topographic maps. In addition, the survey of the Hiawatha quadrangle was completed, that of the Castle Dale and Monument Peak quadrangles was continued, and that of the Emery quadrangle was begun, the total area mapped being 366 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. This work was done for the land-classification branch.

OFFICE WORK.

The drafting of 12 sheets was completed and that of 8 sheets was begun. Primary-level circuits were adjusted for 41 quadrangles. Geographic positions were computed for 26 quadrangles.

PACIFIC DIVISION.

FIELD WORK.

California.—In cooperation with the California Department of Public Works, for work in San Joaquin Valley, the survey of the Caruthers, Conejo, Gravel Ford, Helm, Jamesan, Raisin, San Joaquin, Selma, and Tranquillity quadrangles was completed and that of the Laton and Riverdale quadrangles was begun. In cooperation with the United States Reclamation Service, the Klamath-Shasta Valley irrigation district, and the Department of Public Works of California, the survey of the Shasta Valley project was completed on a scale of 1:24,000, with a contour interval of 5 feet, for preliminary study and planning the general outline of an irrigation system. In connection with this project 160 square miles of topographic mapping was completed. For the control of this area, 15 miles of primary levels were run and 3 permanent bench marks established. In cooperation with Los Angeles County the survey of the Compton, Florence, Inglewood, Sawtelle, Torrance, and Venice 6-minute quadrangles was completed and that of the Van Nuys and Wilmington 6-minute quadrangles was begun, the total area mapped being 242 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. Practically all the expenses for this work were paid by Los Angeles County. Airplane photographs were taken by the Army Air Service, which aided in the progress of mapping wooded and marshy areas. For the control of this work 302 miles of primary levels were run, 67 permanent bench marks established, 78 miles of primary traverse run, 8 permanent marks set, and 51 triangulation stations occupied, 34 of which were marked.

Hawaii.—In cooperation with the governor of Hawaii, the survey of the Kahului NE. ¼, Kahului SE. ¼, Kahului SW. ¼, Kalapana NW. ¼, Kalapana NE. ¼, Kalapana SW. ¼, Lahaina NW. ¼, Lahaina NE. ¼, Lahaina SW. ¼, Lahaina SE. ¼, Makuu NW. ¼, Makuu SE. ¼, Makuu SW. ¼, Puna NE. ¼, and Puna SE. ¼ quadrangles was completed and that of the Puako SE. ¼ quadrangle was begun.

Oregon.—In cooperation with the State engineer, the survey of the Lebanon quadrangle was completed, that of the Airlie quadrangle was continued, and that of the Aumsville quadrangle was begun. In addition, a plan and profile survey of Rogue River and its tributaries, covering 188 linear miles of river, was made, the total area mapped being 122 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 20 feet. In connection

with this work several dam sites were surveyed. This work was done for the land-classification branch and in cooperation with the California Oregon Power Co.

Washington.—In cooperation with the Washington State Department of Conservation and Development, the survey of the Hanford, Othello, and Scooteney Lake quadrangles was completed and that of the Hicksville quadrangle was begun.

OFFICE WORK.

The drafting of 35 sheets was completed and that of 5 sheets was begun. Primary-level circuits were adjusted for 5 quadrangles. Geographic positions were computed for 22 quadrangles.

DIVISION OF WEST INDIAN SURVEYS.

The Geological Survey has continued to supervise topographic work in the Republic of Haiti and in Porto Rico. This work comprised the completion of the compilation from airplane photographs of fifteen 30-minute sheets, showing the coast line and the interior rivers of the Republic of Haiti on the scale of 1:100,000 and a general map of the Republic of Haiti on the scale of 1:400,000. The drawing of publication sheets of the Isabela irrigation district of Porto Rico was also completed.

WATER-RESOURCES BRANCH.

ORGANIZATION.

The work of the water-resources branch was 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, N. C. Grover, chief hydraulic engineer, in charge.

PERSONNEL.

During the year the technical force was reduced 21 and was increased 18—a net reduction of 3. At the end of the year the force consisted of 1 chief hydraulic engineer, 32 hydraulic engineers, 6 engineers, 29 assistant engineers, 19 junior engineers, 4 geologists, 2 assistant geologists, 1 chemist, 3 associate chemists, 9 classifiers, and 1 expert mechanician, a total of 107. Of this number 2 hydraulic engineers, 1 engineer, 3 assistant engineers, 4 junior engineers, and 1 expert mechanician are employed occasionally. In addition 13 members of the advisory board of the superpower survey hold appointments for occasional service in the study of problems relating to interconnection of power systems, especially those crossing State boundaries.

In the clerical force there were 4 separations and 3 accessions, and at the end of the year the force numbered 33. Of this number 7 are employed occasionally.

ALLOTMENTS.

The appropriation for gaging streams was $180,000. In addition $67,869.44 of the appropriation for classification of lands was expended for field work by the water-resources branch. Of the total

appropriations, 81 per cent was allotted for work in public-land States. The cooperative funds made available by State allotments, amounting to $216,228.76, have been increased in some States and decreased in others, making necessary corresponding adjustments of this work.

Allotments of appropriation for gaging streams, 1922–23.

Administration, general	$18,921.12
Branch administration	10,000.00
Computations	15,000.00
Inspection	1,400.00
	45,321.12
Surface water:	
Connecticut	500.00
Maine	1,000.00
New Hampshire	1,500.00
Vermont	1,000.00
Massachusetts	2,500.00
New York	5,500.00
New Jersey	3,000.00
Middle Atlantic States	3,000.00
South Atlantic States	5,000.00
Tennessee and Kentucky	3,000.00
Ohio	3,000.00
Texas	5,000.00
Wisconsin	3,500.00
Minnesota	300.00
Iowa	2,000.00
Illinois	1,500.00
Surface water—Continued.	
Missouri	$4,000.00
Kansas	3,500.00
Colorado, Wyoming, and New Mexico	7,500.00
Montana	5,000.00
North Dakota	300.00
Utah	5,000.00
Nevada	3,000.00
Idaho	5,000.00
Oregon	5,000.00
Washington	5,000.00
California	5,500.00
Arizona	3,500.00
Hawaii	4,500.00
	98,100.00
Ground water	13,500.00
Quality of water	13,000.00
Power resources	8,500.00
General supplies	500.00
Contingent	1,078.88
	180,000.00

COOPERATION.

States.—The following amounts were expended by States from cooperative allotments. In addition, several State agencies cooperated by furnishing office quarters and occasional service in field and office.

Alabama		$72.00
Arizona:		
Gaging streams	$3,000.00	
Water resources	1,433.83	
Ground water, San Pedro Valley	2,600.00	
		7,033.83
California:		
State	23,206.20	
County and city	12,110.59	
		35,316.79
Colorado:		
State	1,300.00	
City	200.00	
		1,500.00
Connecticut		199.97
Georgia		240.00
Hawaii:		
Territorial	$18,414.84	
City and county	1,530.00	
		19,944.84

Idaho:		
State Department of Reclamation—		
Outside of Snake River basin	$14,232.13	
Snake River basin	2,676.56	
Bureau of Mines and Geology	1,601.12	
		$18,509.81
Illinois		3,862.06
Iowa		3,229.30
Kansas		4,004.27
Kentucky		424.65
Maine		4,232.92
Massachusetts		2,876.93
Minnesota		420.21
Missouri		8,879.31
Montana		9,985.81
New Hampshire		1,305.56
New Jersey		11,100.46
Nevada		2,009.85
New York:		
State	$10,670.66	
County and city	84.00	
		10,754.66
North Carolina		4,492.29
North Dakota		650.00
Ohio		6,000.00
Oregon		12,019.00
Tennessee		3,151.98
Texas:		
State	$14,070.00	
County and city	315.00	
		14,385.00
Utah		4,562.43
Vermont		1,199.99
Washington:		
State	$6,216.76	
County and city	5,285.00	
		11,501.76
West Virginia		486.00
Wisconsin		6,146.33
Wyoming		5,730.75
		216,228.76

The work done under cooperative agreements with the States has been restricted to studies of stream flow, except in Arizona, California, Connecticut, Idaho, New Jersey, and North Dakota, where ground-water investigations have been made. (See pp. 65–67.)

Reclamation Service.—The measurements of streams that are to furnish water to reclamation projects under construction was continued in cooperation with the United States Reclamation Service. The field work was done by Survey engineers who were employed in the locality, and the cost was repaid by the Reclamation Service through transfer of funds.

Office of Indian Affairs.—In accordance with authorization by the Office of Indian Affairs, stream gaging was continued on the Crow, Fort Hall, Yakima, Colville, Klamath, Gila River, Wind River Diminished, Western Shoshone, Walker River, and Uinta Indian reservations.

National Park Service.—Streams in the Yosemite, Yellowstone, and Glacier 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. Stream gaging in the Arapaho and Uncompahgre national forests was done by the Forest Service, which was reimbursed by the Geological Survey.

City of San Francisco.—In connection with the 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.

Federal Power Commission.—Projects of the Federal Power Commission in Utah, New Mexico, Idaho, and Colorado were examined. The operations of three licensees of the commission in California, two in Idaho, one in Oregon, one in Nevada, and one in Washington are supervised by the Geological Survey, as well as the operations of five permittees of the commission in Oregon, two in Idaho, one in Montana, one in Arizona, one in California, and one in Utah. All stream gaging by permittees of the commission is done in cooperation with the Geological Survey. Such cooperative stream gaging is in progress in Virginia, North Carolina, South Carolina, Florida, Alabama, Arkansas, Missouri, Montana, Iowa, Idaho, Wisconsin, Utah, Nevada, Colorado, Arizona, Washington, California, Oregon, and Texas.

PUBLICATIONS.

