

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THIRTY-FIRST ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES
GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1910



WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

H. S. Walcott.

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THIRTY-FIRST ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1909-10 comprised items amounting to \$1,497,815. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES OF THE WORK.

PROGRESS IN LAND CLASSIFICATION.

OUTLINE OF WORK.

The work of the land-classification board is for the most part based on field investigations made by other sections, divisions, and branches of the Survey, as well as by the General Land Office. The land-classification work during the year has included—

1. The preparation of withdrawals covering power sites and coal, oil, gas, and phosphate lands.
2. The classification and restoration of withdrawn lands and the classification of certain mineral claims in national forests.
3. The designation of lands under the enlarged-homestead act and the consideration of petitions for such designation.
4. The consideration of applications for the reclassification of lands classified as coal land and of referred reports of special agents of the General Land Office with respect to the mineral character of classified, withdrawn, and other lands.
5. Reports to the Secretary, Land Office, and Indian Office regarding the possibility of developing power on lands involved in applications under the right-of-way acts and regarding the feasibility of proposed irrigation enterprises under the Carey Act.

PHOSPHATE LANDS.

Withdrawals of public phosphate lands have been made in aid of proposed legislation, for the reason that many conflicting claims have arisen through efforts to locate and acquire title to such lands

under existing laws and for the further reason that the maintenance of the agricultural wealth of the country requires that the exportation of these supplies of valuable plant food be prevented by some effective method.

The field examination of these withdrawn lands is being energetically pushed, so that all lands which are in fact not underlain by phosphate deposits may be promptly released from these withdrawals and new phosphate territory may be included. During the fiscal year areas aggregating 2,322,416 acres, which had been included in phosphate withdrawals, have been restored to entry as the result of field work showing that they are not valuable for phosphate, and 401,954 acres of new phosphate territory found by these examinations have been included in the withdrawals. The withdrawals by States are tabulated elsewhere (p. 47).

POWER SITES.

The policy of withdrawing lands in aid of proposed legislation affecting the use and disposition of water-power sites was actively continued during the year at the rate of about 100,000 acres a month, the total withdrawals for the year amounting to 1,219,818 acres. As a result of field work showing the lands not to be valuable for power 45,189 acres were released from existing withdrawals and restored to the public domain. The areas covered by withdrawals in the several States, as well as the total area covered by outstanding withdrawals on July 1, 1910, are given in the table on page 48.

COAL LANDS.

The energies of the coal-land classification board have been directed toward the completion and systematization of the records of past investigations and actions; the classification and appraisement of the large areas which had been examined in previous years but on which no classification had been reported; the reclassification, under the new regulations of April 10, 1909, of all areas previously classified; and the withdrawal of areas which by these former examinations were indicated to contain valuable deposits of coal but with regard to which the information at hand was not sufficient for a complete classification and appraisement.

Classifications and valuations.—The board has during the year classified and appraised, with respect to coal value, 14,512,932 acres which had not previously been classified, of which 587,306 acres were required to offset the amount lost by rewithdrawals where new data indicated the existing classifications to be erroneous. It has reclassified 4,206,528 acres covered by former classifications. These, with the areas restored without appraisal because they are private lands, or without classification because of their doubtful value as to coal,

amounting to 2,602,215 acres, make a total of 21,321,675 acres acted on during the year. The total value of the 5,618,769 acres appraised as coal land during the year, at the minimum price fixed by law, is \$87,816,599; the value fixed by the board is \$380,955,646, an increase of approximately \$300,000,000. The total area on June 30, 1910, covered with classification and appraisal as coal land, under both the old and the new regulations, is 10,031,390 acres, and the total appraised value of those lands is \$449,876,208. The progress of coal-land classifications and the net areas covered by existing classifications under the old and new regulations on July 1, 1909, and July 1, 1910, exclusive of restorations without classification and of classifications as coal land without appraisal, are shown in the table on page 45.

Withdrawals.—The coal-land withdrawals have been extended during the year to cover the principal remaining areas of the extensive coal fields in eastern Montana and Wyoming, only portions of which had been previously withdrawn. These withdrawals, together with those covering newly discovered coal fields in Utah and Arizona and the rewithdrawal of 587,306 acres where new data indicated the existing classifications to be erroneous, make a total withdrawal for the year of 20,425,728 acres.

Recommendations for withdrawal covering the very extensive area of low-grade coal lands in North Dakota and South Dakota were prepared during the fiscal year, but the withdrawals were not made until the early part of July, 1910. Although these lands had been known for many years to contain coal, inclusive withdrawals had not been made for the reason that the agricultural value of the land was almost everywhere greater than the coal value, and the value of the coal was not deemed sufficient to warrant the great retardation of development which would follow withdrawal. With the passage of the law making it possible to obtain patent to the surface of coal lands under the agricultural-land laws, this objection to withdrawal no longer existed. It is believed that with these new withdrawals in Montana, Wyoming, Utah, Arizona, North Dakota, and South Dakota only small areas of public lands will be found to contain coal in amounts which will make additional withdrawals necessary, except in coal fields in existing Indian reservations.

The outstanding withdrawals on July 1, 1909, and July 1, 1910, together with a summary statement of new withdrawals and actions which have tended to reduce existing withdrawals, are given by States in the table on page 46.

OIL LANDS.

At the beginning of the fiscal year oil-land withdrawals from agricultural entry included 2,270,144 acres in California and 173,530

acres in Wyoming, and oil-land withdrawals from all acquisition covered 1,451,520 acres in Louisiana (of which only 6,599 acres are known to be vacant unappropriated land) and 74,849 acres in Oregon.

On September 26, 1909, the President decided that all public oil lands should be withheld from all disposition pending Congressional action, for the reason that the existing mineral-land law is not well adapted to deposits of this character and for the further reason that it seemed desirable to reserve certain fuel-oil deposits for the use of the American navy. Accordingly, the form of all existing withdrawals was changed, and new withdrawals aggregating 2,749,260 acres were made in Arizona, California, Colorado, New Mexico, Utah, and Wyoming. Field examinations passed on by the oil-land classification board during the year resulted in the restoration of 2,172,182 acres of land which were found not to be valuable for oil. The aggregate areas in the several States covered by withdrawals outstanding July 1, 1909, and July 1, 1910, are presented in the table on page 47, together with a summary statement of the restorations of lands found not to be valuable for oil.

GEOLOGIC INVESTIGATIONS.

Geologic surveys and investigations were continued during the year in 32 States and Territories, and over 66 per cent of the appropriation for geologic surveys was expended in the 16 public-land States and Territories. In connection with the land-classification work, about 15,300 square miles of supposed coal territory in the Rocky Mountain region were examined. Other work in the public-land States included continuation of the study of the phosphate deposits in Idaho, Wyoming, and Utah and systematic, detailed surveys of important mining districts in Washington, Colorado, Utah, Nevada, California, Idaho, Arizona, and Missouri and of oil fields in southern California and Oklahoma.

Under instructions of the Secretary of the Interior, C. A. Fisher was detailed to examine for the General Land Office the group of coal claims in Alaska under investigation by that bureau and spent about two months and a half in this work.

HISTORY OF TECHNOLOGIC INVESTIGATIONS.

The organization of the Bureau of Mines July 1, 1910, makes this report of the Geological Survey an appropriate place to review the work now transferred to that bureau.

AUTHORITY.

The Survey's investigation of fuels had its beginning in the appropriation act of February 18, 1904, carrying \$30,000 "for analyzing and testing at the Louisiana Purchase Exposition the coals and

lignites of the United States, * * * under the supervision of the Director of the United States Geological Survey." This was followed by other appropriations—\$30,000 April 27, 1904; \$25,000 January 5, 1905; \$202,000 March 3, 1905; \$250,000 for each of the fiscal years 1906, 1907, 1908, and 1909; and \$100,000 for the fiscal year 1910.

The investigation of structural materials under the Geological Survey was authorized under the sundry civil appropriation act of March 3, 1905, carrying \$7,500 for this purpose, and the deficiency appropriation act of the same date, carrying \$5,000. The work was enlarged and continued by appropriations of \$100,000 for each of the fiscal years 1907, 1908, 1909, and 1910.

The investigations as to the causes of mine explosions, with a view to increasing safety in mining, were first authorized in the legislative appropriation act of May 22, 1908, carrying for this purpose an appropriation of \$150,000. This was followed by a similar appropriation in the act providing for the sundry civil expenses of the Government for 1910. A fully equipped mine experiment station was established in Pittsburg during 1908, at which investigations of explosives, coal gas, dust, electricity, and other possible causes of mine explosions have since been continually under way.

Through the courtesy and cooperation of the Louisiana Purchase Exposition and the city of St. Louis, the investigations of fuels and structural materials were continued on the exposition grounds during 1905 and 1906 and those of structural materials until 1909. During 1907 the fuel investigations were transferred to Norfolk, Va., and early in 1908 to Pittsburg, where a large part of the work on structural materials also is now done. In April, 1907, these two series of investigations were, by order of the Secretary of the Interior, included in an administrative unit—the technologic branch of the Geological Survey.

The act establishing the Bureau of Mines, approved May 16, 1910, as amended in the sundry civil appropriation act approved June 25, 1910, transfers to that bureau the investigations, personnel, and equipment of the fuels and mine-accidents divisions of the technologic branch of the Geological Survey, to take effect July 1 of this year. The sundry civil act also provides that the structural-materials investigations heretofore carried on by the Geological Survey shall be continued by the Bureau of Standards.

INVESTIGATION OF MINE ACCIDENTS.

The study of mine explosions and their causes at the Pittsburg station has been developed under five phases, as follows:

1. Investigations in the mines to determine the conditions leading up to mine explosions and means of preventing them.

2. Investigations of explosives used in coal mines, to determine those that can be used with least risk in mines where gas or inflammable dust may be found.

3. Investigations of the conditions under which electric equipment can be safely used in coal-mining operations where there is risk of explosions.

4. Investigations of mine lamps as possible causes of mine explosions, and of the relative safety and efficiency of mine lamps of different types.

5. Investigations of the various types of artificial breathing apparatus suited for use in the study of mine disasters.

The mining engineering field force of the Geological Survey has already made decided progress in the study of underground mining conditions and methods. Practically all the coal mines in which explosions have occurred during the last two years have been carefully examined; the gases, coal dust, coke, etc., have been analyzed at the Pittsburg laboratory; and every effort has been made to determine the explosibility of various mixtures of gas and air in the presence of shots of explosives of different types. Investigations have been made as to the explosibility of dust from various typical coals under similar conditions, the chemical composition and physical characteristics of this dust and of the coal from which it is formed, and the methods of preventing dust explosions by wetting the dust by sprinkling or other methods.

Considerable progress has been made also in the investigation of explosives used in coal mining and the determination of the conditions under which they may be used with least risk, especially where either gas or inflammable coal dust is present in quantities that indicate danger. In arranging for this work, the manufacturers of explosives were invited to submit for test, according to a published program, such of their explosives as they had reason to believe might meet the conditions prescribed. In response to this invitation a number of explosives have been submitted for investigation, and a considerable portion of them have passed the required tests and have therefore been classed among the "permissible explosives." Three lists of such explosives have been published, the latest (May, 1910) containing a total of 45 permissible explosives.

The investigations in connection with electricity as one of the possible causes of coal-mine explosions have related mainly to inclosed electric fuses, as to whether, in actual use, they may or may not ignite an explosive mixture of air and gas or inflammable dust; to the development of electric methods of determining automatically the percentage of gas present in air in different parts of the mine and indicating it in the superintendent's office; to the relative safety and permanence of different types of insulation of electric wires under mine conditions;

and to the conditions under which closed electric motors may be safely used in gaseous or dusty mines.

The investigations and educational work in connection with the use of artificial breathing apparatus and other types of mine rescue equipment have been useful in developing better methods for using such equipment both in the examination of mines in which explosions have occurred and in mine rescue work. As an outgrowth of the work already done four branch mine rescue experiment stations have already been established and nine others have been authorized by Congress; and three fire-fighting and mine rescue stations have been authorized by the general assembly of Illinois and will be established during the next few months. In addition, many mining companies have purchased mine rescue equipment for establishing local stations of their own in all the more important coal fields.

FUEL TESTING.

The work of the fuel division during the current fiscal year, owing to the reduction in its appropriation from \$250,000 to \$100,000, has been confined largely to the routine testing of coal and other mineral fuels needed for use by the Government. This phase of the work has developed to such an extent that nearly all the fuel now purchased by the Government is either purchased on specifications and subject to tests by the fuel division or purchased after examinations of the coal supplied by the mines from which coal is delivered to the Government.

In addition to this routine testing work, certain investigations have been conducted during the year to promote increased efficiency in the use of fuel by the Government; also general investigations concerning the processes of combustion, the organic composition of coal, the causes of and methods of preventing spontaneous combustion, and other allied subjects that are considered to have a special bearing on the government work.

The investigations begun at St. Louis and continued at Norfolk in connection with the testing of coal under boilers and in gas producers have been, for the most part, necessarily discontinued, and final reports on these subjects are nearly ready for publication.

Investigations as to the adaptability of different grades of coal for briquetting are now limited largely to laboratory investigations of binding materials and experiments in briquetting lignites and lignitic coals from the public-land States.

The chemical laboratories associated with this division have not only made the routine analyses of coals purchased by the Government but have also analyzed many samples of coal collected by the geologists of the Survey in connection with the classification of the public lands.

The investigations into the waste in the mining and utilization of coal have brought out important information as to the nature and extent of this waste and have proved useful in awakening the public to the need of improving the conditions to which it is now largely due. During the last two years much attention has also been given to the problem of a more extensive and less wasteful use of other mineral fuels, especially natural gas, fuel oil, and oil products.

The fuel investigations have also included an inquiry into the possibility of substituting peat for mineral fuels in regions where the latter are scarce and expensive.

INVESTIGATION OF STRUCTURAL MATERIALS.

The investigation of structural materials begun at St. Louis in 1905 was a continuation of and followed logically from the investigations of cement-making materials, building stone, and clays which had been carried on to some extent by the Geological Survey for several years.

Tests of cement were made at St. Louis during the Louisiana Purchase Exposition under the auspices of the Association of American Portland Cement Manufacturers, who had prepared for the exposition a cement pavilion with three rooms, in the largest of which was a working exhibit of cement and concrete testing machinery. At the close of the exposition this pavilion and other necessary buildings were placed at the disposal of the Government for use in the structural-materials investigations then proposed. The enlargement of the work in 1906 made necessary the acquirement of additional buildings for the housing of the laboratories, and the exposition authorities granted for this work the free use of the foundry exhibit building (100 by 125 feet) and metal pavilion (100 by 60 feet floor space). Owing to the necessity of removing these buildings from the exposition grounds, which were retransferred to the city of St. Louis as a part of the public park, and the inability of the Survey to obtain quarters for the work elsewhere in St. Louis, the structural-materials investigations were transferred to the government buildings available for them on the arsenal tract in Pittsburg.

Although the purpose of these investigations has been primarily to meet the Government's own needs, incidentally the results are published in such a manner as to make them of value to the engineering profession and to the general public. Moreover, these investigations were so planned as to make use of and to correlate all similar work by others, in state testing laboratories, in the testing laboratories of universities, and through the agencies of engineering societies and their joint committees.

The investigations conducted during the year include inquiries into the nature, extent, and distribution of materials needed for the use of the Government in its building and construction work. They were

planned after a careful consideration of the statements of needs submitted by the Supervising Architect, the Isthmian Canal Commission, and other branches of the government service having such work in charge. They have related primarily to concrete, reenforced concrete, and other cement products and their constituent materials, clay products, stone, and miscellaneous materials, and the behavior of such structural materials under the action of fire, water, acids, alkalies, and other destructive agencies.

DISTRIBUTION OF PUBLICATIONS.

The increase in the volume of distribution of reports and maps is more than keeping pace with the growth of the Survey. The number of letters received relating to publications and the amount of money received from sales of publications furnish, perhaps, the best index of the relation of the Survey to the public. The increase for 1910 over 1909 in such letters received was more than 20 per cent, and the money receipts show a gain of more than 6 per cent. The total number of reports and maps distributed has increased more than 13 per cent. These figures may be compared with the growth in the total correspondence of the Survey, the number of pieces of incoming mail handled during the year showing an increase of not quite 9 per cent over the number in the fiscal year 1909.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey's work finds public expression chiefly through its reports and maps. The publications of the last fiscal year are briefly described in the following summaries:

Thirtieth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1909. 128 pp., 2 pls.

A report on special features of the Survey's work, brief abstracts of publications of the year, and a summary of the work by branches and divisions, with maps showing the progress of topographic and geologic surveys.

Professional Paper 64. The Yakutat Bay region, Alaska (Physiography and glacial geology by Ralph S. Tarr; Areal geology by Ralph S. Tarr and Bert S. Butler). 183 pp., 37 pls., 10 text figures.

An elaborate description of the region, especially of its glacial history, with chapters on early exploration, the distribution of plants and animals, and the mineral resources.

Professional Paper 65. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 105 pp., 24 pls., 15 text figures.

Describes the geology of the sedimentary rocks—their stratigraphy, structure, and geologic history—and discusses the mineral resources of the region, including underground water, coal, gypsum, and other minerals. Also contains information respecting surface waters available for irrigation and stock raising and notes on timber and climate. The illustrations comprise geologic and topographic maps, a map showing the distribution of underground waters, sections showing stratigraphy, and half-tone reproductions of photographs.

Professional Paper 66. The geology and ore deposits of Goldfield, Nev., by Frederick Leslie Ransome, assisted in the field by W. H. Emmons and G. H. Garrey. 258 pp., 35 pls., 34 text figures.

A description of the geology, geologic history, mineralogy, ore deposits, and mines of the district, with a history of mining and a list of previous reports. Contains also notes on ore treatment and an account of the origin of the mineral deposits. The illustrations include geologic maps and sections, mine plans and sections, half-tone views, and photomicrographs of ores and rocks.

Professional Paper 67. Landslides in the San Juan Mountains, Colorado, including a consideration of their causes and their classification, by Ernest Howe. 58 pp., 20 pls., 4 text figures.

A detailed description of the landslides and rock streams, a brief summary of the various views entertained concerning landslides in general, and a discussion of their nature and causes.

Bulletin 360. Pre-Cambrian geology of North America, by Charles Richard Van Hise and Charles Kenneth Leith. 939 pp., 2 pls.

A full account of the present state of knowledge of the pre-Cambrian rocks of North America, including a general description of the rocks, summaries of the literature on the several regions considered, statements of the established conclusions, and correlations of formations in the several regions. The accompanying maps show pre-Cambrian areas of North America and of the Lake Superior region.

Bulletin 377. The fauna of the Caney shale of Oklahoma, by George H. Girty. 106 pp., 13 pls.

Descriptions of species, a register of localities where the fossils were found, and half-tone figures of specimens. Includes suggestions as to age and correlations.

Bulletin 380. Contributions to economic geology, 1908: Part I, Metals and nonmetals, except fuels; C. W. Hayes and Waldemar Lindgren, geologists in charge. 406 pp., 2 pls., 32 text figures.

Introductory papers by Messrs. Hayes and Lindgren summarize the publications and field work of the year bearing on deposits of metalliferous ores and on non-metallic mineral resources except fuels. The body of the volume comprises the following papers:

Notes on the economic geology of southeastern Gunnison County, Colo., by J. M. Hill.

The Hornsilver district, Nevada, by F. L. Ransome.

Round Mountain, Nevada, by F. L. Ransome.

Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon, by J. S. Diller and G. F. Kay.

Notes on the Bohemia mining district, Oregon, by D. F. MacDonald.

Faulting and vein structure in the Cracker Creek gold district, Baker County, Oreg., by J. T. Pardee.

The Yerington copper district, Nevada, by F. L. Ransome.

The Tres Hermanas mining district, New Mexico, by Waldemar Lindgren.

Tin, tungsten, and tantalum deposits of South Dakota, by Frank L. Hess.

Note on a wolframite deposit in the Whetstone Mountains, Arizona, by Frank L. Hess.

Tonnage estimates of Clinton iron ore in the Chattanooga region of Tennessee, Georgia, and Alabama, by E. F. Burchard.

The Taylor Peak and Whitepine iron-ore deposits, Colorado, by E. C. Harder.

The Hanover iron-ore deposits, New Mexico, by Sidney Paige.

The iron ores of the Appalachian region in Virginia, by E. C. Harder.

- Manganese deposits of the United States, by E. C. Harder.
 An occurrence of asphaltite in northeastern Nevada, by Robert Anderson.
 Grahamsite deposits of southeastern Oklahoma, by J. A. Taff.
 Marble prospects in the Chiricahua Mountains, Arizona, by Sidney Paige.
 The Niobrara limestone of northern Colorado considered as a possible source of Portland cement material, by G. C. Martin.
 Cement material near Havre, Mont., by L. J. Pepperberg.
 Ganister in Blair County, Pa., by Charles Butts.
 Notes on the clays of Florida, by George C. Matson.
 Sodium sulphate in Soda Lake, Carriso Plain, San Luis Obispo County, Cal., by Ralph Arnold and H. R. Johnson.
 Sulphur deposits near Thermopolis, Wyo., by E. G. Woodruff.
 Mica deposits of South Dakota, by D. B. Sterrett.
 Lists of Survey publications on deposits of metals and nonmetals, except fuels.
- Bulletin 382. The effect of oxygen in coal, by David White. 74 pp., 3 pls.
 A report on the results of a comparative study of ultimate coal analyses made and published by the United States Geological Survey, showing that oxygen in coal is economically almost as undesirable as ash.
- Bulletin 383. Notes on explosive mine gases and dusts, with special reference to explosions in the Monongah, Darr, and Naomi coal mines, by Rollin Thomas Chamberlin. 67 pp., 1 text figure.
 A report on the conditions in the mines after the explosions, with analyses of gases, studies of coal dusts, and suggestions as to methods of preventing dust explosions.
- Bulletin 384. A geological reconnaissance in northern Idaho and northwestern Montana, by F. C. Calkins, with notes on the economic geology, by D. F. MacDonald. 112 pp., 2 pls., 3 text figures.
 A sketch of the geography and the areal and economic geology of the region, with detailed descriptions of certain localities and a geologic sketch map.
- Bulletin 385. Briquetting tests at the United States fuel-testing plant, Norfolk, Va., 1907-8, by Charles L. Wright. 41 pp., 9 pls.
 A description of the briquetting plant and of the results of tests of briquets made from several kinds of coal with different binders.
- Bulletin 386. Pleistocene geology of the Leadville quadrangle, Colorado, by Stephen R. Capps, jr. 99 pp., 8 pls., 18 text figures.
 A general consideration of ice action in the quadrangle, followed by a special consideration of glacial deposits and action in particular areas.
- Bulletin 387. Structural materials in parts of Oregon and Washington, by N. H. Darton. 33 pp., 9 pls., 1 text figure.
 An account of deposits of gravel, sand, clay, building stone, limestone, plaster, and cement materials in the regions about Portland, Oreg., and Takoma and Seattle, Wash., with maps showing location of the deposits and other illustrations.
- Bulletin 388. The colloid matter of clay and its measurement, by Harrison Everett Ashley, with a preface by A. V. Bleininger. 65 pp., 1 pl., 9 text figures.
 A report on a series of experiments and tests designed to afford a means of determining the plasticity of clays and the purposes to which they are best adapted.
- Bulletin 389. The Manzano group of the Rio Grande valley, New Mexico, by Willis T. Lee and George H. Girty. 141 pp., 12 pls., 9 text figures.
 Description of the stratigraphy of the group, by Mr. Lee, and of the fossils, by Mr. Girty.

Bulletin 390. Geology of the Lewistown coal field, Montana, by W. R. Calvert. 83 pp., 5 pls., 1 text figure.

Description of the geography, stratigraphy, and structure of the field and of the coal beds as exposed or developed at many places.

Bulletin 391. The Devonian fauna of the Ouray limestone, by E. M. Kindle. 60 pp., 10 pls.

Descriptions and figures of the fossils, with observations on the Devonian and Carboniferous divisions and fossils of the formation.

Bulletin 392. Commercial deductions from comparisons of gasoline and alcohol tests on internal-combustion engines, by Robert M. Strong. 38 pp.

Discusses differences in engines, effect of quality of fuel and of principal operating conditions, limit of rate of fuel consumption and other factors, and presents a summary of the conclusions reached.

Bulletin 393. Incidental problems in gas-producer tests, by R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. 29 pp., 8 text figures.

A discussion of factors affecting the proper length of tests and differences of temperature in the fuel bed.

Bulletin 394. Papers on the conservation of mineral resources. 1909. 214 pp., 12 pls., 2 text figures. Reprinted from report of the National Conservation Commission, February, 1909.

Coal fields, by M. R. Campbell and E. W. Parker; Future coal production, by Henry Gannett; Petroleum, Natural gas, by D. T. Day; Peat, by C. A. Davis; Iron ores, by C. W. Hayes; Gold, silver, copper, lead, and zinc, by Waldemar Lindgren; Phosphate deposits, by F. B. Van Horn; Mineral resources of Alaska, by A. H. Brooks. The illustrations include maps of the United States showing coal, petroleum, and natural-gas fields, a map of Alaska showing known mineral deposits, and several diagrams showing rate and amount of mineral production.

Bulletin 395. Radioactivity of the thermal waters of Yellowstone National Park, by Herman Schlundt and R. B. Moore. 35 pp., 4 pls., 7 text figures.

A description of apparatus and methods used to determine the radioactivity of the waters and a statement and discussion of the results of the experiments.

Bulletin 396. Paleontology of the Coalinga district, California, by Ralph Arnold. 173 pp., 30 pls.

Descriptions of the geologic formations and of their contained fossils, with figures of the fossils.

Bulletin 397. Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Arizona, by F. C. Schrader. 226 pp., 16 pls., 37 text figures.

A general account of the geography, physiography, and geology of the region and a detailed description of the mineral deposits seen at numerous mines. The illustrations include a geologic reconnaissance map, plans and sections of claims and mines, and half-tone views.

Bulletin 398. Geology and oil resources of the Coalinga district, California, by Ralph Arnold and Robert Anderson; with report on oils, by I. C. Allen. 354 pp., 52 pls., 9 text figures.

A discussion of the geography, topography, and geology of the district and a detailed account of the territory from which oil has been obtained, notes on the occurrence and origin of the oil, and description of individual wells, together with conclusions respecting the future development of the field, tables showing areas classified as mineral land, production and estimated supply, and oil companies and wells in the district, and a chapter on character of the oil. The illustrations embrace geologic maps and sections and figures showing fossils.

Bulletin 399. Results of spirit leveling in West Virginia, 1896-1908; compiled by S. S. Gannett and D. H. Baldwin. 81 pp.

A detailed account of precise and primary leveling, showing the altitudes above sea level of more than 1,200 points.

Bulletin 400. Iron ores, fuels, and fluxes of the Birmingham district, Alabama, by E. F. Burchard and Charles Butts; with chapters on the origin of the ores, by E. C. Eckel. 204 pp., 17 pls., 19 text figures.

A description of the general geology of the district and of the Clinton and brown ores, detailed descriptions of the mines and deposits, discussions of the origin of the ores, notes on methods of mining, and an account of the fuel and fluxes used. The illustrations include economic and geologic maps of the district and many plans, sections, and half-tone views.

Bulletin 401. Relations between local magnetic disturbances and the genesis of petroleum, by G. F. Becker. 24 pp, 1 pl.

Presents the various arguments as to the mode of origin of deposits of petroleum and other hydrocarbons and suggests that some such deposits may have originated from iron or other metallic carbides formed by the action of volcanic emanations or waters. The accompanying map, showing irregularities of compass declination in the United States, indicates that petroleum deposits are intimately associated with magnetic disturbances like those arising from the presence of minerals possessing magnetic attraction.

Bulletin 402. The utilization of fuel in locomotive practice, by W. F. M. Goss. 28 pp., 8 text figures.

A report on tests made at the locomotive-testing laboratory of Purdue University, at Lafayette, Ind., with a view of obtaining greater economy and efficiency of service.

Bulletin 403. Comparative tests of run-of-mine and briquetted coals on the torpedo boat *Biddle*, by W. T. Ray and Henry Kreisinger. 49 pp., 10 text figures.

Report on tests made to determine the relative efficiency of briquets and raw coal as fuel on United States torpedo boats.

Bulletin 404. The granites of Vermont, by T. Nelson Dale. 138 pp. 5 pls., 25 text figures.

Scientific and economic discussions of the granites, with detailed accounts of the granite quarries. The report contains a bibliography of the economic geology of granite and is illustrated by maps, diagrams, and half-tone plates.

Bulletin 405. Mercury minerals from Terlingua, Tex., by W. F. Hillebrand and W. T. Schaller. 174 pp., 6 pls., 44 text figures.

A report on the occurrence and associations of the minerals and descriptions of their crystallography, with numerous figures showing forms of crystals.

Bulletin 406. Preliminary report on the McKittrick-Sunset oil region, California, by Ralph Arnold and H. R. Johnson. 225 pp., 5 pls., 2 text figures.

An account of the geography, topography, and geology of the region, the water supply, and the oil fields. Includes lists of areas classified as oil lands and areas withdrawn, a list of oil companies, and tables showing the production of oil by years. The illustrations include geologic maps of the region, showing the structure.

Bulletin 407. Geology and ore deposits of the Bullfrog district, Nevada, by F. L. Ransome, W. H. Emmons, and G. H. Garrey. 130 pp., 14 pls., 20 text figures.

Descriptions of the general and economic geology of the district, with geologic maps and sections, plans of mines, diagrams showing structure, and many half-tone views.

Bulletin 408. Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev., by W. H. Emmons. 130 pp., 5 pls., 22 text figures.

A report on the geology, mines, and mineral deposits of the district, with numerous maps and diagrams.

Bulletin 409. Bibliography of North American geology for 1908, by J. M. Nickles. 148 pp.

A list of papers published in 1908 on North American geology, arranged alphabetically by names of authors, an index of subjects or materials, and lists showing chemical analyses reported and minerals, rocks, and formations described.

Bulletin 410. The Innoko gold-placer district, Alaska, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Madren. 87 pp., 5 pls.

An account of the geography, history, and other features of the district, including routes of travel, a sketch of the geology, and a report on the mineral resources. The illustrations include geologic and topographic maps.

Bulletin 411. Results of spirit leveling in Ohio, 1898-1908, compiled by S. S. Gannett and D. H. Baldwin. 147 pp.

A report on precise and primary leveling in the State, including statements of the altitude above sea level of more than 1,300 places.

Bulletin 412. Tests of run-of-mine and briquetted coal in a locomotive boiler, by W. T. Ray and Henry Kreisinger. 32 pp., 9 text figures.

A description of the fuels, apparatus, and methods employed, and a statement of the results of the tests.

Bulletin 413. A reconnaissance of the gypsum deposits of California, by F. L. Hess; with a note on errors in the chemical analysis of gypsum, by George Steiger. 37 pp., 4 pls., 2 text figures.

A description of the deposits in detail, with maps, sections, and half-tone views.

Bulletin 414. Notes on some mining districts in Humboldt County, Nev., by F. L. Ransome. 75 pp., 1 pl., 7 text figures.

Descriptions of the geology and mineral deposits of the Seven Troughs, Rosebud, and Red Butte mining districts and the Humboldt, Pahute, and Sonoma ranges, and an account of the mineralogy of the ore deposits.

Bulletin 415. Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale. 265 pp., 22 pls., 8 text figures.

An account of the geography and geology of the region and detailed descriptions of the Grand Hogback, Danforth Hills, lower White River, Vernal, western Yampa, and Henrys Fork coal fields, with a chapter on the quality of the coals. The illustrations include topographic and geologic maps, structure sections, and half-tone views.

Bulletin 416. Recent development of the producer-gas power plant in the United States, by R. H. Fernald. 82 pp., 2 pls., 3 text figures.

A report on producer-gas tests made by the Geological Survey and an account of the present status of the producer-gas power plant, with opinions of the operators of plants, summaries and particulars concerning plants visited, and a list of installations in the United States.

Bulletin 417. Mineral resources of the Nabesna-White River district, Alaska, by F. H. Moffit and Adolph Knopf; with a section on the Quaternary, by S. R. Capps. 64 pp., 5 pls., 3 text figures.

An account of the geography, geology, and mineral resources of the district, with topographic and geologic maps and half-tone views.

Bulletin 418. The fire tax and waste of structural materials in the United States, by H. M. Wilson and J. L. Cochrane. 30 pp.

An account of the methods adopted to collect statistics, statements of the results of the inquiries made, and comparisons of the fire waste in the cities of the United States with that in cities in Europe, with suggestions as to methods of reducing fire losses.

Bulletin 419. Analyses of rocks and minerals from the laboratory of the United States Geological Survey, 1880–1908, by F. W. Clarke. 323 pp.

A report of chemical analyses of rocks, clays, and soils, arranged by States, and of meteorites and minerals.

Bulletin 420. Economic geology of the feldspar deposits of the United States, by E. S. Bastin. 85 pp., 8 pls.

Descriptions of the chemical and physical characters of feldspars, of their origin and geologic occurrence, methods of mining and milling, uses, grades, prices, and production, and an account of deposits of feldspar by States. The illustrations include maps and half-tone views.

Bulletin 421. Results of spirit leveling in Illinois, 1896–1908, compiled by S. S. Gannett and D. H. Baldwin. 74 pp.

A report on precise and primary leveling, giving altitudes of more than 400 places in the State.

Bulletin 422. The analysis of silicate and carbonate rocks (a revision of Bulletin 305), by W. F. Hillebrand. 239 pp., 27 text figures.

A detailed description of the various methods of analysis, with diagrams showing the apparatus employed.

Bulletin 423. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 9 pls., 12 text figures.

A discussion of combustion and explosion, of various explosives, squibs, fuses, and detonators, of methods of mining coal with explosives, loading and firing charges, and of means of safe shipment and storage of explosives, with illustrations showing materials and methods.