The publications of the year prepared by the water-resources branch comprised 17 reports and 2 separate chapters. Titles and brief summaries of these publications are given on pages 12–14. At the end of the year 20 other reports were in press and 11 manuscripts were awaiting editorial work.

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 23 districts, including Hawaii. The district offices and engineers in charge are as follows:

New England: C. H. Pierce, customhouse, Boston, Mass.
New York: A. W. Harrington, Journal Building, Albany, N. Y.
New Jersey: O. W. Hartwell, State House, Trenton, N. J.
Middle Atlantic and Ohio River: A. H. Horton, Washington, D. C.
South Atlantic and eastern Gulf: W. E. Hall, 33–35 Broadway, Asheville, N. C.
Tennessee: W. R. King, Municipal Building, Chattanooga, Tenn.
Ohio: Lasley Lee, Orton Hall, Ohio State University, Columbus, Ohio.
Upper Mississippi River: S. B. Soulé, Capitol Building, Madison, Wis.
Illinois: H. E. Grosbach, Kimball Building, Chicago, Ill.
Iowa: J. B. Spiegel, Engineering Hall, Iowa State College, Ames, Iowa.
Kansas: H. B. Kinnison, Federal Building, Topeka, Kans.
Missouri: H. C. Beckman, Rolla, Mo.
Upper Missouri River: W. A. Lamb, Montana National Bank Building, Helena, Mont.

Rocky Mountain: Robert Follansbee, 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: H. D. McGlashan, customhouse, San Francisco, Calif., suboffice, Federal Building, Los Angeles, Calif.
Arizona: R. C. Rice, care of University of Arizona, Tucson, Ariz.
Texas: C. E. Ellsworth, Capitol Building, Austin, Tex.
Hawaii: E. D. Burchard, Capitol Building, Honolulu, Hawaii.

CHARACTER AND METHOD OF WORK.

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

At the end of the year 1,591 gaging stations were being maintained, including 75 in Hawaii; 225 stations were discontinued and 276 new stations established during the year. Records for about 162 additional stations were received, ready for publication, from a number of Government bureaus and private persons, and a number of Government and State organizations and individuals also cooperated in the maintenance of the regular gaging stations.

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Gaging stations and cooperating parties for the year ended June 30, 1923.

State or Territory.	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	....	....	....	....	2	1	....	1	2	5	2	9	2	3	54	5
Arizona	....	2	....	2	....	1	....	23	2	5	13	22	4	4	675	83
Arkansas	....	....	....	....	....	....	....	....	....	3	....	3	1	....	17	.....
California	....	....	21	1	....	1	6	214	44	91	164	214	32	11	1,941	615
Colorado	9	1	5	....	....	1	....	19	1	2	2	36	3	2	127	1
Connecticut	1	....	....	....	....	....	....	....	....	2	.....	3	.....	.....	12	.....
Florida	....	....	....	....	....	....	....	....	.....	1	.....	1	.....	1	7	.....
Georgia	....	....	....	....	....	2	....	4	.....	8	1	13	.....	1	11	.....
Idaho	....	6	7	14	....	2	....	97	1	188	81	234	126	128	1,694	281
Illinois	....	....	....	....	2	2	....	29	1	1	6	29	3	1	80	4
Indiana	....	....	....	....	....	....	....	....	.....	....	.....	....	.....	2	1	.....
Iowa	....	....	....	....	....	6	....	23	.....	6	7	28	.....	.....	130	.....
Kansas	....	....	....	....	....	3	....	31	1	9	13	31	1	.....	178	6
Kentucky	....	....	....	....	6	1	....	6	.....	....	7	6	3	2	29	1
Louisiana	....	....	....	....	....	....	....	....	.....	3	.....	3	2	.....	78	.....
Maine	....	....	....	....	....	....	....	16	.....	4	4	16	.....	.....	74	1
Maryland	3	....	....	....	....	....	....	....	.....	....	.....	3	2	2	6	1
Massachusetts	....	....	....	....	....	....	....	17	.....	....	.....	17	.....	.....	104	2
Michigan	....	....	....	....	....	....	....	....	.....	1	.....	1	.....	.....	1	.....
Minnesota	....	....	....	....	2	2	....	6	.....	....	.....	10	.....	.....	34	.....
Missouri	....	....	....	....	....	3	....	51	.....	10	13	51	6	.....	289	18
Montana	8	31	2	11	....	....	15	63	.....	6	14	122	12	14	543	35
Nevada	....	....	....	3	....	....	....	29	.....	12	15	29	.....	.....	166	14
New Hampshire	....	....	....	....	....	....	....	13	.....	9	9	13	3	.....	78	4
New Jersey	....	....	....	....	....	1	....	33	4	7	12	33	7	.....	258	50
New Mexico	....	1	....	....	....	....	....	....	.....	....	.....	1	.....	.....	6	.....
New York	....	....	....	....	1	....	....	55	1	18	20	55	11	10	369	1
North Carolina	....	....	....	....	14	....	....	28	.....	7	19	30	8	3	116	5
North Dakota	....	....	....	....	....	....	....	8	.....	....	.....	8	.....	.....	20	.....
Ohio	....	....	....	....	3	6	....	23	10	6	2	46	6	2	185	22
Oregon	....	1	1	6	....	3	....	81	31	26	60	89	10	13	576	10
South Carolina	....	....	....	....	....	....	....	....	.....	1	.....	1	.....	1	2	.....
Tennessee	....	....	....	....	38	15	....	43	.....	7	60	43	9	1	251	19
Texas	....	....	....	....	....	3	....	49	6	6	15	49	.....	1	393	67
Utah	....	1	....	4	....	....	....	55	1	21	27	55	3	2	154	23
Vermont	....	....	....	....	....	....	....	12	.....	7	7	12	3	2	58	1
Virginia	3	....	....	....	7	1	....	....	.....	6	1	16	2	.....	20	4
Washington	....	....	4	10	....	....	2	50	20	28	49	65	7	10	407	10
West Virginia	....	....	....	....	6	....	....	11	.....	8	6	19	3	.....	52	1
Wisconsin	....	....	....	....	3	....	....	40	.....	8	11	40	.....	3	193	10
Wyoming	....	7	1	6	....	1	6	41	.....	11	13	60	6	3	215	5
Hawaii	....	....	....	....	....	....	....	74	3	29	31	75	1	3	423	52
	24	50	41	57	84	55	29	1,245	128	562	684	1,591	276	225	10,027	1,351

PUBLICATIONS.

For convenience and uniformity in publications 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; the records for the twelfth division are published in three papers. In addition to the progress reports, special reports on hydraulic subjects have been completed for publication during the year.

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 livestock and desert travelers. Each year surveys

are made of selected areas where the problems of water supply are most urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. 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 are made by the geologic branch. 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 number of these projects.

One of the most important new activities of the division during the year was the establishment of a small hydrologic laboratory to determine the mechanical composition, porosity, moisture equivalent, and permeability of water-bearing materials. This laboratory will be in charge of Norah E. Dowell. Another important project, undertaken in cooperation with the Department of Conservation and Development of New Jersey, is an intensive investigation of the ground-water supplies in that State for municipal and industrial purposes. This investigation was placed in charge of D. G. Thompson, but only preliminary work was done on it before the end of the fiscal year.

Kirk Bryan was assigned as geologist for the investigation of the Columbia Basin project by the Reclamation Service. He began field work on this project April 16, 1923.

G. E. P. Smith, irrigation engineer of the Arizona Agricultural Experiment Station, spent about four months in the Washington office on cooperative work and presented a paper before the Geological Society of Washington on his investigation of the discharge of ground water by vegetation, based on daily fluctuations of the water table.

Progress was made by O. E. Meinzer on his work on "Ground water in the United States, with a discussion of principles." At the end of the year Part I, which relates to the occurrence of ground water, was in galley proof, and Part II, which relates to the origin, discharge, and quantity of ground water, was nearly half completed. A brief paper entitled "Investigations of ground water in the western part of the United States" was prepared by Mr. Meinzer for use in the Pan-Pacific Scientific Congress, held in Australia in August and September, 1923. A brief paper on thermal springs in Nevada, Utah, and Idaho was presented by Mr. Meinzer at the meeting of the American Geophysical Union in Washington, D. C., April 18, 1923.

Cooperation with the committee on physiography was continued through Mr. Meinzer, who serves on that committee. Several manuscripts for geologic folios were examined with respect to their treatment on the subject of ground water.

WORK BY STATES.

Arizona.—A comprehensive report, entitled "The Papago country—a geographic, geologic, and hydrologic reconnaissance," was completed by Mr. Bryan for publication as a water-supply paper. Progress was made on a report on the geology and water resources of San Pedro Valley, by Mr. Bryan, of the Geological Survey, and Mr. Smith, of the Arizona Agricultural Experiment Station.

Arkansas.—Field and office studies of the temperature and source of the hot-water supply in the Hot Springs National Park were continued by Mr. Bryan.

California.—A comprehensive report, entitled "The Mohave Desert region—a geographic, geologic, and hydrologic reconnaissance," was virtually completed by D. G. Thompson for publication as a water-supply paper. Parts of this paper have already been made available to the public in the form of manuscript reports filed in the Los Angeles office of the Geological Survey. Ground-water maps of Salinas Valley and data in regard to irrigation wells in that valley were sent to the San Francisco office of the Geological Survey and to the county agent at Salinas, where they can be consulted by the public. These maps and data are based on field work done in previous years by W. O. Clark. The ground-water conditions in the Mariposa Grove of the Yosemite National Park were examined in June and July, 1922, by Mr. Bryan, who prepared a report for the National Park Service on an additional water supply for this part of the park. Water levels were measured in selected wells in southern California, as in previous years, under the direction of F. C. Ebert. The ground-water work in California was supported by financial cooperation of the State Department of Engineering.

Connecticut.—Additional field work was done in the Pomperaug Valley, Conn., by H. T. Stearns in May and June. All work in Connecticut is done in cooperation with the State Geological and Natural History Survey.

Hawaii.—An investigation of ground water in the Kau district, Hawaii, was nearly completed by Mr. Clark prior to his resignation, December 31, 1921, but the report has not yet been submitted.

Idaho.—The investigation of the water resources of the Mud Lake basin, Idaho, begun in 1921, was carried on during the year by Mr. Stearns, who did the geologic work, and L. L. Bryan, of the surface-water division, who did the engineering work. A preliminary mimeographed report was issued early in July. Financial cooperation was received from the Idaho Department of Reclamation, the United States General Land Office, and the Idaho Bureau of Mines and Geology. The survey of artesian basins in the State was continued in cooperation with the State Bureau of Mines and Geology. The report on the Goose Creek basin was completed by A. M. Piper, of that bureau, which is to publish it as Bulletin 6. An investigation was also made by Mr. Piper of certain artesian basins in Owyhee County, and a report is being prepared on these basins.

Maryland.—A brief examination of the ground-water conditions in the vicinity of Braddock Heights, Md., was made by G. M. Hall, and advice was given as to methods of increasing the water supply for that community.

Mississippi.—A report on ground water in Mississippi, prepared in cooperation with the geologic branch by L. W. Stephenson, E. N. Lowe, and G. A. Waring, was completed and is to be published as a water-supply paper.

Montana.—A report on the geology and water resources of the Townsend Basin, Mont., was completed by J. T. Pardee, of the geologic branch; a report on Yellowstone and Treasure counties was nearly completed by Mr. Hall; and a report on Big Horn County was partly prepared by Mr. Hall. All these reports are to be published as water-supply papers. Field work was begun by Mr. Hall in Fergus County.

Nevada.—Examinations of the artesian and other ground-water conditions near Orovada, Winnemucca, and Hawthorne, Nev., and of dam sites in Paradise Valley were made by Mr. Bryan. Brief manuscript or mimeographed reports were issued on most of these areas.

New Jersey.—An intensive study of the ground-water resources of New Jersey was undertaken in cooperation with the State Department of Conservation and Development. A preliminary field examination was made by Messrs. Meinzer and Thompson in April, and active field work was begun by Mr. Thompson July 1, 1923.

New Mexico.—Mr. Bryan examined the ground-water conditions in the vicinity of Clayton, N. Mex., and submitted to the city authorities a brief report on methods of increasing the public water supply.

North Carolina.—A report on the hydrology of the experiment field of the Public Health Service at Fort Caswell, N. C., was made to that service by Miss Dowell, based on field work in May, 1922.

North Dakota.—Progress was made by H. E. Simpson, State water geologist, on a report on ground water in North Dakota. This work is being done in cooperation with the State Geological Survey. Data were collected by correspondence on the decline of the artesian head in the Edgeley and Lamoure

quadrangles for use in a report prepared on this area for the geologic branch by Herbert Hard.

South Carolina.—Progress was made on a report on ground water in the Coastal Plain of South Carolina by C. W. Cooke, of the geologic branch.

Texas.—Additional work was done on a report on the Coastal Plain of Texas southwest of Brazos River by Alexander Deussen.

DIVISION OF QUALITY OF WATER.

The division of quality of water makes analyses of the mineral content of surface and ground waters and interprets such analyses with reference to geologic conditions and to the utilization of the waters in so far as it is affected by their chemical composition. During the year 275 samples of water were analyzed and laboratory studies were made of several analytical methods. A report showing the chemical composition of the water of public supplies used by nearly 39,000,000 persons in 307 cities in the United States was published as Water-Supply Paper 496. Discussions of quality of water were prepared for reports on the New Haven area, Conn.; on Yellowstone and Treasure counties, Mont.; and on the State of North Dakota. Analyses were made for reports on ground water in Owyhee County, Idaho; Fergus County, Mont.; and the Coastal Plain of South Carolina; and for five geologic folios covering areas in Pennsylvania. Manuscripts of two reports and proofs of three reports were examined with reference to statements in regard to quality of water. The report on production of mineral waters in 1921 was prepared.

DIVISION OF POWER RESOURCES.

The work of the division of power resources during the year comprised the preparation of monthly reports of the production of electricity and consumption of fuel by public-utility power plants, of State maps showing the location of the power stations and transmission lines used in public service, and of reports on the stock of coal on hand at electric public-utility plants at different dates.

The monthly reports are based on reports submitted by public-utility companies. About 3,900 power plants, each having a monthly output of 10,000 kilowatt-hours or more, are requested to submit reports of their production of electricity and consumption of fuel. The total capacity of the generators in these plants in March, 1923, was about 16,150,000 kilowatts. Reports received represent over 95 per cent of the total generating capacity of these plants. Each report is published about 30 days after the end of the last month included in it. The following tables show the power and fuel statistics for the calendar years 1919 to 1922:

Electricity produced at public-utility power plants in the United States, 1919–1922.

Year.	Total.		Water power.			Fuel power.		
	Kilowatt-hours.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).	Kilowatt-hours.	Per cent of total.	Change from previous year (per cent).
1919	38,921,000,000	.....	14,606,000,000	37.5	.....	24,315,000,000	62.5	.....
1920	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+12.7
1921	40,976,000,000	−5.9	14,971,000,000	36.5	−7.3	26,005,000,000	63.5	−5.1
1922	47,659,000,000	+16.3	17,206,000,000	36.1	+14.9	30,453,000,000	63.9	+17.1

Fuel consumed in the production of power at public-utility plants in the United States, 1919–1922.

Year.	Coal.		Fuel oil.		Gas.	
	Short tons.	Change from previous year (per cent).	Barrels.	Change from previous year (per cent).	M cubic feet.	Change from previous year (per cent).
1919	35,100,000	.....	11,050,000	.....	21,406,000	.....
1920	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921	31,585,000	−14.9	12,045,000	−8.2	23,722,000	−4.0
1922	34,179,000	+8.3	13,197,000	+9.6	27,172,000	+14.5

Maps of West Virginia and Kentucky showing the location of the power stations and transmission lines used in public service and the names of the public-utility companies and their plants were published. The preparation of maps of other States and the revision of maps already published has not been undertaken on account of lack of funds for the continuation of this work.

Reports on the stock of coal held by electric public-utility power plants were made for inclusion in reports on commercial stocks of coal undertaken by the Bureau of the Census, Department of Commerce, and the Geological Survey under authority of the Federal Fuel Distributor. Seven of these reports were prepared during the year giving the stock of coal held on the first day of the months of September, October, and November, 1922, and January, February, March, and June, 1923.

DIVISION OF ENLARGED AND STOCK-RAISING HOMESTEADS.

The work of the division of enlarged and stock-raising homesteads comprises two distinct classes—the examination of public lands for designation under the enlarged and stock-raising homestead laws and the examination of streams and neighboring lands as a basis for the classification of public lands with respect to their value for water power or irrigation.

Owing to a reduction in the appropriation for the classification of lands during this fiscal year only 9 classifiers out of a force of 15 were retained at the beginning of the year for the examination of

lands to be classified under the stock-raising homestead law. Further plans to meet the reduction in appropriation had been made at the beginning of the field season, and the classifiers who in previous years had examined only lands applied for under the stock-raising homestead law were assigned also to the examination of lands subject to entry under enlarged-homestead laws.

Field examination under these laws was confined mainly to lands for which applications had already been made, but in all the States in which work was done reconnaissance examinations were made of block areas, including considerable land not covered by applications. During the summer of 1922 the lands in the following States included in applications pending at the beginning of the year were examined:

Arizona: All districts.
California: Practically all districts.
Colorado: Glenwood Springs, Durango, and Denver districts and most of Del Norte, Leadville, Montrose, and Pueblo districts.
Idaho: Blackfoot, Boise, and Hailey districts.
Kansas: Western part.
Montana: Billings, Bozeman, Glasgow, Great Falls, Havre, and Lewistown districts and most of Miles City district.
Nebraska: Northwestern part.
New Mexico: Santa Fe district.
North Dakota: All districts.
Oregon: All districts.
South Dakota: All districts.
Utah: Vernal district and most of Salt Lake City district.
Washington: All districts.
Wyoming: Buffalo, Lander, Douglas, and Evanston districts and most of Cheyenne and Newcastle districts.

During the field season of 1923 work was begun early in June by the force assigned to the examination of lands under the homestead laws and at the end of the month was in progress in California, Colorado, Idaho, Montana, Oregon, South Dakota, Utah, and Wyoming.

The reconnaissance examination of lands withdrawn for power sites along Arkansas River and its headwater tributaries west of Pueblo, Colo., in progress in the previous fiscal year, was completed early this year.

A reconnaissance of the power-site value of lands in the Eel and Mad River basins, California, begun in the previous year, was completed in the summer of 1922.

An examination of Colorado River between Halls Crossing, Utah, and Lees Ferry, Ariz., a distance of about 120 miles, was made for the purpose of surveying in detail certain possible dam sites disclosed by maps made from the previous year's surveys. The power sites at the mouth of Diamond Creek and on the lower portion of the river from Boulder Canyon to Needles were also examined.

A study of the possibilities of irrigation in Arizona by means of Colorado River was made in cooperation with the State of Arizona, which created the Arizona Engineering Commission, consisting of E. C. La Rue, of the Geological Survey, chairman; P. J. Preston, of the Reclamation Service; and H. E. Turner, of the State engineer's office. This commission has made reconnaissance surveys and studies of three or more projects of great magnitude for diverting and using the waters of the river for irrigation in Arizona, and a

report thereon was submitted to the governor of Arizona at the end of the fiscal year.