Bulletin 424. The valuation of public coal lands: The value of coal land, by G. H. Ashley; Depth and minimum thickness of beds as limiting factors in valuation, by C. A. Fisher. 75 pp.

A statement of the laws relating to coal lands and the areas of coal lands classified, with discussion of the royalty value of coal land, factors affecting the sale price of the land, consideration of its market value, statement of the basis of the government valuation of coal lands, and a discussion of maximum depth of coal mining and minimum thickness of minable beds.

Bulletin 428. The purchase of coal by the Government under specifications, with analyses of coal delivered for the fiscal year 1908–9, by G. S. Pope. 80 pp.

A report setting forth the factors affecting the value of coal as a fuel and a statement of the Government's plan of purchasing coal under specifications, with descriptions of methods of sampling and testing, form of specifications, and tables showing the extent of the Government's use of coal.

Water-Supply Paper 227. Geology and underground waters of South Dakota, by N. H. Darton. 156 pp., 15 pls., 7 text figures.

A detailed description of the stratigraphy of the Black Hills region and summary accounts of the geology of other parts of the State, a brief description of the water horizons, and descriptions by counties of deep wells and well prospects, with a chapter on the construction and management of artesian wells. The illustrations include a geologic map, a map showing artesian conditions, other maps, diagrams, and half-tone views.

Water-Supply Paper 232. Underground water resources of Connecticut, by Herbert E. Gregory, with a study of the occurrence of water in crystalline rocks, by E. E. Ellis. 200 pp., 5 pls., 31 text figures.

A description of the geography, geology, and ground waters and of the character of the water, with chapters on well construction and springs. Contains maps showing distribution of chlorine, other maps, and diagrams and half-tone views.

Water-Supply Paper 233. Water resources of the Blue Grass region, Kentucky, by George Charlton Matson, with a chapter on the quality of the waters, by Chase Palmer. 223 pp., 3 pls., 6 text figures.

Describes briefly the geology, physiography, soils, and surface waters, treats in detail the underground waters, the source of municipal supplies, and the condition in each county, and discusses the chemical content of the waters, including those of the mineral springs.

Water-Supply Paper 234. Papers on the conservation of water resources. Reprinted from report of the National Conservation Commission, February, 1909. 96 pp., 2 pls.

Papers on distribution of rainfall, by Henry Gannett; on floods and on developed and undeveloped water powers, by M. O. Leighton; on irrigation, by F. H. Newell; on underground waters, by W. C. Mendenhall; on denudation, by R. B. Dole and Herman Stabler; and on control of catchment areas, by H. N. Parker. Contains maps of the United States showing mean annual precipitation and percentages of annual precipitation received during the warmer months.

Water-Supply Paper 235. The purification of some textile and other factory wastes, by Herman Stabler and Gilbert H. Platt. 76 pp.

Studies of the pollution of streams by wastes from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and by the manufacture of oleomargarine, fertilizer, and glue, and report on experiments for purification of the wastes.

Water-Supply Paper 236. The quality of surface waters in the United States. Part I. Analyses of waters east of the one hundredth meridian, by R. B. Dole. 123 pp.

States methods of examination, the probable accuracy of the analytical results and the mode of expressing them, and the location of the sampling stations, and presents mineral analyses of samples of water taken from many rivers.

Water-Supply Paper 238. The public utility of water powers and their governmental regulation, by René Tavernier and Marshall O. Leighton. 161 pp.

An introduction by Mr. Leighton; chapters on French and foreign legislation affecting water powers, proposed French laws, and a review of the French administrative work in hydraulics and agricultural improvements, by Mr. Tavernier; and a chapter on water-power legislation in the United States, by Mr. Leighton.

Water-Supply Paper 239. The quality of the surface waters of Illinois, by W. D. Collins. 94 pp., 3 pls.

An outline of the physical and economic features of the State and a detailed consideration of the quality of the waters, with many mineral analyses.

Water-Supply Paper 241. Surface water supply of the north Atlantic coast, 1907-8, by H. K. Barrows and R. H. Bolster. 356 pp., 6 pls.

Water-Supply Paper 242. Surface water supply of the south Atlantic coast and eastern Gulf of Mexico, 1907-8, by M. R. Hall and R. H. Bolster. 226 pp., 3 pls., 1 text figure.

- Water-Supply Paper 243. Surface water supply of the Ohio River basin, 1907-8, by A. H. Horton, M. R. Hall, and R. H. Bolster. 224 pp., 4 pls., 1 text figure.
- Water-Supply Paper 244. Surface water supply of the St. Lawrence River basin, 1907-8, by H. K. Barrows, A. H. Horton, and R. H. Bolster. 163 pp., 7 pls., 1 text figure.
- Water-Supply Paper 245. Surface water supply of upper Mississippi and Hudson Bay basins, 1907-8, by A. H. Horton, E. F. Chandler, and R. H. Bolster. 133 pp., 5 pls., 1 text figure.
- Water-Supply Paper 247. Surface water supply of lower Mississippi basin, 1907-8, by A. B. Freeman, W. A. Lamb, and R. H. Bolster. 124 pp., 2 pls., 2 text figures.
- Water-Supply Paper 248. Surface water supply of western Gulf of Mexico, 1907-8, by A. B. Freeman and R. H. Bolster. 171 pp., 4 pls., 1 text figure.
- Water-Supply Paper 249. Surface water supply of Colorado River basin, 1907-8, by A. B. Freeman and R. H. Bolster. 206 pp., 10 pls.
- Water-Supply Paper 250. Surface water supply of the Great Basin, 1907-8, by E. C. La Rue and F. F. Henshaw. 151 pp., 6 pls., 1 text figure.
- Water-Supply Paper 252. Surface water supply of Columbia River and the north Pacific coast, 1907-8, by J. C. Stevens and F. F. Henshaw. 1910. 418 pp., 9 pls.

Water-Supply Papers 241 to 252 contain the results of stream measurements in the United States during the calendar years 1907 and 1908, continuing the Survey's series of reports on stream gaging. These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharges at stations maintained on many streams.

- Mineral resources of the United States, calendar year 1908. Part I. Metallic products; 816 pp., 2 pls., 3 text figures. Part II. Nonmetallic products; 899 pp., 1 pl., 6 text figures.

Statistics of production of mineral substances in the United States, including accounts of the chief features of mining progress and comparisons of past and present production and conditions. A consolidation of 48 advance chapters each reporting on a separate mining industry.

- Geologic folio 167. Description and maps of the Trenton quadrangle, comprising 912 square miles in New Jersey and Pennsylvania, by F. Bascom, N. H. Darton, H. B. Kümmel, W. B. Clark, B. L. Miller, and R. D. Salisbury. Survey made in cooperation with the States of New Jersey and Pennsylvania. 24 folio pages of text (with 3 text figures), 2 maps, 1 structure-section sheet, 2 columnar sections, and a table of formations. Published also in octavo form: 185 pages of text, with 3 figures; maps in pocket.
- Geologic folio 168. Description and maps of the Jamestown, Eckelson, and Tower quadrangles, comprising 2,460 square miles in South Dakota, by Daniel E. Willard. 10 folio pages of text (including 6 text figures) and 9 maps showing topography, geology, and artesian-water prospects. Published also in octavo form: 76 pages of text, with 6 figures; maps in pocket.
- Geologic folio 169. Description and maps of the Watkins Glen and Catatunk quadrangles, comprising 885 square miles in New York, by Henry S. Williams, Ralph S. Tarr, and Edward M. Kindle. Survey made in cooperation with the State of New York. 33 folio pages of text (including 13 text figures), 6 maps, and 2 sheets of half-tone illustrations. Published also in octavo form: 242 pages of text, with 37 figures; maps in pocket.

- Geologic folio 170. Description and maps of the Mercersburg and Chambersburg quadrangles, consisting of 458 square miles in Pennsylvania, by George W. Stose. Survey made in cooperation with the State of Pennsylvania. 19 folio pages of text (including 5 text figures), 4 maps, 2 structure-section sheets, 1 columnar section, and 1 sheet of half-tone illustrations. Published also in octavo form: 144 pages of text, 18 figures; maps in pocket.
- Geologic folio 171. Description and maps of the Engineer Mountain quadrangle, comprising 236 square miles in Colorado, by Whitman Cross and Allen D. Hole. 13 folio pages of text (including index map), 1 topographic, 1 geologic, and 1 structure-section map, 1 columnar section, and 2 sheets of half-tone illustrations. Published also in octavo form: 101 pages of text, with index map; 13 plates; maps and structure and columnar sections in pocket.
- Geologic folio 173. Description and maps of the Laramie and Sherman quadrangles, comprising 1,797 square miles in Wyoming, by N. H. Darton, Eliot Blackwelder, and C. E. Siebenthal. 17 folio pages of text (including 3 text figures), 2 topographic and 2 geologic maps, 2 sheets showing structure sections, 2 columnar sections, 1 map showing artesian-water prospects, and 1 sheet of half-tone illustrations. Published also in octavo form: 128 pages of text, with 3 figures; 8 plates; maps and sheets of sections in pocket.

Topographic maps as follows:

Acworth, Ga.	Gaffney, N. C.—S. C.	Oconomowoc, Wis.
Alliance, Ohio.	Gallina, N. Mex.	Pawhuska, Okla.
Antietam, Md.—Va.—W. Va.	Garden Valley, Idaho.	Perkins, Okla.
Atlanta, Tex.—Ark.—La.	Gassaway, W. Va.	Pleasant Grove, Cal.
Bedford, Pa.	Glendive, Mont.—N. Dak.	Providence, Ky.
Bellefonte, Pa.	Goose Creek, Cal.	Rangely, Colo.
Bloomington, Ind.	Grand Hogback, Colo.	Ray, Ariz.
Breckenridge special, Colo.	Granville, Ohio.	Rockford, Minn.
Carbondale, Cal.	Gros Ventre, Wyo.	Rock Springs, Wyo.
Carson Sink, Nev.	Hartford, Ky.	Roosevelt, Ariz.
Castle, Cal.	Herrin, Ill.	Sapphire, Mont.
Central City, Ky.	Higdon, Mo.	Silver City, N. Mex.
Clay, Cal.	Howell, Mich.	Sparta, Wis.
Clay, W. Va.	Isleton, Cal.	Stony Creek, N. Y.
Coharie, N. C.	Jensen, Utah—Colo.	Strawberry Valley, Utah.
Colorado Springs, Colo.	Lancaster, Ohio.	Thornville, Ohio.
Columbiana, Ohio—Pa.	Linden, Tex.	Thurston, Ohio.
Conesville, Ohio.	Lisbon, Ohio.	Tuskahoma, Okla.
Continental, Ohio.	Livermore, Colo.	Waterloo, Wis.
Cooperstown, N. Y.	Logan, Ohio.	Watertown, N. Y.
Cosumnes, Cal.	Luther, Okla.	Wayne, W. Va.
Defiance, Ohio.	McAlester, Okla.	West Frankfort, Ill.
Ducktown special, Tenn.	McClure, Ohio.	White River, Colo.
Earlington, Ky.	Madisonville, Ky.	Whitesville, Ky.
Elk Grove, Cal.	Midkiff, W. Va.	Winding Stair, Okla.
Elkins, W. Va.	Milford, Mich.	Winnepesaukee, N. H.
Eugene, Oreg.	Milo, Iowa.	York, Pa.
Fairbanks, Alaska.	Montgomery, W. Va.	Yosemite Park, adminis-
Fairfield, Pa.	Mound, La.	trative map.
Fish Springs, Utah.	Newark, Ohio.	Zanesville, Ohio.
Florin, Cal.	New Boston, Tex.	Zillah, Wash.
Franklin, Tenn.		

FIELD WORK BY THE DIRECTOR.

During the year the Director visited topographic parties in California and engaged in geologic work in the high Sierra. In company with the Secretary of the Interior he visited the Yosemite Valley and other sections of the west slope of the Sierra for the study of departmental problems. He took part in field conferences with administrative officers, geologists, and engineers of the Survey and of the Reclamation and Forest services and attended the irrigation congress at Spokane, the mining congress at Goldfield, and the Minnesota conservation convention at St. Paul.

GEOLOGIC BRANCH.**ADMINISTRATION.**

The geologic branch consists of four divisions—(1) geology and paleontology, C. W. Hayes in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mining and mineral resources, E. W. Parker in charge; and (4) chemical and physical research, G. F. Becker in charge.

The chief geologist, C. W. Hayes, has general supervision of the work of the geologic branch, and the divisions cooperate in the several lines of work. Members of one division are employed in the work of another whenever it seems desirable, and such transfer is easily effected. The statistical reports of the division of mineral resources are for the most part prepared by geologists from the division of geology who are detailed to the work for a portion of the year.

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 6 geologic folios, 4 professional papers, 29 bulletins, and the annual volume on mineral resources. Besides these a large number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies, and some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications. Such publications are ordinarily restatements of results in a more technical form, and are usually prepared by members of the Survey without compensation.

The progress of geologic mapping during the year, as represented in the publications of the Survey, is shown on Plate I.

DIVISION OF GEOLOGY AND PALEONTOLOGY.**ORGANIZATION.**

The scientific force at the beginning of the year consisted of 51 geologists, 50 assistant geologists, and 29 junior geologists. During the year there were 10 resignations and 3 appointments, resulting in

a net loss of 7, or a total of 123 at the end of the year. Of the total number 76 were continuously employed, 24 carried on the per diem roll gave only a portion of their time to Survey work, and 30 were not employed during the year. In addition to the regular force 35 field assistants were employed for a portion of the year.

The work of the division is organized under a number of sections, as follows:

- Areal and structural geology, Arthur Keith in charge.
- Paleontology and stratigraphic geology, T. W. Stanton in charge.
- Economic geology, metalliferous ores, Waldemar Lindgren in charge.
- Economic geology, fuels, M. R. Campbell in charge.
- Land classification, A. C. Veatch in charge.

The section chiefs have direct supervision, both in the field and in the office, of the work in their sections and are directly responsible for maintaining a high scientific standard.

FIELD WORK BY THE CHIEF GEOLOGIST.

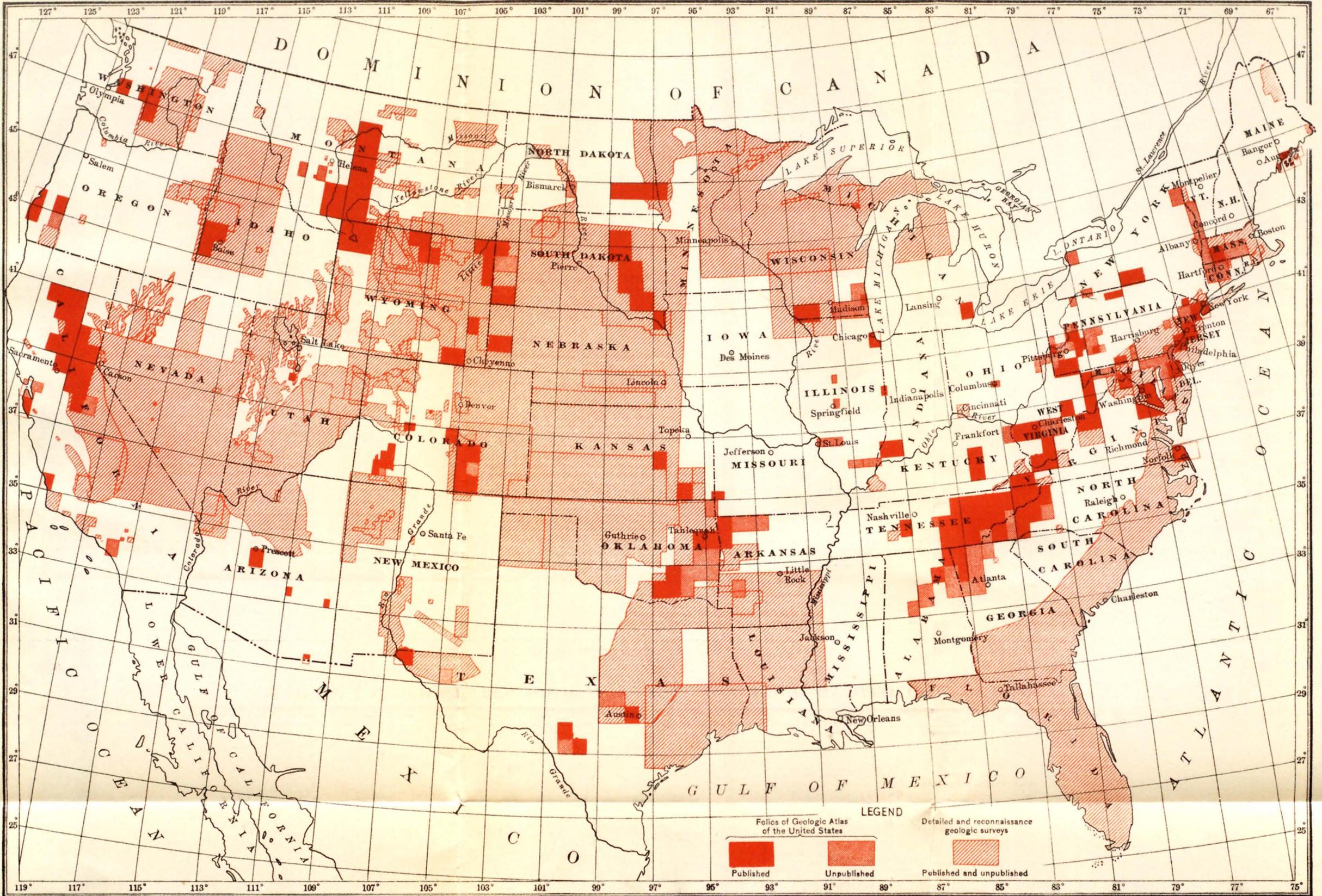
During July, 1909, the chief geologist completed an inspection of work in progress in the Oklahoma oil fields. He then visited all the producing oil fields in California in company with Ralph Arnold, who had been carrying on investigations in these fields for several years. This inspection was made for the purpose of determining where and by what methods the oil investigations could be most advantageously extended. In September he visited the parties in Utah, Idaho, and Wyoming engaged in the investigation of phosphate deposits and the classification of public lands containing these deposits. Questions of special importance in connection with the classification and valuation of these lands and the application to them of the mining law required consideration in the field with the geologists engaged in making the surveys and the section chief in charge of the work. On the completion of this inspection a party working in Oklahoma was visited and also some localities in Louisiana where oil, gas, rock salt, and sulphur had been recently discovered under conditions throwing much light on the general scientific and economic problems of oil and gas accumulation in the Gulf Coastal Plain.

The chief geologist was out of the United States for two months during the year on leave without pay.

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—Cooperative geologic work in Maine was continued during the year, \$1,200 being allotted by the State Survey and \$1,300 by the Federal Survey.

The preparation of the Eastport folio (Me.) was carried nearly to completion by E. S. Bastin and C. L. Breger. It is thought that the text and maps will be submitted for publication before the close of the year 1910. In connection with the preparation of this folio a



MAP OF UNITED STATES, SHOWING AREAS COVERED BY GEOLOGIC SURVEYS

Scale
100 0 200 300 Miles
1910

special study of the Silurian faunas was made by Mr. Breger. The late Silurian formations in the Eastport region are remarkably well developed, and Mr. Breger's report is expected to be of considerable value to students of the Silurian.

The report on the fossil fauna of the Chapman sandstone of Aroostook County, Me., by H. S. Williams and C. L. Breger, was completed and submitted for publication. This report will be an important contribution to the problem of determining the boundaries between the Silurian and Devonian.

A report on the pegmatite deposits of Maine, by E. S. Bastin, was completed.

Work in the preparation of the Mount Desert folio (Me.) was continued by C. W. Brown.

A study of the ore deposits of Maine and New Hampshire was made by W. H. Emmons, and the report is now in press (Bulletin 432).

Field work for a supplemental report on the granites of New Hampshire was completed by T. N. Dale, and this report was published in Bulletin 430.

The geologic and economic survey of the Monadnock quadrangle, in southwestern New Hampshire, was well advanced by B. K. Emerson.

Considerable progress was made by T. N. Dale in the preparation of the Ticonderoga folio (Vt.-N. Y.), and Mr. Dale has completed the microscopic study of the rocks in the Brandon quadrangle (Vt.).

An extensive reconnaissance was made by Arthur Keith in the valley of western Vermont and adjoining parts of the Green Mountains to determine the sequence and structure of the Cambrian and Ordovician formations. The divisibility of the great limestone mass of the valley from Canada to Massachusetts was made clear, as well as the general existence of overthrust faults along the east side and the center of the valley.

Additional field work was done by T. N. Dale on the granites of Massachusetts, forty quarries being visited. The results of this work will be published as a supplemental note on the granites of Massachusetts.

The bulletin on the granites of Connecticut, by T. N. Dale and H. E. Gregory, was completed and has been submitted for publication.

Atlantic and Gulf coastal plains.—In cooperation with the state geological surveys the studies of the Atlantic and Gulf coastal plains were continued throughout the year. The work was carried on under the general supervision of T. W. Vaughan, who personally inspected various critical localities. W. B. Clark continued in immediate charge of the coastal-plain district extending from Massachusetts to and including North Carolina, and Mr. Vaughan had immediate charge of the remainder of the coastal-plain area.

During the year the field work for the report on the underground water resources of Delaware, Maryland, and the District of Columbia, which is being prepared in cooperation with the State Survey of Maryland, was completed by G. C. Matson, representing the Federal Survey, and E. H. Sapp, representing the Maryland Survey. The manuscript for this report is nearly finished and will soon be ready for publication.

Progress was made by W. B. Clark, assisted by A. D. Bibbins and H. P. Little, in the preparation of the folios covering the Choptank and Tolchester quadrangles of Maryland.

The report on the geology and underground waters of the coastal plain of Virginia, by W. B. Clark, B. L. Miller, E. W. Berry, and Samuel Sanford, has been completed and submitted. Special work on the formations of the Potomac group was done by A. D. Bibbins and H. P. Little.

The report on the geology and underground waters of the coastal plain of North Carolina, by W. B. Clark, L. W. Stephenson, B. L. Miller, and B. L. Johnson, has been completed and is now going through the press as a bulletin of the North Carolina Geological Survey.

Progress was made in the preparation of the report on the coastal plain of South Carolina, which is in charge of Earle Sloan, state geologist of South Carolina.

The report on the coastal plain of Georgia is well advanced. The manuscript covering the stratigraphy of the Cretaceous area has been completed by L. W. Stephenson, the discussion of the stratigraphy of the Tertiary area has been begun by Otto Veatch, and considerable progress has been made in the chapter on the underground water resources.

Work on the coastal plain of Alabama is being carried on by L. W. Stephenson and E. W. Berry. The study of the Cretaceous formations of this State was extended westward into Mississippi, where valuable geologic data were obtained.

Reports on the geology and underground water resources of north-eastern Texas, by C. H. Gordon, and on the geology and underground water resources of the coastal plain of Texas east of Brazos River, by A. Deussen, have been transmitted for publication. Mr. Deussen is now engaged in the preparation of a report on the geology and underground water resources of the coastal plain of Texas between Brazos and Guadalupe rivers; in this work he is giving considerable attention to the clays and lignites of the region.

Studies of the oil and gas resources of northwestern Louisiana and eastern Texas were continued by G. D. Harris, who has given to the Survey much valuable information collected by him in the past.

During the year a detailed survey of Terrebonne Parish, La., with reference to its oil and gas resources, was made and the report is nearly completed. Mr. Harris, assisted by C. J. Maury, is at present engaged in a study of coast shells and well material of the Mississippi embayment. Owing to the nature of the coastal-plain deposits great difficulty is experienced in identifying geologic horizons, and it is expected that this study will be of considerable assistance.

In the study of the fossils, which play an important part in deciphering the stratigraphy of the Coastal Plain, valuable assistance has been rendered by W. B. Clark, B. L. Miller, E. W. Berry, and Miss Julia A. Gardner.

Northern Appalachian region.—In the coal fields of Pennsylvania the geologic work of the year has been confined mainly to the completion of the examination of a number of quadrangles in cooperation with the State. Until May 1 the work was in charge of G. H. Ashley, who resigned to become state geologist of Tennessee. Since that time it has been in charge of David White. Work has been carried on by Charles Butts, M. J. Munn, E. W. Shaw, W. C. Phalen, and E. F. Lines. In several of the quadrangles the studies have been restricted chiefly to the collection of supplementary data needed for bringing up to date the economic reports and maps.

Some revisionary work on the surficial geology of the Foxburg quadrangle (Pa.) was done by E. W. Shaw, and a bulletin on the coal, oil, and gas of that quadrangle was prepared by Mr. Shaw and M. J. Munn.

A reexamination of certain features in the Hollidaysburg quadrangle (Pa.) was made by Charles Butts, whose manuscript for the folio covering this quadrangle is nearly finished. Special studies of the stratigraphy of the coals in the Barnesboro and Patton quadrangles (Pa.) were also made by Mr. Butts in connection with sampling the coals for chemical analysis. The results will be embodied in the folio treating of the two quadrangles.

The folio covering the Burgettstown and Carnegie quadrangles (Pa.) was completed and submitted for publication by E. W. Shaw, who also made an examination of the surficial geology of the Newcastle quadrangle (Pa.) and brought the information on the economic resources of that quadrangle up to date. The report on the survey of the Newcastle quadrangle, which was made by F. W. De Wolf, has been greatly delayed by Mr. De Wolf's duties as acting state geologist of Illinois.

The manuscript for the Claysville folio (Pa.) was completed and submitted by M. J. Munn.

Economic reports on the Punxsutawney, Clearfield, and Houtzdale quadrangles (Pa.) have been published and work in the preparation

of the folios and bulletins has been begun by G. H. Ashley. This work, however, is likely to be delayed because of Mr. Ashley's new duties as state geologist of Tennessee.

During the year a number of oil and gas areas in the northern Appalachian region were examined by M. J. Munn, for the purpose of incorporating the results in a general summary report on the oil and gas fields of the Appalachian region.

A paper on the sand and gravel resources of the Pittsburg district was prepared and submitted by E. W. Shaw (in Bulletin 430).

The geologic survey of the Fairfield quadrangle (Pa.) was completed by G. W. Stose, and considerable work was done in the preparation of the text for the folio on the Fairfield and Gettysburg quadrangles. This folio will form one of the series of folios covering the northern Appalachian region. Of these the Mercersburg-Chambersburg folio (Pa.) has already been published, the Pawpaw-Hancock folio (W. Va.-Md.-Pa.) was completed during the year, and the Accident-Grantsville folio (Md.-W. Va.-Pa.), on the most western quadrangles of the series, has been published.

An examination of the iron ores near Dillsburg, Pa., was made by A. C. Spencer and E. C. Harder. A brief report on this work will be found in Bulletin 430.

Considerable progress was made by Florence Bascom in the geologic mapping of the Reading, Boyertown, Honeybrook, and Phoenixville quadrangles (Pa.). During a part of the time Miss Bascom was assisted by E. T. Wherry.

A study of the stratigraphy and paleontology of the western part of the Appalachian Valley in Maryland, Pennsylvania, and New York was continued by Edwin Kirk under the direction of E. O. Ulrich.

In cooperation with the State Geological Survey of New Jersey the maps and text for the Raritan folio were completed and submitted. This folio was prepared by W. S. Bayley, H. B. Kümmel, and R. D. Salisbury.

Southern Appalachian region.—In Alabama the geologic work on the southwestern half of the Cahaba coal field was completed by Charles Butts and the economic report thereon, now in hand, is companion to that on the northern half of the field, already published (in Bulletin 316). A small area in the southeast corner of the Brookwood quadrangle remains to be examined. The geologic mapping of the Bessemer special quadrangle has been nearly finished by Mr. Butts, who has also completed the final work on that portion (comprising about one-third) of the Montevallo special quadrangle which is included in the Cahaba coal field. The text for the folio on the Birmingham quadrangle is practically finished.

In the Ellijay quadrangle (Ga.) Arthur Keith made special studies of the faulted structure of the rocks just southeast of the marble belt,

and W. C. Phalen completed the report on the economic geology of the quadrangle, which is to form part of the Ellijay folio.

The examination of the metamorphic area of the Dalton quadrangle (Ga.) was finished by Mr. Phalen, who also accomplished the areal mapping of approximately one-third of the Dahlonga quadrangle.

In cooperation with the state geological surveys of Kentucky and Tennessee the oil fields of those States have been made the subject of a preliminary examination by M. J. Munn, who has in preparation two reports, one relating to each State. In the course of this work a large number of oil and gas fields in northern Tennessee, eastern Kentucky, southeastern Ohio, and adjacent portions of West Virginia have been examined and samples of oil and salt water have been collected from the different oil sands for the purpose of making analyses. Detailed studies have been made of the Campton oil field of Wolfe County, Ky., and of the Steubenville, Cooper, Oil Valley, and Johnson Fork fields of Wayne County, Ky. The field work for these reports is nearly finished and the maps are well advanced.

In November, 1909, S. F. Emmons made a visit to the Ducktown district of Tennessee, and as a result a special study of the geology and ore deposits of this district has been commenced by W. H. Emmons and is now in progress.

The preparation of the final maps and text for the folio on the Woodbury quadrangle (Tenn.) was well advanced by E. O. Ulrich, and areal mapping for the Pikeville special quadrangle was begun by W. C. Phalen.

Additional work on the surficial geology of the Kenova quadrangle (W. Va.-Ohio-Ky.) was done by E. W. Shaw and W. C. Phalen, and the manuscript for the Kenova folio was carried nearly to completion by Mr. Phalen.

In connection with a comprehensive sampling of the coals of the New River and Pocahontas coal fields, for chemical analyses by the technologic branch, David White made a study of the stratigraphic identification and correlation of the coals sampled.

Special studies in the Kings Mountain and Gaffney quadrangles (N. C.-S. C.) were continued by Arthur Keith and D. B. Sterrett. A brief reconnaissance around those quadrangles, in the Gastonia, Hickory, and Statesville (N. C.) and Spartansburg (S. C.) quadrangles, was made by Mr. Keith, who also completed about two-thirds of the mapping of the Cowee quadrangle (N. C.).

A report on the mica deposits of North Carolina was prepared by D. B. Sterrett (in Bulletin 430).

By request, a special examination of the Dan River coal field in Stokes and Rockingham counties, N. C., was made by R. W. Stone, under the direction of M. R. Campbell. A brief report on this investigation has been prepared.

GEOLOGIC WORK IN CENTRAL STATES EAST OF 97°.

In Illinois geologic investigations have been continued in cooperation with the State Geological Survey. The greater part of the expense has been borne by the State Survey, but the results of the studies are available to either Survey. On the part of the Federal Survey, E. W. Shaw has geologically mapped the Murphysboro quadrangle, reviewed the surficial geology of the Herrin and West Frankfort quadrangles, and commenced the preparation of the Murphysboro folio text. An economic report describing the coals of the Murphysboro quadrangle has been placed in the hands of the state geologist, who has forwarded to the Federal Survey a full geologic report, by J. A. Udden, on the Belleville and Breese quadrangles, together with manuscript material, by T. E. Savage, for a bulletin on the geology of the Springfield quadrangle. Mr. Shaw is now engaged in a review of the surficial geology of the Galatia quadrangle. A special field examination of obscure Mississippian and Pennsylvanian sections along the borders of the Murphysboro quadrangle was made by E. W. Shaw, Stuart Weller, and David White.

A study of the stratigraphy of the fire clays of western Illinois was made by E. F. Lines, who thoroughly sampled the clays for chemical analyses and submitted to the State Survey a report covering this work.

The survey of the East Cincinnati and West Cincinnati quadrangles (Ohio-Ky.) was completed by N. M. Fenneman, R. S. Bassler, and J. M. Nickles, under the direction of E. O. Ulrich. The preparation of the folio texts is well in hand.

A report on the Ordovician rocks of the Cincinnati uplift is being prepared by E. O. Ulrich and is nearly ready for publication.

The monograph on the Pleistocene formations of Indiana and Michigan has been finally revised and completed by Frank Leverett and F. B. Taylor. This monograph includes not only a report of the work carried on under the auspices of the Survey by Mr. Leverett and Mr. Taylor, but also the results of several seasons' work by Mr. Taylor partly at private expense and partly under the auspices of the Canadian Survey. It embraces the glacial and lake history not only of Michigan and Indiana but also of neighboring portions of Canada whose history is closely connected with that of those States.

In cooperation with the State Geological Survey of Michigan special studies of the glacial deposits and shores of the old lakes in the Northern Peninsula were made by Frank Leverett. The State Survey was represented by L. H. Wood.

Under the direction of C. R. Van Hise the investigations of the physical and chemical properties of the ores and iron formations of the Lake Superior region were continued by C. K. Leith and W. J. Mead. The results of these investigations have been incor-

porated in the monograph on the Lake Superior region, which is now in the hands of the editor. Mr. Leith carried on considerable correspondence with the mining companies, in order to procure the latest statistics for this monograph, for which he also obtained additional data regarding geologic boundaries.

A special study was made by Frank Leverett of the pre-Wisconsin drift sheets in southeastern Minnesota, eastern Iowa, and northwestern Illinois. The object was to determine the amount of weathering of the Illinoian drift of the Labrador ice field and the Iowan drift of the Keewatin field. As a result of this study the Iowan drift is tentatively correlated with the Illinoian drift.

Detailed study and areal mapping of the Quaternary deposits of southeastern Wisconsin, together with the mapping of the underlying Paleozoic and pre-Cambrian rocks, were continued by W. C. Alden. The work during the year was done chiefly in Fond du Lac, Dodge, Columbia, Green Lake, Marquette, and Winnebago counties and nearly completed the survey of the area between latitude $42^{\circ} 30'$ and 44° north and east of longitude 90° west. The manuscript for a professional paper covering this area is well advanced. As in previous years, this work was done under the supervision of T. C. Chamberlin.

In cooperation with the state authorities a systematic examination of the coal fields of Missouri was commenced in June by Henry Hinds, assisted by C. T. Lupton.