In order to designate dam sites for detailed survey and to obtain information necessary for preparing a report on the water-power and reservoir possibilities of Green River between Green River, Wyo., and Green River, Utah, an engineer was attached to a topographic party making a survey of that stretch of the river; another engineer was attached to a topographic party making a survey of Yampa River, a tributary of Green River, from Juniper reservoir to the mouth of the river in Colorado; and two other engineers are attached to the topographic parties that are now mapping Rogue River and its tributaries in Oregon.

In Montana a survey of the South Fork of Flathead River from the Hungry Horse ranger station to the mouth of the river, a distance of about 10 miles, was made for the purpose of locating a power site, and an examination is now in progress as to the present use of water for power and irrigation and the possible future use of water, principally for irrigation, in the drainage area of Missouri River above the mouth of Portage Creek (12 miles below Great Falls).

An engineer was detailed for about two months as a member of a board to review the Milk River project of the Reclamation Service and to make a report and recommendations to the Secretary of the Interior.

A reconnaissance survey has been made of South Platte River above the north line of T. 7 S., R. 69 W., Colorado, in order to ascertain the power value of the stream and adjoining lands. A similar survey is now in progress along Sweetwater River, Wyo.

An office study is being made of the water supply of streams flowing to the Pacific coast between the Klamath and Columbia River basins in Oregon and California.

Manuscript reports, based on surveys made in previous years, on the water-power possibilities of Snake River from Milner to Weiser, Idaho, and from Huntington, Oreg., to Lewiston, Idaho; of Salmon River from Salmon, Idaho, to the mouth of the river; and of Big Horn River between Lovell, Wyo., and Hardin, Mont., were prepared in the expectation that they will be published as water-supply papers. As there will be considerable delay in the publication of these reports, manuscript copies have been placed in local offices and the Washington office of the Geological Survey for inspection by the public. A report on the utilization of Klamath River, Oregon and California, completed a year ago, has likewise been made available for public inspection.

LAND-CLASSIFICATION BRANCH.

ORGANIZATION AND PERSONNEL.

The work of the land-classification branch consists of classification based on mineral character, on water supply, and on value as stock-raising homesteads. The corresponding units of organization are the division of mineral classification, the division of hydrographic classification, and the division of homestead classification. The division of hydrographic classification includes two sections, each dealing with a type of classification work in which water sup-

ply is an essential element. At the end of the fiscal year the organization and the technical personnel were as follows:

Chief, Herman Stabler.
Assistant chief, J. D. Northrop.
Chief clerk, Elsie Patterson.
Division of mineral classification: J. D. Northrop, geologist, chief; C. D. Avery, mining engineer; G. W. Holland and N. W. Bass, classifiers; W. W. Boyer, associate geologist.
Division of hydrographic classification: W. G. Hoyt, hydraulic engineer, chief. Power section: B. E. Jones, hydraulic engineer, chief; N. J. Tubbs, engineer; E. E. Jones and R. O. Helland, classifiers; Warren Oakey, assistant engineer. Irrigation section: J. F. Deeds, hydraulic engineer, chief; C. E. Nordeen, topographic engineer; W. N. White, classifier.
Division of homestead classification: A. E. Aldous, classifier, chief; J. G. Mathers, engineer; W. L. Hopper, classifier.

In addition two engineers, R. W. Davenport and D. J. Guy, have been detailed from the branch for duty with the Federal Power Commission.

During the year there were 3 additions to the force and 8 separations. At its end the total number of persons on the regular staff, including the clerical force and employees detailed to the Federal Power Commission, was 48. In addition to this regular force 9 classifiers on the rolls of the water-resources branch joined the staff of the land-classification branch during the office season in connection with the stock-raising homestead classifications.

SCOPE AND CHARACTER OF THE WORK.

The land-classification branch was organized to perform the duties relating to "the classification of public lands" with which the Geological Survey is charged by the law of March 3, 1879 (20 Stat. 394). Since its organization the branch has prepared and recommended withdrawals of lands known or believed to be valuable for coal, planned their examination, classified and appraised them, and initiated their restoration to the public domain for disposal in accordance with their classification. It has recommended the creation of oil, phosphate, and potash reserves pending the enactment by Congress of appropriate laws for the disposition of the minerals involved. It has classified large areas of oil-shale lands and has selected lands to be set aside as oil and oil-shale reserves for the Navy and drafted orders for their withdrawal. It has formally classified as to all minerals all or parts of several Indian reservations and as to metalliferous minerals extensive areas of lands within the Northern Pacific Railroad grant. It has initiated withdrawals of lands valuable for the development of water power in order to prevent possible serious interference with their use for that purpose, and it bears an important part in facilitating the utilization of the withdrawn lands for water-power development. It prepares and recommends designations required prior to allowance of applications for entry of lands under the enlarged and stock-raising homestead acts and the Nevada ground-water reclamation act.

Under the mineral leasing act of February 25, 1920 (41 Stat. 437), deposits of coal, phosphate, sodium, oil, oil shale, or natural gas and lands containing them, whether classified or included in mineral reserves on recommendation of the branch or whether unclassified

or unreserved, are subject to prospecting under permit or to lease. The branch is required to define the "known geologic structure" of producing oil or gas fields, to determine what is leasing and what is prospecting ground, to recommend the creation of leasing units, to suggest appropriate requirements as to royalty, minimum annual production, and minimum investment, and generally to make the classifications and to give advice on the geologic and economic problems that must be solved to render the leasing act effective.

The tasks that arise in connection with the work above outlined are performed on the basis of records accumulated by the Survey in mapping the topography and investigating the mineral and water resources of the public domain since its creation in 1879. If existing records are deficient and can not be supplemented satisfactorily from other scientific sources, the branch prepares plans for field investigation and makes an allotment from its funds to such other branch of the Survey as is best equipped to obtain the needed information. In a sense the land-classification branch is a repository of essential data relating to the natural resources of the public domain and a clearing house for information of many types required in the administration of the laws enacted by Congress and the policies adopted by the Executive for the conservation and utilization of those resources.

The greater part of the information disseminated by the branch is utilized through the General Land Office and the office of the Secretary of the Interior, where such facts as to the character of lands are needed as a basis for the administration of certain laws and the development of certain policies. Much of the land-classification work is done under a plan of procedure arranged with the General Land Office, which involves the submission of technical reports on numerous types of cases before that office and the department for disposal. Other bureaus and offices of the Interior Department, as well as other departments of the Government, are also supplied with information pertaining to the character of the public domain.

FUNDS.

The act of May 24, 1922 (Public No. 224, 67th Congress), appropriated $225,000 for classification of lands by the Geological Survey in the fiscal year ended June 30, 1923, a reduction of $75,000 from the appropriation for the preceding year that has been inevitably reflected in the amount of work accomplished. The major part of the appropriation was expended for special field examinations necessary as a prerequisite to classification of lands, somewhat less than half being used for general administration and the office work of classifying and reporting on character of lands.

As an offset to the reduced appropriation, the act of January 24, 1923 (Public No. 395, 67th Congress), made available on the date of its approval the sum of $280,000 to be expended for land classification prior to June 30, 1924. Only a small part of this appropriation was utilized during the current year, as the seeming advantage of its early availability was largely discounted by climatic conditions in most of the public-land States which prevented the start of many urgently needed field investigations until after the beginning of the ensuing fiscal year.

CORRESPONDENCE.

During the year 16,523 letters and petitions were received by the land-classification branch. In addition 5,600 copies of miscellaneous correspondence were sent to the branch for its information and filing; this correspondence was made up largely of letters from the General Land Office to its local officers and of reports on the character of lands by its inspectors and examiners, copies of decisions rendered by the Department of the Interior, and copies of withdrawals and restorations recommended by the Reclamation Service. Within the same period 11,697 letters were prepared by the branch. These figures show an average of 54 incoming letters and of 38 outgoing letters for each working day of the year.

SUMMARY OF CASES.

The information supplied by the branch is furnished either in reports submitted in response to specific requests for data or in the form of broad areal classifications made under the laws relating to the public domain and its natural resources. The following table gives a summary of the cases before the branch for action during the year and indicates that reports were rendered on more than 15,000 specific requests. The mere number of cases disposed of, however, is not a true index to the magnitude of tasks accomplished, for some cases require only a few minutes' consideration, whereas others require exhaustive study and research extending over several days or weeks, and some necessitate field investigations. The terms "gain" and "loss" in the table signify, respectively, decrease and increase in the number of cases pending.

General summary of cases, land-classification branch.

Class of cases.	Record for fiscal year 1922-23.						Record since receipt of first case.	
	Pending July 1, 1922.	Received during fiscal year.	Total.	Acted on during fiscal year.	Pending June 30, 1923.	Gain or loss during fiscal year.	Received.	Acted on.
General Land Office requests	882	1,440	2,322	1,839	483	+399	.....	.....
Applications for classification as to mineral:								
Coal	26	19	45	27	18	+8	743	725
Oil	132	800	932	813	119	+13	2,378	2,259
Phosphate	1	2	3	2	1	.....	30	29
Applications for mineral permits	713	4,838	5,551	4,932	619	+94	20,729	20,110
Applications for mineral leases	47	217	264	229	35	+12	460	425
Applications for patent, potassium	.....	3	3	1	2	−2	17	15
Federal Power Commission cases:								
Preliminary permits	2	5	7	6	1	+1	40	39
Licenses	1	.....	1	.....	1	.....	12	11
Determinations under sec. 24	2	8	10	3	7	−5	61	54
Applications for reclassification as to water resources	7	11	18	11	7	.....	628	621
Applications for rights of way	9	143	152	124	28	−19	5,239	5,211
Irrigation project reports	9	16	25	21	4	+5	872	868
Applications under enlarged-homestead acts	723	785	1,508	930	578	+145	54,322	53,744
Applications under stock-raising homestead act	3,901	5,391	9,292	6,338	2,954	+947	105,470	102,516
Applications under ground-water reclamation act	42	106	148	103	45	−3	694	649
Indian Office requests for information	5	11	16	13	3	+2	9,486	9,483
Cases in national forests	2	9	11	10	1	+1	283	282
	6,504	13,804	20,308	15,402	4,906	+1,598	.....	.....