Work in the preparation of the geologic folio covering the Wyandotte quadrangle (Mo.-Okla.) was well advanced by C. E. Siebenthal. Mr. Siebenthal also made a special examination of the deeper ore deposits of the Joplin district of Missouri.

In Arkansas A. H. Purdue and H. D. Miser mapped the area geology of the southwestern part of the Harrison quadrangle, revised the boundaries in the southwestern part of the Eureka Springs quadrangle, and completed the areal mapping for the Hot Springs special quadrangle. In the office good progress was made in the preparation of the reports on these quadrangles.

The fauna of the basal part of the Fayetteville shale of Arkansas was made the subject of special study by G. H. Girty.

GEOLOGIC WORK IN WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Central States west of 97° .—Some additional studies were made by G. H. Girty of the Carboniferous rocks of Kansas, and a short paleobotanic examination of the Chase and Sumner groups of Kansas was made by David White, for the purpose of procuring fossil-plant evidence bearing on the age of these beds. The fossils obtained are confirmatory of the Permian age of the strata. The southern extension of the search revealed similar Permian evidence at several

points in the "Red Beds" of Oklahoma and in the Wichita formation of northern Texas.

A detailed survey of the Pawhuska quadrangle (Okla.) was made by C. D. Smith. The purpose of this work was to determine if possible the relation of the oil and gas accumulations to the structure.

The preparation of the maps and text for the Llano-Burnet folio, covering two quadrangles in central Texas, was practically completed. In the survey of these quadrangles, the geology of which is extremely complicated, A. C. Spencer, Sidney Paige, W. S. Bayley, F. H. Kay, and E. O. Ulrich have participated for longer or shorter periods. A bulletin on the economic resources of this mineral region and a report on the pre-Cambrian geology of the iron ores (in Bulletin 430) were prepared by Sidney Paige.

A detailed study of the quicksilver deposits of the Terlingua region, in Texas, was begun by H. D. McCaskey. The mapping of the western portion of the area covered by the Terlingua special map, which contains all the Lower Cretaceous deposits that have so far proved productive, was completed. During the present season the eastern half of the area will be mapped and a study made of the Upper Cretaceous deposits and the igneous rocks.

The folio covering the Van Horn quadrangle (Tex.) was completed and submitted by G. B. Richardson.

Rocky Mountain region.—The work of classifying and placing valuations on the coal lands of the Rocky Mountain region and Pacific coast States was continued throughout the year. As in previous years, this work was in charge of M. R. Campbell, who supervised all the geologic work of the Survey relating to coal, oil, and gas except in Alaska. During the summer and fall he visited the various parties in the field and gave personal direction to the conduct of the work. During the winter the results of the field examinations were compiled in the office, under Mr. Campbell's supervision. This work involved the preparation of geologic maps, of township plats showing the classification and valuation of the coal lands examined, and of special preliminary reports on the geology and economic resources of the various regions. The following is a brief statement of the work accomplished and of the men directly engaged in its prosecution:

Eastern part of Bull Mountains, Mont. Topographic and geologic surveys for coal-land valuation completed by C. T. Lupton and Henry Hinds, under the supervision of R. W. Stone. Report well in hand.

Part of Milk River coal field, Mont., which lies to the east of the Bearpaw Mountains. Examination by L. J. Pepperberg. Land classified and report partly completed when Mr. Pepperberg resigned to engage in private work.

Hound Creek district of Great Falls coal field, Mont. Mapped and studied by V. H. Barnett, under the supervision of W. R. Calvert. Land classified and brief report submitted for publication.

Upper Powder River coal field, Wyo. Topographic and geologic map of seven townships completed by C. H. Wegemann and R. W. Howell, under the supervision of R. W. Stone. Map and brief report submitted for publication.

Salt Creek oil field, Natrona County, Wyo. Ten townships surveyed by C. H. Wegemann and R. W. Howell, under the supervision of R. W. Stone. Map and report submitted for publication.

Coal field at Aladdin, Wyo. Examined by R. W. Stone.

Wind River coal and oil field, Wyo. Examined by E. G. Woodruff. Lands classified and preliminary report submitted for publication.

Lander oil field, Wyo. Examined by E. G. Woodruff. Lands classified and report submitted for publication.

Rock Springs coal field, Wyo. Examined by A. R. Schultz. Survey completed, preliminary reports published (in Bulletins 341 and 381), and final report well advanced.

Little Snake River coal field, Wyo. Lands classified and brief report prepared by M. W. Ball and Eugene Stebinger (in Bulletin 381).

Black Hills coal field, Wyo. Examined by R. W. Stone.

Standing Rock and Cheyenne Indian reservations, N. Dak. and S. Dak. Examination undertaken at the request of the Bureau of Indian Affairs. Completed by M. A. Pishel, V. H. Barnett, and A. L. Beekly, under the supervision of W. R. Calvert. Reports on valuation have been sent to the Bureau of Indian Affairs. More detailed geologic reports are in course of preparation.

Williams Fork district of Yampa coal field, Colo. Examined by J. A. Davis. Lands classified and report submitted.

Part of Grand Hogback coal field of Colorado between Newcastle and Coal Basin. Examined by A. L. Beekly. Lands classified and report nearly finished.

Anthracite-Crested Butte coal field, Colo. Examined by W. T. Lee. Lands classified and report completed.

South Park and Canon City coal fields, Colo. Lands classified by C. W. Washburne and preliminary reports submitted (in Bulletin 381).

Book Cliffs coal field, Colo. Lands classified by G. B. Richardson.

Trinidad coal field, Colo. Report completed and submitted by G. B. Richardson (in Bulletin 381).

Florence oil field, Colo. Detailed report completed by C. W. Washburne.

Southwestern Colorado. Oil prospects near Dolores and San Miguel rivers examined by C. W. Washburne.

San Juan coal region, N. Mex. and Colo. Detailed examination of certain townships near Monero, N. Mex., by J. H. Gardner. General geologic reconnaissance over southeastern part of field for the purpose of correlating the geologic formations with other formations in this and adjacent fields.

Coal field north of Greeley, Colo. Examined by E. G. Woodruff.

Oil prospects near Mount Pleasant, Utah. Examined by E. G. Woodruff.

Southern Utah coal field. Lands classified by G. B. Richardson.

Coos Bay and Eckley coal fields, Oreg. Examined by J. S. Diller, assisted by M. A. Pishel. Lands classified and preliminary geologic report submitted for publication.

Ontario gas field, Oreg. Examined by C. W. Washburne. Report in hand.

Astoria gas and oil field, Oreg. Examination now in progress by C. W. Washburne.

State of Washington. Practically all the coal fields in this State examined by E. E. Smith, for the purpose of studying the character of the coal and collecting samples for chemical analysis. A report on this subject is nearly ready for publication. Mr. Smith also made a reconnaissance of the Carlton Pass coal field of Washington, at the request of the Forest Service, for the purpose of classifying the coal lands of that area.

Considerable progress in the mapping of the Deadwood and Rapid quadrangles (S. Dak.) was made by Albert Johannsen. Until his resignation in the spring, to accept a professorship in the University of Chicago, Mr. Johannsen also had charge of the petrographic reference collection of the Survey.

A brief examination of Carboniferous sections in the Little Belt Mountains region of Montana was made by W. R. Calvert and G. H. Girty. Problems in Cretaceous stratigraphy in the Crazy Mountains, Montana, were made the subject of a short field conference by several geologists.

The maps and text for the Philipsburg folio (Mont.) were practically completed by F. C. Calkins. The report on the economic geology of this area, which is finished, is by W. H. Emmons.

At the request of the Department of Justice, F. C. Schrader was detailed to examine certain mining prospects in the northern part of Idaho and adjacent parts of Montana. Regarding this investigation Mr. Schrader testified before the grand jury in Spokane, and later in the year prepared a preliminary report on the matter for the use of the post-office inspectors and the Department of Justice.

A study of the copper deposits near Montpelier, Idaho, was made by H. S. Gale, and a report was completed and submitted for publication (in Bulletin 430).

At the request of the Forest Service, mining claims comprising more than 2,300 acres of timber and mineral land in the Clearwater National Forest, Idaho, were examined by F. C. Schrader, and subsequently reports thereon were submitted. Mr. Schrader's observations during this examination also led him to prepare a paper on the occurrence of monazite in northern Idaho, with generalizations on the occurrence of monazite elsewhere in the State (in Bulletin 430).

Some of the areas in Idaho, Utah, and Wyoming which had been withdrawn by the Secretary of the Interior because of the probable existence of phosphate rock were examined by two geologic parties. In northeastern Utah Eliot Blackwelder examined and classified the phosphate withdrawals from Croyden and Devils Slide northward to Huntsville and Eden. A larger party, consisting of H. S. Gale, in charge, R. W. Richards, C. L. Breger, and G. H. Girty, examined and classified the phosphate withdrawals about Montpelier, Idaho, and along the east side of Bear Lake Valley from Georgetown Canyon, Idaho, to Laketown, Utah. On the east this work was extended so as to include the Sublette Mountains and Beckwith Hills in Wyoming and the Crawford Range along the Wyoming-Utah border. Phosphate deposits in the region along Twelvemile Creek, southwest of Woodruff, Utah, were also examined. In this work W. H. Waggoner, of the Department of Agriculture, rendered valuable assistance

as chemist, analyzing in the field about 340 samples of phosphate rock. Reports on these phosphate deposits have been completed and submitted for publication (in Bulletin 430).

A brief report (see Bulletin 430) on the salt resources of the Wyoming-Idaho border, embracing Stump Creek, Tygee Creek, and Crow Creek in Bannock County, Idaho, and Salt Creek in Uinta County, Wyo., was prepared by C. L. Breger.

An examination of possible future oil fields in the Virgin River region, Utah, and in the Bighorn Basin, Wyoming, was made by Robert Anderson, who classified the lands in those regions.

A study of the graphite deposits near Brigham, Utah, was made by H. S. Gale, and a report was prepared and submitted for publication (in Bulletin 430).

In the survey of phosphate lands in northern Utah Eliot Blackwelder acquired much new information relating to the stratigraphy and structure of the Wasatch Mountains. Reports and scientific papers embodying these results have been prepared by Mr. Blackwelder.

The study of the areal geology and mines of the Frisco district, Utah, was completed by B. S. Butler and considerable progress was made in the preparation of the report.

Geologic mapping in the San Juan region of Colorado was continued by Whitman Cross, assisted by E. S. Larsen and for a short time by J. H. Gardner. During the season the northeastern portion of the Ignacio quadrangle was mapped and considerable progress was made in the mapping of the San Cristobal quadrangle, which was started the previous year and will be finished during the coming season. The San Juan is an extremely complex volcanic district, and a general report on the volcanic geology, covering the work of several years, is in course of preparation by Mr. Cross. In this study Mr. Larsen, who has since been placed in charge of the petrographic reference collection of the Survey, has continuously rendered assistance. Considerable progress was made by Mr. Cross and W. W. Atwood in the study of the Quaternary geology and physiographic history of the San Juan Mountains. During the winter Mr. Cross prepared a paper on the natural classification of igneous rocks, which was read before the Geological Society of London in June.

Late in the year an examination of certain areas tributary to the Rio Grande in the San Juan Mountains of Colorado was made by E. S. Larsen, at the request of the Forest Service.

In response to a petition addressed to the Secretary of the Interior and signed by nearly every person having important interests in the district, a study of the Breckenridge district of Colorado has been

made by F. L. Ransome, assisted by E. S. Bastin. The report will be ready for publication by October. A preliminary inspection of the field was made by S. F. Emmons.

A general reconnaissance of the tungsten field in Boulder County, Colo., to obtain information for use in the contemplated report on the tungsten deposits of the United States, was made by F. L. Hess.

The areal geology in the vicinity of Idaho Springs, Colo., was mapped by E. S. Bastin and J. M. Hill, who also made considerable progress in the study of the economic geology of the Central City quadrangle (Colo.).

Special studies of stratigraphic problems in the Trinidad coal field of Colorado were made by F. H. Knowlton and A. C. Peale.

A paleobotanic reconnaissance by David White of the "Red Beds" in the valley of Arkansas River in Colorado and in the Santa Fe quadrangle (N. Mex.) resulted in the discovery of Permian types in portions of the series whose age has, for lack of fossils, hitherto been unknown.

A reconnaissance of the Sylvanite and Fremont mining districts near Hachita, N. Mex., was made by J. M. Hill. (See Professional Paper 68.)

The areal and economic survey of the Silver City quadrangle (N. Mex.) was commenced toward the close of this fiscal year and is now in progress. This work is in charge of Sidney Paige, assisted by J. L. Rich.

Geologic problems in the Raton coal field of New Mexico were studied by F. H. Knowlton and A. C. Peale in connection with investigations of the coal-bearing formations.

A report on a reconnaissance of the ore deposits of northern Yuma County, Ariz., was completed and transmitted by Howland Bancroft, who also submitted a report on the occurrence of quicksilver at Cinnabar, Ariz. (in Bulletin 430).

S. F. Emmons spent a week at Globe, Ariz., studying the geology of that district in the light of underground explorations which have been made since the district was surveyed by F. L. Ransome in 1901-2. As a result of this examination a supplementary report will be prepared by Mr. Ransome.

Brief reports on the occurrence of tungsten minerals near Calabasas, Ariz., and on the placer deposits of Greaterville, Ariz., were prepared by J. M. Hill for Bulletin 430.

Considerable progress was made in the report on the mineral deposits of the Santa Rita and Patagonia mountains of Arizona, which is in course of preparation by F. C. Schrader, assisted by J. M. Hill. The same authors also prepared a special report on the occurrence of molybdenite in these mountains (in Bulletin 430).

Near the close of the year a reconnaissance of some newly developed and promising gypsum deposits in the Rocky Mountain region was begun by E. F. Burchard.

Pacific coast.—During the summer and fall of 1909 the investigations of the California oil fields were continued by Robert Anderson, with R. W. Pack as field assistant. The work was pushed farther beyond the limits of actual production than in previous years, with a view to outlining the areas of possible productive territory in the undeveloped regions adjoining some of the important fields. The early part of the summer was spent in the region surrounding the Carrizo Plain, west of the McKittrick, Midway, and Sunset districts, and the rest of the field season in the Cantua-Panoche region, which extends northward from the Coalinga district. This work resulted in the classification of some tracts as possible oil land and the restoration to entry of large areas of nonoil land which had been temporarily withdrawn pending examination. During the spring of 1910 two reports were issued, one on the geology and oil resources of the Coalinga district, by Ralph Arnold and Robert Anderson (Bulletin 398), and a preliminary report on the McKittrick-Sunset region, by Ralph Arnold and H. R. Johnson (Bulletin 406). A preliminary report on the Cantua-Panoche region was prepared.

Considerable progress was made by B. S. Butler in the completion of the report on the copper-mining district of Shasta County, Cal.

A reconnaissance survey of the gypsum deposits of the Palen Mountains, Riverside County, Cal., was made by E. C. Harder; also a reconnaissance of chromite, manganese, and iron ore deposits in central and western California and western Nevada. Brief reports on these surveys will be found in Bulletin 430.

A detailed examination of the iron ores of the Eagle Mountains, Riverside County, Cal., was made by E. C. Harder and J. L. Rich. A report is in progress. Detailed geologic work in the Randsburg quadrangle (Cal.) was continued by F. L. Hess and some progress was made in the preparation of the report on that area.

The report on the auriferous gravels of California, by Waldemar Lindgren, was sent forward for publication.

At the request of the Forest Service an examination of placer claims in Trinity County, Cal., was made by D. F. MacDonald. These claims included 2,800 acres of supposed mineral ground. A hearing was held from September 1 to September 10 at Redding, Cal.

At the request of the Secretary of War an examination of the underground-water resources of Angel Island, Cal., was made by F. L. Ransome. A brief report on this subject has been submitted.

The geologic mapping of the Ely quadrangle (Nev.) was practically completed by A. C. Spencer and considerable progress was made in

the detailed study of the strongly mineralized belt of this region, within which the important copper ores have been developed. The study of these mines is still in progress, but it is expected that the report on this district will be finished and submitted before the close of the present calendar year.

A brief report on an occurrence of platinum in southeastern Nevada was submitted by Howland Bancroft (in Bulletin 430).

An examination of recent underground workings in the Goldfield district of Nevada was made by F. L. Ransome. The report on the survey of this district, made two years ago (Professional Paper 66), appeared in time for distribution at the meeting of the American Mining Congress at Goldfield in October, 1909.

The areal mapping of part of the Sumpter quadrangle, in eastern Oregon, was finished by F. C. Calkins, assisted by J. T. Pardee, and considerable progress was made in the preparation of the maps and report. A paper on the placer deposits of this region was prepared for Bulletin 430 by Mr. Pardee, under the supervision of Mr. Calkins.

An examination of the canyon of Clackamas River above Cazadero, near Portland, Oreg., was made by J. S. Diller, for the purpose of determining the availability of the rock of the canyon walls for the construction of dams. A report on this investigation was published in the daily press of the Pacific coast.

A reconnaissance of the ore deposits in the northeastern part of the State of Washington was commenced by Howland Bancroft. It is expected that the work will be completed during the coming year. Mr. Bancroft also prepared a report on tungsten near Deer Park, Wash. (in Bulletin 430).

GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

T. W. Stanton has had general supervision of the paleontologic work during the year. In order to make this work of the highest possible service it is necessary to bring the paleontologists and geologists into close touch in the field. Hence most of the field work of the paleontologists is done in connection with geologic parties. The paleontologic work is essential in connection not only with the study of stratigraphic, structural, and areal geology but also with various problems of economic geology. This is notably true of the investigations of oil and coal fields, where the tracing of productive horizons and the correlation of beds from place to place would be impossible without the assistance of the expert paleontologist.

In addition to the aid rendered in the field, a large share of the time of the paleontologists during the office season is occupied in the determination of fossil collections submitted by the field geologists. So fully is their time taken by this routine work that little opportunity remains for the general studies and correlations that are essential for the symmetrical development of the Survey work.

In addition to the supervision of the paleontologic work, Mr. Stanton visited several field parties in South Dakota, North Dakota, Wyoming, and Montana, chiefly those engaged in land-classification surveys, for the purpose of correlating the coal-bearing formations and of studying problems bearing on the late Cretaceous and early Tertiary rocks of the Rocky Mountain region. In cooperation with M. R. Campbell, F. H. Knowlton, W. R. Calvert, and R. W. Stone, Mr. Stanton made a special study of the stratigraphic relations of the Livingston formation of Montana, by means of a reconnaissance trip around the Crazy Mountains. This study resulted in the elucidation of a particularly obscure stratigraphic problem. The formation, which consists of andesitic material, was found to be of small geographic extent and to finger out in various directions into different Tertiary and Upper Cretaceous formations. The details of this investigation have been explained in a report prepared by Messrs. Stone and Calvert. During Mr. Stanton's field work a special study was also made of the Fox Hills sandstone and the overlying Lance formation ("Ceratops beds"), the results of which have been incorporated in a report which has been completed and submitted for publication.

The investigation of the stratigraphy and paleontology of the coal-bearing rocks of the Rocky Mountain region was continued in the field and office by F. H. Knowlton, who also visited numerous field parties in New Mexico, Colorado, Wyoming, and Montana. In addition Mr. Knowlton has been engaged in the preparation of reports on the Laramie flora of eastern Wyoming and the Jurassic flora of the Pacific coast and a catalogue of Mesozoic and Cenozoic plants of North America.

During the year W. H. Dall has continued his studies of the "silex beds" of Florida and the Tertiary faunas of the Pacific coast and the eastern Gulf coast. The collection of American Tertiary fossils at the National Museum is the largest in the world and is constantly consulted by outside paleontologists, as well as by the government paleontologists. Recently valuable accessions have been made, especially from the southeastern States.

Under the joint supervision of F. H. Knowlton and David White the work on the bibliography and compendium of paleobotany has been continued by Miss C. H. Schmidt.

Studies of the Cambrian, Ordovician, and Silurian rocks in central and eastern Pennsylvania were continued by E. O. Ulrich, the principal object being the determination of practical formational boundaries that would be indicated by lithologic criteria and at the same time mark off important stages in the physical and faunal history of the region.

A report on the Cretaceous fossil plants of South Carolina, by E. W. Berry, is nearly finished.

The study of the Mesozoic and Cenozoic Echinodermata of the United States has been continued by W. B. Clark, assisted by M. W. Twitchell. A large amount of new material has been acquired from the work in the Coastal Plain States.

A report on the Tertiary and Cretaceous floras of Georgia has been completed by E. W. Berry and submitted for publication as a professional paper.

A report on the New Madrid earthquake, by M. L. Fuller, has been received.

Considerable progress was made in the preparation of a bibliography of the mineral phosphate industry of the world by C. L. Breger. This bibliography embraces works on the occurrence, mining, treatment, etc., of rock and mineral phosphates, guanos, and artificial phosphatic slags. It is classified by countries and in America by States.

A special study of correlation problems relating to the Devonian rocks of the Allegheny region was made by E. M. Kindle. Type sections in southeastern New York were first examined, and studies were made through the Allegheny Mountain region and in northern Georgia and Alabama. One of the results of this survey has been the preparation of a report, now ready for the press, describing a previously unrecognized southerly extension of the Onondaga fauna. In the office, and for a few days in the field, Mr. Kindle was assisted part of the time by P. V. Roundy, who prepared the fossils for study.

The work of figuring the type Carboniferous specimens of Winchell, which is in charge of G. H. Girty, is nearly finished. The lack of figures of these specimens has been felt by every student of Carboniferous types, and it is expected that this work will be of considerable value. The figures will be accompanied by a reprint of the original descriptions. In the office Mr. Girty has part of the time had the assistance of P. V. Roundy as preparator.

The classification of the physiographic features shown on the topographic maps published by the Survey was completed by W. W. Atwood. This material is arranged from an educational point of view, so as to be of value to those engaged in teaching as well as to those unacquainted with topographic maps. (See circular 9-323 z.)

Geologic problems in eastern, central, and western Wyoming were made the subject of a special investigation by F. H. Knowlton and A. C. Peale. A large amount of material bearing on the correlation of the Upper Cretaceous and Tertiary formations was acquired.

Considerable progress was made by W. D. Johnson in the preparation of a report on the glaciation of the Sierra Nevada. Recent faulting in the Owens Valley of California was also investigated by Mr. Johnson.

A cooperative study of the Eo-Paleozoic rocks of New York, begun several years ago by E. O. Ulrich, of the Federal Survey, and H. P. Cushing and Rudolph Ruedemann, of the New York Geological Survey, was extended around the southern flank of the Adirondack uplift. The results so far as they relate to the "Calciferous" have been published by Messrs. Ulrich and Cushing in the annual report of the director of the New York State Survey.

The special study of the Upper Devonian was continued by H. S. Williams, and considerable progress was made.

A paper on the criteria of downward sulphide enrichment was prepared by F. L. Ransome and read at the meeting of the Canadian Institute at Toronto.

The report by J. P. Smith on the Middle Triassic of America was completed and submitted for publication, and Mr. Smith made good progress in the studies of the Upper Triassic and Lower Triassic.

The geologic map of North America, which has engaged the attention of Bailey Willis for some time, was completed and the engraving has been commenced. The accompanying text is in an advanced state.

Several geologists were detailed to the technologic branch for the purpose of conducting, for the Supervising Architect of the Treasury Department, a survey of the structural materials available in localities where public buildings have been authorized by Congress. About 150 localities were visited and reports forwarded to the Supervising Architect. Among the minerals to which special attention was paid were building and ornamental stones, materials for cement, mortar, concrete, wall plasters, brick, tile, fireproofing wares, and roofing materials. The geologic relations of newly developed deposits were noted, also the advances in the technology of the manufacture and utilization of structural materials and mineral paints.

LAND-CLASSIFICATION BOARD.

Some special features of the work of the land-classification board are discussed on pages 7-10. The detailed statements of the work, with some notes on the other features, are presented below.

PERSONNEL.

The board consists of a general advisory section and such classification sections as may be established from time to time to deal with any particular class of lands. The chairman of the general board is also chairman of the several classification sections and is in charge of the records and office force, consisting of 3 scientific assistants, 6 clerks, and 4 draftsmen.

The advisory board, which is charged with consideration of questions of policy and approval of standards only, consists of the chair-

man and the chiefs of sections and branches in charge of the field work on which the classifications of the board are based. Its personnel is as follows: A. C. Veatch, chairman; C. W. Hayes, chief geologist; M. O. Leighton, chief hydrographer; M. R. Campbell, chief of section of economic geology of fuels; and Waldemar Lindgren, chief of section of metalliferous ores.

The actual classifications are made by sections composed of three members, the chairman of the board and two members specially qualified in each case to deal with the questions involved in the classification. These sections are at present constituted as follows:

Coal: A. R. Schultz and W. R. Calvert.

Oil: M. J. Munn and Robert Anderson.

Phosphate: F. B. Van Horn and E. O. Ulrich.

Metalliferous deposits: H. D. McCaskey and F. L. Ransome.

Nonirrigable lands: W. C. Mendenhall and J. C. Hoyt.

COAL LANDS.

The year's work in coal-land classification (see pp. 8-9) is shown in detail in the following tables:

Progress of coal-land classification for the year ending June 30, 1910.

[Areas in acres.]

State.	Date.	Total area classified as coal land and appraised.		Total area classified as non-coal land.		Total valuation as fixed for coal land.		Total minimum valuation.		Average price per acre.	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Arizona.....	July 1, 1909										
	July 1, 1910										
Arkansas.....	July 1, 1909	60,715		70,041		\$1,473,762		\$1,214,320		\$24.3	
	July 1, 1910	60,715		70,041		1,473,762		1,214,320		24.3	
California.....	July 1, 1909										
	July 1, 1910		7,720		6,242		\$585,086		\$154,404		\$75.8
Colorado.....	July 1, 1909	488,826	104,298	2,595,851	331,865	14,116,985	2,325,330	7,136,850	2,085,960	28.9	22.3
	July 1, 1910	349,264	1,807,521	2,069,923	2,718,871	9,893,425	115,755,958	4,360,010	35,196,015	28.3	64.0
Montana.....	July 1, 1909	457,676	493,931	5,567,533	2,241,210	9,004,115	12,026,847	8,670,651	9,739,919	19.7	24.3
	July 1, 1910	405,556	792,351	4,826,109	3,642,754	7,962,915	20,604,859	7,629,451	15,164,461	19.6	26.0
New Mexico.....	July 1, 1909	1,795,918		3,502,931		21,894,731		21,861,171		12.2	
	July 1, 1910	1,794,258	7,406	3,368,410	249,748	21,853,231	274,486	21,827,971	148,128	12.2	37.1
North Dakota.....	July 1, 1909	227,795				4,480,295		4,480,295		19.7	
	July 1, 1910	227,795			679,075	4,480,295		4,480,295		19.7	
Oregon.....	July 1, 1909			884,617							
	July 1, 1910		80	884,617			1,600		1,600		20.0
South Dakota.....	July 1, 1909										
	July 1, 1910				4,340,366						
Utah.....	July 1, 1909	416,007		1,197,678		12,743,525		6,258,738		30.6	
	July 1, 1910	398,661	67,092	1,167,417	286,942	12,100,205	3,521,591	5,964,610	1,201,591	30.4	52.5
Washington.....	July 1, 1909			627,198							
	July 1, 1910			627,198	6,240						
Wyoming.....	July 1, 1909	2,000,114	144,344	4,577,837	1,839,546	41,990,766	16,136,174	34,424,435	2,316,833	21.0	111.8
	July 1, 1910	1,355,064	2,936,599	2,659,181	5,738,341	26,696,448	224,672,347	22,627,798	50,093,112	19.7	76.5
Total.....	July 1, 1909	5,447,051	742,573	19,023,686	4,412,621	105,704,179	30,488,351	84,046,460	14,142,712	19.4	41.1
	July 1, 1910	4,591,313	5,618,769	15,672,896	17,668,579	84,460,281	365,415,927	68,104,455	101,959,311	18.4	65.0

^a Under old regulations.

^b Under new regulations.

Statement of coal-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals. ^a	Restorations and classifications. ^b	Withdrawals outstanding July 1, 1910.
Arizona.....		161,280		161,280
Colorado.....	10,224,368	701,265	4,736,372	6,189,261
Montana.....	6,692,985	14,619,371	1,103,491	20,208,865
New Mexico.....	4,160,787		1,216,508	2,944,279
Oregon.....	379,722		80	379,642
Utah.....	5,199,843	953,930	338,486	5,815,287
Washington.....	2,252,087		44,120	2,207,967
Wyoming.....	13,218,830	3,989,882	4,218,647	12,990,065
	42,128,622	20,425,728	11,657,704	50,896,646

^a Exclusive of change in form and including 587,306 acres which were rewithdrawn where new data indicated the existing classification to be erroneous.

^b Exclusive of classification of areas never withdrawn, amounting to 5,457,443 acres, of which 5,019,441 acres of noncoal land are in the old Standing Rock and Cheyenne Indian reservations, North Dakota and South Dakota, and of reclassifications amounting to 4,206,528 acres.

Outstanding coal classification work.—The work of the coal-land board is in arrears to the extent of 7,432,091 acres on which field work is reported as completed, but on which classifications have not been sent to the General Land Office, and to the extent of 20,264,209 acres which are classified under the old regulations but have not been reclassified under the new. Action on most of this work is well advanced and will probably be completed during the coming fiscal year.

Applications for reclassification.—Applications for the reclassification of lands classified as coal land are forwarded to this office by the General Land Office. These petitions allege that the existing coal classification of the lands is erroneous and that they should properly be classed as noncoal lands. In 3 cases during the year the allegation of the applicant was sustained and the lands classified as noncoal. In 3 other cases it was sustained as to a part of the land involved, and in 116 cases the application was denied. There are pending at the end of the year 5 such applications, making a total of 127, which are divided among the several States as follows:

Applications for reclassification of areas classified as coal land.

State.	Approved.	Part approved.	Denied.	Pending.	Total.
Colorado.....				2	2
Montana.....	3	1	43	2	49
New Mexico.....			7	1	8
Utah.....		2	2		4
Wyoming.....			64		64
	3	3	116	5	127

OIL LANDS.

The status of the work on oil lands (see p. 10) is indicated in the following table:

Statement of oil-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals. ^a	Restorations.	Withdrawals outstanding July 1, 1910.
Arizona.....		230,400		230,400
California.....	2,270,144	591,062	378,456	2,482,750
Colorado.....		87,474		87,474
Louisiana.....	1,451,520		1,036,800	414,720
New Mexico.....		419,901		419,901
Oregon.....	74,849			74,849
Utah.....		1,196,848	615,282	581,566
Wyoming.....	173,530	223,575	141,644	255,461
	3,970,043	2,749,260	2,172,182	4,547,121

^a Excluding changes in form of withdrawals.

PHOSPHATE LANDS.

The withdrawals of phosphate lands (see p. 8), by States, are as follows:

Statement of phosphate-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals.	Restorations.	Withdrawals outstanding July 1, 1910.
Florida.....		2,400		2,400
Idaho.....	1,625,425	189,132	712,240	1,102,317
Utah.....	524,975	8,116	425,546	107,545
Wyoming.....	2,364,175	202,306	1,184,630	1,381,851
	4,514,575	401,954	2,322,416	2,594,113

MINERAL CLAIMS IN NATIONAL FORESTS.

In a number of cases, involving claims under the mining laws to lands within national forests, the Forester has requested the Geological Survey to make special examinations. Reports on the examination of 29 such claims have been transmitted to the board during the year by the chief of the section of economic geology of metalliferous ores. The land in 17 of these claims was found by the metalliferous section of the land board to be nonmineral, and that in 12 to be only in part mineral land. The total area classified as nonmineral land was 4,237 acres and that as mineral land 1,130 acres.

ACTION ON SPECIAL AGENTS' REPORTS ON MINERAL CHARACTER OF LANDS IN NON-MINERAL SELECTIONS.

The Commissioner of the General Land Office has from time to time during the year transmitted reports of special agents of his office regarding the mineral character of nonmineral selections. For the

most part these reports have dealt with the coal character of the land, but of the 302 reports that have been received, 2 have related to precious metals, 4 to iron, 2 to phosphate, and 2 to oil. The reports of the special agents were approved in 209 cases, disapproved in 66, and approved as to part of the area involved in 4. The portion of the reports approved involves 75,435 acres, that disapproved 16,880 acres. The action by States is shown in the following table:

Action on special agents' reports on the mineral character of lands in nonmineral selections, year ending June 30, 1910.

[Areas in acres.]

State.	Approved.		Ap- proved in part (num- ber).	Disapproved.		Pending.		Total.	
	Num- ber.	Area.		Num- ber.	Area.	Num- ber.	Area.	Num- ber.	Area.
Arkansas.....				2	320			2	320
California.....				2	480			2	480
Colorado.....	6	880		3	440		560	13	1,880
Idaho.....						1	40	1	40
Montana.....	39	27,635		12	1,640			51	29,275
New Mexico.....		80	1		80			1	160
North Dakota.....						1	80	1	80
Oregon.....	5	360						5	360
Utah.....	95	24,840	2	27	8,760	17	3,080	141	36,680
Washington.....	6	10,840						6	10,840
Wyoming.....	58	10,800	1	20	5,160			79	15,960
	209	75,435	4	66	16,880	23	3,760	302	96,075

POWER SITES.

The status of the work on power sites (see p. 8) appears in the subjoined table:

Statement of power-site withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New with- drawals.	Restorations.	Withdrawals outstanding July 1, 1910.
Arizona.....		107,550		107,550
California.....		47,819		47,819
Colorado.....	22,240	182,776	3,467	201,549
Idaho.....	59,882	171,089		230,971
Montana.....	46,367	77,029	881	122,515
Nevada.....		14,091		14,091
New Mexico.....		14,536		14,536
Oregon.....	81,118	96,803	1,200	176,721
Utah.....	34,880	380,671	35,639	379,912
Washington.....		55,439		55,439
Wyoming.....	35,383	72,015	4,002	109,396
	279,870	1,219,818	45,189	1,454,499

REPORTS ON RIGHT-OF-WAY APPLICATIONS.