DIVISION OF MINERAL CLASSIFICATION.

The activities of the division of mineral classification are directed along three primary lines of effort involving, first, the withdrawal, classification, and restoration of public lands based on mineral character; second, the solution of geologic and economic problems arising in the administration of the acts that provide for leasing of mineral lands; and, third, the preparation of reports concerning the mineral character of specific lands for the information and guidance of other Government bureaus charged with the administration of the public land and Indian land laws.

Despite the preoccupation of the division with urgent problems pertaining to the second phase of its activities, some progress was made during the year along the broader lines of mineral-land classification.

The approval of the potash-land leasing act in October, 1917, and of the general mineral-lands leasing act in February, 1920, opened to disposition the deposits of coal, oil, gas, phosphate, oil shale, sodium, and potash in some 50,000,000 acres then embraced in outstanding mineral-land withdrawals, but it did not obviate the necessity for the classification of these lands and their restoration to the public domain. To this unfinished task the mineral division is devoting as much energy as the limitations imposed by small personnel, inadequate geologic information, and pressure of more urgent tasks will permit. The results accomplished in the fiscal year include a net increase of 6,620 acres in the total area previously classified as coal land, and decreases of 408,123 acres in the area of outstanding coal withdrawals, of 162,949 acres in the area of outstanding petroleum reserves, and of 40 acres in the area of outstanding phosphate reserves. No change was effected during the year in the areas previously classified as oil land, withdrawn or classified as oil-shale land, classified as phosphate land, included in potash reserves, or withdrawn on account of concealed deposits of metalliferous minerals.

The gross areas already classified as valuable for mineral and those remaining withdrawn at the end of the fiscal year for certain minerals under the act of June 25, 1910, are shown in the following table:

Summary of outstanding mineral withdrawals and classifications, June 30, 1923, in acres.

State.	Coal.		Oil.	
	Withdrawn.	Classified as coal land.	Withdrawn.	Classified as oil land.
Alaska		56,993		
Arizona	141,243		230,400	
Arkansas		61,160		
California	17,643	8,720	1,178,392	
Colorado	4,241,552	3,170,645	222,977	
Idaho	4,761	4,603		
Louisiana			466,990	
Montana	10,510,700	6,591,821	1,350,426	42,097
Nevada	83,833			
New Mexico	5,220,584	582,684		
North Dakota	5,954,364	11,178,286	84,894	
Oregon	4,361	18,887		
South Dakota		250,093		
Utah	5,058,832	1,101,587	1,870,627	
Washington	691,852	141,444		
Wyoming	2,437,283	6,736,183	1,018,898	
	34,367,008	29,903,106	6,423,604	42,097

State.	Oil shale.		Phosphate.		Potash (withdrawn).
	Withdrawn.	Classified as oil-shale land.	Withdrawn.	Classified as phosphate land.	
California					90,518
Colorado	41,560	952,239			
Florida			119,523		
Idaho			720,534	267,722	
Montana			287,883		
Nevada	123				39,422
Utah	86,584	2,705,035	302,465		
Wyoming		460,103	995,049	25,293	
	128,267	4,117,377	2,425,454	293,015	129,940

The contributions of the mineral division to the administration of the mineral-lands leasing acts are fundamental and important. They involve, with respect to coal, the determination whether a prospecting permit or a lease should be issued and, if a lease is required, the establishment of a leasing unit consistent in area and content of coal with the mining operation to be undertaken and the recommendation of appropriate stipulations in the matters of royalty, minimum investment, and minimum annual production. With respect to oil and gas they require the definition of the "known geologic structure" of producing oil or gas fields as the primary distinction between leasing and prospecting areas, the determination of the structural relations of lands embraced in prospecting-permit applications, and the classification of all tracts included in such applications which are at the same time involved in unperfected entries under the nonmineral-land laws. Similar types of essential service involving decisions based on geologic evidence are rendered in the administration of the potash-land leasing act and the sections of the general mineral-lands leasing act pertaining to phosphate, oil shale, and sodium.

The following table summarizes the year's activities of the division to the extent that they involve the consideration of specific applications for permit or lease rights under the leasing acts:

Applications under the mineral-leasing acts, fiscal year 1922–23.

Mineral.	Permits.			Leases.			Patents.		
	Received.	Acted on.	Pending.	Received.	Acted on.	Pending.	Received.	Acted on.	Pending.
Oil and gas	4,443	4,369	536	32	27	5			
Coal	347	498	83	174	194	23			
Phosphate				6	6	1			
Sodium	7	9							
Potassium	41	56			1		3	1	2
Oil shale				5	1	6			

The broader phases of the division's activities under the leasing acts were restricted during the year almost entirely to the designations of the boundaries of the "known geologic structure" of producing oil and gas fields—that is, the designation of the lands that are subject to lease only as distinguished from those on which prospecting permits may be granted. The results, which involve an exhaustive study of each area considered, include definitions of the White River and Williams Park Anticline gas fields, Colo.; Shelby gas field and Gas Ridge and Kevin-Sunburst oil fields, Mont.; Big Polecat and Little Polecat gas fields and Derby Dome oil field, Wyo.; and of extensions of the McKittrick, Buena Vista Hills, and Midway oil fields, Calif. At the end of the year 46 fields, having a total area of 421,066 acres, had been defined.

Reports rendered in response to requests of the General Land Office and the Office of Indian Affairs for information concerning the mineral possibilities of specific lands have been brought to and maintained at a current basis. The general summary of cases shows a net gain of 399 such cases involving reports to the General Land Office and of 2 cases involving reports to the Office of Indian Affairs.

In all the types of activity pursued by the division the requisite of definite information on which to base decisions and recommendations of appropriate action has necessitated the planning and financing of considerable field work, both reconnaissance and detailed, undertaken by the geologic and topographic branches.

Important items of field work to obtain data for mineral classification in progress at the request of the land-classification branch and financed in whole or in part by allotments from its funds during the year are (1) general geologic investigations on the north and east flanks of Bearpaw Mountains and in an area west of the Crow Indian Reservation, Mont.; in a large area east and northeast of Kanab, Kane County, Utah; in a large area in Moffat County, Colo., and adjacent parts of Sweetwater County, Wyo.; on the west and northwest flanks of the Black Hills in Wyoming and Montana; and in the northern part of the Big Horn Basin, Wyo.; (2) detailed studies of the occurrence of coal in the Dawson County lignite field, Mont.; the Tongue River and Armells Creek districts of the Powder River basin coal field, Mont.; the eastern part of the Yampa River, Danforth Hills, Grand Hogback, and Little Book Cliffs coal fields, Colo.; the Rio Puerco and Monero coal districts of San Juan Basin, N. Mex.; the southern and western parts of the Wasatch Plateau and western part of the Book Cliffs coal fields, Utah; and the Gillette, Upper Powder River Basin, and Gebo coal fields, Wyo.; (3) detailed

studies of oil and gas possibilities in the Douglas River and Cold Bay regions, Alaska; the Kern River district, Calif.; the southern part of the Sweetgrass arch, Mont.; the Bates Hole, Baxter Basin, Billy Creek, Golden Eagle, and other districts, Wyo.; (4) a general reconnaissance of phosphate resources in Florida, in southeastern Idaho, and in the Mission Range area in Montana; and (5) an investigation of the occurrence of oil shale in a small area near Medford. Oreg.

DIVISION OF HYDROGRAPHIC CLASSIFICATION.

POWER SECTION.

The work of the power section consists primarily in obtaining and making available for administration under the public-land laws information as to the water-power resources of the public lands. Reports are made on specific problems as they arise, such problems ordinarily involving conflict between projects for power development and applications under the land laws. The endeavor is made to reach solutions by which the possibilities for developing power may be preserved with a minimum of interference with agricultural, transportation, or other interests. In connection with these specific problems and also in a broad way, constant review is being made of power reserves in order that all land having material value for the development of power, and only such land, shall be held reserved for that purpose. The extent of this task is indicated by the fact that over 4,600,000 acres of land is included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that its information may be substantially complete, the section designates areas not thoroughly surveyed for examination by the field branches of the Survey. Important items of field work to obtain data for power classification, in progress at the request of the land-classification branch and financed by allotments from its funds during the year, include (1) plan and profile surveys and power-site investigations of Green River from Green River, Wyo., to Green River, Utah; Yampa River, Colo., from Craig to mouth; portions of Colorado River in Arizona, California, and Utah; Rogue River, Oreg.; and (2) detailed studies and reports on the possibilities of developing power in the Eel and Mad River basins, Calif.; upper South Platte and Arkansas River basins, Colo.; Missouri and Flathead River basins, Mont.; coast streams in Oregon; and Encampment and Sweetwater rivers, Wyo. All such information as it becomes available is carefully indexed and incorporated in an inventory of water resources maintained by the land-classification branch, which, when complete, will enable the section to give competent advice on short notice as to the manner in which each tract of public land having value for power can best be used in connection with the development of water power and as to the relation of such use to other possible uses of the tract.

The work of the section, in so far as it is readily subject to statistical record, is briefly summarized in the table of power-site reserves, the table of outstanding water-resources withdrawals and classifications, and the general summary of cases. Certain features of the operations under power permits and grants issued prior to the pas-

sage of the Federal water-power act, as disclosed by reports made on request of the section, are summarized in the following paragraph:

Pursuant to the instructions of the Secretary, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), to whom rights have been granted 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 1922. An examination of these reports shows that the total installation of the 59 reporting companies is 1,410,000 kilowatts, of which 1,129,000 kilowatts is installed at hydroelectric plants. The total energy generated amounted to 4,947,000,000 kilowatt-hours, of which 4,629,000,000 kilowatt-hours was generated by water power. The operating expenses for the companies generating 100,000,000 kilowatt-hours or more a year (90 per cent of which was generated by water power), including taxes and depreciation, averaged 7.4 mills per kilowatt-hour sold. The gross income from electrical operations of the same companies was 15 mills per kilowatt-hour of energy sold.

Power output of permittees and grantees, 1916–1922.

Year.	Number reporting.	Kilowatt-hours.	Increase or decrease.	
			Kilowatt-hours.	Per cent.
1916	26	1,200,000,000		
1917	32	2,000,000,000	+800,000,000	+67
1918	51	3,200,000,000	+1,200,000,000	+60
1919	57	3,100,000,000	−100,000,000	−3
1920	56	4,200,000,000	+1,100,000,000	+35
1921	59	3,725,000,000	−475,000,000	−11
1922	59	4,947,000,000	+1,222,000,000	+33

Power-site reserves, in acres.

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction.]

State.	Reserved prior to July 1, 1922.	Eliminated prior to July 1, 1922.	Reserves outstanding prior to July 1, 1922.	Reserved during fiscal year.	Eliminated during fiscal year.	Reserves outstanding June 30, 1923.
Alabama	749		749			749
Alaska	151,765	520	151,245	16,476		167,721
Arizona	1,103,239	105,194	998,045	58,471		1,056,516
Arkansas	28,469		28,469			28,469
California	817,345	18,252	799,093	135,727		934,820
Colorado	323,752	48,246	275,506	18,654	8	294,152
Florida	486		486			486
Idaho	399,603	165,351	234,252	41,333	7,116	268,469
Michigan	1,240		1,240			1,240
Minnesota	12,841	532	12,309			12,309
Montana	250,819	78,126	172,693	32,762	360	205,095
Nebraska	761		761			761
Nevada	272,596	280	272,316	27,826		300,142
New Mexico	215,181	6,537	208,644			208,644
Oregon	506,846	65,283	441,563	5,449	13,519	433,493
South Dakota	12		12			12
Utah	588,672	117,312	471,360		3,500	467,860
Washington	176,090	35,841	140,249	2,351	5,164	137,436
Wisconsin	1,096	226	870			870
Wyoming	216,923	67,546	149,377	160	452	149,085
	5,068,485	709,246	4,359,239	339,209	30,119	4,668,329

Summary of outstanding water-resources withdrawals and classifications June 30, 1923, in acres.

State.	Power reserves.					Reservoir withdrawals.	Public water withdrawals.	Ground-water reclamation designations.
	Withdrawals.	Classifications.	Designations.[a]	Miscellaneous.	Total.			
Alabama	120	190		439	749			
Alaska	93,415	3,478		70,828	167,721			
Arizona	302,208	37,182	528,245	188,881	1,056,516	23,040	14,521	
Arkansas	22,354	1,590		4,525	28,469			
California	297,105	69,969		567,746	934,820	1,160	68,188	
Colorado	252,502	18,368		23,282	294,152	1,728	1,820	
Florida				486	486			
Idaho	224,439	38,589		5,441	268,469		12,000	
Michigan	1,240				1,240			
Minnesota	12,309				12,309			
Montana	147,837	35,423		21,835	205,095	9,080	7,263	
Nebraska	761				761			
Nevada	27,543	27,786		244,813	300,142		10,126	1,300,940
New Mexico	65,483		143,161		208,644		8,366	
North Dakota						1,569		
Oregon	401,661	1,863	15,891	14,078	433,493	10,619	14,311	
South Dakota				12	12		240	
Utah	447,270	1,792		18,798	467,860	80	33,376	
Washington	109,006	6,702		21,728	137,436	35,943	920	
Wisconsin				870	870			
Wyoming	88,239	20,351		40,495	149,085	1,714	81,905	
	2,493,492	263,283	687,297	1,224,257	4,668,329	84,933	253,036	1,300,940

[a] Designated and not otherwise withdrawn.

IRRIGATION SECTION.

The primary work of the irrigation section is classification of lands with respect to irrigability under the enlarged and stock-raising homestead acts and the Nevada ground-water reclamation act. The greater portion of the thousands of applications for lands under these acts received are disposed of on the basis of data obtained through field examinations by the technical force of the branch and office information gathered from various sources bearing upon the matter of water supplies and irrigation. Broad areal classifications are made as far as practicable, and in consequence a number of applications are disposed of at the time of filing, thus decreasing the number of incoming cases. Cases that can not be handled otherwise are listed for field examination, and reports are made which not only serve as a basis for action upon the particular cases but often prove helpful in the consideration of applications embracing land in the immediate vicinity. Additional broad field studies in critical areas are planned for execution by the field branches when required and financed by allotments from the funds of the branch. During the year such studies were in progress in the Snake River Plains of southern Idaho, in four or five counties of eastern Montana, and in the Missouri River drainage area in Montana.

The section initiates designations of land appropriate for entry under the Nevada ground-water reclamation act, and during the year the area so designated was increased from 1,109,000 to 1,300,940 acres.

The section also makes reports on the sufficiency of water supply and general feasibility of irrigation projects that require some form

of Federal approval in connection with the administration of the public-land laws, and it initiates the withdrawal of lands for reservoir sites.

The tables relating to enlarged and stock-raising homestead designations and the general summary of cases show briefly the results of many features of the work of the section.

Summary of enlarged-homestead designations, in acres.

[Areas classified as arid and nonirrigable, residence by entrymen required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38Stat. 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply, residence by entrymen not required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho).]

State.	Designations prior to July 1, 1922.	Cancellations prior to July 1, 1922.	Designations outstanding prior to July 1, 1922.	Designations during fiscal year.	Cancellations during fiscal year.	Designations outstanding June 30, 1923.
Arizona	31,016,679	5,409,474	25,607,205	234,290	.....	25,841,495
California	12,982,601	238,320	12,744,281	108,065	.....	12,852,346
Colorado	32,762,497	184,960	32,577,537	364,979	28	32,942,488
Idaho:						
Total	13,424,381	453,405	12,970,976	80,820	[a] 2,880	13,048,916
Nonresidence	563,787	4,233	559,554	3,440	.....	562,994
Kansas	637,734	.....	637,734	6,340	.....	644,074
Montana	53,101,706	244,282	52,857,424	92,779	.....	52,950,203
Nevada	50,015,275	3,564,797	46,450,478	104,875	.....	46,555,353
New Mexico	43,035,939	227,732	42,808,207	378,905	.....	43,187,112
North Dakota	12,262,870	3,848	12,259,022	4,840	.....	12,263,862
Oregon	21,164,514	984,702	20,179,812	43,810	4,760	20,218,862
South Dakota	16,321,265	348,170	15,973,095	3,270	.....	15,976,365
Utah:						
Total	10,849,264	369,975	10,479,289	394,295	[b] 13,120	10,860,464
Nonresidence	1,584,454	21,840	1,562,614	16,800	960	1,578,454
Washington	6,581,875	251,842	6,330,033	13,130	.....	6,343,163
Wyoming	28,799,728	156,256	28,643,472	248,420	5,428	28,886,464
	332,956,328	12,437,763	320,518,565	2,078,818	26,216	322,571,167

[a] 2,880 acres previously designated under secs. 1–5 now designated under sec. 6.
[b] 12,160 acres previously designated under secs. 1–5 now designated under sec. 6.

DIVISION OF HOMESTEAD CLASSIFICATION.

The stock-raising homestead law requires that prior to entry under its terms the land shall be classified as nontimbered, nonirrigable, valuable chiefly for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family. The division of homestead classification determines what lands shall be so classified, except as to irrigability, which is determined by the irrigation section of the division of hydrographic classification. The nature of the classification is so complex that in many extensive areas detailed information concerning the particular tract applied for is essential. Field examination of individual tracts by the water-resources branch is therefore planned by this division and financed by allotments from the funds appropriated for classification of lands. Broad areal classification, after general reconnaissance, is applied wherever practicable, thus reducing the number of detailed field investigations to a minimum.

Under instructions of the Secretary of the Interior the division is cooperating with the Department of Agriculture in preparing a

report on the agriculture and the utilization of land in the northern Great Plains region.

Reservation and restoration of tracts valuable for watering stock is also a duty of this division. During the year additions to public water reserves embraced 570 acres in Arizona, 480 acres in California, 40 acres in Colorado, 40 acres in Idaho, 80 acres in Montana, 120 acres in Nevada, 2,085 acres in New Mexico, 1,320 acres in Oregon, and 40 acres in Wyoming, and the cancellations of such reserves included 80 acres in California, 40 acres in Colorado, 160 acres in Idaho, 16 acres in Montana, 425 acres in Nevada, 210 acres in Oregon, 1,150 acres in Utah, and 320 acres in Wyoming. The areas remaining reserved as public watering places in the several States at the end of the year are shown in the table of outstanding water-resources withdrawals and classifications.

The general summary of cases and the summary of stock-raising homestead designations show in detail other features of the progress of the work of this division, which has been kept substantially current throughout the year.

Summary of stock-raising homestead designations, in acres.

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family (act of Dec. 29, 1916, 39 Stat. 862).]