On November 3, 1909, on recommendation of the Commissioner of the General Land Office, the Secretary directed that all right-of-way applications be forwarded to the Geological Survey for report, in order that no application might be approved which would interfere

with any valuable power site desired to be withdrawn in aid of legislation. Of the 261 such applications which have been received, 130 were found to affect sites not valuable for power, the lands covered by 73 were included in power-site withdrawals or such stipulations were made as to fully protect the power sites involved, and 58 are now pending, for the most part awaiting the results of field investigations.

REPORTS ON CAREY ACT SELECTIONS.

Twenty applications under the Carey Act have been referred to the board during the year for report as to the feasibility of the proposed irrigation. Adverse reports were made with respect to eleven of these; favorable reports on the remaining nine.

ENLARGED-HOMESTEAD DESIGNATIONS.

Immediately after the passage of the enlarged-homestead act large areas were designated in each of the States affected thereby. These designations did not cover all the lands of the character named in the act, but only those areas which, so far as it was possible from existing information to determine quickly, should be designated. The data on which some of the designations were made proved to be inaccurate, and a correction of the errors by the cancellation of the parts of the designations involved was necessary. Throughout the year an effort has been made to increase designations wherever there was a demand therefor, on the basis either of information already at hand or of that supplied by special field examinations. These field examinations were made not only by the Geological Survey but by the General Land Office. The designations and cancellations during the year are shown below:

Enlarged-homestead designations and cancellations, year ending June 30, 1910.

State.	Total area subject to provisions of act on July 1, 1909.	Additional designations made during fiscal year.	Cancellations of designations erroneously made.	Total area subject to provisions of act on July 1, 1910.
Arizona.....	26,657,280	.....	.....	26,657,280
Colorado.....	20,299,840	3,880	.....	20,303,720
Montana.....	19,957,960	a 9,728,366	200	29,686,126
Nevada.....	49,512,960	.....	.....	49,512,960
New Mexico.....	14,808,520	1,138,963	64,140	15,883,343
Oregon.....	8,346,560	820,400	.....	9,166,960
Utah, secs. 1-5 only.....	7,020,642	308,463	.....	6,654,469
Utah, sec. 6.....	b 571,182			
Washington.....	3,576,960	107,096	282,240	3,401,816
Wyoming.....	10,676,280	6,276,033	47,640	16,904,673
	161,428,184	18,383,201	394,220	179,417,165

a Of which 105,080 acres are based on field examinations by General Land Office.
 b Based on field examinations by General Land Office.

During the fiscal year 256 petitions for designations under the enlarged-homestead act have been received. These, with the 38

pending at the close of the last fiscal year, make a total of 294, which have been acted on as follows:

Action on petitions under the enlarged-homestead-act, year ending June 30, 1910.

State.	Designations made.		Refused.	Pending.	Total.
	Including all lands asked for.	Including only part of lands asked for.			
Arizona.....			4	1	5
Colorado.....	1		10		11
Montana.....	27	35	28	28	118
New Mexico.....	29	6	22	8	65
Oregon.....	16	2	3	2	23
Utah.....			1	1	2
Nevada.....			1		1
Washington.....	4	2	12		18
Wyoming.....	26	10	6	9	51
	103	55	87	49	294

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of \$90,000 for "continuation of the investigation of the mineral resources of Alaska." Under this authority the following classes of work were carried on: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigations of water resources with reference to the supply available for placer mining; and collection of statistics on mineral production.

PERSONNEL.

The personnel of the division varies greatly during the year on account of the transfer of technical employees to and from other divisions of the Survey and the employment of temporary clerks as the work demands. There have been employed throughout the year 1 geologist in charge, 10 other geologists, 4 topographers, and 3 clerks. In addition to these, 3 geologists were employed on per diem salaries for part of the year. Three engineers gave the greater part of their time to the Alaska work. One topographer was added to the Alaska division by transfer from the topographic branch on April 15, 1910. One engineer was detailed to the division from the water-resources branch for a short period during the field season. A draftsman was also employed in the office for four and a half months, 1 clerk for six months, and 5 clerical assistants for short periods of time.

During the season of 1909 the field force included also 2 topographic and 2 geologic field assistants, together with about 30 teamsters, cooks, etc. In addition, several gage readers were employed, who gave only a part of their time to the work. The temporary assistants in the field force for 1910 included 2 geologic field assistants, with about 27 laborers. On June 30, 1910, the division included 1 geolo-

gist in charge, 10 geologists on annual salaries and 3 geologists employed at a per diem compensation, 4 topographers on annual salary, 1 assistant topographer on monthly salary, 1 geologic field assistant, 2 engineers, 27 camp hands, and 3 clerks.

FIELD OPERATIONS IN SEASON OF 1909.

Allotments and areas covered.—Fourteen parties were engaged in Alaskan surveys and investigations during the season of 1909 for varying periods of time between March and November. Some of these parties were subdivided in the field, making a total of seventeen parties that were engaged in investigations of various kinds. In addition to these, the geologist in charge spent a part of the summer in Alaska, carrying on geologic investigations and visiting field parties.

During the year 6,190 square miles were covered by exploratory topographic surveys, 5,170 square miles by reconnaissance topographic surveys, and 444 square miles by detailed topographic surveys.^a Detailed geologic surveys were made of 450 square miles and geologic reconnaissance surveys of 5,500 square miles, while 6,100 square miles were geologically explored. Most of the geologists also spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of approximately 6,600 square miles and included 81 gaging stations maintained and 703 measurements of stream volumes. Fifteen of the twenty-eight mining districts of Alaska which are being developed, including all but two of the most important, were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work as well as inspection.

Allotments to Alaskan surveys and investigations, 1909-10.

Southeastern Alaska.....	\$10,700
Copper River region.....	8,200
Kenai Peninsula, Iliamna Lake, and Alaska Peninsula region..	27,950
Matanuska region.....	10,900
Northwestern Alaska, including Seward Peninsula.....	13,400
Yukon basin.....	18,850
	90,000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, as in some cases the same party, or even the same man, carried on two different kinds of work; but this statement will help to elucidate the later table, which summarizes the complete areal surveys.

^a Exploratory surveys are published on a scale of 1 : 625,000 or 1 : 1,000,000; reconnaissance surveys on a scale of 1 : 250,000 or 1 : 500,000; and detailed surveys on a scale of 1 : 62,500.

Approximate allotment of Alaskan funds to different classes of surveys and investigations, 1909-10.

Geologic reconnaissance and exploratory surveys.....	\$31, 800
Detailed geologic surveys.....	9, 200
Special geologic investigations.....	2, 500
Topographic reconnaissance and exploratory surveys.....	11, 500
Detailed topographic surveys.....	15, 000
Investigation of water resources.....	8, 300
Collection of statistics of mineral production.....	1, 500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment....	10, 200
	90, 000

Allotments for salaries, field expenses, and office salaries are shown in the following table. The scientific and technical salaries include those of geologists, topographers, and engineers. Salaries of temporary employees are included under field expenses.

Allotments for salaries, field and office expenses, 1909-10.

Scientific and technical salaries.....	\$30, 720
Field expenses, including equipment and supplies.....	50, 660
Clerical and other office salaries.....	8, 620
	90, 000

The following table shows the progress of Alaskan surveys since the beginning of systematic work in 1898:

Progress of surveys in Alaska, 1898-1909.^b

Year.	Appropriations.	Areas covered by geologic surveys (square miles).			Areas covered by topographic surveys (square miles). ^b			Lines of levels (miles).	Bench marks set.	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, and 100 foot contours).			Gaging stations maintained part of year.	Stream-volume measurements made.
1898-99...	\$46, 189. 60	9, 500	.....	.....	12, 840	2, 070	.....	.....	.....	.....
1899-1900...	25, 000. 00	6, 000	.....	.....	8, 690	.....	.....	.....	.....	.....
1900-1.....	60, 000. 00	3, 300	6, 700	.....	630	11, 150	.....	.....	.....	.....
1901-2.....	60, 000. 00	6, 203	5, 800	.....	10, 200	5, 450	.....	.....	.....	.....
1902-3.....	60, 000. 00	6, 950	10, 050	.....	8, 330	11, 970	96	.....	.....	.....
1903-4.....	60, 000. 00	5, 000	8, 000	96	.....	15, 000	.....	.....	.....	.....
1904-5.....	60, 000. 00	4, 050	3, 500	.....	800	6, 480	480	86	19	.....
1905-6.....	80, 000. 00	4, 000	4, 100	536	.....	4, 880	787	202	28	.....
1906-7.....	80, 000. 00	5, 000	4, 000	421	.....	13, 500	40	.....	.....	14
1907-8.....	80, 000. 00	2, 600	1, 400	442	.....	6, 120	501	95	16	48
1908-9.....	80, 000. 00	2, 000	2, 850	604	.....	3, 980	427	76	9	53
1909-10.....	90, 000. 00	6, 100	5, 500	450	6, 190	5, 170	444	.....	.....	81
	781, 189. 60	60, 700	51, 900	2, 549	47, 680	85, 770	2, 775	459	72
Percentage of total area of Alaska.....		10. 35	8. 85	0. 44	8. 13	14. 63	0. 47

^a The areas presented in this table differ somewhat from those previously published. This is in part due to the reclassification of the work and in part to the fact that areas have been more carefully scaled off the map than was previously done.

^b In addition to the above, the International Boundary Survey and Coast and Geodetic Survey have made surveys of parts of Alaska.

The above table presents the progress of Alaskan surveys and investigations so far as is possible in tabular form and in percentages of the total areas which have been mapped geologically and topographically. From 1904 to 1908, inclusive, much of the appropriation was allotted to detailed surveys. There being, however, great need for the investigation of new regions, nearly half the appropriation in 1909 was spent on exploratory and reconnaissance surveys. As a consequence, over 11,000 square miles were covered during the year by topographic and geologic exploratory and reconnaissance mapping. This large amount of exploratory surveying has been done, however, at the cost of curtailing much detailed work for which there is urgent demand.

General investigations.—The field investigations of Alfred H. Brooks, geologist in charge of the division, covered the period from about June 25 till October 1. Of the time actually devoted to field work, about two weeks was spent with Mr. Moffit and Mr. Capps on the geology of the Nizina district. A month was then occupied in making an overland trip through the Copper and Tanana valleys to Fairbanks. During this journey special attention was given to the matter of selecting areas for subdivisional surveys. About a week was spent at Fairbanks in making a hasty examination of the lode deposits and in visiting the Prindle party. Later, the return journey to the coast was made by way of Yukon River and White Pass. About a week was spent with Mr. Knopf and Mr. Bagley, who were surveying near Eagle River, in the Juneau district.

In the office Mr. Brooks has given a large part of his time to administrative and routine work, in which he was aided by R. H. Sargent, who supervised the Alaskan topographic surveys. During Mr. Brooks's absence in the field E. M. Aten looked after the office work and also rendered valuable services in the office routine and in the compilation of the mineral statistics of Alaska. About one month in all was devoted to the continuation of the work on the Mount McKinley report. A large part of Mr. Brooks's time during the winter months was given to a study of the distribution of and markets for coal in the countries bordering the Pacific Ocean. Some of the results of these investigations are contained in the annual progress report (Bulletin 442).

By instructions from the Secretary, Mr. Brooks and Mr. Sargent made a comprehensive scheme for subdivisional surveys in Alaska and submitted estimates of cost. On the basis of this estimate an appropriation of \$100,000 for surveys of public lands in Alaska was made in the sundry civil act. This work is to be carried on by the Geological Survey and the General Land Office in cooperation. The money does not become available till July 1, but plans are made to start surveys in the Fairbanks district as soon as parties can be put in the field after that date. Mr. Sargent has been charged with the

execution of these plans and is assisted by C. L. Nelson, S. G. Lunde, and W. N. Vance, who have been detailed from the topographic branch. It is believed that these agricultural surveys will result in the homesteading and cultivation of considerable good agricultural land, which should reduce, to some extent, the cost of living in many of the mining centers. It is estimated that Alaska contains a possible agricultural and grazing area of 15,000 or 20,000 square miles, and these land surveys should be pushed to completion as rapidly as possible.

Southeastern Alaska.—The detailed geologic mapping of the Berners Bay district was completed by Adolph Knopf, who also completed the survey of about two-thirds of the gold belt between Berners Bay and Juneau. Mr. Knopf mapped a total area of about 125 square miles.

Surveys for the topographic base maps needed for the detailed geologic work between Berners Bay and Juneau were made by J. W. Bagley and R. E. Johnson. Work was continued in this field from May to October, and about 154 square miles was surveyed, being about nine-tenths of the total area.

C. W. Wright was employed for about three months in the office on his report on the copper deposits of the Kasaan Peninsula and Copper Mountain districts. He was called to Sardinia on private work before the report was finished, but arrangements have been made by which he will complete the report during the next fiscal year.

Copper River region.—F. H. Moffit, assisted by S. R. Capps, made a detailed survey of the copper and gold bearing belt covered by the Nizina special topographic map. Field work began the first of July and continued until the middle of September, during which time 325 square miles was mapped.

Kenai Peninsula and Prince William Sound.—A reconnaissance of the Prince William Sound region was completed by U. S. Grant in 1908, but in 1909 some additional data were obtained. Most of the season was devoted by Mr. Grant, assisted by D. F. Higgins, to a reconnaissance of the southeastern part of Kenai Peninsula. In the course of this work the newly discovered lode districts of Moose Pass and False Creek were visited. In all about 600 square miles was covered by geologic and topographic surveys.

Southwestern Alaska.—W. W. Atwood completed his report on the geology and mineral resources of the Alaska Peninsula, which was transmitted for publication on June 27. This report includes not only the results of his own investigations in that portion of Alaska, but a compilation of all previous work done in this portion of the district by members of the Geological Survey.

Iliamna and Clark lakes region.—As a part of the general plan to extend reconnaissance surveys as rapidly as possible, such work was

undertaken in the Iliamna and Clark lakes region. D. C. Wither-
spoon, assisted by C. E. Giffin, made a topographic survey of an area
of 5,150 square miles, while G. C. Martin, assisted by F. J. Katz,
mapped the geology of about 3,000 square miles in the same field.

Matanuska Valley.—In accordance with the policy of surveying
the more valuable coal fields as soon as circumstances permit, the
preparation of the base map of the Matanuska field was undertaken
this year. This survey was made by R. H. Sargent, assisted by
J. B. Leavitt, who covered some 196 square miles.

Yukon basin.—The reconnaissance geologic mapping of that part
of the Fairbanks quadrangle lying north of the Tanana was com-
pleted by L. M. Prindle, assisted by B. L. Johnson. The Prindle
party mapped about 2,000 square miles and also made a study of the
newly discovered auriferous lode district near Fairbanks.

In 1907 investigation of the water resources of the Yukon-Tanana
district was begun in the Fairbanks region. This work was extended
by C. E. Ellsworth in 1909. For the purpose of obtaining data
regarding the spring run-off when the melting of the snow takes
place in March Mr. Ellsworth proceeded to Fairbanks over the ice.
He devoted the early part of the season to a study of the water con-
ditions of the streams tributary to the Chatanika, and later pro-
ceeded overland to the Circle district. The remainder of the season
was devoted to stream gaging in the Circle and Fairbanks regions.
Twenty-one gaging stations were maintained during the whole or
part of the season, and 232 measurements of stream volume were
made. This work furnishes data in regard to the run-off of about
3,000 square miles.

Reconnaissance surveys were made of the Koyukuk and Chandalar
district in 1899. The rich placer discoveries in this district during
the last few years made a reexamination imperative. A. G. Maddren
was assigned to this work, and in the course of the season visited all
the productive placers in the field and also made geologic and topo-
graphic surveys of some 500 square miles.

Norton Bay region.—An exploratory survey of the region lying
north and east of Norton Bay and between the lower Yukon and
Seward Peninsula was made by P. S. Smith, assisted by H. M. Eakin.
An area of about 5,000 square miles was covered by this party, in
addition to which a more detailed geologic and topographic survey
of some 200 to 300 square miles was completed.

The investigation of the water resources of Seward Peninsula, so
far as they refer to placer mining, was begun in 1906 and continued
through 1907, 1908, and 1909. In 1909 the work was in charge of
F. F. Henshaw, assisted by G. L. Parker, who maintained 60 gaging
stations and made 471 stream-flow measurements. Stream gaging
has now been continued through four years, which gives fairly definite

results regarding run-off. A report is in preparation by Mr. Henshaw, which will summarize all the data and also discuss the methods of mining.

Collection of statistics.—The work of collecting statistics of gold, silver, and copper production from the operators begun in 1906 was continued through 1909. It is gratifying to note that the operators are showing an increased interest in this work, and that most of the large producers are now furnishing the desired information in regard to production. During 1909 practically every lode mine of importance in the Territory furnished the statistical data requested. There are still many placer miners who have neglected to reply to the inquiries, which are of necessity sent by mail.

FIELD OPERATIONS FOR SEASON OF 1910.

Under an allotment of \$90,000 thirteen parties were dispatched to Alaska during the months of March, April, May, and June. One of these parties is carrying on detailed topographic surveys in southeastern Alaska. Another is doing detailed geologic work in the same region. One geologic party and two topographic parties are making reconnaissance surveys in the upper Copper and Susitna basins. Two parties are making detailed geologic surveys of the Matanuska coal field and adjacent areas. One party has begun a geologic and topographic reconnaissance survey of the region bounded by Tanana River on the north, the Delta on the east, the Nenana on the west, and the Alaska Range on the south.

The investigation of the water resources of the Fairbanks, Birch Creek, and Rampart regions is being continued, and similar work has been started in the Fortymile district. A party is also engaged in making an exploratory survey from the Koyukuk to the Kobuk and thence to Seward Peninsula. The survey of the Innoko placer district made in 1907 is being extended. Some gaging stations are being continued in Seward Peninsula.

OFFICE WORK.

During the year two bulletins (Nos. 410 and 417) which contain results of the work of the Alaska division have been issued. Both contain maps and in addition there have been issued separately as sale publications two reconnaissance maps, those of the Rampart and Fairbanks quadrangles.

The following publications are in press:

Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by P. S. Smith (Bulletin 433).

The Fortymile quadrangle (reconnaissance map 1, by E. C. Barnard), new edition; scale 1:250,000; contour interval, 200 feet.

There have been submitted for publication the following manuscripts:

The Yakutat Bay earthquake of September, 1899, by R. S. Tarr and Lawrence Martin (Professional Paper 69).

Mineral resources of Alaska; report on progress of investigations in 1909, by Alfred H. Brooks and others (Bulletin 442).

Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins (Bulletin 443).

Geology and mineral resources of the Berners Bay region, Alaska, by Adolph Knopf.

Geology and mineral resources of the Nizina district, by F. H. Moffit and S. R. Capps.

Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood.

Geologic reconnaissance in the southeastern part of Seward Peninsula and the Norton Bay-Nulato region, by P. S. Smith and H. M. Eakin.

The Circle quadrangle (reconnaissance map), by D. C. Witherspoon, T. G. Gerdine, and J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

The following reports are in hand:

Geology and mineral resources of the Nome and Grand Central quadrangles, by F. H. Moffit and P. S. Smith (75 per cent completed).

Geology of the Fairbanks district, by L. M. Prindle (75 per cent completed).

The Mount McKinley region, by Alfred H. Brooks and L. M. Prindle (Professional Paper 70; 95 per cent completed).

Geology and ore deposits of the Kasaan Peninsula and Copper Mountain region, Prince of Wales Island, by C. W. Wright (60 per cent completed.)

The Koyukuk and Chandalar placer districts, by A. G. Maddren (75 per cent completed).

Geologic reconnaissance in the Iliamna and Clark lakes region, by G. C. Martin and F. J. Katz (80 per cent completed).

Geology of the Fairbanks quadrangle, by L. M. Prindle (50 per cent completed).

The water supply of Seward Peninsula, by F. F. Henshaw (30 per cent completed).

Geology of the Glacier and Lituya bays region, by F. E. Wright and C. W. Wright (30 per cent completed).

The stratigraphy of the Upper Cretaceous and Tertiary coal horizons of Alaska, by W. W. Atwood (10 per cent completed).

The following maps have been completed during the year. Some will be held for the survey of additional areas before publication. The office work on maps is completed to date.

Kasaan special map, Prince of Wales Island; scale 1: 62,500; contour interval 50 feet. Topography by R. H. Sargent, J. W. Bagley, and D. C. Witherspoon.

Copper Mountain special map, Prince of Wales Island, by R. H. Sargent; scale 1: 250,000; contour interval 50 feet.

Eagle River special map, by J. W. Bagley; scale 1: 62,500; contour interval 50 feet. Additional areas to be surveyed before publication.

Reconnaissance map of Iliamna and Clark lakes region, by D. C. Witherspoon and C. E. Giffin; scale 1: 250,000; contour interval 200 feet.

Matanuska special map, by R. H. Sargent; scale 1: 62,500; contour interval 50 feet.

Nabesna quadrangle (reconnaissance map), by D. C. Witherspoon and J. W. Bagley; scale 1: 250,000; contour interval 200 feet. Additional areas to be surveyed before publication.

Gardiner Creek quadrangle (reconnaissance map), by D. C. Witherspoon and J. W. Bagley; scale 1: 250,000; contour interval 200 feet. Additional area to be surveyed before publication.

Map of Seward Peninsula, by U. S. Geological Survey; scale 1: 500,000; contour interval 200 feet.

GEOLOGIC RESULTS.

Mr. Knopf's studies in the Berners Bay region show that a part of the rocks of the Juneau gold belt, all previously assigned to the Carboniferous, are Jurassic—a result which indicates a very close similarity between the geology of this field and that of the California Mother Lode district. The work of Mr. Grant and Mr. Higgins shows that the metamorphic rocks of Kenai Peninsula, like those of Prince William Sound, are divisible into two large groups. The Iliamna and Clark lakes region has been found by Mr. Martin and Mr. Katz to be made up largely of lavas and intrusive rocks, with some Mesozoic and Paleozoic sediments. The cupriferous mineralization seems to be similar in character to that of Prince of Wales Island, and the copper ores occur near the contacts of crystalline limestones and intrusives. Messrs. Moffit and Capps have shown that the Jurassic rocks of the Nizina district are locally auriferous, and this fact suggests that the mineralization may belong to the same epoch as that of southeastern Alaska. In the Fairbanks district Mr. Prindle's studies have shown that there were two periods of intrusion by quartz veins and that the later one was accompanied by auriferous mineralization. In the Koyukuk Mr. Maddren found evidence of a much wider extent of glaciation than was previously supposed. The work of Mr. Smith and Mr. Eakin shows that the region between Norton Bay and Seward Peninsula is largely occupied by Cretaceous rocks. Of significance is their determination of the Mesozoic age of the auriferous mineralization on Bonanza Creek.

DIVISION OF MINERAL RESOURCES.

What is now the division of mineral resources was organized in 1882 as the division of mining statistics and technology under the direction of Albert Williams, jr. Mr. Williams continued in charge until 1885 and was succeeded by David T. Day, who remained in charge until August, 1907, when (at his own request) he was relieved of the administrative duties. Since that time the work of the division has been carried on under the supervision of Edward W. Parker as statistician in charge. At the time that Mr. Parker took charge of the division Waldemar Lindgren was placed in charge of the section relating to metalliferous statistics (except iron).

The statistical reports of this division cover the calendar year. The first report was published in 1883 and covered the calendar year 1882. As the statistics are compiled for the calendar year, the expenses of compilation and publication are necessarily distributed through two fiscal years. On account of the great development in the mining industry during the past few years it has been necessary to increase the size of the publications, and the reports for 1907 and 1908 have been issued in two octavo volumes each. The report for 1909 will also be published in two volumes.

Since 1906 the annual appropriation "for the preparation of the report on the mineral resources of the United States" has been \$75,000. While these reports are necessarily to a large extent statistical compilations, the effort in recent years has been toward making them also a storehouse of information regarding the occurrence, development, and utilization of the mineral products of the country. It seems that the knowledge of what are the resources of the future is even more essential to our economic development than the record of the past as shown in the statistical compilations. In carrying out this idea the cooperation with the division of geology has been most helpful. The geologists and assistant geologists chosen to aid in the preparation of the report on mineral resources have been those who have specialized in these lines of investigation, and their combined work, having the more scientific bearing in geology and the economic bearing in mineral resources, has been mutually beneficial.

The report for 1908, of two volumes, contains a total of 1,715 pages. Among the important contributions to this report were maps showing the occurrence of the different varieties of iron ores and of petroleum and natural gas, similar to the maps showing the distribution of coal throughout the United States and of the precious and semiprecious metals in the Western States, which were published in the report for 1907. It is proposed to prepare similar maps for future reports showing the distribution of the varieties of stone suitable for building purposes and of materials suitable for cement manufacture.

For the statistical canvass covering the calendar year 1909 a cooperative plan between the Geological Survey and the Bureau of the Census was arranged and approved by the Secretaries of the Departments of the Interior and of Commerce and Labor. This plan includes in the first place the furnishing by the Geological Survey to the Census Bureau of all its complete lists of mineral producers throughout the country. A supplemental schedule for the statistics of production was printed for the use of both the Census and the Survey, the expense of printing being borne by both bureaus in an agreed proportion. The supplemental schedules are collected by the special agents of the Census at the same time they are collecting the general schedules required for the Census Bureau, and are transmitted by the Census Bureau to the Geological Survey for the tabulation of the statistics of production. This tabulation is being done by the division of mineral resources, and the Census Bureau will accept the results as furnished by the Survey. On account of the more detailed information required by the Census Bureau, and because of the fact that practically all the work is being done by special agents in the field, the completion of the report will necessarily be delayed beyond the usual date of publication, but the schedules as transmitted by the Census Bureau have been in the main satisfactorily filled out and less correspondence has been necessary than when the work is done by

mail. Up to June 30, 1910, the percentage of schedules received was 25.80. Comparisons with the previous year for the more important subjects for which figures for both years are available are as follows:

Schedules received from producers, June 30, 1909 and 1910.

Industry.	Schedules received.	
	June 30, 1909.	June 30, 1910.
	<i>Per cent.</i>	<i>Per cent.</i>
Building stone.....	97	26
Clay working.....	98	35
Coal.....	98	26
Coke.....	100	15
Iron ores.....	100	24
Natural gas.....	90	43
Quicksilver.....	99	33

A few subjects were omitted from the cooperative agreement with the Census Bureau. These were sand and gravel, mineral waters, aluminum, and briquets. The report on sand and gravel has been completed and transmitted to the printer. Statistics for the reports on mineral waters and briquets have been completed, and the reports will be transmitted to the printer early in July. The Survey also prepared a preliminary report on cement production. This was done on the request of the cement producers for an early publication of the statistics for 1909. A special report on the distribution of Lake Superior iron ores, accompanied by a map, was prepared and transmitted to the printer in May. An important part of the work during the last fiscal year has been the preparation of a chapter on the useful minerals of the United States, similar to those published in the reports for 1882 and 1887. Since the publication of the chapter in the 1887 report a large amount of information has been made available through the work of the Geological Survey and of the state geologists, and it is believed that this publication will be of much value.

During the month of January preliminary statistics of production in 1909, with reviews of the trade during the year, were given to the press in the form of special bulletins on the following subjects: Gold and silver; copper, lead, and zinc; cement; coal; and petroleum.

A considerable portion of the time of the specialists was consumed in answering technical inquiries and in making examinations of numerous mineral specimens submitted by different persons for determination. Such information is freely given where a chemical analysis or assay is not necessary, and it is the endeavor of those in charge to answer all such inquiries as promptly as possible.

In the section of metal statistics, under the charge of Waldemar Lindgren, statistics of the annual production of all metals except iron are collected. H. D. McCaskey has the supervision of the local offices in Denver, Salt Lake City, and San Francisco, which are in

charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively. It is the duty of these offices to collect data of mine production by direct correspondence with the producers and to keep in constant touch with the mining industry in their respective territories. C. E. Siebenthal is in charge of the collection of statistics from lead and zinc smelters and also obtains by correspondence the production of the lead and zinc mines in the Central States. B. S. Butler gathers the statistics from copper smelters and also from the mines of Michigan. F. L. Hess has in charge the collection of statistics relating to the rarer metals, such as tungsten, tin, arsenic, and antimony. In addition to his duties mentioned above, Mr. McCaskey collects the statistics from the smelting works producing quicksilver and gathers the data from the gold and silver mines in the Eastern States. D. T. Day prepares a report on platinum.

The reports on gold, silver, copper, lead, and zinc are issued in two forms. The first contains what are termed the smelter reports, based on actual production of metals as reported by the smelters; the second, which is termed the mine report, is based on the returns from the individual mines and contains an epitome of the mining operations and output by quantity of metal and tons of ore in all the mining camps in the country. Thus, the volume "Mineral resources" contains, in addition to the figures of actual smelter production, a detailed account of the condition of the mining and smelting industry throughout the United States. All these reports were issued in the last months of the calendar year except the mine reports from the Western States and the general report on gold and silver, which were not published until January, 1910. For all the metals, however, preliminary statements of production had been issued in the first half of 1909. On January 1, 1910, preliminary statements were issued giving the approximate production in 1909 of copper, lead, zinc, quicksilver, and tungsten, and a few days later a preliminary account of the gold and silver industry was issued in conjunction with the Bureau of the Mint.

In accordance with the plans for cooperation between the Geological Survey and the Census Bureau for the collection of metal statistics for 1909 the agents of the latter bureau are now collecting the data on production of mines and smelters for the Geological Survey. As complete figures have not yet been received at the close of the fiscal year, it has not been possible to follow the usual custom of publishing the correct totals at the end of the fiscal year, in advance of the final, more elaborate reports.

In addition to his administrative duties as statistician in charge, Mr. Parker prepares the reports on the production of coal and on the manufacture of coke. David T. Day continues with the division as expert in charge of the work on petroleum and natural gas. He is also preparing the report for 1909 on the allied subjects—*asphalt*

and bituminous rock. This report was formerly prepared by J. A. Taff, who has resigned from the Survey. Jefferson Middleton supervises the preparation of the report on the clay-working industries. The reports on the production of iron and manganese are prepared by E. C. Harder, assistant geologist. E. F. Burchard, assistant geologist, has charge of the reports on building stones and other structural materials, mineral paints, and several other subjects. Samuel Sanford supervises the preparation of the chapter on mineral waters and is also preparing the special chapter on the useful minerals of the United States. F. B. Van Horn, assistant geologist, supervises the work on phosphate rock and fuller's earth, and the following members of the Survey are preparing reports on minor but important mineral substances: J. S. Diller, geologist, asbestos and talc and soapstone; W. C. Phalen, assistant geologist, abrasive materials, aluminum and bauxite, bromine, grindstones and whetstones, salt, sodium and potash, and sulphur and pyrite; E. S. Bastin, assistant geologist, flint and feldspar and graphite; D. B. Sterrett, assistant geologist, mica, monazite and zircon, and precious stones; and C. A. Davis, peat.

In the investigation of the petroleum resources of the United States, carried on by David T. Day, representative samples of petroleum were collected from the Mid-Continent or Kansas and Oklahoma oil field, and in cooperation with the state geologists similar samples were collected from West Virginia and Louisiana. These were submitted to chemical analysis by the uniform system of examination adopted by the Geological Survey in conformity with the recommendations so far made by the international commission for the unification of petroleum-testing methods. Many samples of petroleum sent in by field geologists were similarly examined. In all, 130 specimens were analyzed, and in the course of the work 2,040 individual determinations were made. In cooperation with the division of geology field examinations of the occurrence of petroleum and natural gas were made in Utah, Louisiana, Texas, and New Mexico. The petroleum section also cooperated with the technologic branch in the development of methods of investigation of California petroleum and in the collection and examination of representative fuel oils for use in the navy.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

Routine work in the laboratory has necessarily followed well-established lines. During the year 138 quantitative analyses were reported and 678 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey. Analyses which proved of special interest were those of two tin minerals from Alaska, a new mineral from Colorado allied to amblygonite, the rare mineral thaumasite from a new locality in Utah,

and a new mercury mineral from Texas. These analyses were made by W. T. Schaller.

The investigation of the new titanate of iron, which was last year discovered by Chase Palmer in material received from Arizona, has been concluded. The mineral is named arizonite and a description of it has been published by Mr. Palmer.

A study of peat and bog water, with special reference to the humus acid problem, is being made by Mr. Palmer.

A new method for the accurate analysis of natural phosphate rock was worked out by George Steiger, who made an analysis of a composite sample of phosphate rock for the National Fertilizer Association. Additional investigations on the colorimetric determination of fluorine were also made by Mr. Steiger.

The recalculation of the atomic weights was completed by F. W. Clarke and has been published by the Smithsonian Institution. A paper by the same author on chemical denudation has also appeared.

The study of the California tourmaline field was continued by W. T. Schaller, who also prepared a discussion of the composition of the rutile-tapiolite group of minerals.

Investigations of certain minerals containing elements which recent technical developments have rendered important (tungsten, vanadium, molybdenum, uranium, titanium, columbium, tantalum, thorium, and the rare earths) have been conducted by R. C. Wells. It is proposed to publish certain of these results in a bulletin in conjunction with crystallographic and geologic discussions of the minerals by W. T. Schaller and F. L. Hess. Mr. Wells has also published a paper on hydrogiobertite, a basic magnesian carbonate, which has been identified for the first time in this country.

Investigations in the physical laboratory have been conducted as heretofore by C. E. Van Orstrand. The experimental work consisted of a continuation of the experiments on elasticity and diffusivity of metals at various temperatures. The theoretical work consisted largely in a study of the theory of homogeneous stress and strain as applied to rock cleavage. Progress has been made in the preparation of a complete table of the probability integral and its reverse.