State.	Designations prior to July 1, 1922.	Cancellations prior to July 1, 1922.	Designations outstanding prior to July 1, 1922.	Designations during fiscal year.	Cancellations during fiscal year.	Designations outstanding June 30, 1923.
Arizona	13,699,316	832,040	12,867,276	79,794	160	12,946,910
Arkansas	1,120	.....	1,120	.....	.....	1,120
California	7,381,667	.....	7,381,667	148,263	.....	7,529,930
Colorado	7,089,107	8,880	7,080,227	389,845	360	7,469,712
Idaho	4,874,549	974	4,873,575	166,486	160	5,039,901
Kansas	101,434	.....	101,434	6,425	.....	107,859
Michigan	2,831	.....	2,831	120	.....	2,951
Montana	14,255,552	16,000	14,239,552	288,426	1,041	14,526,937
Nebraska	136,135	.....	136,135	24,120	.....	160,255
Nevada	418,309	2,800	415,509	15,816	.....	431,325
New Mexico	30,507,100	600	30,506,500	332,255	.....	30,838,755
North Dakota	329,832	.....	329,832	24,598	.....	354,430
Oklahoma	61,151	.....	61,151	5,960	.....	67,111
Oregon	5,900,159	1,048	5,899,111	136,830	1,360	6,034,581
South Dakota	6,393,647	390	6,393,257	43,600	160	6,436,697
Utah	990,768	240	990,528	89,714	640	1,079,602
Washington	592,423	1,134	591,289	46,110	.....	637,399
Wyoming	18,870,983	3,080	18,867,903	454,107	1,854	19,320,156
	111,606,083	867,186	110,738,897	2,252,469	5,735	112,985,631

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 24,473 pages of manuscript were edited and prepared for printing, and proof sheets comprising 2,748 galley proofs and 20,628 page proofs were read and corrected. Indexes were prepared for 55 publications, covering 12,985 pages. Copy and proof or stencils for 1,010 pages of multigraph and mimeograph matter were read. The publications of the year are listed and abstracted on pages 5–14.

At the end of the fiscal year five 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 drawings prepared was 4,052, including 186 maps, 1,543 sections and diagrams, 428 photographs, and 1,895 paleontologic drawings; 186 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany manuscripts numbered 956, to be reproduced by chromolithography, photolithography, halftone, zinc etching, and cuts already engraved. The number of proofs received and examined was 1,630. At the end of the year material for illustrating 31 reports was on hand. There are now, as last year, 11 employees in the section.

DIVISION OF MAP EDITING.

SECTION OF GEOLOGIC MAPS.

Geologic maps, structure sections, and other illustrations for 6 folios were drawn, edited, and prepared for publication and proofs of them were read during the year. Illustrations for 25 other reports in course of publication were examined and edited. Geologic maps and sections for several reports not yet submitted for publication were compiled for the authors and drawn.

One geologic folio (No. 214, Raton-Brilliant-Koehler, N. Mex.-Colo.) was completed and published. The 5 other folios in hand were well advanced toward completion. No new folios were received for publication during the year. The geologic map of Wyoming on the scale of 1 to 500,000 was received for preparation for publication, and editing was begun. The geologic map of Arizona on the same scale, prepared by the Arizona Bureau of Mines in cooperation with the United States Geological Survey, was also received for editing and preparation. The section was authorized to compile a geologic map of the United States on a scale of 1 to 2,500,000 for publication by the Geological Survey.

SECTION OF INSPECTION AND EDITING OF TOPOGRAPHIC MAPS.

During the year 70 topographic maps were edited and transmitted for engraving, 143 published topographic maps were edited for reprint, 41 plan and profile river-survey sheets were edited for photolithography, 16 miscellaneous maps were edited for engraving or photolithography, and 195 maps were edited as illustrations for Survey reports, a total of 465 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 424 were read and 185 proofs of maps reproduced by photolithography. At the end of the year 68 new topographic maps were in process of engraving and printing. Index maps for 12 State circulars were revised and proofs corrected. (See also "Topographic branch," p. 55.)

DIVISION OF DISTRIBUTION.

A total of 516 publications, comprising 152 new books and pamphlets, 15 reprinted books and pamphlets, 1 new geologic folio, 7 new geologic maps, Part I of the World Atlas of Commercial Geology reprinted, 133 new or revised topographic and other maps, and 207 reprinted topographic and other maps were received by the division of distribution during the year. A number of special pamphlets and forms prepared for administrative use were also delivered and distributed. The total units of all publications received numbered 482,951 books and pamphlets, 3,551 geologic folios, 3,000 copies of Part I of the World Atlas, 700 geologic maps, and 1,027,585 topographic and other maps, a grand total of 1,519,787.

The division distributed 470,491 books, 8,262 folios, 1,053 copies of the World Atlas (544 of Part I and 509 of Part II), and 741,116 maps, a total of 1,220,922, of which 7,237 folios, 848 copies of the World Atlas (460 of Part I and 388 of Part II), and 596,513 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was $42,928.77, including $40,782.57 for topographic and geologic maps, $1,053.80 for geologic folios, and $1,092.40 for copies of the World Atlas. In addition to this, $1,341.54 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were $44,270.31. The division received and answered 96,688 letters.

DIVISION OF ENGRAVING AND PRINTING.

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS.

During the fiscal year 71 new topographic maps were engraved and printed, and 1 map previously published in photolithographed form was also engraved and printed. A revised edition of 1 topographic map and a photolithographic edition of another were also printed and delivered, making a total of 73 new topographic maps published. In addition to these, 32 new topographic maps were engraved, but the printing was not completed by June 30. Engraving on 15 more new topographic maps was nearly completed. Sixty new maps were photolithographed and printed, making a total of 133 new maps printed and delivered.

Corrections were engraved on the plates of 143 maps. Reprint editions of 196 topographic maps and of 11 corrected State and other photolithographed maps were printed and delivered.

Of new and reprinted maps 340 different editions, amounting to 1,027,585 copies, were delivered to the map room.

One new geologic folio was published, the edition amounting to 3,551 copies. Extra geologic maps of this folio to the number of 700 copies were also delivered.

OTHER GOVERNMENT MAP PRINTING.

A large amount of work was also done for the Government Printing Office, various branches of the War Department, Veterans' Bureau, Federal Board for Vocational Education, Forest Service,

Department of Labor, Interstate Commerce Commission, Bureau of Agricultural Economics, Bureau of Public Roads, Bureau of Standards, Department of Commerce, Office of Public Buildings and Grounds, Bureau of Animal Industry, Post Office Department, Bureau of the Census, Department of State, Coal Commission, Bureau of Lighthouses, Bureau of Plant Industry, Shipping Board, States Relations Service, Weather Bureau, Federal Fuel Distributor, Department of the Interior, Alaskan Engineering Commission, Arlington Memorial Bridge Commission, International Boundary Commission, Federal Power Commission, Brazilian Centennial Exposition, Reclamation Service, Bureau of Mines, National Park Service, General Land Office, Office of Indian Affairs, and Bureau of Foreign and Domestic Commerce. This work for other branches of the Government included many reprint editions and amounted to about $100,000, for which the appropriation for engraving and printing geologic maps was reimbursed by transfer of credit on the books of the Treasury Department.

Transfer impressions to the number of 538 were made during the year, including 194 furnished to contracting printers on requisition of the Government Printing Office, 117 furnished to private firms, 152 furnished under cooperative agreements without charge to various State geological surveys, and 75 furnished to the War Department. The amount turned over to miscellaneous receipts from this work was $64.50.

During the year a reprint edition of the World Atlas of Commercial Geology (Part I) was completed, as well as a large amount of miscellaneous work relating to the map publications of the Geological Survey.

Of contract and miscellaneous printing of all kinds, 2,944,974 copies were printed. Including topographic maps and geologic folios, a grand total of 3,976,110 copies were printed and delivered. As most of this work was in colors involving many separate printings, it is estimated that the total number of impressions was 20,000,000 or more.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory consisted of 13,890 negatives (1,597 wet, 491 paper, 2,466 dry, 5,234 field negatives developed, and 4,102 photolithographic), 671 lantern slides, 120,497 prints (91,846 maps and diagrams, 22,775 photographs for illustrations, and 5,876 rectigraphs), 3,552 zinc plates, 204 zinc etchings, 49 celluloid prints, 176 lantern slides colored, and 748 prints mounted.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work of the executive division was of the same general character as during the fiscal year 1922.

Mails, files, and records.—During the year 144,467 pieces of mail, of which 2,166 were registered, were opened and referred; besides 5,000 letters and cards were received in connection with revisions of mailing lists. In addition 194,398 letters were received direct by the

other divisions, making a total of 338,865, an increase of 3 per cent compared with 1922. Of the letters opened in this division, 20,047 contained money remitted in payment for publications of the Survey. The number of ordinary letters mailed through the division was 112,380; of registered letters and packages, 19,374; and of form letters and cards, etc. (addressograph section), 500,000. In addition 780,019 pieces of mail were sent out direct from other divisions. The total number of outgoing pieces of mail for the Geological Survey was 1,412,773.

Freight and express.—During the year 1,667 pieces of freight and express were handled, 896 outgoing and 771 incoming.

Personnel.—At the end of the fiscal year the roll of Secretary's appointees numbered 915, 38 more than at the end of 1922. The total number of changes in the personnel was 481, which included 147 appointments, 109 separations, and 225 miscellaneous changes.

During the calendar year 16,597 days of annual leave and 4,020 days of sick leave were granted, being 77¼ per cent of the amount of the annual leave which could have been taken and 18¾ per cent of the amount of sick leave which it would have been possible to grant to an average of 716 employees; 10,155 days of leave without pay and furlough were also granted.

The clerical personnel consisted of 27 employees, including the chief; 12 of these were employed in the addressograph section. In addition there were 2 general laborers, a chief messenger, and 10 messengers.

DIVISION OF SCIENTIFIC AND TECHNICAL EQUIPMENT.