Researches on geophysical problems were continued by G. F. Becker, chief of the division. He also published a paper on the origin of the gold of the Witwatersrand and, with Mr. Van Orstrand, "Smithsonian mathematical tables, hyperbolic functions." A second edition of the latter work is already called for and it is undergoing revision at the hands of the authors.

Four bulletins have been issued from this division during the year—Nos. 401, 405, 419, and 422. Titles and brief notes on these bulletins are given on pages 19 and 21. The Smithsonian Institution has also published a paper by Mr. Becker entitled "The age of the earth."

TOPOGRAPHIC BRANCH.**ORGANIZATION.**

The organization of the topographic branch remained the same as at the close of the last fiscal year until June 1, when Sledge Tatum was placed in charge of the Rocky Mountain division and E. C. Barnard was detailed to the State Department for work on the United States and Canada Boundary Survey. The branch is now organized as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

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

Rocky Mountain division, Sledge Tatum, geographer in charge.

Pacific division, T. G. Gardine, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 1 geographer, 19 junior topographers, 2 assistant topographers, and 1 draftsman. It was reduced 41 by transfers and resignations. With these changes the technical force now includes a chief geographer, 10 geographers, 47 topographers, 36 assistant topographers, 58 junior topographers, and 10 draftsmen. One geographer, 8 topographers, and 4 assistant topographers are on leave without pay. In addition to the men named above 95 technical field assistants were employed during the whole or a part of the field season.

PUBLICATIONS.

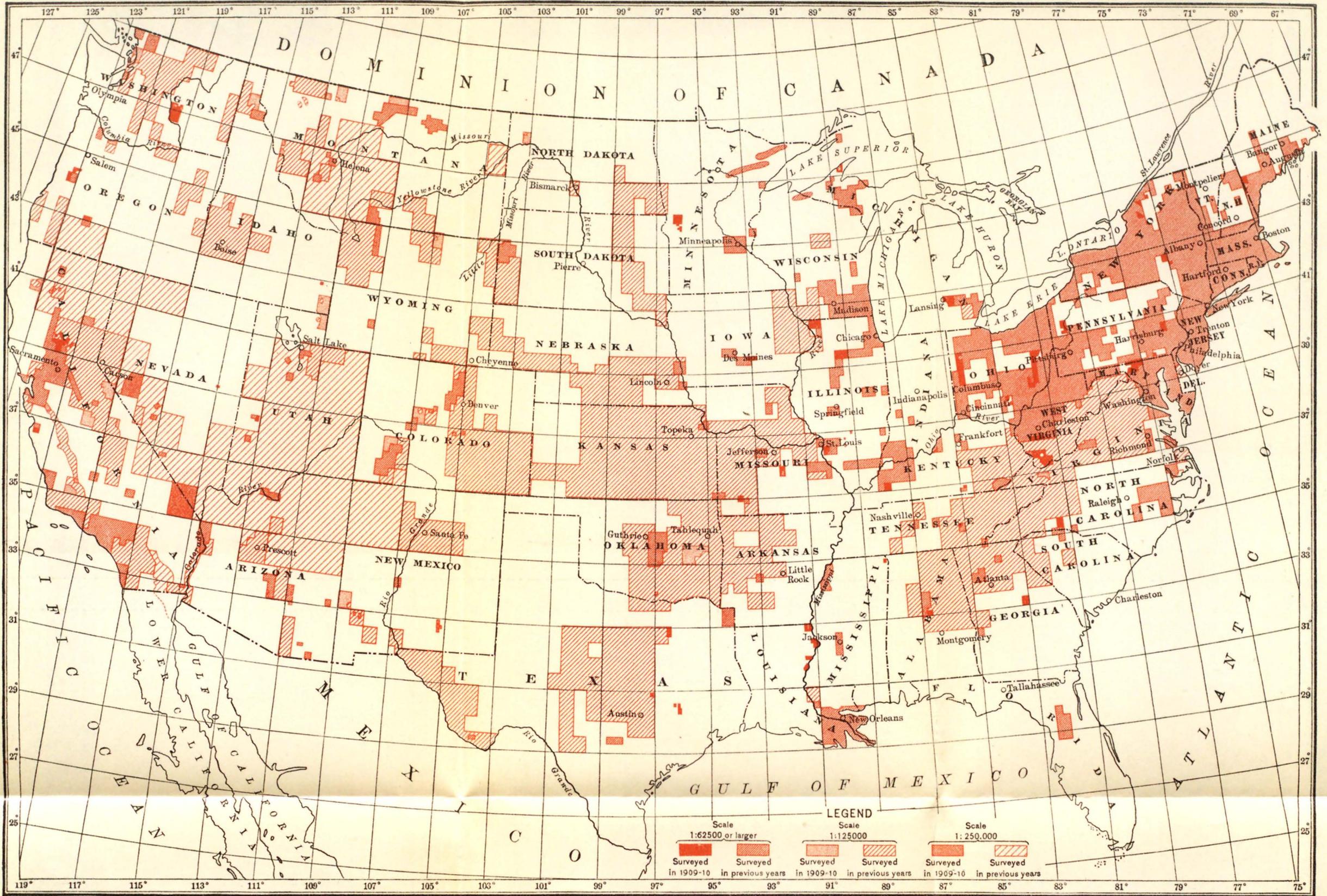
The work of the topographic branch is represented in the following publications issued during the year: Bulletins 399, 411, and 421; 93 new topographic maps. Titles and brief summaries of these publications are given on pages 19-21.

SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1910, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 32,808 square miles, making the total area surveyed to date in the United States 1,107,765 square miles, or about 36.5 per cent of the entire country. In addition 3,731 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 36,539 square miles.

Triangulation stations to the number of 156 were occupied, of which 124 were permanently marked; and in addition 141 points were located by intersections. There were run 2,762 miles of primary



MAP OF UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE SCALE EMPLOYED FOR EACH AREA



traverse, in connection with which 454 permanent marks were set. In the course of this work 23,400 square miles were covered by primary control.

In connection with these surveys 5,216 linear miles of primary levels were run, making the total amount of primary and precise leveling done since the authorization of this work by Congress, in 1896, 224,432 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1909-10, as reported in detail on pages 52-56, was about 11,804 square miles—444 for publication on the scale of 1:62,500, 5,170 for publication on the scale of 1:250,000, and 6,190 for publication on the scale of 1:625,000 or 1:100,000.

Present condition of topographic surveys of the United States and new areas surveyed in 1909-10.

State.	New area surveyed in 1909-10.	Total area surveyed to July 1, 1910.	Percentage of total area of State surveyed to July 1, 1910.
	Sq. miles.	Sq. miles.	
Alabama.....	18,283	18,283	35
Arizona.....	45	63,478	56
Arkansas.....	.....	20,798	39
California.....	8,183	92,914	59
Colorado.....	1,221	41,751	40
Connecticut.....	.....	4,965	100
Delaware.....	.....	1,008	43
District of Columbia.....	.....	70	100
Florida.....	.....	1,821	3
Georgia.....	250	17,337	29
Idaho.....	2,198	18,198	21
Illinois.....	1,136	10,082	18
Indiana.....	.....	2,941	8
Iowa.....	182	10,448	19
Kansas.....	.....	64,159	78
Kentucky.....	329	16,476	41
Louisiana.....	30	8,283	17
Maine.....	402	7,801	88
Maryland.....	321	10,771	88
Massachusetts.....	.....	8,266	100
Michigan.....	439	4,924	8
Minnesota.....	495	3,582	4
Mississippi.....	47	1,796	4
Missouri.....	320	34,692	50
Montana.....	3,351	52,648	36
Nebraska.....	.....	25,974	34
Nevada.....	1,772	50,475	46
New Hampshire.....	4	3,380	36
New Jersey.....	.....	8,224	100
New Mexico.....	1,733	31,907	26
New York.....	649	40,221	81
North Carolina.....	243	17,661	34
North Dakota.....	741	9,716	14
Ohio.....	2,022	27,319	67
Oklahoma.....	.....	38,677	55
Oregon.....	605	18,279	19
Pennsylvania.....	629	22,813	50
Rhode Island.....	.....	1,248	100
South Carolina.....	.....	5,640	18
South Dakota.....	.....	17,956	23
Tennessee.....	.....	20,345	48
Texas.....	493	66,807	25
Utah.....	373	67,425	79
Vermont.....	.....	3,537	37
Virginia.....	.....	29,980	70
Washington.....	2,228	20,754	30
West Virginia.....	.....	24,120	99.8
Wisconsin.....	.....	11,789	21
Wyoming.....	2,123	26,026	27
	32,808	1,107,765	.....

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Georgia, Louisiana, Maine, Maryland, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and West Virginia. This work comprised the survey of 14 quadrangles and the resurvey or revision of 6 quadrangles. In addition, 18 quadrangles were partly surveyed, 5 were partly resurveyed, and large-scale traverse surveys were made of 2 counties and 1 district. The total new area mapped was 2,905 square miles—2,545 for publication on the scale of 1:62,500 and 360 for publication on the scale of 1:24,000. The area resurveyed was 1,941 square miles—633 for publication on the scale of 1:125,000 and 1,308 for publication on the scale of 1:62,500. In connection with this work, 994 miles of primary levels were run and 268 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Louisiana, Maine, Maryland, North Carolina, and West Virginia. The total area covered by the primary control was about 2,500 square miles, of which 1,350 were controlled by primary traverse, 537 miles being run and 115 permanent marks set. Eighteen triangulation stations were occupied and 11 were marked. The result of this work was to make control available in six 15-minute quadrangles and one irregular area.

Topographic surveys in Atlantic division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:125,000.		1:62,500.		Distance run.	Bench marks.	Distance run.	Permanent marks.
		Re-survey.	New.	Re-survey.					
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>		<i>Miles.</i>	
Alabama.....	50	.....	.....	250	250	64	20	.....	.....
Georgia.....	20	.....	250	.....	250	71	15	.....	.....
Louisiana.....	5	.....	.....	.....	^a 360	284	62	467	110
Maine.....	20	.....	402	.....	402	46	12	.....	.....
Maryland.....	20	.....	321	.....	321	.....	.....	.....	.....
Mississippi.....	20	.....	47	.....	47	70	12	.....	.....
New Hampshire.....	20	.....	4	.....	4	.....	.....	.....	.....
New York.....	20	.....	649	.....	649	56	17	.....	.....
North Carolina.....	20, 100	66	243	.....	309	132	44	70	5
Pennsylvania.....	20	.....	629	.....	629	78	36	.....	.....
Tennessee.....	20, 100	142	.....	66	208	.....	.....	.....	.....
Virginia.....	50, 100	425	.....	35	460	96	21	.....	.....
West Virginia.....	50	.....	.....	957	957	97	29	.....	.....
		633	2,545	1,308	4,846	994	268	537	115

^a 360 square miles in Louisiana for publication on the scale of 1:24,000.

DETAILS OF WORK BY STATES.

Alabama.—The resurvey of the southeast quarter of the Bessemer 30-minute quadrangle, constituting the Columbiana quadrangle, in Shelby and Chilton counties, Ala., was completed by W. J. Lloyd, F. E. Hale, jr., C. K. Alexander, and F. L. Kendig, the total area mapped being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area William Oram ran 64 miles of primary levels and established 20 permanent bench marks.

Georgia.—The survey of the Milledgeville quadrangle, in Baldwin and Hancock counties, Ga., was completed by Oscar Jones, J. I. Gayetty, and L. K. Rushing, the total area mapped being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area F. W. Farnsworth ran 71 miles of primary levels and established 15 permanent bench marks.

Louisiana.—Work was continued under the allotment of \$20,000 made by the president of the board of commissioners of the fifth Louisiana levee district for the beginning of cooperative topographic surveys in the Tensas basin, \$6,700 being allotted by the United States Geological Survey. The survey of the Mound and Lake Providence quadrangles and parts of the Millikens Bend, Tallulah, Delta Bridge, Baxter Bayou, Millikin, Ashton Bridge, Vidalia, Lake Bruen, Sycamore Landing, Wilson Point, Delta Point, and Longwood quadrangles was completed, the total area mapped being 360 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. This work was done by W. N. Vance, Olinus Smith, H. W. Peabody, L. L. Lee, J. M. Rawls, R. A. Kiger, and E. V. Perkinson and is included in portions of Madison, East and West Carroll, Tensas, and Concordia parishes. For the control of these areas W. H. Gray and T. A. Green ran 284 miles of primary levels, in connection with which 62 permanent bench marks were set, and C. B. Kendall ran 467 miles of primary traverse and set 110 permanent marks.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted \$3,500 and the United States Geological Survey allotted a like sum. The survey of the Fryeburg quadrangle, in Cumberland and Oxford counties, and the Kezar Falls quadrangle, in Oxford, York, and Cumberland counties, Me., and Carroll County, N. H., was completed, and that of the Livermore quadrangle, in Androscoggin and Kennebec counties, was begun by Hersey Munroe, R. H. Reineck, and Charles Hartmann, jr., the total area mapped being 406 square miles, of which 4 square miles was in New Hampshire, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Fryeburg and

Livermore quadrangles E. B. Hillegass and Mr. Hartmann ran 46 miles of primary levels and established 12 permanent bench marks. For the control of the Buckfield, Bethel, and Livermore quadrangles, in Androscoggin, Oxford, and Kennebec counties, E. L. McNair occupied 10 triangulation stations and marked 7. Secondary control for the Waldoboro quadrangle, in Knox and Lincoln counties, was commenced by Ray Purington.

Maryland.—For the continuation of cooperative topographic surveys in Maryland the state geologist allotted \$3,000 and the Federal Survey \$4,000. The survey of the Taneytown and Emmitsburg quadrangles, in Carroll, Frederick, and Washington counties, Md., and Adams and Franklin counties, Pa., was completed and that of the Hagerstown quadrangle was commenced, the total area mapped being 402 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. Of this area 81 square miles lies in Pennsylvania, and the mapping of that portion was paid for from funds of that State. For the control of the Williamsport quadrangle, in Washington, Franklin, and Berkeley counties, G. T. Hawkins occupied 4 triangulation stations and marked 2. Secondary control on this quadrangle was continued by R. H. Reineck, Jay De Puy, P. W. McMillen, and Olinus Smith.

Mississippi.—The survey of the Iuka quadrangle, in Tishomingo County, Miss., was commenced by C. C. Gardner, the area mapped being 47 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. For the control of this quadrangle William Oram ran 70 miles of primary levels and established 12 permanent bench marks.

New York.—The state engineer and surveyor of New York allotted \$7,000 for the continuation of cooperative topographic surveys in the State and the Federal Survey allotted a like sum for the same purpose. The survey of the Delhi and Hartwick quadrangles, in Otsego and Delaware counties, and of the Antwerp and Hammond quadrangles, in Jefferson and St. Lawrence counties, was completed, and that of the Canton quadrangle, in St. Lawrence County, was commenced, the total area mapped being 649 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. This work was done by R. D. Cummin, C. E. Cooke, R. C. McKinney, W. H. S. Morey, J. R. Haswell, and J. M. Whitman. For the control of the Hartwick quadrangle A. F. McNair ran 56 miles of primary levels and established 17 permanent bench marks. Secondary control for the New Berlin quadrangle, in Chenango and Otsego counties, was completed by L. C. Fletcher.

North Carolina.—The state geologist of North Carolina allotted \$2,500 and the Federal Survey a like sum for the continuation of cooperative topographic surveys. A traverse survey of Cleveland

and Franklin counties, on the scale of 1:24,000, was completed by R. L. Harrison, M. W. Gray, and C. S. Wells. In addition to the cooperative work, the survey of the Lincolnton quadrangle, in Lincoln, Gaston, and Cleveland counties, was completed by Mr. Harrison, J. D. Forster, and J. B. Metcalfe, the area mapped being 243 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area G. T. Hawkins ran 70 miles of primary traverse and set 5 permanent marks, and F. P. Hoover ran 132 miles of primary levels and established 44 permanent bench marks. The portion of the Lincolnton quadrangle that lies in Cleveland County was mapped in cooperation with the state geologist.

Pennsylvania.—The Topographic and Geological Survey Commission of Pennsylvania allotted \$4,238 for the continuation of the cooperative topographic survey of the State and the United States Geological Survey allotted a like sum for the same purpose. The survey of the Hamburg quadrangle, in Berks, Lehigh, and Carbon counties, and the Franklin quadrangle, in Venango County, was completed, and that of the Hilliards quadrangle, in Butler and Venango counties, and the McCalls Ferry quadrangle, in Lancaster and York counties, was begun, the total area mapped being 548 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by R. C. McKinney, S. P. Floore, R. H. Reineck, R. A. Kiger, W. N. Vance, and Duncan Hannegan. For the control of the McCalls Ferry quadrangle C. H. Semper ran 78 miles of primary levels and established 36 permanent bench marks. (See also Maryland, above.)

Tennessee.—The resurvey of the Pikeville 30-minute quadrangle (Tenn.) was continued by Oscar Jones and J. I. Gayetty and resulted in the completion of the work on the Pikeville special quadrangle, in Bledsoe and Rhea counties, the area mapped being 66 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Tennessee-North Carolina.—J. I. Gayetty continued the revision of the Mount Guyot quadrangle, completing 4 square miles in Haywood County, N. C., and 14 square miles in Cocke and Sevier counties, Tenn., for republication on the scale of 1:125,000, with a contour interval of 100 feet.

Virginia.—For cooperative topographic surveys in Virginia the state geologist and the United States Geological Survey each allotted \$1,750. A traverse survey of the Virgilina district, in Halifax, Charlotte, and Mecklenburg counties, was completed by T. Foster Slaughter on the scale of 1:24,000. (See also West Virginia, below.)

Virginia-Tennessee-North Carolina.—The resurvey of the Abingdon quadrangle, in Smyth, Washington, Russell, and Tazewell counties, Va., Sullivan and Johnson counties, Tenn., and Ashe County, N. C.,

was completed by Duncan Hannegan, R. A. Kiger, H. W. Peabody, J. D. Forster, and C. C. Gardner, the total area mapped being 615 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area J. B. Metcalfe ran 96 miles of primary levels and established 21 permanent bench marks. Of the area mapped, 425 square miles lies in Virginia, 62 in North Carolina, and 128 in Tennessee.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the state geologist allotted \$15,000, which was met by a like sum from the Federal Survey. The resurvey of areas previously mapped resulted in the completion of the survey of the Madison and Peytona quadrangles, in Kanawha, Boone, Lincoln, and Logan counties, and the Pocahontas special and Gilbert quadrangles, in Mercer, McDowell, and Wyoming counties, W. Va., and Tazewell County, Va.; and in the completion of parts of the Welch and Pineville quadrangles, in McDowell and Wyoming counties, and the Matewan quadrangle, in Mingo and Logan counties, the total area mapped being 992 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by F. E. Matthes, E. P. Davis, S. E. Taylor, F. O. Leonard, E. I. Ireland, C. S. Wells, A. J. Dailey, C. C. Gardner, J. D. Forster, Fred McLaughlin, Oscar Jones, J. H. Wilson, J. B. Metcalfe, R. A. Ireland, R. H. Kilmer, and J. S. Nurnberger. Of the Pocahontas special quadrangle, 35 square miles lies in Virginia, and the mapping of this portion was paid for from federal funds. For the control of the Gilbert quadrangle T. A. Green and J. H. Wilson ran 56 miles of primary levels and established 16 permanent bench marks, and for the control of the Pineville quadrangle J. B. Metcalfe ran 41 miles of primary levels and established 13 permanent bench marks. For the control of the Warfield quadrangle, in Mingo and Wayne counties, R. C. Seitz occupied 4 triangulation stations and marked 2.

OFFICE WORK.

The drafting of the following sheets was completed: Columbiana, Ala.; Milledgeville, Ga.; Ellsworth, Me.; Fryeburg, Me.-N. H.; Neversink, Antwerp, Monticello, and Delhi, N. Y.; Lincolnton, N. C.; Emmitsburg and Taneytown, Md.-Pa.; Hamburg, Franklin, and Butler, Pa.; Mound and Lake Providence, La.; Pikeville special, Tenn.; Abingdon, Va.-N. C.-Tenn.; Pocahontas special, Va.-W. Va.; and Peytona, Madison, and Gilbert, W. Va.

Progress in the drafting of additional sheets was made as follows: Millikens Bend, Tallulah, and Delta Bridge, La., 80 per cent; Baxter Bayou, La., 66 per cent; Millikin, La., 50 per cent; Ashton Bridge, La., 35 per cent; Vidalia, La., 40 per cent; Lake Bruen, La., 30 per cent; Sycamore Landing, Wilson Point, and Delta Point, La., 20 per cent; Longwood, La., 5 per cent; Kezar Falls, Me., 50 per cent;

Hartwick, N. Y., 70 per cent; Hammond, N. Y., 65 per cent; Mount Guyot, Tenn., 60 per cent; Matewan, W. Va., 66 per cent; Welch, W. Va., 25 per cent; Williamson and Pineville, W. Va., 10 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Columbiana quadrangle (Ala.) were adjusted.

Primary level circuits in the Milledgeville quadrangle (Ga.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the area embraced by the Tensas drainage district (La.).

Primary level circuits run by the water-resources branch of the Survey along the east and west forks of Penobscot River, in Penobscot and Piscataquis counties, Me., and level circuits in the Bethel, Fryeburg, Kezar Falls, and Rumford quadrangles (Me.) were adjusted.

Latitudes, departures, and geographic positions in the Hagerstown quadrangle (Md.-Pa.) and geodetic positions and distances in the Williamsport quadrangle (Md.-W. Va.-Pa.) were computed.

Primary level circuits in the Iuka quadrangle (Miss.-Ala.-Tenn.) were adjusted.

Primary level circuits in the Bath and New Berlin quadrangles (N. Y.) were adjusted.

Precise level circuits in the Greensboro quadrangle (N. C.) and primary level circuits in the Lincolnton quadrangle (N. C.) were adjusted. Latitudes, departures, and geographic positions in the Lincolnton quadrangle were computed.

Primary level circuits in the Pikeville quadrangle (Tenn.) were adjusted.

Precise level circuits in the Covington quadrangle (Va.-W. Va.) and primary level circuits in the Abingdon quadrangle (Va.-N. C.-Tenn.) were adjusted.

Distances and positions in the Bald Knob, Eccles, Mullen, Pineville, and Wayne (W. Va.), Iaeger, Oceana, and Welch (Va.-W. Va.), and Gilbert and Matewan (W. Va.-Va.-Ky.) quadrangles were computed. Primary level circuits in the Iaeger, Pocahontas, and Welch (W. Va.-Va.) and Gilbert and Matewan (W. Va.-Va.-Ky.) quadrangles were adjusted.

Level lists covering the work done in the areas embraced by the following groups of States were assembled, computations and readjustments being made where necessary, and sent to the editor for publication as bulletins, with the exception of the last group, which is not yet completed: Alabama, Georgia, North Carolina, South Carolina, and Tennessee (Bulletin 441); Maine, New Hampshire, and Vermont (Bulletin 437); Delaware, District of Columbia, Maryland, and Virginia (Bulletin 434); and Arkansas, Louisiana, and Mississippi.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Illinois, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, and Ohio. The work comprised the survey of 20 quadrangles and 1 special area and the resurvey of 1 special area. In addition, 7 quadrangles, 1 special area, and 2 river projects were partly surveyed. The total new area mapped was 4,923 square miles—4,656 for publication on the scale of 1:62,500 and 267 for publication on the scale of 1:24,000. The area resurveyed was 14 square miles, for publication on the scale of 1:24,000. In connection with this work 1,673 miles of primary levels were run and 424 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Illinois, Kentucky, Minnesota, Missouri, and Ohio. The total area covered by this primary control was about 9,600 square miles, of which 6,800 were controlled by primary traverse, 1,469 miles being run and 132 permanent marks set. Seventy triangulation stations were occupied, 58 were marked, and 110 were intersected. The result of this work was to make control available in thirty-six 15-minute quadrangles and two river projects.

Topographic surveys in Central division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Levels.		Primary traverse.	
		1:62,500.		1:24,000.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.						
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>		<i>Miles.</i>		
Illinois.....	5, 20	1,034	102	.....	1,136	432	97	347	30
Iowa.....	20	182	.....	.....	182	90	20	.....	.....
Kansas.....	20	.....	.....	14	14	.....	.....	.....	.....
Kentucky.....	20	329	.....	.....	329	127	38	.....	.....
Michigan.....	20	274	165	.....	439	46	12	74	6
Minnesota.....	10	495	.....	.....	495	281	112	.....	.....
Missouri.....	10, 20	320	.....	.....	320	123	24	126	16
Ohio.....	20	2,022	.....	.....	2,022	574	121	922	80
		4,656	267	14	4,937	1,673	424	1,469	132	

DETAILS OF WORK BY STATES.

Illinois.—The governor of Illinois allotted \$17,500 for the continuation of cooperative topographic surveys in the State and the United States Geological Survey allotted \$12,500 for the same purpose. The survey of Apple River and the Illinois portion of the Galena quadrangle, in Jo Daviess County; the Hennepin and LaSalle quadrangles,

gles, in Bureau, Putnam, and LaSalle counties; and the New Athens quadrangle, in St. Clair and Monroe counties, was completed, the total area mapped being 1,034 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by J. H. Renshawe, Frank Tweedy, A. M. Walker, J. F. McBeth, R. T. Evans, B. A. Jenkins, J. De Puy, and G. R. Hoffman. The survey of the Embarrass River project, in Jasper, Crawford, and Lawrence counties, was begun by L. L. Lee and H. W. Peabody, and that of the Spoon River project, in Fulton County, by C. C. Gardner. The total area mapped was 102 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet, and for its control C. B. Kendall ran 293 miles of primary traverse and set 27 permanent marks, and Mr. Peabody and S. R. Archer ran 79 miles of primary levels and set 6 permanent bench marks. For the control of the Lincoln quadrangle, in Logan County, and the Canton, Havana, Macomb, Vermont, Colchester, Carthage, and Keokuk quadrangles, in Fulton, Hancock, McDonough, and Schuyler counties, E. M. Bandli ran 263 miles of primary levels and established 70 permanent bench marks. For the control of the Milan quadrangle, in Rock Island and Mercer counties, G. E. Heebink ran 90 miles of primary levels and established 21 permanent bench marks. For the control of the Kimswick and Waterloo quadrangles, in Monroe and St. Clair counties, J. R. Ellis ran 54 miles of primary traverse and set 3 permanent marks. Secondary control for the Lincoln quadrangle, in Logan County; the Bridgeport quadrangle, in Lawrence, Edwards, Richland, and Wabash counties; and the Crystal City and Renault quadrangles, in Monroe and Randolph counties, was begun by R. C. Seitz.

Iowa.—The state geologist of Iowa allotted \$1,750 for cooperative topographic surveys in Iowa and the Federal Survey allotted a like sum for the same purpose. The survey of the Knoxville quadrangle, in Marion County, and parts of the Pella quadrangle, in Marion and Mahaska counties, was completed by M. Hackett, the total area mapped being 182 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Pella quadrangle, G. E. Heebink ran 90 miles of primary levels, in connection with which 20 permanent bench marks were established.

Kansas.—The resurvey of the Fort Leavenworth quadrangle, in Jefferson, Atchison, and Leavenworth counties, Kans., was completed by J. G. Staack and E. L. Hain, the total area mapped being 14 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Kentucky.—For the continuation of cooperative topographic surveys within Kentucky, the state geologist allotted \$5,000 and the Federal Survey allotted a like sum. The survey of the Dawson

Springs quadrangle, in Hopkins, Christian, and Caldwell counties, was completed by C. L. Sadler and F. B. Barrett, and that of the Monticello quadrangle, in Wayne, Russell, and Pulaski counties, was commenced by J. F. McBeth, the total area mapped being 258 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Dawson Springs quadrangle S. R. Archer ran 68 miles of primary levels and established 21 permanent bench marks. For the control of the Laynesville and Inez quadrangles, in Pike, Floyd, Martin, Lawrence, and Johnson counties, and the Ewing, Soldier, Rectorville, Flemingsburg, and Mount Sterling quadrangles, in Fleming, Nicholas, Bath, Lewis, Rowan, Mason, and Montgomery counties, E. L. McNair and R. C. Seitz occupied 25 triangulation stations and marked 21. For the control of the Paintsville quadrangle, in Johnson, Lawrence, Morgan, and Magoffin counties, and the Inez and Louisa quadrangles, Mr. Archer ran 59 miles of primary levels and established 17 permanent bench marks. In addition to the cooperative work, the survey of the Kentucky portion of the Kosmosdale quadrangle, in Jefferson and Bullitt counties, was completed by C. D. S. Clarkson, the total area mapped being 71 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted \$2,000. The survey of the Mason quadrangle, in Ingham County, was completed, and that of the Lansing quadrangle, in Ingham and Eaton counties, was commenced by C. D. S. Clarkson, the total area mapped being 274 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Lansing quadrangle J. R. Ellis ran 74 miles of primary traverse and set 6 permanent marks and L. D. Townsend ran 46 miles of primary levels and set 12 permanent bench marks. In addition to the cooperative work, the survey of the Calumet special quadrangle, in Keweenaw and Houghton counties, was completed by A. M. Walker, the area mapped being 165 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Minnesota.—Work was continued in Minnesota under the allotment of \$10,000 made by the state drainage engineer, which was met by an allotment of \$5,000 by the Federal Survey. The survey of the Barrett and Herman quadrangles, in Grant, Douglas, and Stevens counties, was completed, and that of the Morris quadrangle, in the same counties, was commenced, the total area mapped being 495 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. This work was done by J. G. Staack, O. H. Nelson, E. L. Hain, W. B. Newhall, and C. S. Stewart. For the control of

this area, as well as for the Chokio, Ashby, and Wendell quadrangles, in the same counties, E. M. Douglas and C. S. Stewart occupied 45 triangulation stations, marked 37, and located 110 secondary points and three-point stations, and C. R. Beckler and G. E. Halstead ran 281 miles of primary levels and established 112 permanent bench marks, secondary control being run by R. C. Seitz.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the state geologist and the United States Geological Survey each allotted \$4,500. The survey of the Rolla quadrangle, in Phelps and Dent counties, was completed, and that of the Aurora special quadrangle, in Lawrence, Jasper, and Newton counties, was commenced by H. H. Hodgeson, F. W. Hughes, C. H. Swift, and Paul Robins, the total area mapped being 320 square miles, for publication on the scale of 1:62,500, with contour intervals of 20 and 10 feet, respectively. For the control of the Rolla quadrangle Mr. Swift ran 17 miles of primary levels and established 4 permanent bench marks, and for the control of the Aurora special area J. R. Ellis ran 126 miles of primary traverse and set 16 permanent marks and G. P. Featherstone ran 106 miles of primary levels and established 20 permanent bench marks.

Ohio.—The governor of Ohio allotted \$15,000 for the continuation of the cooperative topographic survey of the State and a like sum was set apart for the same purpose by the United States Geological Survey. The survey of the Delphos, Spencerville, Loramie, and Covington quadrangles, in Van Wert, Allen, Putnam, Auglaize, Shelby, Miami, and Darke counties, and the Cumberland, Caldwell, Summerfield, Uhrichsville, Canal Dover, and Antrim quadrangles, in Noble, Guernsey, Muskingum, Washington, Morgan, Monroe, Tuscarawas, Harrison, Carroll, Coshocton, Holmes, and Stark counties, was completed, and that of the Laurelville quadrangle, in Vinton, Hocking, Ross, and Pickaway counties, and the Carrollton quadrangle, in Carroll, Stark, and Columbiana counties, was commenced, the total area mapped being 2,022 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by J. H. Jennings, C. W. Goodlove, O. H. Nelson, M. Hackett, H. P. Hancock, L. R. Ebert, H. R. Sargent, J. A. Duck, Charles Hartmann, jr., Fred Graff, jr., and Horace Rayner. For the control of these areas 461 miles of primary levels were run and 95 permanent bench marks were established by C. L. Beckler, H. B. Hoel, N. E. Ballmer, and C. B. Mincks. For the control of the New Comerstown, Millersburg, and Navarre quadrangles, in Tuscarawas, Coshocton, Holmes, Wayne, and Stark counties, E. C. Bibbee and C. B. Mincks ran 60 miles of primary levels and established 10 permanent bench marks. For the control of the Jackson quadrangle, in Jackson and Vinton counties, C. B. Shaw and C. E. Mills ran 53 miles of primary

levels and established 16 permanent bench marks. For the control of the Lebanon, Waynesville, Xenia, Sabina, Jeffersonville, Greenfield, Roxabel, Bainbridge, Era, Piketon, Batavia, Hillsboro, Lynchburg, Circleville, and Millersburg quadrangles, in Warren, Green, Clinton, Fayette, Highland, Ross, Pike, Adams, Pickaway, Clermont, Brown, Fairfield, Holmes, and Wayne counties, and the Scioto, Oak Hill, Jackson, Greenup, Otway, Peebles, Portsmouth, West Union, Vanceburg, Manchester, Georgetown, and Bethel quadrangles, in Scioto, Jackson, Lawrence, Adams, Brown, and Clermont counties, J. R. Ellis ran 922 miles of primary traverse and established 80 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Knoxville, Iowa; Hennepin, Stockton, New Athens, La Salle, Ill.; Leavenworth special, Kans.-Mo.; Dawson Springs, Ky.; Mason and Calumet special, Mich.; Herman and Barrett, Minn.; Cumberland, Antrim, Oxford, Caldwell, Summerfield, Covington, Uhrichsville, Delphos, Spencerville, Loramie, and Cambridge, Ohio; Rolla, Mo.

Progress in the drafting of additional sheets was made as follows: Easton, Kans., 50 per cent; Monticello, Kosmosdale, and Prospect, Ky., 50 per cent; Pella, Iowa, 50 per cent; Galena, Ill.-Iowa, 80 per cent; DeQueen, Ark., 40 per cent; Aurora special, Mo., 50 per cent; Lansing, Mich., 25 per cent; Canal Dover, Ohio, 75 per cent.