The requisitions on the division of scientific and technical equipment numbered 1,186, of which 1,154 were completed. Registration of instruments was checked and errors corrected. The instrument shop has built several pieces of experimental apparatus at a cost 40 to 60 per cent below outside estimates. It has also been successful in working nonmagnetic and noncorrosive steel, having drilled a tube about 260 inches with a ⅝-inch bore, a feat that has been found difficult by outside concerns. This tube has been used to carry a thermometer in measuring deep-well temperatures and shows no signs of corrosion, whereas tubes made of brass and other metals have had to be replaced annually. The instrument shop has done work during the year for the Bureau of Mines and the Reclamation Service. The electrical section inspected all Survey electrical equipment monthly and made general repairs. The carpenter and cabinet section made and repaired cases for various purposes, special stadia rods, and other appliances.

Section of field property.—The section of field property serves the entire field force of the Geological Survey. The types of instruments and supplies that have been found by years of successful use to meet the needs of the service are replaced when worn out, and other desirable instruments are added to the general stock. A certain standard for the different supplies is adhered to as far as possible, and a supply of repair parts is kept on hand. Records of camp equipment, livestock, and automobiles are kept. The services of one skilled laborer and one messenger are used for work in preparing

shipments and unpacking instruments sent to Washington. These assistants also make minor repairs. On the return of equipment from the field it is placed in condition for reissue or turned over to the instrument-repair man for attention.

LIBRARY.

The accessions to the library numbered 13,606 books, pamphlets, and periodicals, and 437 maps. Among the purchases were the issues of the Zoological Record for 1906 to 1920, which brought up to date the file of this valuable and expensive work, which is essential for use in paleontology. Cooperation among the Government libraries in Washington continues to lessen duplication. The insertion in the Survey catalog of titles of periodicals and serials available in other libraries is making unnecessary the purchase of many of these for this library. The number of readers and visitors was 13,659, and the loans made for outside use comprised 7,496 books and 356 maps. The library has continued to an increased extent to loan books and to give bibliographic information to specialists in other cities through the system of interlibrary loans and reference. New cards numbering 6,782 were added to the catalog, and 677 catalog entries were sent to the Library of Congress for printing. The correspondence consisted of 2,632 letters received and 2,556 letters sent. Foreign articles and letters to the number of 302 were translated for other divisions of the Survey. The bibliography of North American geology for 1919–20 was published as Bulletin 731. Of Part I of the cumulated bibliography for 1785–1918 (Bulletin 746) 256 galley proofs were read.

DIVISION OF ACCOUNTS.

Condensed statements covering the expenditures from Federal funds during the year are given on pages 87–88. The amounts contributed by States for cooperative work are set forth on pages 29, 52, and 60–61.

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1923.[a]

Appropriation.	Amount of appropriation.	Funds available.				Expenditures.			Balance.
		Repayments on account of work performed.			Total.	Disbursements.	Outstanding liabilities.	Total.	
		For other Government establishments.		For other Geological Survey units.					
		Made.	To be made.						
Salaries, office of Director	$20,760.00	.....	$2.43	.....	$20,762.43	$16,664.93	.....	$16,664.93	$4,097.50
Salaries, scientific assistants	29,900.00	.....	.....	.....	29,900.00	29,900.00	.....	29,900.00	.....
Topographic surveys	325,000.00	$41,038.97	15,917.95	$12,476.09	394,433.01	389,366.71	$4,942.12	394,308.83	124.18
Geologic surveys	300,000.00	6,308.96	2,167.48	197.25	308,673.69	299,163.67	8,332.75	307,496.42	1,177.27
Chemical and physical researches	40,000.00	.....	.....	.....	40,000.00	39,681.64	243.36	39,925.00	75.00
Preparation of illustrations	18,280.00	397.43	.....	.....	18,677.43	18,560.80	55.32	18,616.12	61.31
Mineral resources of the United States	125,000.00	1,598.26	258.33	100.00	126,956.59	125,468.32	526.69	125,995.01	961.58
Mineral resources of Alaska	75,000.00	4.10	738.68	.....	75,742.78	65,676.56	9,527.77	75,204.33	538.45
Gaging streams, etc	180,000.00	27,515.78	13,127.32	2,758.45	223,401.55	217,401.92	4,962.21	222,364.13	1,037.42
Books for the library	2,000.00	.....	.....	.....	2,000.00	1,609.22	381.95	1,991.17	8.83
Geologic maps of the United States	110,000.00	80,587.00	10,594.55	17,336.99	218,518.54	211,328.48	6,498.69	217,827.17	691.37
Classification of lands	225,000.00	613.81	25.00	253.15	225,891.96	221,162.51	4,407.36	225,569.87	322.09
	1,450,940.00	158,064.31	42,831.74	33,121.93	[b]1,684,957.98	[b]1,635,984.76	39,878.22	[b c]1,675,862.98	9,095.00

[a] In addition to these appropriations, $119,000 for Survey publications was contained in the appropriation for printing and binding but not disbursed by Survey officials There was also an allotment of $8,000 for miscellaneous printing and binding from the Interior Department appropriation for that purpose, and an allotment of $5,050.93 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

[b] Included in this amount is $33,121.93 covering work performed by Survey units for other Survey units; necessarily reported in combining totals but otherwise a duplication.

[c] Of this total $9,915.33 is in the hands of special disbursing agents and therefore has not been included in the classification of expenditures, as no vouchers covering disbursement have been received.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1923.

Object of expenditure.	Salaries, office of the director.	Salaries, scientific assistants.	Topographic surveys.	Geologic surveys.	Chemical and physical researches.	Preparation of illustrations.	Mineral resources of the United States.	Mineral resources of Alaska.	Gaging streams, etc.	Books for the library.	Geologic maps of the United States.	Classification of lands.	Total.
Personal services	$16,664.93	$29,900.00	$277,101.61	$258,760.80	$33,204.78	$18,354.48	$116,448.41	$49,464.17	$173,963.33	.....	$168,888.18	$164,191.47	$1,306,942.16
Stationery and office supplies	.....	.....	884.21	956.00	297.13	19.17	247.37	275.33	565.33	.....	31,193.77	[illegible]7.88	35,206.19
Printed forms and letterheads	.....	.....	154.55	65.73	.....	.....	157.08	47.90	1,023.93	.....	.....	.....	1,449.19
Scientific and educational supplies	.....	.....	421.96	1,256.26	961.05	.....	403.88	150.30	1,876.02	.....	1,917.90	142.34	7,129.71
Sundry supplies	.....	.....	1,995.02	677.12	109.00	67.90	34.67	190.57	2,281.53	.....	5,477.57	303.17	11,136.55
Materials	.....	.....	630.82	7.63	.....	.....	.....	.....	115.14	.....	.....	7.00	760.59
Subsistence and care of animals, and storage and care of vehicles	.....	.....	1,626.66	1,218.11	15.00	.....	41.18	.....	109.51	.....	.....	284.94	3,295.40
Telegraph service	.....	.....	655.33	181.46	2.85	.....	1,221.53	123.74	401.75	.....	5.49	167.54	2,759.69
Telephone service	.....	.....	30.25	30.45	1.20	.....	179.89	2.50	507.39	.....	.....	70.23	821.91
Other communication service	.....	.....	1.70	.....	.60	.....	.70	1.68	13.00	.....	.....	4.70	22.38
Travel expenses	.....	.....	58,509.08	18,511.24	2,268.75	.....	4,068.31	12,066.06	14,833.14	.....	289.74	29,268.28	139,814.60
Hire, maintenance, operation, and repair of horse-drawn and passenger-carrying vehicles	.....	.....	8,730.29	2,269.53	286.43	.....	171.84	46.00	2,603.54	.....	.....	3,153.27	17,260.90
Transportation of things	.....	.....	11,787.78	3,245.51	569.50	.41	159.97	435.95	3,880.21	.....	19.76	7,814.95	27,914.01
Printing and binding	.....	.....	23.00	.....	.....	.....	2.00	.....	18.25	.....	.....	2.40	45.65
Lithographing, engraving, and engrossing	.....	.....	5,854.75	962.98	8.40	14.14	207.18	116.04	663.14	.....	3.00	321.98	8,151.61
Stenographic work, typewriting, and duplicating work, etc. (job work)	.....	.....	10.55	150.82	12.38	.....	1.20	.....	15.50	.....	.....	50.00	240.45
Photographing and making photographs and prints	.....	.....	3,717.56	3,138.69	61.10	160.02	188.27	325.76	1,001.02	.....	98.87	1,186.45	9,877.74
Rents	.....	.....	22.20	160.90	54.31	.....	.....	.....	1,973.15	.....	.....	35.00	2,245.56
Repairs and alterations	.....	.....	1,898.21	1,555.46	767.66	.....	123.34	86.01	1,138.22	.....	3,771.74	182.32	9,522.96
Special and miscellaneous current expenses	.....	.....	5,789.00	7,784.69	376.79	.....	1,581.68	1,313.92	1,049.55	.....	786.30	2,752.54	21,434.47
Purchase of passenger-carrying vehicles	.....	.....	1,527.97	1,009.80	.....	.....	.....	.....	4,159.40	.....	.....	2,865.00	9,562.17
Furniture, furnishings, and fixtures	.....	.....	693.86	378.64	.50	.....	133.50	1,208.98	313.71	.....	318.00	708.36	3,755.55
Educational and scientific equipment	.....	.....	137.77	1,726.74	909.97	.....	32.00	248.33	4,713.11	$1,991.17	1,038.35	134.28	10,931.72
Livestock	.....	.....	622.10	.....	.....	.....	.....	500.00	.....	.....	.....	2,265.00	3,387.10
Other equipment	.....	.....	9,442.27	3,447.86	17.60	.....	591.01	726.09	2,798.58	.....	4,018.53	8,890.77	29,932.71
Structures	.....	.....	.....	.....	.....	.....	.....	.....	2,346.68	.....	.....	.....	2,346.68
	16,664.93	29,900.00	392,268.50	307,496.42	39,925.00	18,616.12	125,995.01	67,329.33	222,364.13	1,991.17	217,827.17	225,569.87	1,665,947.65

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