The following sheets were completely adjusted: Carrolton, Ohio; Lansing, Mich.; and Bridgeport, Ill.

In the triangulation and computing section the following computations were made:

Latitudes, departures, and geographic positions were computed in the Eaton, Lincoln, Rosehill, Sparta, and Waterloo (Ill.) and Crystal City, Kimmswick, and Renault (Ill.-Mo.) quadrangles. Primary level circuits in the Canton, Havana, Lincoln, and Milan quadrangles (Ill.) were adjusted.

Latitudes, departures, and geographic positions in the Vincennes quadrangle (Ind.-Ill.) were computed.

Primary level circuits in the Easton quadrangle (Kans.) were adjusted.

Latitudes, departures, and geographic positions were computed in the Horsebranch, Morgantown, and Rochester quadrangles (Ky.). Geodetic positions and distances in the Ewing, Flemingsburg, Hazard, Laynesville, Mount Sterling, Soldier, and Williamson (Ky.), Inez, Warfield, and Whitesburg (Ky.-W. Va.), and Vanceburg (Ky.-Ohio) quadrangles were computed. Primary level circuits in the Dawson Springs and White Plains quadrangles (Ky.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Lansing quadrangle (Mich.).

Primary level circuits in the area embraced by the Red Lake district and in the Barrett, Herman, Morris, and Wendell quadrangles (Minn.) were adjusted. Geodetic distances and positions in the Ashby, Barrett, Chokio, Herman, Morris, and Wendell quadrangles (Minn.) were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Aurora special quadrangle (Mo.). Primary level circuits in the Rolla quadrangle (Mo.) were adjusted.

Latitudes, departures, and geographic positions were computed in the Bainbridge, Batavia, Blanchester, Chillicothe, Circleville, Era, Georgetown, Greenfield, Hillsboro, Jackson, Jeffersonville, Lebanon, Lynchburg, Mason, Mount Sterling, Oak Hill, Octa, Otway, Peebles, Piketon, Portsmouth, Roxabell, Sabina, Springfield, Waynesville, West Union, and Xenia (Ohio) and East Cincinnati, Greenup, and Scioto (Ohio-Ky.) quadrangles. Primary level circuits in the Brinkhaven, Canal Dover, Carrollton, Coshocton, Covington, Delphos, Loramie, Millersburg, New Comerstown, Spencerville, and Uhrichsville quadrangles (Ohio) were adjusted.

Primary level circuits in the Marathon, Waterloo, and Wausau quadrangles (Wis.) were adjusted.

Level lists covering the work done in Illinois (Bulletin 421) and Ohio (Bulletin 411) were published.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, New Mexico, North Dakota, Oklahoma, Texas, and Wyoming. This work comprised the survey of 16 quadrangles and 1 national forest and the revision of 2 quadrangles. In addition, 1 national forest was partly surveyed. The total new area mapped was 9,504 square miles—2,766 for publication on the scale of 1:250,000, 6,245 for publication on the scale of 1:125,000, and 493 for publication on the scale of 1:31,680. The area resurveyed was 921 square miles, for publication on the scale of 1:125,000. In connection with this work, 1,389 miles of primary levels were run and 422 permanent bench marks were established. Profile surveys of 2 rivers were also made, the distance traversed being 157 miles.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Colorado, New Mexico, and Texas. The total area covered by this primary control was about 4,800 square miles, of which 1,800 were controlled by primary traverse, 684 miles being run and 204 permanent marks set. Twenty-two triangulation stations were occu-

pied and 31 marked. The result of this work was to make control available in one 30-minute quadrangle, one national forest, and three river projects.

Topographic surveys in Rocky Mountain division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Levels.		Primary traverse.	
		1:250,000.		1:125,000.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.						
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>		<i>Miles.</i>		
Colorado.....	100	.....	1,221	.....	^a 1,221	180	44	.....	.....
Idaho.....	100	.....	86	.....	86	.....	.....	.....	.....
Montana.....	20, 100, 200	650	2,615	.....	^b 3,265	140	38	.....	.....
New Mexico.....	100, 200	885	848	.....	1,733	158	42	.....	.....
North Dakota.....	50	.....	741	.....	741	29	10	.....	.....
Oklahoma.....	50	.....	.....	921	921	.....	.....	.....	.....
Texas.....	5	.....	.....	.....	^c 493	612	224	684	204
Wyoming.....	100, 200	1,231	734	.....	1,965	270	64	.....	.....
	.....	2,766	6,245	921	10,425	1,389	422	684	204

^a 105 square miles mapped by Reclamation Service and published on scale of 1:125,000.

^b 944 square miles mapped by General Land Office and published on scale of 1:125,000.

^c 493 square miles in Texas for publication on scale of 1:31,680.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Eagle, Pitkin, Gunnison, and Chaffee counties, and the Montrose quadrangle, in Montrose, Gunnison, Ouray, and San Miguel counties, Colo., was completed by Gilbert Young, E. R. Bartlett, S. T. Penick, J. A. Burriss, W. M. Kent, and Stanley Hargen. The work on the Aspen 15-minute quadrangle, which is included in the Mount Jackson quadrangle, was revised by E. I. Ireland, and that on the Ouray 15-minute quadrangle, which is included in the Montrose quadrangle, was revised by E. R. Bartlett, as well as 105 square miles of Reclamation Service surveys. The total new area mapped was 1,116 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Montrose quadrangle Mr. Young occupied and marked 6 triangulation stations and for the control of both the Montrose and the Mount Jackson quadrangles F. J. McMaugh ran 180 miles of primary levels and established 44 permanent bench marks. A profile survey of Gunnison River, in Gunnison, Summit, and Grand counties, was made by Stanley Hargen, the total distance traversed being 120 miles.

Montana.—The survey of the Thibideau Lake and Zurich quadrangles, in Chouteau County, Mont., was completed by W. L. Miller, Basil Duke, and G. W. Lucas, the total area mapped being 769 square miles, the southern half of these quadrangles having been previously mapped for publication on the scale of 1:62,500. For the control of

these areas W. R. Winstead ran 93 miles of primary levels and established 25 permanent bench marks. The survey of the Cutbank and Blackfoot quadrangles, in Teton County, was completed by R. W. Berry, H. G. Parry, and Conrad Ecklund, the total area surveyed being 634 square miles. The remainder of these quadrangles, consisting of 944 square miles, is included within the Blackfeet Indian Reservation, already topographically mapped by the General Land Office, in connection with its subdivision surveys, the results of which were incorporated in the maps. All of the above work was for publication on the scale of 1:125,000, with a contour interval of 20 feet. For the control of the Cutbank quadrangle Mr. Parry ran 47 miles of primary levels and established 13 permanent bench marks. A profile survey of Judith River, in Fergus County, was made by C. A. Leonard, the total distance traversed being 37 miles.

Montana-Idaho.—The survey of the Missoula quadrangle, in the Lolo National Forest, in Missoula, Ravalli, Flathead, and Clearwater counties, Mont., and Idaho County, Idaho, was completed by Lee Morrison and W. J. Forster, the area mapped being 354 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet; 86 square miles of this area is in Idaho.

New Mexico.—The survey of the Mogollon quadrangle, in Grant and Socorro counties, N. Mex., was completed by A. B. Searle, A. P. Meade, jr., and R. S. Van Atta, the total area mapped being 848 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of parts of the Alamo National Forest, in Otero, Chaves, and Lincoln counties, was completed by V. H. Manning, J. H. Wilke, and K. W. Trimble, the area mapped being 885 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this forest R. B. Robertson occupied 16 triangulation stations and marked 25, and Mr. Trimble ran 158 miles of primary levels and established 42 permanent bench marks.

North Dakota.—The survey of the Ray quadrangle, in Williams and McKenzie counties, N. Dak., was completed by G. S. Smith, J. H. Van Wagenen, Conrad Ecklund, Chester Irvine, and C. A. Leonard, the total area mapped being 741 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area Messrs. Van Wagenen and Leonard ran 29 miles of primary levels and established 10 permanent bench marks.

Oklahoma.—The revision of the culture on the Sanbois and Sallisaw quadrangles, in Sequoyah, Haskell, Latimer, Pittsburg, Muskogee, and LeFlore counties, Okla., was completed by C. P. Janerson, D. B. Penick, and C. J. Ballinger, the total area revised being 921 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Texas.—The governor of Texas allotted \$20,000 for the initiation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum for the same purpose. Work was begun in the Brazos and Little River valleys, and also in the valley of the East Fork of Trinity River. The survey of the Howth, Courtney, and Navasota quadrangles, in Burleson, Brazos, Grimes, and Washington counties, the Buckholtz quadrangle, in Milan County, and the Rockwall and Barnesbridge quadrangles, in Rockwall, Kaufman, and Collin counties, was completed, the total area mapped being 493 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by Gilbert Young, T. F. Slaughter, S. P. Floore, A. P. Meade, B. A. Jenkins, Charles Hartmann, jr., Fred Graff, jr., R. T. Evans, and S. T. Penick. For the control of these areas F. J. McMaugh, P. W. McMillen, and E. L. McNair ran 684 miles of primary traverse and set 204 permanent marks; C. H. Semper, F. H. West, P. W. McMillen, F. Hurst, and E. L. McNair ran 612 miles of primary levels, in connection with which 224 permanent bench marks were established.

Wyoming.—The survey of the Sheridan quadrangle, in Sheridan and Johnson counties, Wyo., was completed by C. E. Cooke, F. H. West, C. A. Leonard, P. W. McMillen, and H. W. Parry, the area mapped being 734 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area F. H. West and C. F. Fisher ran 98 miles of primary levels and established 19 permanent bench marks.

Wyoming-Montana.—The survey of the Shoshone National Forest, in Bighorn County, Wyo., and Carbon, Sweet Grass, and Park counties, Mont., was completed by E. I. Ireland, the area mapped being 650 square miles in Montana and 1,231 square miles in Wyoming, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this forest Orr Meredith ran 172 miles of primary levels and established 45 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Montrose and Mount Jackson, Colo.; Zurich, Thibideau Lake, Blackfoot, Cutbank, and Bear Tooth National Forest, Mont.; Missoula, Mont.-Idaho; Ray, N. Dak.; Sanbois and Sallisaw, Okla.; Sheridan and Shoshone National Forest, Wyo.; Barnesbridge, Rockwall, Howth, Courtney, Navasota, and Buckholtz, Tex.

Progress in the drafting of additional sheets was made as follows: Mogollon, N. Mex., 95 per cent; Alamo National Forest, N. Mex., 75 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Carbondale, Glenwood Springs, Leadville, Montrose, Mount Jackson, San Cristobal, and Uncompahgre quadrangles (Colo.) were adjusted.

Primary level circuits in the Brocton, Browning, Cutbank, Nashua, Pacific Junction, Plentywood, Poplar, Scobey, Wolf Point, and Zurich (Mont.) and Missoula (Mont.-Idaho) quadrangles were adjusted.

Primary level circuits in the Magdalena quadrangle (N. Mex.) were adjusted and geodetic distances and positions in the Alamogordo quadrangle (N. Mex.) were computed.

Primary level circuits in the Ray quadrangle (N. Dak.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Brazos River, Little River, and Trinity River basins (Tex.).

Primary level circuits in the Shoshone National Forest (Wyo.) were adjusted.

Level lists were revised for the States of Colorado, Oklahoma, Montana, Wyoming, Texas, Utah, Nebraska, and South Dakota.

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming. This work comprised the survey of 27 quadrangles and 1 national park and the revision of 1 special area. In addition, 15 quadrangles, 3 national forests, and 2 special areas were partly surveyed. The total new area mapped was 15,476 square miles—9,433 for publication on the scale of 1:250,000, 4,793 for publication on the scale of 1:125,000, 1,215 for publication on the scale of 1:62,500, and 35 for publication on the scale of 1:45,000. The area resurveyed was 855 square miles—847 for publication on the scale of 1:31,680 and 8 for publication on the scale of 1:30,000. In connection with this work, 1,210 miles of primary levels were run and 284 permanent bench marks were established. In addition, profile surveys of 3 rivers were made, the distance traversed being 417 miles.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of California, Oregon, Nevada, and Washington. The total area covered by this primary control was about 6,500 square miles, of which 797 were controlled by primary traverse, 72 miles being run and 3 permanent marks set; 46 triangulation stations were occupied, 24 were marked, and 31 were intersected. The result of this work

was to make control available in eighteen 7½-minute quadrangles, two 30-minute quadrangles, one 1-degree quadrangle, and one national park.

Topographic surveys in Pacific division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:250,000 (new).	1:125,000 (new).	1:62,500 (new).		Distance run.	Bench marks.	Distance run.	Permanent marks.
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>		<i>Miles.</i>	
Arizona.....	100	45	45	45	45	79	20	.....	.....
California.....	5, 50, 100, 200	6, 432	1, 637	114	a 9, 030	466	112	.....	.....
Idaho.....	100, 200	565	1, 489	58	2, 112	186	30	.....	.....
Nevada.....	50, 100	1, 691	81	.....	b 1, 780	11	3	.....	.....
Oregon.....	7, 50, 100	.....	299	306	c 605	123	22	.....	.....
Utah.....	50, 100	.....	338	.....	c 373	88	23	.....	.....
Washington.....	25, 50, 200	745	746	737	2, 228	257	74	72	3
Wyoming.....	50, 100	.....	158	.....	158	.....	.....	.....	.....
		9, 433	4, 793	1, 215	16, 331	1, 210	284	72	3

a 847 square miles resurvey in California for publication on scale of 1:31,680.

b 8 square miles resurvey in Nevada for publication on scale of 1:30,000.

c 35 square miles in Utah for publication on scale of 1:45,000.

DETAILS OF WORK BY STATES.

Arizona.—The survey of the Winkleman quadrangle, in Pinal County, Ariz., was commenced by J. E. Blackburn and S. G. Lunde, the total area mapped being 45 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle L. F. Biggs ran 79 miles of primary levels and established 20 permanent bench marks.

California.—The Department of Engineering of California allotted \$14,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of the Marysville and Smartsville quadrangles, in Yuba, Sutter, Colusa, Butte, Glenn, and Tehama counties, was continued and resulted in the mapping of the Browns Valley, Yuba City, Grimes, Butte City, Reeds, Honcut, Lomo, Sutter City, Gridley, Meridian, French Crossing, Palermo, Butte Creek, and Biggs quadrangles and parts of the Smartsville, Nelson, Oroville, Eddys, Marysville Buttes, and Pennington quadrangles, the total area mapped being 847 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The mapping of the Salinas quadrangle, in Monterey County, was also commenced, the area completed being 114 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by W. H. Griffin, W. B. Lewis, J. P. Harrison, T. H. Moncure, A. T. Fowler, Robert Muldrow, M. A. Knock, Bayard Knock, W. H. Barringer, A. J. Ogle, J. L. Lewis,

and E. R. Bartlett. For the control of the above-named areas and the Soledad quadrangle 36 triangulation stations were occupied, 16 were marked, and 26 points were intersected by C. F. Urquhart. For the control of the Sacramento Valley areas mentioned above and also for the Dry Creek, Newhard, Dayton, Durham, Clear Creek, Keefers, and Nord quadrangles, as well as for the Soledad quadrangle, L. F. Biggs ran 174 miles of primary levels and established 39 permanent bench marks. In addition to the cooperative work in California, the survey of the Mount Goddard quadrangle, which lies partly in the Sierra National Forest, in Fresno and Mono counties, was completed by G. R. Davis, and that of the Mariposa quadrangle, in Mariposa, Fresno, and Madera counties, was continued by C. H. Birdseye, T. P. Pendleton, and A. J. Ogle, the total area mapped being 622 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Big Bar quadrangle and adjacent territory, in the Trinity National Forest, in Trinity County, was continued by J. P. Harrison, the area mapped being 497 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the oil belt, in Stanislaus and San Joaquin counties, and that of the McKittrick quadrangle, in Kern, San Luis Obispo, and Santa Barbara counties, was completed by R. M. La Follette and T. P. Pendleton, the total area mapped being 423 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For additional control of the Mariposa quadrangle 17 miles of primary levels were run by Sidney Birdseye, and 3 vertical-angle bench marks were established on the Mount Goddard quadrangle by G. R. Davis.

California-Nevada.—The survey of the Bridgeport quadrangle, which lies partly in the Sierra National Forest, in Mono and Tuolumne counties, Cal., and Esmeralda County, Nev., was completed by G. R. Davis, Pearson Chapman, and C. M. Weston, the area mapped being 673 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 81 square miles lies in Nevada. For the control of this area Mr. Weston ran 38 miles of primary levels and established 10 permanent bench marks. Five permanent bench marks were also established by vertical angulation. The survey of the Hawthorne quadrangle, in Mono County, Cal., and Esmeralda and Nye counties, Nev., was completed by C. G. Anderson, and that of the Ivanpah quadrangle, in San Bernardino County, Cal., and Lincoln, Inyo, and Clark counties, Nev., was completed by J. E. Blackburn and S. G. Lunde, the total area mapped being 7,626 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. Of this area 1,691 square miles lies in Nevada. For the control of the Ivanpah quadrangle C. F. Urquhart occupied 8 triangulation stations, marked 7, and intersected 5, and L. F. Biggs ran

237 miles of primary levels, in connection with which 55 permanent bench marks were established. For the control of the Hawthorne quadrangle C. M. Weston ran 11 miles of primary levels and established 3 permanent bench marks.

Idaho.—The survey of the Meadows quadrangle, which lies partly in the Weiser National Forest, in Washington and Boise counties, Idaho, was completed by A. O. Burkland and E. A. Lincoln, and that of the Cataldo quadrangle, in the Cœur d'Alene National Forest, in Shoshone, Bonner, and Kootenai counties, was completed by W. O. Tufts, J. W. Muller, and O. G. Taylor, the total area mapped being 766 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of portions of the Kaniksu and Pend Oreille national forests, in Bonner County, was continued by Messrs. Tufts, Muller, and Taylor, the area mapped being 565 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Wayan quadrangle, which lies partly in the Caribou National Forest, in Bannock and Bear Lake counties, was begun by Albert Pike and W. O. Tufts, the area mapped being 33 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. (See also p. 79.)

Idaho-Wyoming.—The survey of the Montpelier quadrangle, which lies partly within the Bear River and Caribou national forests, in Bear Lake and Bannock counties, Idaho, and Uinta County, Wyo., was completed by A. E. Murlin, Albert Pike, and M. A. Knock, the total area mapped being 781 square miles, of which 91 square miles is in Wyoming, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area L. F. Biggs ran 186 miles of primary levels and set 30 permanent bench marks.

Nevada.—The revision of the culture of the Ely special quadrangle, in White Pine County, Nev., was completed by W. O. Tufts, the area revised being 8 square miles, for republication on the scale of 1:30,000, with a contour interval of 50 feet.

Oregon.—The state engineer of Oregon allotted \$2,500 for the continuation of cooperative topographic surveys in that State, which was met by a like sum for the same purpose from the United States Geological Survey. The survey of the Willamette Valley was continued and resulted in the completion of the mapping of parts of the Halsey and Elmira quadrangles, in Lane, Benton, and Linn counties, the total area mapped being 171 square miles, for publication on the scale of 1:62,500, with a contour interval of 7 feet. This work was done by C. A. Clunet, Robert Muldrow, and W. B. Lewis. For the control of these areas L. F. Biggs ran 123 miles of primary levels and established 22 permanent bench marks. In addition to the cooperative work, the survey of the Crater Lake National Park, in Klamath County, was completed by Pearson Chapman, the area mapped being 135 square miles, for publication on the scale of 1:62,500, with a con-

tour interval of 50 feet. For the control of this park Mr. Chapman occupied 2 triangulation stations and marked 1. A profile survey of Deschutes and John Day rivers, in Wheeler, Wasco, and Crook counties, was made by J. L. Lewis and E. L. Sellon, the length of traverse being 240 miles.

Oregon-Washington.—The survey of the Mount Hood special quadrangle, which lies partly in the Bull Run National Forest, in Multnomah, Clackamas, and Wasco counties, Oreg., and Clarke and Skamania counties, Wash., was continued by R. M. La Follette, E. L. Sellon, and E. R. Johnston, the area mapped being 299 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The entire area mapped was in Oregon.

Utah-Wyoming.—The survey of the Randolph quadrangle, which lies partly in the Bear River National Forest, in Rich and Cache counties, Utah, and Uinta County, Wyo., was continued by Albert Pike, the area mapped being 405 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 67 square miles lies in Wyoming. For the control of this quadrangle L. F. Biggs ran 88 miles of primary levels and established 23 permanent bench marks.

Utah.—The Frisco special quadrangle, in Beaver County, Utah, was enlarged by the mapping of 35 square miles by W. M. Beaman, for publication on the scale of 1:45,000, with a contour interval of 50 feet. A profile survey of Green River, in Uinta and Emery counties, was made by Stanley Hargen, the area traversed being 177 miles.

Washington.—Under the allotment of \$10,000 each made by the Board of Geological Survey of Washington and the United States Geological Survey, topographic mapping was continued, and resulted in the completion of the survey of the Quincy, Red Rock, and Winchester quadrangles and part of the Beverly quadrangle, in Grant, Adams, and Douglas counties, for publication on the scale of 1:62,500, with a contour interval of 25 feet; also the completion of the Mount Vernon quadrangle, in Snohomish and Skagit counties, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The total area mapped was 1,425 square miles, the work being done by J. R. Eakin, W. B. Kern, G. V. Brown, W. A. Gelbach, C. F. Eberly, H. L. McDonald, A. O. Burkland, and R. M. La Follette. For the control of these areas W. A. Gelbach and C. H. Semper ran 257 miles of primary levels and established 74 permanent bench marks, and C. A. Clunet ran 72 miles of primary traverse and set 3 permanent bench marks. In addition to the cooperative work, the survey of the Washington National Forest, in Skagit and Whatcom counties, was continued by J. E. Blackburn, the area mapped being 745 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet.

IDAHO-WASHINGTON BOUNDARY LINE.

Work on the Idaho-Washington boundary line was continued under the appropriation of \$25,000 made by Congress in 1908 for its survey, the work having been placed in charge of the United States Geological Survey by the Secretary of the Interior. The survey was completed by C. L. Nelson and S. G. Lunde, 42 miles of the line being surveyed and marked by 45 iron monuments 6 feet long, 4 inches in diameter, filled with concrete, and by 2 granite monuments 6 feet long and 10 inches square. In addition to these, 55 iron monuments 4 feet long and 3 inches in diameter, filled with concrete, were placed at the closing corners of the public-land surveys. In connection with this work, the topography of an area one-half mile in width on each side of the line was mapped by Bayard Knock and Mr. Nelson, this area comprising 116 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Bridgeport, Cal.-Nev.; Mount Goddard, Reeds, Yuba City, Sutter City, Lomo, Arcade, Antelope, Brighton, Mills, Browns Valley, Grimes, Meridian, McKittrick, and Smartsville special, Cal.; Montpelier, Cataldo, and Meadows, Idaho; Crater Lake, Harrisburg, and Rowland, Oreg.; Frisco special, Utah; Mount Vernon, Winchester, Red Rock, and Quincy, Wash.; Idaho-Washington boundary line; Hawthorne, Nev.

Progress in the drafting of additional sheets was made as follows: Eddys, Cal., 75 per cent; Mariposa, Gridley, Honcut, French Crossing, and Salinas, Cal., 66 per cent; Marysville Buttes, Cal., 50 per cent; Big Bar, Cal., 75 per cent; Bangor and Pennington, Cal., 25 per cent; Tracy (oil belt), Cal., 25 per cent; Smartsville, Cal., 40 per cent; Kaniksu and Pend Oreille national forests, Idaho, 35 per cent; Mount Hood special, Oreg., 66 per cent; Elmira and Smithfield, Oreg., 66 per cent; Diamond Hill School, Oreg., 15 per cent; Ivanpah, Cal.-Nev., 50 per cent; Randolph, Utah, 50 per cent; Beverly and Mount Baker, Wash., 50 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Winkleman quadrangle (Ariz.) were adjusted.

Precise level circuits in the Antioch and Rio Vista quadrangles and primary level circuits in the Bangor, Biggs, Butte City, Grimes, Nelson, Nord, and Oroville (Cal.) and Bridgeport and Ivanpah (Cal.-Nev.) quadrangles were adjusted. Geodetic distances and positions in the Biggs, Butte City, Grimes, Hollister, Metz, Nelson, Nord,

Oroville, Salinas, San Lucas, Soledad, and Yuba City (Cal.) and Ivanpah (Cal.-Nev.) quadrangles were computed.

Primary level circuits in the Pocatello and Soda Springs (Idaho) and Montpelier (Idaho-Wyo.) quadrangles were adjusted.

Primary level circuits in the Hawthorne and Ivanpah quadrangles (Nev.-Cal.) were adjusted.

Primary level circuits in the Elmira, Eugene, Halsey, Monroe, and Smithfield quadrangles (Oreg.) were adjusted and geodetic distances and positions were computed in the Albany, Brownsville, Corvallis, Elmira, Halsey, and Monroe quadrangles (Oreg.).

Geodetic distances and positions in the Randolph quadrangle (Utah-Wyo.) were computed.

Primary level circuits in the Bellingham, Beverly, Crater, Ephrata, Kittitas, Malaga, Mount Vernon, Quincy, Red Rock, and Stillaguamish quadrangles (Wash.) were adjusted and latitudes, departures, and geographic positions in the Mount Vernon quadrangle were computed.

Level lists were revised for Arizona, California, and Nevada.

Level lists covering the work done in the State of Washington were assembled, computations and readjustments being made where necessary, preparatory to transmission to the editor for publication as a bulletin.

COMPILATION OF SPECIAL NATIONAL FOREST MAPS.

The work of preparing the folios of the atlas of the national forests was continued under the direction of A. C. Roberts.

The maps were made on the scale of 1 mile to the inch and published with 6 townships to the page. All the work of the United States Geological Survey, the General Land Office, and the Hayden, Transcontinental, and Wheeler surveys, as well as work done by the Forest Service, was incorporated in these maps. The status of all lands inside the forests was furnished by the Forest Service. Where the timber classification was considered up to date, it was shown in color on the maps.

Folios were finished during the fiscal year 1909-10 for the following forests: Datil, Stanislaus, Sierra, Tahoe, Sevier, Santa Barbara, Fish Lake, Powell, Ozark, Inyo, Uinta, Cleveland, Tonto, Alamo, Gila, Prescott, Crook, Modoc, Oregon, Toiyabe, Idaho, Nez Perce, Colville, Ashley, Monterey, Nebo, Deerlodge, Payette, Weiser, Pend Oreille, Cascade, San Luis, Umpqua, Sequoia, Challis, and Kootenai.

The work on the Ocala, Beaverhead, Cabinet, and Deschutes folios was partly completed and they were turned over to the Forest Service by order of the Director.

The folios have been lithographed and delivered to the Forest Service with the exception of the Inyo, Sequoia, and Umpqua, which have been sent to the lithographer.

The Mono and Inyo folios were completed in January, but were partly recompiled from new data finished last season.

The Sierra folio is now undergoing changes from the new data and is practically finished. Seven sheets have been recompiled and sent to the lithographer. The Trinity folio is having the new Big Bar quadrangle added.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

As in the past, the field time of the inspectors was divided between regular topographic work and inspection duty. J. H. Renshawe was engaged in the early part of the season in inspection work in the Central and Rocky Mountain divisions, and in the latter part of the season in regular topographic sketching on the Hennepin quadrangle (Ill.). After the completion of the addition to the Frisco special quadrangle (Utah) and its inking in the field, W. M. Beaman spent the balance of the season in inspection work in the Rocky Mountain and Pacific divisions. F. E. Matthes divided his time in the field between topographic work on the Pocahontas special quadrangle (Va.-W. Va.), the instruction of new field men in topographic methods applicable to West Virginia, and inspection in the Atlantic division.

During the office season careful attention was given by Messrs. Renshawe and Beaman to the final drawing of the topographic sheets, with an aim to insuring uniformity of treatment and eliminating personal mannerisms and errors of expression; also to the examination of the finished sheets preparatory to transmission for engraving or photolithographing; to the examination of woodland and land-classification sheets and correction material for the office record; and to the proper transmission of all field-map material within the office. Mr. Matthes's time was devoted to the inking of his field work, to the completion of the report on the Yosemite Valley, and to the revision of the book of instructions for the topographic branch.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

The minor repairs to instruments were made as heretofore in the Survey shop, much less repair work than usual being given to outside contractors. Two new traverse transits, 102 box compasses of a new style, 6 Beaman alidades, and 4 micrometer alidades were the principal additions to the stock. After considerable investigation, it was decided to adopt an alloy of aluminum bronze (Cu 90 per cent, Al 10 per cent) for bench-mark tablets and for the caps of bench-mark posts.

The addition to the topographic records consisted of 203 triangulation and traverse books, 1,961 level books, 154 vertical-angle or stadia books, and 152 plane-table sheets, all of which were numbered and catalogued.

MAP OF THE UNITED STATES.

The initial point (meridian of Greenwich) in the numbering of the sheets of the 1:1,000,000 scale map adopted by this office was changed to the meridian of 180° from Greenwich by the International Geographic Society at a meeting held in London in 1909. The sheets are now numbered from 1 to 60 and proceed eastward around the world.

Of the work begun last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, the coastal-plain area of North Carolina (sheets I and J 17 and 18), the State of Illinois (portions of sheets J and K 15 and 16), the special Wisconsin area (sheet K 16, latitude 42° to 44°, longitude 87° 30' to 90°, scale 1:250,000), and portions of New Hampshire, Massachusetts, Connecticut, and Rhode Island (sheet K 19) were completed, and the compilation and inking of sheet K 18 was completed, as well as the lettering of the Vermont, New Hampshire, Massachusetts, and Connecticut portions and 18 per cent of the Pennsylvania portion. The submarine contours were compiled for the Florida sheets.

New work included the following:

- Sheet L 19, Vermont portion, compiled, inked, and lettered.
- Sheet L 18, New York and Vermont portion, compiled, inked, and lettered.
- Sheet J 18, Pennsylvania portion, compiled and inked.
- Sheet L 16, Michigan portion, compiled, inked, and lettered; Wisconsin portion, compiled and inked; Canadian portion, compiled and inked.
- Sheet L 17, Michigan portion, compiled, inked, and lettered.
- Sheet M 16 (Canada), compiled and inked to the forty-ninth parallel.
- Sheet M 15, Minnesota portion, compiled and inked; Canadian portion to the forty-ninth parallel, compiled and inked.
- Sheet L 15, Wisconsin portion, compiled and inked; Minnesota portion, compiled and inked as far west as the ninety-fifth meridian.
- Sheet K 15, Wisconsin portion, compiled and inked.
- Sheet K 17, New York, Pennsylvania, and West Virginia portions, compiled and inked; Ohio portion, compiled and 60 per cent inked; Michigan portion, compiled, inked, and lettered.
- Sheet J 17, Ohio portion, compiled and 30 per cent inked; Pennsylvania portion, compiled and inked.
- Sheet K 16, Michigan portion, compiled, inked, and lettered; Indiana portion, compiled and inked; Ohio portion, compiled; Wisconsin portion, transferred from a reduction of the area on the special scale, inked, and lettered.
- Sheet J 16, Indiana portion, compiled and inked; Ohio portion, compiled and 50 per cent inked.
- Sheet H 14, a special area extending about 1½° north and 2° west of Austin, Tex., compiled, inked, and lettered.

WATER-RESOURCES BRANCH.**INVESTIGATION OF POWER SITES.**

The character and usefulness of the work performed by the water-resources branch have been discussed in previous reports. The most prominent feature of the last year's work is the investigation of power sites on the public lands. Nearly 1,500,000 acres have been designated for temporary withdrawal from entry. This work was performed so that the power sites now remaining in federal ownership might be retained pending suitable consideration of the matter by Congress. The withdrawal act, approved June 25, 1910, provides that—

The President may, at any time in his discretion, temporarily withdraw from settlement, location, sale, or entry any of the public lands of the United States, including the District of Alaska, and reserve the same for water-power sites, irrigation, classification of lands, or other public purposes to be specified in the orders of withdrawals, and such withdrawals or reservations shall remain in force until revoked by him or by an act of Congress.

The lands withdrawn for power sites are located in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. A statement of the acreage represented in each State is given on page 48. Although the withdrawals were made through the agency of the Survey's land-classification board, nearly all the designations of land suitable for the purpose were made by the water-resources branch. These designations were based largely on information collected by the Survey during the last thirty years. Some of it was specific, actual power sites being located and defined. The greater proportion of the withdrawals were, however, based on general information collected incidentally during the progress of previous investigations. Such information usually consisted of a knowledge of the slope and flow of a river, derived from specific surveys made by the topographic branch, or from river profiles and gagings previously made by the water-resources branch. Data for Columbia River were furnished by the Corps of Engineers, War Department. Specific information was also obtained from published and unpublished notes and maps made in the course of geologic investigations. One of the most interesting incidental features of the water-power work was the demonstration of the utility of the investigations made by the Survey for other purposes during past years, affording evidence of the wide scope and comprehensiveness of the Survey's previous work.

Since the adoption of the power-site withdrawal policy it has been the practice of the Commissioner of the General Land Office to refer all right-of-way applications to the Geological Survey for an opinion

as to whether the granting of them would "interfere with the use of any valuable power site desired to be withdrawn by the Geological Survey pending contemplated legislation." These applications have brought to the Survey's attention many sites that would otherwise have been unrecognized until a later date, when the property would have been examined in the regular course of work.

Field examination is required to confirm or to disprove the assumptions made with reference to the power-site lands withdrawn on general information, as above described. There are certain tracts that on critical investigation will prove not to be adapted for power purposes. Indeed, such examinations as have already been made have resulted in the restoration to entry of many tracts. Some rivers are known to have a certain slope in a given distance, indicating that power development may be possible along that reach, and all the public land bordering that reach is withdrawn from entry. Subsequent field examination, however, may show that the greater part of that slope occurs within only a short distance along the river and that the remainder, or the greater part of it, is valueless for the development of power. Again, it may be found that although a certain withdrawn reach of river has a decided fall and therefore is apparently well adapted for power development, the water supply is not sufficient to afford a good power. These and other conditions may affect the value of lands withdrawn for power sites on general information, and therefore emphasize the necessity for field examinations and surveys. It is the purpose to push this work so far as may be possible with the appropriations available during the coming year and to restore to entry all lands not found useful for power-site development.

The previous work of the Survey in the measurement of stream flow in the West has been and will be of the highest importance in determining many of the necessary facts. Much remains to be done in the gaging of stream flow in rivers on which power sites have been withdrawn. The logical work for the immediate future relative to these sites must therefore be, first, the critical examination of these lands with reference to their specific suitability for power development, and second, the observation of stream flow to determine how much power may be made available. There is no present basis on which to estimate the amount of power that may be developed at many of these sites. Gaging stations will be established on all unmeasured rivers along which lands have been withdrawn.

It has been found necessary to determine what shall be considered a power site, suitable for withdrawal, and how much land shall be withdrawn to protect it. To do this the necessities in the case must

first be defined and then interpreted according to what may be considered a reasonable federal policy. The subject is broad and provocative of many diverse opinions. It is therefore necessary to adopt standards which seem to cover in the widest degree the important points involved.

A reform is usually the result of abuses, present and past. The water-power land reform is no exception to the rule. Among the most widely discussed abuses in this country at present are those which many persons apprehend as a result of the centralization of water powers in common ownership covering wide fields and dominating a great market. It would be strange indeed if this great industry should not, in common with all others of importance, gravitate toward the modern industrial idea of centralization. All the industrial economies resulting from centralization apply to this as to other industries. It can hardly be expected that the familiar abuses will not creep in unless they are restrained. There is, however, a physical difference which sets the water-power industry apart from many of the others. To be of the highest utility water power must meet the market's demands. It must instantaneously adapt itself to market fluctuations. These fluctuations occur, not from season to season, but from hour to hour. A water power that may be sufficient to meet all demands at noon may be quite insufficient to meet the demands of a few hours later. At another place the period of maximum load may be the reverse, or at a quite different time. The capacity of a single water power can not, except under unusual conditions, be fully adapted to a general market, but the capacity of many united water powers can easily be so distributed as to cover varying necessities. In this way the shortage at one place at a certain time can be compensated by the surplus at another place at that time. The situation is analogous to that of the car-dispatching system of a railroad. It would not be good management to have each division of a railroad equipped with rolling stock sufficient to respond to the maximum demand of that division. Cars are shifted from one division to another according to local demand. So it is with a power system. If each unit of a power system must respond to the maximum demands in the locality of that unit, then it is plain that there will be a large waste of resources represented by idle machinery during the hours of minimum use in each locality. Needless to say, the cost of power to the ultimate consumer would have to be increased in like proportion.

There is then a physical necessity for consolidation in water power. To prevent abuses, it is not necessary to prevent consolidation. Abuses may be constructively restrained. How shall this be done in the case of powers on the public lands?

The only feasible way at present is to withdraw the power sites from general entry, to put them in a special class, under either national or state control, and to stipulate that when they are developed they shall be operated subject to reasonable regulations. Such a plan provides for those sites which are to be developed in the near future, as well as those for which there may be no demand in a century. The developments in the future will be quite as important as those of the present, yet while the sites are awaiting development they should be relieved from all property entanglements and be subject to regulation when the market demands them. None should be taken up for speculation under another guise. None should pass from government ownership except for immediate and purposeful use. It is plain that the only way by which the Federal Government can, under present statutes, properly conserve the water powers of the public domain is by withdrawing them from entry pending the enactment of appropriate legislation.

Many lands on which power may be developed are nevertheless more useful for irrigation. The present policy of the department is based on the "higher use." Any tract of land that has a higher use for irrigation or any other industrial purpose than for power should be devoted to that use. It is equally true that in many places, though irrigation may be the higher use, the power use can also be preserved.

CAREY ACT SEGREGATIONS.

The water-resources branch has been obliged to consider during the year a large number of proposed Carey Act segregations for the purpose of determining whether the contemplated water supply is sufficient to properly irrigate the acreage applied for. This is a most important matter. Although the Government does not by virtue of the Carey Act guarantee the success of any project, the fact that it is supposed to look well into the conditions controlling any of these projects and to grant the lands necessary only after it has satisfied itself under the law and under the rules of the department that the proposition is a worthy one places an implied obligation on the department to reduce the area allowed for segregation to that which can safely be served by the available water supply. The general impression has been spread widely by those interested in the promotion of such projects that they must be safe because the Government has so guaranteed, and as a result many settlers have invested in these projects with that erroneous idea. Many applications for Carey Act grants have been referred to the Geological Survey, and examinations have been made by the aid of stream-flow records that have been collected during previous years. As a result certain

projects have been shown to be deficient in water supply. Thus protection is accorded to the prospective settler on these tracts.

AUTHORITY FOR INVESTIGATIONS.

The water-resources investigations of the year were made under the authority of the following clause in the sundry civil act:

For gauging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and the preparation of reports upon the best methods of utilizing the water resources, one hundred thousand dollars.

This amount, which has been appropriated annually for several years, is not sufficient to perform the required work in all parts of the United States. It is therefore necessary to select each year the areas in which the work is to be done. This selection is based, first, on the relative importance of the investigations in the various parts of the country with especial reference to the needs for information concerning the amount and character of both surface and underground waters; second, on the amount of work previously performed in the several parts of the country, those areas that have had the least attention in the past receiving preference.

ALLOTMENTS.

The allotments from the appropriation for the last fiscal year are as follows:

Allotments from appropriation for stream gaging, etc.

Administrative salaries of the Survey.....	\$5,271
Clerical assistance and supervision of work.....	9,980
Purchase of supplies and equipment.....	500
Computations, reports, and technical studies.....	10,080
Stream gagings in—	
New England and New York.....	5,750
New Jersey, Pennsylvania, and Maryland.....	500
Virginia, South Carolina, North Carolina, Georgia, Alabama, Mississippi, and Tennessee.....	6,000
West Virginia, Kentucky, Ohio, Indiana, and Illinois.....	5,500
Southern Wyoming, Colorado, and New Mexico.....	7,500
Northern Wyoming, Montana, and North Dakota.....	4,500
Idaho, Utah, and Nevada.....	5,500
Washington and Oregon.....	7,500
California.....	4,500
Field inspection.....	4,000
Ground-water investigations.....	13,810
Investigations of quality of water.....	7,550
Débris investigations.....	2,000
Contingent.....	59
	100,000

COOPERATION.

STATES.

Cooperation with several States has been maintained, as described in previous reports, the States and the amounts allotted by them being given in the following table:

Amounts allotted by States for cooperative hydrographic work.

California.....	\$9,000	New York.....	\$5,000
Idaho.....	2,000	Oregon.....	2,500
Illinois.....	2,000	Utah.....	2,000
Maine.....	3,300	Vermont.....	1,000
Massachusetts.....	1,050	Washington.....	5,000
Minnesota.....	17,500		
New Mexico.....	2,500		52,850

The work performed under these agreements is outlined in the following paragraphs:

California: The determination of the flow of rivers, together with the survey of reservoir, dam, and canal sites for the purposes of development of irrigation, water power, and municipal supply; also the study of underground waters.

Idaho: The determination of the amount of water flowing in rivers.

Illinois: The determination of stream flow, especially low waters and flood heights, for use as a basis for the drainage of swamp and overflow lands.

Maine: The determination of stream flow and the survey of river profiles and reservoir sites.

Minnesota: The determination of stream flow and the survey of river profiles and reservoir sites.

New Mexico: The determination of stream flow for irrigation and water-power purposes.

New York: There are two cooperative agreements in force in this State—one with the state engineer, in which \$1,500 is expended by each party for the determination of stream flow at points designated by the state engineer, and the second with the state water supply commission, amounting to \$3,500 by each party, the money being devoted to the examination of stream flow for storage and water-power purposes.

Oregon: The determination of stream flow for irrigation and water-power purposes.

Utah: The determination of stream flow for irrigation purposes.

Vermont: The determination of stream flow and the survey of river profiles.

Washington: The determination of stream flow for irrigation and water-power purposes and the survey of river profiles and reservoir sites.

RECLAMATION SERVICE.

Cooperation has also been maintained with the United States Reclamation Service. The rivers supplying water to the reclamation projects under construction by that bureau must necessarily be investigated to determine the amounts of water that they will yield for irrigation. This work, being specifically applied to these projects, becomes a proper charge thereon, and the Reclamation Service has deemed it of advantage to utilize the Survey engineers for this

work, paying to the Survey, through transfer of funds in the Treasury Department, the actual cost of the investigations. During the last year 152 stations have been maintained under this cooperative agreement.

OFFICE OF INDIAN AFFAIRS.

Cooperation has also been effected with the Office of Indian Affairs in connection with ground-water investigations. At the request of the Commissioner of Indian Affairs a study of ground-water supplies was undertaken in the Moki and Navajo reservations of Arizona, New Mexico, and southern Utah, \$3,000 being set aside for this purpose by the Indian Office. A report, with recommendations, based on this study and intended for the guidance of representatives of the Indian Office who are responsible for water development in this region, has been transmitted to the Commissioner.

Stream-flow investigations on Indian reservations have also been placed in charge of the Geological Survey by the Commissioner of Indian Affairs. The work during the last year has been performed on the following reservations:

Indian reservations on which investigations of stream flow have been made.

	Number of stations.		Number of stations.
Montana:		Wyoming: Shoshone.....	15
Blackfeet.....	7	Idaho: Fort Hall.....	3
Fort Belknap	1	Washington: Yakima.....	12
Fort Peck.....	4	Oregon:	
Crow.....	1	Warm Springs.....	1
		Klamath.....	2

The cost of this work has been paid by transfer in the United States Treasury from the Indian Office appropriation.

FOREST SERVICE.

At the request of the Forester a geologist was detailed to the Paulina district, in eastern Oregon, to advise the local forest officials as to the possibility of developing underground waters in that area for domestic and stock purposes and, further, to assist in determining the depths of wells for which contracts are to be let in the future. The amount set aside by the Forest Service and expended in this work was approximately \$400.

PUBLICATIONS.

The work of the water-resources branch is represented in the following publications issued during the year: Professional Paper 65;

Water-Supply Papers 232 to 236, 238, 239, 241 to 245, 247 to 250, and 252. Titles and brief summaries of these publications are given on pages 15, 21-23. Seven other papers were in press at the close of the year, 3 have been submitted for publication, and '34 are in different stages of preparation.

CHARACTER OF INVESTIGATIONS.

The investigation of water resources in the United States involves work of three kinds. One is the determination of river flow, which is the basis for the development of storage, water power, irrigation, flood prevention, and land drainage. Another is the determination of the occurrence, location, and amount of underground waters. The third is the study of the quality of water, both surface water and that occurring underground, and its fitness for the various industrial and domestic uses. The problems involved are of engineering, geologic, and chemical character and wide fields are covered in each of these branches of science.

MEASUREMENTS OF RIVER FLOW.

DISTRICTS AND GAGING STATIONS.

The methods followed in gaging streams are discussed in detail in the printed annual progress reports of the work. (See Water-Supply Papers 241-252.) For administrative purposes the country is divided into districts, each in charge of a district engineer, as follows:

New England district: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. T. W. Norcross, district engineer, 6 Beacon street, Boston, Mass. District engineer in subdistrict of Maine, C. C. Babb, state capitol, Augusta, Me.

New York district: New York, New Jersey, and northern Pennsylvania. C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district: Southern Pennsylvania, Maryland, Delaware, Virginia, and the eastern part of West Virginia. R. H. Bolster, district engineer, Washington, D. C.

Southeastern district: North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Tennessee. M. R. Hall, district engineer, Federal Building, Atlanta, Ga.

Ohio Valley district: Ohio, Indiana, Illinois, Michigan, middle Missouri, and Arkansas. A. H. Horton, district engineer, Federal Building, Newport, Ky.

Upper Mississippi district: Minnesota, Wisconsin, and Iowa. Robert Follansbee, district engineer, Old Capitol Building, St. Paul, Minn.

Denver district: Southern Wyoming, Colorado, and New Mexico. W. B. Freeman, district engineer, Commonwealth Building, Denver, Colo.

Upper Missouri district: Northern Wyoming, Montana, North Dakota, and South Dakota. W. A. Lamb, district engineer, Helena, Mont.

Great Basin district: Utah, Idaho, and Nevada. E. C. La Rue, district engineer, Brooks Arcade, Salt Lake City, Utah.

Columbia River district: Oregon and Washington. J. C. Stevens, district engineer, Tilford Building, Portland, Ore.

California district: California and Arizona. W. B. Clapp, district engineer, Federal Building, Sacramento, Cal.

The results of the work performed in these districts are compiled and computed for publication by the computing section in the Washington office, under the charge of R. H. Bolster, assistant engineer. The distribution of the gaging stations by States is as follows:

Stream-gaging stations, by States.

State.	Number of river stations.	Number of measurements.	New stations established in year ending June 30.	Stations discontinued during year ending June 30.	Number of stations maintained in cooperation with state or federal bureaus.
Alabama.....	9	16	0	0	8
Arizona.....	0	0	0	0	0
Arkansas.....	6	0	6	6	6
California.....	72	674	1	2	42
Colorado.....	43	951	6	12	19
Connecticut.....	2	0	0	0	2
Delaware.....	0	0	0	0	0
District of Columbia.....	1	0	0	0	0
Florida.....	0	0	0	0	0
Georgia.....	17	84	2	1	9
Idaho.....	44	344	19	6	44
Illinois.....	23	165	6	0	23
Indiana.....	1	2	0	0	1
Iowa.....	1	0	0	0	0
Kansas.....	0	1	0	0	0
Kentucky.....	0	0	0	0	0
Louisiana.....	0	1	0	0	0
Maine.....	30	99	10	4	30
Maryland.....	2	6	0	0	0
Massachusetts.....	16	82	9	0	16
Michigan.....	8	0	0	0	1
Minnesota.....	51	251	22	9	51
Mississippi.....	9	9	0	0	8
Missouri.....	1	2	1	0	1
Montana.....	94	443	6	3	72
Nebraska.....	6	28	0	0	6
Nevada.....	11	33	1	4	6
New Jersey.....	3	3	0	0	2
New Hampshire.....	8	24	2	0	0
New Mexico.....	32	194	11	3	23
New York.....	39	176	3	5	39
North Carolina.....	15	38	0	7	1
North Dakota.....	19	12	0	7	12
Ohio.....	4	8	1	0	3
Oklahoma.....	0	0	0	0	0
Oregon.....	94	128	10	7	71
Pennsylvania.....	0	0	0	0	0
Rhode Island.....	5	40	5	1	5
South Carolina.....	4	12	0	0	1
South Dakota.....	0	5	0	0	0
Tennessee.....	7	13	0	0	5
Texas.....	8	1	0	0	8
Utah.....	49	293	10	0	48
Vermont.....	9	48	1	0	9
Virginia.....	16	35	0	3	1
Washington.....	71	515	14	8	58
West Virginia.....	21	48	0	0	2
Wisconsin.....	6	0	0	0	1
Wyoming.....	21	40	0	17	21
	878	4,824	146	105	655

NEW FEATURES OF THE WORK.

Special attention has been given during the year to raising the standard of the progress report on stream measurements. The methods of computation have been revised so as to insure much greater accuracy in the results than heretofore. This work has been under the direct supervision of R. H. Bolster, who has had many years' experience in work of this class. He has been assisted by a corps of trained men, who, under his direction, make up a computing section that is to be a permanent feature of the water-resources branch.

In order to insure the greatest accuracy in the data, they are carefully reviewed by the field men before being transmitted to this office. These data, with full notes on all special points, form the basis for the work in the computing section, where the final estimates are made. These estimates are then submitted to the district engineers for inspection, so that all published results have a double check.

All the descriptive matter in the progress reports has been carefully revised and all nonessential material eliminated.

The physical conditions governing the work of stream gaging are such that the data for the different stations can not be of the same standard of accuracy. In order that the engineer using the report may know what reliance to place on the results given, a column has been added to the monthly estimate table for each station, showing the probable error.

The increased demand for water for municipal supply, irrigation, and other uses has forced the utilization of many small sources of supply which heretofore have not been considered important. This has created a demand for data on the small streams, and every effort has been made to meet this demand.

During the year the instruments for determining stream flow have been greatly improved, with the result both of facilitating the work and of increasing the accuracy of the results. A new automatic gage, which gives a printed record of the time and stage of the river for every fifteen minutes, has been developed by Gurley & Co., of Troy, N. Y., from preliminary plans and suggestions given by the engineers of the water-resources branch. It is believed that this instrument will be a large factor in future stream-gaging work, as the diurnal fluctuations in most streams, due to natural and artificial conditions, require a continuous record of stage in order to obtain accurate results.

To facilitate the use of government reports relating to water supply, climate, etc., the United States has, by agreement between the Survey and the Weather Bureau, been divided into twelve areas and the progress report of stream gaging has been divided into

twelve parts, each part covering one of these areas. The areas and the numbers of the corresponding reports giving the results for 1907-8 and for 1909 are as follows:

Areas represented by progress reports.

Area.	Water-Supply Paper No.	
	1907-8.	1909. ^a
North Atlantic coast.....	241	261
South Atlantic coast and eastern Gulf of Mexico.....	242	262
Ohio River basin.....	243	263
St. Lawrence River basin.....	244	264
Upper Mississippi River and Hudson Bay basins.....	245	265
Missouri River basin.....	246	266
Lower Mississippi River basin.....	247	267
Western Gulf of Mexico.....	248	268
Colorado River basin.....	249	269
Great Basin.....	250	270
California.....	251	271
North Pacific coast.....	252	272

^a The reports for 1909 have not yet been published.

RIVER-PROFILE SURVEYS.

Preliminary river-profile surveys in advance of topographic mapping have been made during the year in Maine, Minnesota, and Oregon. The work in Minnesota was done at the expense of the State, but under the direction of the Geological Survey. Certain reservoir-site surveys formed a part of these examinations. The localities of the work are given in the following table:

River-profile surveys, fiscal year 1910.

Minnesota:	Linear miles surveyed.	Maine—Continued.
Root River.....	108.3	Molasses Pond.
Rum River.....	140.6	Webbs Pond Outlet.
Red Lake River.....	142.8	Alligator Pond.
Cannon River.....	65.3	Rocky Pond.
Cloquet River.....	62.0	Spectacle Pond.
St. Louis River.....	162.0	Great Pond.
Ottertail River.....	58.6	Green Lake Outlet.
Crow Wing River.....	89.7	Branch Lake Outlet.
Lake Millelacs.		Union River, Goodwins Bridge to Great Pond.
Maine:		Union River, Ellsworth to Great Pond.
Umbagog Lake.		Washington:
Lower Richardson Lake.		Klickitat River.
Upper Richardson Lake.		Lewis River.
Mooselucmaguntic Lake.		Toutle River.
Mooselucmaguntic Lake Outlet.		White Salmon River.
Richardson Lake Outlet.		Little White Salmon River.
Abraham Pond.		
Scammons Pond.		

GROUND-WATER INVESTIGATIONS.

At the beginning of the fiscal year \$13,810 was set aside as a special allotment for the investigation of underground waters. Of this amount, \$4,000 was transferred to the division of geology for expenditure under the supervision of the chief geologist in the investigation of the ground waters of the Atlantic and Gulf coastal plains, and an additional amount of \$1,080 was allotted for clerical assistance, leaving \$8,730 for the study of ground waters. This sum was devoted to investigations in California, New Mexico, Utah, Arizona, and north-central Texas.

A two years' field investigation of the springs of California, begun in the fiscal year 1909, was continued during 1910, and at its close the work was advanced to such a point that an additional month's field work, to be followed by a month's office work, will result in the completion of a full report. This work has been done by G. A. Waring. Near the close of the fiscal year 1910 Mr. Waring was invited by the Republic of Brazil to initiate studies of water resources in that country of the same general character as those carried out by the United States Geological Survey. Mr. Waring has accepted this invitation and will depart for his new field in September, 1910.

The work in the State of Iowa, begun several years ago, has been brought to a close during the present year, and a voluminous report embodying the results has been prepared under the general supervision of W. H. Norton, of Mount Vernon, Iowa, the part dealing with the chemistry of the waters being prepared by W. S. Hendrixson, of Iowa College. In order to complete the work within the year, O. E. Meinzer, of the Survey staff, was assigned to Professor Norton to complete certain county descriptions. This field work was finished in the autumn of 1909, and Mr. Meinzer's report was prepared and embodied with the rest of the Iowa material. This entire report, which is considered to be of much importance, is now in course of preparation for publication and should be issued during the next fiscal year.

In addition to the Iowa work Mr. Meinzer was assigned to a study of ground-water conditions in the Estancia Valley, New Mexico, and also undertook some studies in Utah to supplement those commenced by him during the fiscal year 1909. The Estancia Valley report has been written and transmitted for publication, and at the close of the fiscal year the Utah report is nearly completed.

A small allotment has been set aside for the use of C. H. Gordon, of the University of Tennessee, Knoxville, Tenn., to enable him to complete a report on the geology and underground waters of north-

central Texas, his report on the northeastern part of this State having been submitted during 1909. The later report is about complete at the close of the fiscal year and will probably be submitted for publication during the summer.

Studies of ground-water conditions in the Moki and Navajo reservations, undertaken by H. E. Gregory at the request of the Office of Indian Affairs during the previous year, were continued in the fiscal year 1910, and a report embodying Professor Gregory's conclusions was forwarded to the Indian Office for its guidance in the development of underground water on the reservations. The Indian Office has set aside an additional sum of \$1,500 for the extension of these investigations during the fiscal year 1911 and Professor Gregory has been assigned to this field to continue the work and to prepare the desired report.

At the request of the Forest Service a brief examination of conditions of the water supply in the Paulina district in eastern Oregon was undertaken by the Geological Survey during May and June, 1910. This study, likewise made by Professor Gregory, was completed and its results were transmitted directly to the Forest Service officials in the Portland district.

W. C. Mendenhall, in administrative charge of ground-water investigations, remained in the Washington office until late in the summer reviewing reports and preparing them for publication. In the fall he made a reconnaissance through three districts in eastern and central Washington and in Owens Valley, California. Later, accompanied by H. R. Johnson, who resigned from the service early in the fiscal year to enter private work, he reviewed Mr. Johnson's field work in the Antelope Valley and the southern parts of the Mohave Desert in California. Subsequently Mr. Johnson's report was completed and at the close of the fiscal year submitted for publication. Mr. Mendenhall also made some studies in the San Jacinto Valley in California during the early winter, but these were interrupted before their completion and a report on this field has not been prepared. A large part of Mr. Mendenhall's time toward the close of the year was expended in the review of manuscripts and in general routine and committee work for the Survey.

The greatest demand for ground-water studies comes from the arid States, where surface supplies are not available or are meager. The stimulus given by the enlarged-homestead act to the settlement of arid and semiarid districts has increased this demand, for in many places settlement is possible or dry farming is successful only if sufficient ground-water supplies can be procured for domestic and stock purposes. It is planned to investigate the arid and semiarid valleys of the West in advance of settlement, so far as the limited funds, the cooperative agreements, and other considerations permit.

INVESTIGATIONS OF THE QUALITY OF WATER.

In 1905 a study was commenced with the object of ascertaining the mineral content of surface waters of the United States in relation to geologic, climatic, and other conditions and especially in relation to chemical denudation. With this end in view and with the cooperation of the Reclamation Service, of state authorities in California, Illinois, Kansas, and Washington, and of many municipalities daily samples of water have been collected from the principal streams of the country at about 240 stations and the composite samples from these have been analyzed, a collection having been thus obtained of about 6,000 mineral analyses comparable with each other and indicative of the amount and character of the mineral matter carried by the streams of the United States.

During the fiscal year 1910 much of this work has been brought to a close and several reports on it have been completed. Water-supply papers on the quality of surface waters of California (No. 237), by Walton Van Winkle and F. M. Eaton; of Illinois (No. 239), by W. D. Collins; and of the United States east of the one hundredth meridian (No. 236), by R. B. Dole, have been published. A report has been prepared on the quality of the waters of Kansas, by H. N. Parker. The study of the quality of streams of the arid States conducted by the Reclamation Service has been correlated with similar work by the Geological Survey, and the manuscript containing the analyses of the waters has been prepared by Herman Stabler for publication as a water-supply paper. Part 2 of the "Quality of surface waters of the United States east of the one hundredth meridian" has been commenced by R. B. Dole and is to be completed during the next fiscal year.

In November, 1910, under a cooperative agreement with the state board of health of Washington, a study of the surface waters of that State, particularly in the Columbia River basin, was begun. Twenty stations for the daily collection of samples have been established and the chemical analyses are being made by Walton Van Winkle in a laboratory placed at the disposal of the Survey by the University of Washington. It is planned to complete the field studies and to prepare the report on them during the fiscal year 1911.

The completion of the Washington work will conclude this study of the quality of surface waters, by which the Survey will have obtained data covering the average quality and the general fluctuations in mineral content of most of the larger bodies of surface water in the United States.

In March, 1910, H. N. Parker resigned to enter private work. During the first six months of the fiscal year 1910 R. B. Dole was furloughed, being on duty for the Department of State in Ecuador. Since his return the greater part of his time has been consumed in

supervision of the work on the quality of water, in review of manuscripts, and in the preparation of several papers on the chemical composition of underground waters, to accompany special reports. For the first four months of the year Walton Van Winkle was in charge of the chemical laboratory at the Alaska-Yukon-Pacific Exposition and later organized the study of waters in the State of Washington.

During the fiscal year 1910 the sum of \$5,500 has been expended in investigations dealing with the quality of water. At the close of this year these investigations have been combined with those of underground waters, for under present conditions the studies of quality are confined almost exclusively to ground waters.

DÉBRIS INVESTIGATION.

The investigation of the natural laws governing the transportation of suspended material by rivers, described in previous reports, was discontinued on January 1, 1909. The results, covering a period of three and one-half years' experimentation, are now being compiled. They show certain fundamental relations between the amount of material carried by streams under varying conditions of slope, depth, width, etc. Although the work was carried on under laboratory conditions—that is, in small troughs and with artificially applied water and débris—certain relations, exponential and others, are indicated which, with suitable modifications, may be applied to practical conditions. The treatment of rivers in which suspended matter is a large factor has been based on rules that are largely empirical. It is believed that the application of the laws discovered in these investigations will have a wide and valuable application.

PERSONNEL.

The work during the year has been in charge of M. O. Leighton, chief hydrographer, and J. C. Hoyt, assistant chief hydrographer.

TECHNOLOGIC BRANCH.

ORGANIZATION AND SCOPE.

The organization of the technologic branch includes three divisions corresponding to the three separate appropriations—mine accidents, fuels, and structural materials. The work under these divisions was continued throughout the fiscal year as in the year previous.

The general supervision of the work has also remained as during the previous year, under Joseph A. Holmes, expert in charge, afterward chief technologist; Herbert M. Wilson, chief engineer, afterward assistant chief technologist; J. C. Roberts, assistant chief engineer, in charge of the Pittsburg experiment station, assisted by A. W. Belden.

In the mine-accidents division the technical force consisted of 5 mining engineers, 2 assistant engineers, 4 junior engineers, 1 explosives engineer, 1 junior testing engineer, 1 geologist, 1 assistant geologist, 1 electrical engineer, 1 junior electrical engineer, 1 consulting electrical engineer, 1 chemist, 1 explosives chemist, 2 assistant chemists, 1 junior chemist, and consulting mining engineers employed temporarily as needed.

In the fuel division the technical force consisted of 3 engineers in charge, 1 metallurgical engineer, 2 engineers, 13 assistant engineers, 15 junior engineers, 2 consulting engineers, 1 chief chemist, 5 chemists, 8 assistant chemists, 17 junior chemists, 1 physicist, 1 peat expert, 1 laboratory assistant, and 3 laboratory helpers.

In the structural-materials division the technical force consisted of 1 engineer in charge, 1 metallographer, 1 engineer, 3 assistant engineers, 8 junior engineers, 1 engineer of tests, 1 chemist, 1 assistant chemist, 10 junior chemists, 1 ceramic chemist, 1 assistant ceramic chemist, 2 junior ceramic chemists, 1 assistant geologist a portion of the time, in addition to 1 laboratory helper and 2 apprentices.

LABORATORIES AND TESTING FACILITIES.

No material enlargement of the facilities for testing and research was made during the fiscal year other than that incident to steady development in the mine-accidents and structural-materials divisions. As the appropriation for fuel testing was \$100,000, as against \$250,000 the year before, a corresponding curtailment in the extent and variety of the operations and in the personnel of the fuel division for the year was necessary.

The facilities for structural-materials investigations at the Pittsburg experiment station were increased by the construction and equipment of a kiln house, containing several types of kilns for the burning of brick, tile, and other clay products.

A laboratory was established at Atlantic City, N. J., for the investigation of the influence of sea water on concrete and of sea water and salt air on paint used as a preservative of structural materials; this was continued in operation throughout the year, as was also the laboratory at Northampton, Pa., for testing cement for use in the construction of the Panama Canal.

The small explosives testing gallery No. 2 at Pittsburg was equipped with necessary appliances for use in testing electric motors, electrically operated mining machines, and other electric equipment in the presence of explosive mixtures of gas.

During the year four substations were established as headquarters for investigations of the mining engineers—one in the Federal Building, Knoxville, Tenn.; one in a building of the University of Illinois, provided through the cooperation of the Illinois State Geological

Survey at Urbana; one in the Philippine Exposition Building on the grounds of the State University, Seattle, Wash., in cooperation with the state mine inspector of Washington; and one at McAlester, Okla., in cooperation with the state mine inspector for the Five Civilized Tribes and the Oklahoma Coal Operators Association. Each of these buildings was equipped with gas-tight rooms and the necessary apparatus for training miners in rescue work.

PUBLICATIONS.

During the fiscal year 12 bulletins (Nos. 382, 383, 387, 388, 392, 393, 402, 403, 412, 416, 418, and 423) were issued. Titles and brief summaries of these bulletins are given on pages 17-21. Seven of them relate to fuel testing, 3 to structural materials, and 2 to mine accidents. One is in press, 18 have been submitted for publication, and a number of others are in different stages of preparation.

MINE-ACCIDENTS DIVISION.

The organization and researches of the mine-accidents division were continued during the fiscal year as reported for the last year.

The inspection of coal mines in the Territory of New Mexico was continued under Jo E. Sheridan, mine inspector, and the work was kept current.

G. S. Rice, assisted by R. Y. Williams, J. J. Rutledge, H. M. Wolflin, and L. M. Jones, and for a portion of the year by A. C. Ramsay, David White, J. W. Groves, and C. A. Fisher, examined and sampled a number of coal mines in West Virginia, Illinois, Missouri, Pennsylvania, Ohio, Utah, Washington, and other States. These samples were collected and analyzed for one or another branch of the government service, in connection with the purchase of coal for the use of the Government, and this work has been done in cooperation with the fuel division. In Washington, Illinois, and Missouri the state geologists cooperated in the collection of the coal samples. In all, 355 mines were inspected and 1,476 coal samples, 158 samples of mine dust, and 134 samples of mine air were taken for analysis.

These engineers have also visited the scenes of explosions and mine fires and investigated the condition of the mines, sampled and tested the coal dust and gas, and made other studies with a view to determining the cause of the disasters. They have also carried on experiments to determine the influence of sprayed water or steam and of calcium chloride, etc., as means of preventing dust explosions.

J. W. Paul, assisted at various times by F. F. Morris, F. W. Horton, L. M. Jones, A. C. Ramsay, assistant mining engineers, and J. R. Cavanaugh, coal miner, has continued investigations and tests of safety lamps and of the efficiency of various types of rescue apparatus. With the cooperation of the mining engineers, Mr. Paul has super-

vised the training of practical miners in the use of rescue apparatus, in order to secure their assistance in investigations in the different coal fields. In connection with investigations of the mines, the mining engineers and assistants and the chief technologist aided state officials at 21 mine disasters, at the following places:

Mine explosions:

- Roslyn, Wash., October 3, 1909.
- Hartshorne, Okla., October 21, 1909.
- Johnstown, Pa., November 1, 1909.
- Herrin, Ill., December 23, 1909.
- Primer, Colo., January 31, 1910.
- Drakesboro, Ky., Lowder or Wickliffe mine, February 1, 1910.
- Ernest, Pa., February 5, 1910.
- Stearns, Ky., February 8, 1910.
- Craig, Okla., March 8, 1910.
- Bolen-Darnal, Okla., March 8, 1910.
- Wilberton, Okla., March 31, 1910.
- Ensley, Ala., April 21, 1910.
- Amsterdam, Ohio, April 22, 1910.
- Palos, Ala., May 5, 1910.

Mine fires:

- Duquoin, Ill., September 20, 1909.
- Cherry, Ill., November 13, 1909.
- Copper Hill, Tenn., November 29, 1909.
- Artemus, Ky., December 28, 1909.
- Cumberland, Ky., January 2, 1910.
- Artemus, Ky., Sturgis mine, January 6, 1910.
- South Bartonville, Ill., February 2, 1910.

Tests of the several types of rescue apparatus were made to determine their efficiency and safety under conditions of service use and for maximum periods of time. Tests have also been made and are still in progress on the various types of safety lamps and electric safety lamps in general use.

Clarence Hall, explosives engineer, with S. P. Howell, assistant engineer, and A. B. Coates and A. J. Hazlewood, junior engineers, made physical tests of explosives, with a view to determining their permissibility in coal-mining operations. In all 28 explosives passed the tests provided during the year and were announced in two different circulars issued in October, 1909, and May, 1910. The tests made included the following: Trauzl lead blocks, 114; small lead blocks, 86; rate of detonation of burning, 253; flame tests, 158; gallery No. 1, 1,272; ballistic pendulum, 401; pressure gages 1 and 2, 204; miscellaneous, 198.

On each Saturday throughout the year demonstrations were given at the Pittsburg testing station to organizations of state mine inspectors, mining associations, groups of coal operators, and their superintendents, foremen, and mine workers. These have included tests to show the safety or danger of the explosives used when detonated

in the presence of explosive mixtures of mine gas, coal dust, and air in proportions similar to those occurring in the mines. Public demonstrations of the safety of mine lamps and of the use and method of operating mine rescue apparatus were also conducted throughout the year.

Chemical analyses of each of the explosives and of the gas resulting from the firing of the explosives and from the explosion of the materials used in conducting the investigations were continued throughout the year under W. O. Snelling, chemist, assisted by C. G. Storm, A. L. Hyde, W. C. Cope, assistant chemists, and C. A. Lambert, junior chemist. In this work 2,500 chemical analyses of explosives used in mining and 750 physical tests were made.

H. H. Clark, electric engineer, assisted by William Buhl, jr., continued investigations and tests relative to the use of electricity in mining and its relation to mine explosions. This work included a series of competitive tests of blown-out fuses in the presence of dangerous mixtures of mine gas and air, the investigation of insulation for electric wiring, and tests of incandescent lamps in similar mixtures and of coal-cutting machines.

FUEL DIVISION.

The organization of the fuel division continued throughout the year practically as during the preceding year, except that as a result of the reduction in appropriation a considerable curtailment was necessary in the large-scale producer-gas, briquetting, and steaming tests, and there was a corresponding reduction in the personnel engaged on these tests. The energies of the division were taxed to keep up the routine analyses and tests of coal purchased by the Government, including the special tests required by the Quartermaster's Department to ascertain the fuel equivalent of one cord of oak wood.

A number of tests of the briquetting properties of lignite without binder were made on the large German briquetting press, and a series of investigative tests were made in the long combustion chamber, with a view to solving certain problems relative to processes of combustion. A certain amount of necessary investigative chemical work on fuels was continued throughout the year.

The inspection of fuels used by the Government was continued under G. S. Pope, assisted by P. M. Riefkin, J. W. Peters, N. H. Snyder, A. A. Straub, W. J. Harris, jr., E. W. Miller, and H. H. McKee. This work included the preparation of specifications for use in the purchase of coal by purchasing officers in the city of Washington and elsewhere in the United States, also by the general supply committee and the Panama Railroad Company and Isthmian Canal Commission. Inspectors were permanently stationed at New York City and Norfolk, Va., and trips were made by Messrs. Pope and Riefkin to Boston, Omaha, St. Louis, Kansas City, Chicago, and other

cities in order to give advice and assistance in connection with local coal problems. Mr. Riefkin was stationed for this purpose for several months at Superior, Wis., on behalf of the Office of Indian Affairs.

Among the results of the fuel investigations during the year was the fact that the purchase of over half of the coal used by the Government was based on some form of specification prepared by the technologic branch. During the year 7,300 samples of coal were received from government buildings and were analyzed, and on the basis of these analyses the payments for the coal were made. Of the samples collected, 2,800 were taken from coal delivered in the District of Columbia. As indicating the growth of this method of purchasing coal, it may be stated that 611,336 tons were so purchased in 1908-9, estimated to cost \$1,858,750, and that 829,289 tons were purchased in the present fiscal year (1909-10), at an estimated cost of \$2,286,800.

S. S. Voorhees, assisted by J. D. Davis, H. M. Cooper, J. A. Scherrer, William Buttner, W. Alexander, Wood Freeman, H. G. Elledge, and E. G. Borden, was engaged throughout the year in making chemical analyses and tests in Washington of the coals purchased by the Government in Washington and for public buildings throughout the United States.

During the absence of F. M. Stanton on sick leave, A. C. Fieldner, assisted by C. J. Monahan, D. I. Brown, H. Isenberg, W. E. Surbled, and C. K. Glycart, was in charge of chemical analyses of fuels sampled in the mines of the United States. During the year the following analyses and determinations were made: Analyses of gases, 5,000; analyses of mine air, 288; miscellaneous analyses, 556; number of determinations, 14,928.

The field and laboratory study of the chemical and microscopic structure of coal was continued by David White, assisted by Reinhard Thiessen; and field investigations into the character and distribution of peats and certain native coals was continued by C. A. Davis, chiefly in Massachusetts.

These special chemical investigations have added to the knowledge of the character and value of the coal underlying several million acres of public land, and the results were used in the classification of these lands. The samples of coal from the public lands were all collected by members of the geologic branch under M. R. Campbell.

A. C. Fieldner, assisted by G. A. Burrell, was engaged throughout the year in making chemical analyses and tests of natural gas and producer gas.

H. C. Porter, assisted by F. K. Ovitz, continued special chemical investigations concerning the distillation of typical coals at different temperatures. Mr. Porter carried on through the larger part of the year a series of investigations in cooperation with the Bureau of Yards and Docks, Navy Department, concerning the relative merits

of storing steaming coal under salt water, in fresh water, and in air both sheltered and in the open. Investigations relative to the nature and possible means of preventing spontaneous combustion of coals were continued, and in cooperation with the Panama Railroad Company a study was made of the deterioration of coal stored in air in a large pile in the temperature of the Isthmus of Panama. This work included 430 tests and analyses, involving 1,500 determinations.

J. C. W. Frazer, assisted by E. J. Hoffman, continued his chemical research into the hydrocarbons in coal with a view to determining its ultimate chemical composition. Mr. Frazer also carried on a series of investigations and tests relative to the explosibility of coal dust of different degrees of fineness and to the gases evolved from coal, using therefor 205 samples of dust.

I. C. Allen, assisted by A. W. Jacobs, continued his chemical and physical examination into the character and fuel value of the different crude petroleums. This inquiry concerned chiefly the petroleums of California but included also miscellaneous petroleums and petroleum products, with a view to acquiring information desired by the Navy, War, and other departments. In the course of this work 1,500 tests were made.

J. K. Clement, assisted for a portion of the year by L. K. Adams, continued cooperation with Henry Kreisinger and J. C. W. Frazer in investigations of special combustion problems, and assisted W. T. Ray, A. V. Bleining, R. L. Humphrey, and others in certain investigations requiring his special knowledge of the physics of high temperatures.

Fuel-efficiency investigations in connection with the heating and power plants of the Government were continued with special equipment by Henry Kreisinger and W. T. Ray. Mr. Ray left the service in January, 1910. Steaming tests, including smoke investigations, were made, chiefly on behalf of the Quartermaster's Department, by S. B. Flagg on the horizontal return tubular boiler and certain house-heating boilers. In addition, Mr. Flagg made a number of steaming tests at the heating plants of several bureaus in Washington, including the filtration plant, Government Printing Office, General Land Office, and others. He also, with the assistance of S. S. Voorhees and G. S. Pope, furnished advice to the chief clerk of the Treasury Department concerning problems arising at public buildings in different portions of the United States, especially with relation to the kind of fuel and most efficient manner of preventing or removing boiler-tube scale. In all, this work comprised 240 combustion tests, involving 30,600 observations.

R. M. Strong was engaged during a portion of the year in completing, with the advice and assistance of R. H. Fernald, a report on the tests of small internal-combustion engines. Mr. Strong left the service in May, 1910.

C. D. Smith, assisted by F. E. Woodman, conducted a number of producer-gas tests of coals and lignite, both raw and briquetted, and of a few low-grade coals, including samples of two graphitic anthracites from Rhode Island. In connection with producer-gas investigations 15 tests were made, involving 12,000 observations.

C. L. Wright completed certain large-scale lignite briquetting tests on carload lots from Texas, California, and North Dakota, and continued investigative tests on the small hand press in briquetting lignite and coal at various pressures and temperatures and with and without various proportions of binder.

A. W. Belden was engaged throughout the year in the study of the commercial coking processes and in completing his report on coking and washing tests and formulating a projected series of tests on the use of coke in foundry practice.

Lauson Stone continued throughout the year in charge of all computing for the fuel division, assisted at times by the assistant and junior engineers concerned.

A summary of the work for the fiscal year is as follows: Coal, lignite, peat, and oil, samples 2,317, determinations 16,093; gas mixtures (gallery gas), mine air, natural gas, producer and flue gas, samples 1,456, determinations 4,909; miscellaneous, samples 10, determinations 538.

STRUCTURAL-MATERIALS DIVISION.

The organization of the investigations of structural materials continued during the fiscal year as in the previous year. A change in the phraseology of the legislation provided for "the investigation of structural materials both belonging to and for the use of the United States, such as stone, clays, cement, etc." As construed by the Comptroller of the Treasury, the work authorized by the appropriation is limited to the investigation of such materials as are actual property of the United States and are to be used by the United States. The tests of samples representative of materials submitted by contractors for acceptance by the United States should therefore not be paid for from this appropriation, and in consequence, though the structural-materials division continued to test materials of this nature when submitted through the bureaus of the Government, the purchasing officers of those bureaus have been required to reimburse the structural-materials appropriation for the expense involved. The more important laboratory for the investigation of materials of this nature is that at Northampton, Pa., where cement purchased by the Isthmian Canal Commission is tested to ascertain its acceptability. Cement submitted for use in navy-yard and dry-dock construction has been tested at the Pittsburg laboratory, and miscellaneous materials of like kind at the Washington and Pittsburg laboratories.

The structural-materials investigations conducted under the appropriation were carried on chiefly at the Pittsburg laboratory and at the Atlantic City special laboratory. R. L. Humphrey continued in charge of the investigations of cement, concrete, and reinforced concrete, assisted during a part of the year by L. H. Losse and during the remainder of the year by Harry Kaplan, with the aid of E. B. Tolsted, J. G. Bragg, jr., and E. R. Gates. This force was chiefly engaged on investigations of reinforced-concrete beams and columns and a study of the building materials, including chiefly the aggregate for concrete, sent in by the field force, as well as on special investigations for the Isthmian Canal Commission and the Navy, War, and Treasury departments. During the year 13,000 briquet samples were made and 13,500 tests completed on sand, gravel, cement, clay, concrete, reinforced-concrete beams, etc.

The chemical research associated with the investigations of structural materials was conducted by P. H. Bates, assisted by H. H. Phillips and G. E. Webster. The most important problems occupying the attention of this force during the year were those connected with the effect of alkaline soils and waters on concrete and clay products, the effect of sea water on similar materials, and the waterproofing properties of asphalts and coal tars. During the year 1,700 mineral samples were tested and 6,500 determinations were made; and 350 tests and 1,500 analyses were made for government departments.

The investigations of clays and clay products for use in government buildings were conducted at Pittsburg by A. V. Bleininger, assisted by H. E. Ashley, G. H. Brown, and R. K. Hursh, and included chiefly studies of the durability of fire brick when exposed to high temperatures and placed under compressive strain at such temperatures and of the drying properties of clay and the best temperatures for burning it to produce building materials. In cooperation with the States of Arkansas, Texas, and Oklahoma, a study was made of the most efficient means of preparing clay products from indigenous clays so as to make them most suitable for use in public building construction.

During the year the following tests and investigations on clays were conducted:

Crushing strength of clay.....	1,000
Fire-brick tests.....	650
Colloid matter of clay.....	300
Drying investigations.....	80
Burnt-clay investigations.....	1,800
Miscellaneous investigations.....	1,500
	5,330

Under the direction of A. V. Bleininger, assisted by W. E. Emley, investigations of lime, caustic and hydrated, including studies of the

methods of burning it, were conducted to determine the types of lime locally available for public building construction and the methods of mixing and proportioning them with sand to make mortar of greatest compressive and tensile strength.

The following work pertaining to lime was done during the year:

Lime plants inspected.....	14
Density determinations on limes and limestones.....	200
Lime briquets made for determining compression strength.....	1,100
Lime briquets made for determining tensile strength.....	400
Miscellaneous tests.....	750

The most important investigation conducted by the structural-materials division during the year related to the structural materials most available as to quantity, quality, and location for use in some 400 public buildings authorized by Congress and planned or under construction by the Office of the Supervising Architect. This work was carried on in the States west and south of New England by E. F. Burchard, assisted by J. E. Todd, H. L. Gardner, and J. A. Udden. In New England and portions of New York, Pennsylvania, and a few of the Southern States the field work was continued by N. H. Darton, assisted by T. Nelson Dale. J. A. Holmes assisted in this work at intervals in different parts of the United States. Every quarry furnishing building stone or stone for screenings for use in concrete and numerous gravel and sand pits and brick and tile works were examined; notes were made as to their capacity, output, transportation facilities, and market prices; and samples were collected and forwarded to the Pittsburg laboratory for investigation. Reports of the field investigations were submitted to the Supervising Architect. The materials sampled have been retained for future examination at such time as the Treasury Department may call for additional information regarding them, and in a number of cases the necessary investigations have, on request, been made and the results reported.

The investigations at the Atlantic City laboratory relative to the behavior of concrete exposed to salt water were continued by R. J. Wig under the supervision of R. L. Humphrey. During the year shipments of iron cement from Germany and of cement ground with tufa from California were procured, and these materials were investigated along with typical Portland cement. In addition to these investigations on behalf of the Navy and War departments, a similar series of related investigations concerning the effect of salt water on reinforced-concrete piles for use by the Panama Railroad and the Isthmian Canal Commission were commenced.

The following work was done during the year:

Cement cylinders made and tested.....	1,000
Cement briquets made and tested.....	2,100
Other tests.....	350

A study of the effect of paint, chiefly mineral pigment, as a preservative of structural materials was commenced by S. S. Voorhees, at the request of the Supervising Architect. During a portion of the time Mr. Voorhees was assisted by H. A. Gardner. This investigation included analyses of the pigments and of the oil. The paint was applied to various steel and iron plates, also to such plates when coated with protective coverings of zinc, tin, etc. These plates were exposed to atmospheric action at the Atlantic City laboratory and a record was kept of their behavior.

The testing of cement for the Isthmian Canal Commission under the supervision of R. L. Humphrey was continued at the Northampton laboratory for a portion of the time under W. A. Campbell; later by A. D. Gates. That for the Navy Department was commenced and is in progress at Pittsburg under E. B. Tolsted and T. N. Holmes. The following work was done during the year:

Bins sampled.....	250
Briquets made.....	95,500
Samples taken.....	11,000
Briquets tested.....	87,500
Soundness pats made.....	44,000
Time of set tests.....	11,000
Specific-gravity tests.....	10,000
Fineness tests.....	10,500

At the Washington laboratory investigations of structural materials purchased for use by the several branches of the Government were continued under the direction of S. S. Voorhees and G. O. Spittler, assisted by A. C. Nothstine, J. G. Fairchild, F. H. Tucker, and others. For the Treasury, War, and other departments of the Government 4,500 samples were received and tested.

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 4 professional papers, 47 bulletins, 9 advance chapters from two other bulletins, 18 water-supply papers, 1 annual report on mineral resources for 1908 (also published in 48 advance chapters), and 6 geologic folios. These publications were the Thirtieth Annual Report; Professional Papers 64 to 67; Bulletins 360, 377, 380, 2 separates from 381, 382 to 424, 428, and 7 separates from 430; Water-Supply Papers 227, 232 to 236, 238, 239, 241 to 245, 247 to 250, and 252; Mineral Resources for 1908 (volume and 48 separates); Geologic Atlas, folios 167 to 171 and 173 (published in folio and octavo forms). Titles and summaries of these publications are given on pages 15-24. In addition to the publi-

cations of the regular classes the following were issued: A list of maps illustrating physiographic types; 2 circulars on permissible explosives; a pamphlet entitled "Cooperation between the United States and various States in topographic, hydrographic, and geologic work;" and Press Bulletins 389 to 427 (also 6 special issues). The total number of pages in these publications was 12,855; for the year 1908-9 the number of pages was 10,180.

During the year 29,257 pages of manuscript were prepared for printing and proof sheets for 12,517 final printed pages were read and corrected, this work involving the handling of 4,893 galley proofs and 28,005 page proofs. The corresponding figures for last year were 19,775 pages of manuscript, 11,840 final printed pages, 4,139 galley proofs, and 23,748 page proofs.

Indexes were prepared for 56 publications, covering 10,782 pages, the corresponding figures for last year being 47 publications and 9,730 pages.

The copy and proofs of all account and record books and blanks, circulars, office cards, etc., are examined in this section. This work consumes a large part of the time of one person, but it is not practicable to report the amount statistically.

The personnel of this section consists of the editor, the assistant editor, three editorial clerks, and one stenographer and typewriter. The division of mineral resources and the water-resources branch have continued to render special assistance in copy preparing and proof reading.

During the year members of the section of texts have at various times cooperated with the section of distribution.

SECTION OF ILLUSTRATIONS.

During the year 3,382 illustrations were prepared and most of them were transmitted to accompany 42 bulletins, 17 water-supply papers, 3 professional papers, 1 monograph, 1 annual report, and 1 report on mineral resources. These illustrations included 250 maps, 744 diagrams, 1,674 paleontologic drawings, 2 landscape drawings, 478 photographs retouched, and 234 miscellaneous.

Proofs to the number of 1,720 were received and compared critically, and the printed editions of all illustrations furnished by contract during the year were examined.

During the year 272 electrotypes were furnished to outside applicants; the number furnished last year was 109.

At the close of the year material for the illustration of 37 reports is in hand.

The personnel of the section consists of ten draftsmen (including the draftsman in charge) and one copyist clerk.

SECTION OF GEOLOGIC MAPS.

During the year 1909-10 six folios (Nos. 167 to 171 and 173; see pp. 23-24) were published, in both folio and octavo (field) editions. The maps for the Warren (Pa.), Johnstown (Pa.), Sewickley (Pa.), and Birmingham (Ala.) folios were also printed and these folios will soon be issued. In addition the following folios were received for publication during the year and are in various stages of engraving and editing: Bismarck, N. Dak.; Burgettstown-Carnegie, Pa.; Burnet-Llano, Tex.; Claysville, Pa.; Ellijay, Ga.-N. C.-Tenn.; Foxburg-Clarion, Pa.; Hollidaysburg, Pa.; Pawpaw-Hancock, W. Va.-Md.-Pa.; Raritan, N. J.; Van Horn, Tex.

The geologic map of North America was completely revised and prepared for publication, and its engraving was begun.

SECTION OF TOPOGRAPHIC MAPS.

On June 30, 1910, there were in the custody of the editor of topographic maps 40 new topographic atlas sheets and special maps which had not yet been put into the hands of the engravers, and 57 maps were in process of publication. The corresponding figures on June 30, 1909, were 76 and 59. During the year 56 new maps were received for publication, 1 map was withdrawn, and 93 maps were published.

The manuscripts edited comprise 88 new topographic atlas sheets and special maps; corrections for 371 sheets hitherto published; 2 maps published under contract; and 168 map illustrations which are or will be included in 27 volumes of Geological Survey reports. The proof read comprises 90 new maps and corrections to 103 maps.

Compilations were made for a revision of the large United States base map (49 by 76 inches) and the copy was prepared for engraving. The revision and correction has been completed and an office edition in nine sheets printed. The three-sheet sale edition was in press at the close of the year. For a new edition of the pamphlet "Topographic maps and folios and geologic folios" the lists of topographic maps were completed to date and each item of the old lists was verified or corrected.

Five men were engaged in the work of this section during the entire year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 128 new books, 6 folios, 93 new maps, 7 revised maps, 2 photolithographs, and 369 reprints of maps, a total of 605; the totals of all editions were 571,175 books, 28,541 geologic folios, 184 topographic folios, and 1,238,307 maps; grand total, 1,838,207. During the year 508,917 books, 36,139 folios, and 593,622 maps (including 478,737 sold), a total of 1,138,678, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was \$21,202.55 (of which \$20,606.35 was from sales of topographic and geologic maps), an increase of \$1,303.27 over the amount received in the fiscal year 1908-9.

During the year 95,877 letters were received, answered, and filed, an increase of 22,562 over the number in the preceding year.

Fifteen persons are engaged in the work of this section.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 135 atlas sheets and special maps were on hand for publication and the accessions during the year were 56 maps. The status of these 191 maps on June 30, 1910, was as follows:

Published during the year.....	93
Withdrawn from publication.....	1
In press.....	21
In process of engraving.....	36
Not taken up.....	40

Besides the engraving of new maps, corrections were made on the plates of 371 maps hitherto published. Editions of 469 maps, including new sheets and reprints, were printed and delivered to the map room.

Six geologic folios were published, and 28,541 copies were delivered. One geologic folio was in press at the close of the year and six others had been partly completed.

Under contracts with the Government Printing Office, illustrations were printed for the following Survey publications: Bulletins 381, 390, 398, 406, 407, 408, 410, 415, 416, 427, 432; Professional Papers 66 and 68; Water-Supply Papers 220, 221, 231, 234, 237; Mineral Resources, 1908; Thirtieth Annual Report of the Director; and Stadia Tables. For the Government Printing Office, also, the following items were printed and delivered: Maps to illustrate the American Ephemeris and Nautical Almanac, Annual Report Chief Signal Officer U. S. Army, Annual Report Commissioner of Indian Affairs, Annual Report Department of the Interior, Annual Report Isthmian Canal Commission, Annual Report Superintendent Mount Rainier National Park, Engineers' Field Manual U. S. Army, Twenty-first Annual Report on the Statistics of Railways, and 29 House documents and Senate reports; illustrations for Forest Service Form 979 and General Land Office Form 4-675a; sketching sheets for Forest Atlas; sectional township blanks; maps of 9 national monuments and reservations; and homestead maps of States and Territories. The following work was done for other government departments and bureaus: For the Forest Service, maps of 46 national forests, dia-

grams for 27 national-forest proclamations, Forest Atlas legend page, two maps of North America showing natural-forest regions, map of national forests and related projects and data, statistical diagrams and illustration for supervisor's report; for the General Land Office, 1,605 township plats; for the Department of the Interior, maps of three national parks; for the Reclamation Service, War Department, Office of Indian Affairs, Isthmian Canal Commission, Smithsonian Institution, Civil Service Commission, Biological Survey, Weather Bureau, Interstate Commerce Commission, Bureau of Soils, Army Service Schools, and Bureau of American Ethnology, a large amount of miscellaneous work. This work for other branches of the Government amounted to about \$45,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was more than a million and a third and required nearly three and one-half million printings. The total number of copies printed, including topographic maps and geologic folios, was 2,604,666, requiring over nine and one-third million impressions. On requisition of the Government Printing Office 796 transfer impressions were made and shipped to contracting printers.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments and making copperplates and electrotypes. More than 3,000 repairs were made to instruments and 375 new copperplates and 22 electrotypes were finished.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 10,260 negatives, of which 2,884 were wet, 648 paper, and 6,728 dry; and 25,337 prints, of which 8,994 were maps and 16,343 matte prints.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Correspondence, records, appointments, supplies, and shipments.—The work of this section during the year continued along the lines previously followed, the only change being in the method of granting leave without pay. In accordance with instructions from the Secretary dated May 13, 1910, all applications for such leave are referred to the department for action instead of being passed on by the chief clerk of the Survey. The volume of work performed in this section has increased in almost every item.

Mails, files, and records.—During the year 132,182 pieces of incoming mail were handled in this section, a gain of nearly 9 per cent over the preceding fiscal year. The gain in 1909 over 1908 was more than 13 per cent. Of this mail 2,348 pieces were registered

and 25,670, an increase of 1.6 per cent over the preceding year, contained remittances for publications of the Survey. The amount of money received in this mail was \$23,858.86, an increase of 5.8 per cent over 1909.

The recording, referring, and filing of correspondence required the services of four clerks through the year. The number of letters mailed through the section was 85,307, an increase of 6.7 per cent over the previous year. Of this number 12,120 were registered.

Personnel.—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 958 persons, compared with 955 at the close of 1909. Although the total number is thus practically the same, the number of changes in the personnel was 1,083 during the year. These changes included original appointments, separations, promotions, extensions, and changes of status of every description. Of these 296 were new appointments, or accessions, 293 were separations, 377 were promotions, 5 were reductions, and the remainder extensions of limited appointments, changes in titles or in the basis of payment, the designation of disbursing agents, and such other minor changes as neither increased nor decreased the total number of persons.

During the year 16,358 days of annual leave and 2,938 days of sick leave were granted, being about 55 per cent of the amount of annual leave and 11 per cent of the amount of sick leave which it is permissible to grant under the law; 15,613 days of leave without pay were also granted. These figures show considerable increases, the leave without pay being 127 per cent higher than last year. There were also 111 transfers to state pay rolls, in cooperative work.

Property accountability.—During the year the system of property accountability by custodians for various branches and divisions was continued, with a custodian of office property. An inventory of all nonexpendable property in Washington was submitted to the department at the close of the calendar year 1909.

Express and freight.—During the year 4,472 pieces of freight and express were handled by the shipping clerk, of which 1,043 were outgoing and 3,429 incoming; 567 freight and express accounts were examined and checked. This is an increase of 35 per cent in the number of pieces handled, but a decrease in the number of accounts checked.

Purchase and distribution of supplies.—During the year three persons were engaged in the purchase and distribution of supplies, which includes the procuring of bids, the issuing of orders, and the preparation of vouchers covering all purchases in the open market. The number of requisitions handled was 2,015; this was a decrease of 29 per cent from 1909, but in that year the number was abnormally large because of the two fires that necessitated the replacing of destroyed property.

Stationery.—In the stationery room the services of three men are required in handling the mails, packing and shipping supplies to field parties, keeping an account of the charges for stationery supplies, and making requisitions on the department for printing and supplies. During the year 6,740 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand, and 302 requisitions were drawn on the department for stationery supplies, 505 for printing, and 317 for furniture and miscellaneous supplies. These figures are all smaller than the corresponding ones for 1909.

Administrative bookkeeper.—During the year the administrative bookkeeper, in addition to his regular duties, was put in charge of the bookkeeping of the division of disbursements and accounts, economy of work and expense being effected by this arrangement. He continued to handle all Survey transactions of an administrative character, passed on all requisitions for supplies to be procured from the Department of the Interior, and verified and prepared for settlement the accounts covering charges thus arising against Survey appropriations.

The following table gives the classified net expenditures by the Survey for the fiscal year 1910, the repayments shown in the table on page 123 having been deducted:

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1910.

Appropriation.	Total.	Salaries and wages.	Traveling expenses.	Rent, electric light, and motive power.	Office furniture and fixtures.	Stationery supplies.	Library.	Transportation of property.	Instruments.	Telegrams and telephone service.
Salaries, statutory.....	\$64,339.71	\$64,339.71	.....	.....	.....	.....	.....	.....	.....	.....
Skilled laborers, etc.....	19,999.51	19,999.51	.....	.....	.....	.....	.....	.....	.....	.....
Gaging streams, etc.....	98,896.49	78,775.51	\$8,347.22	\$2,407.16	\$1,114.60	\$1,057.21	.....	\$334.55	\$1,681.11	\$287.44
Chemical and physical researches.....	19,939.18	18,809.20	25.50	342.18	5.00	34.72	.....	12.83	.....	.....
Preparation of illustrations.....	17,153.82	15,784.43	.....	.....	13.95	326.77	.....	.50	.....	13.33
Mineral resources of the United States.....	74,252.45	64,633.77	3,897.11	555.80	542.30	1,138.02	\$4.20	170.34	17.55	332.60
Books for the library.....	1,143.48	.....	.....	.....	.....	.....	1,134.68	8.80	.....	.....
Topographic surveys.....	347,311.29	234,909.22	24,994.69	.....	1,151.77	5,318.52	2.70	7,719.03	4,559.76	401.40
Geologic surveys.....	221,285.57	179,942.38	11,814.19	154.99	1,884.85	2,138.11	.....	1,682.89	1,097.27	305.91
Mineral resources of Alaska.....	89,640.12	55,205.78	12,989.72	25.00	815.41	271.73	.....	5,696.63	642.66	75.90
Replacing articles destroyed by fire.....	338.43	.....	.....	.....	.....	.....	.....	.....	.....	.....
Geologic maps of the United States.....	87,476.20	72,979.20	767.37	2,137.38	34.85	289.93	.....	73.10	.....	46.89
Surveying forest reserves.....	74,452.80	50,733.34	4,445.66	.....	150.00	501.76	.....	1,524.37	199.08	42.15
Testing fuel.....	99,661.84	85,618.43	1,898.99	657.46	192.19	323.33	142.27	1,310.61	17.85	228.07
Testing structural materials.....	91,494.80	65,249.20	3,854.64	485.22	68.67	208.49	248.80	1,253.43	.....	136.67
Inspecting mines in Territories.....	3,064.80	1,999.99	524.81	.....	.....	.....	.....	.....	.....	.....
Investigating mine accidents.....	149,510.43	119,830.36	5,877.44	3.08	510.96	426.39	129.60	974.25	.....	248.24
	1,459,960.92	1,128,810.03	79,437.34	6,768.27	6,484.55	12,034.98	1,662.25	20,761.33	8,215.28	2,118.60

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1910—Continued.

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photo-graphic material.	Engraving and print-ing ma-terial.	Chemical and phys-ical labora-tory ma-terial.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory										
Skilled laborers, etc.										
Gaging streams, etc.	\$450.93	\$2,651.75	\$363.30	\$844.44		\$487.91	\$93.36			
Chemical and physical researches		8.75		4.20		694.16	2.64			
Preparation of illustrations				749.50			265.34			
Mineral resources of the United States	14.25	2,176.18	10.70	244.89		512.31	2.43			
Books for the library										
Topographic surveys	12,709.90	32,024.74	16,403.45	3,038.34		27.85	1,266.70	\$2,733.22		
Geologic surveys	2,029.15	11,218.92	2,735.14	3,548.77		2,187.22	543.78	2.00		
Mineral resources of Alaska	5,703.61	6,320.82	1,055.34	577.86		87.00	172.66			
Replacing articles destroyed by fire						338.43				
Geologic maps of the United States		306.37		529.90	\$10,311.21					
Surveying forest reserves	2,780.59	9,771.57	3,916.82	301.60			38.10	47.76		
Testing fuel		1,183.61		179.94		3,282.53	45.00		\$2,708.09	\$1,873.47
Testing structural materials		3,488.27		268.68		964.99	12.97		12,361.24	2,893.53
Inspecting mines in Territories		540.00								
Investigating mine accidents		4,396.07	.25	464.05		5,507.88	4.20		6,231.26	4,906.40
Total	23,688.43	74,087.05	24,485.00	10,752.17	10,311.21	14,090.28	2,447.18	2,832.98	21,300.59	9,673.40

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1910.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director.	\$34,860.00	\$5.00	\$34,865.00	\$34,444.81	\$420.19
Salaries, scientific assistants.	29,900.00	81.75	29,981.75	29,981.65	.10
Skilled laborers, etc.	20,000.00	-----	20,000.00	19,999.51	.49
Gaging streams, etc.	100,000.00	28,268.64	128,268.64	127,165.13	1,103.51
Chemical and physical researches.	20,000.00	-----	20,000.00	19,989.18	60.82
Preparation of illustrations.	18,280.00	16.67	18,296.67	17,170.49	1,126.18
Mineral resources of the United States.	75,000.00	23.64	75,023.64	74,276.09	747.55
Books for the library.	2,000.00	-----	2,000.00	1,143.48	856.52
Topographic surveys.	350,000.00	44,287.46	394,287.46	391,598.75	2,688.71
Geologic surveys.	225,000.00	34,246.57	259,246.57	255,532.14	3,714.43
Mineral resources of Alaska.	90,000.00	65.16	90,065.16	89,705.28	359.88
Replacing articles destroyed by fire.	425.00	-----	425.00	338.43	86.57
Geologic maps of United States.	100,000.00	54,013.11	154,013.11	141,489.31	12,523.80
Surveying forest reserves.	75,000.00	49.20	75,049.20	74,502.00	547.20
Testing fuel.	100,015.38	4,264.55	104,279.93	103,926.39	353.54
Testing structural materials.	100,000.00	23,793.02	123,793.02	115,287.82	8,505.20
Inspecting mines in Territories.	7,350.00	-----	7,350.00	3,064.80	4,285.20
Investigating mine accidents.	150,000.00	8,127.15	158,127.15	157,637.58	489.57
	1,497,830.38	197,241.92	1,695,072.30	1,657,202.84	37,869.46

LIBRARY.

The library received during the year 11,563 book publications and 851 maps. The accessions record shows a total of 69,778 volumes; of this number 3,972 volumes have been transferred to the Library of Congress or otherwise disposed of, leaving 65,806 now on hand. The estimated number of maps is 35,800 and of pamphlets 85,000. During the year 8,010 volumes and 980 maps were catalogued.

Constant care is exercised to procure, as nearly as possible, all new original works of geologic interest and such as are needed of the more recent publications in the fields of the related sciences. Some additions have also been made to the earlier literature of geology and paleontology, thus increasing the value of the library for reference purposes.

The number of visits to the library during the year was 8,578, and 12,340 books and 547 maps were loaned for use outside of the library.

In order to bring up to the authorized quota of 500 the distribution of geologic folios and at the same time to place these folios where they may serve the widest educational needs, letters were sent to about 150 selected libraries in various parts of the world stating that the folios were available under certain conditions. As a result of these negotiations over 15,000 folios which had accumulated in the stock

rooms have been distributed to the libraries of universities, mining schools, and other institutions where they were desired.

The bibliography of North American geology for 1908 was completed, proof read, and issued as Bulletin 409. The corresponding volume for 1909 (Bulletin 444) is well advanced.

The Survey exchange list at present consists of 910 addresses, all of institutions. To these, 62,762 volumes of Survey publications were distributed.

The correspondence consisted of 3,327 letters received and 3,364 letters written, and 82 letters and other papers were translated in the library for the use of other divisions of the office.

The personnel of the library consists of the librarian, the assistant librarian, two cataloguers, and three other persons.

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