DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

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

WASHINGTON
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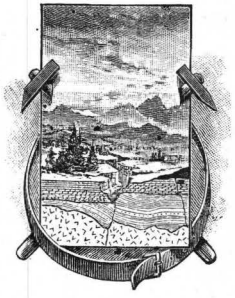

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THIRTIETH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1908–9 comprised items amounting to $1,590,680. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the various branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES OF THE WORK.

PROGRESS IN LAND CLASSIFICATION.

Land classification in aid of the administration of the public lands has been for several years and is now actively prosecuted by the Geological Survey, and reports setting forth in detail the mineral or nonmineral character of public lands of which the Survey has made actual field examination are being transmitted to the General Land Office.

Another and more recent line of activity in land classification is the segregation of nonirrigable lands under the terms of the enlarged homestead act of February 19, 1909. The recommendations of the Geological Survey on which the Secretary of the Interior bases his designations have not depended on surveys made for this specific purpose, but on data collected through a period of many years by federal geologists and engineers. The existence of this information whereby, within the few months since the enactment of the law, the Secretary has been able to designate areas in 9 States and Territories aggregating 162,000,000 acres, is in itself a forceful argument for a land classification that is complete and authoritative.

This classification of the public lands serves two important ends, one administrative, the other legislative, and it is believed that both were contemplated by Congress at the time of the creation of the Survey. The classification of the public domain and the investigation of its resources not only facilitate the work of fulfilling the

requirements of existing law, but also furnish Congress with data on which to base new legislation and particularly aid in the development in the land laws of the principle of relative worth, which is that the land must be so disposed of or so reserved as to insure utilization for the purposes for which it is most valuable. No principle is more fundamental to real conservation and at the same time more beneficial to the mining and other industries than this of giving preference to the highest possible use for the public lands. The earliest land laws, those of a century ago, provided for the reservation of mineral lands from disposal for other purposes, and the present coal-land law expresses this principle of relative worth by giving gold, silver, and copper deposits priority over the coal, and coal in turn preference over agricultural values. With classification data at hand the principle of relative worth can be further developed. Wherever the different values conflict the higher use should prevail. On the other hand, wherever the different values can be separated that separation by appropriate legislation is at once the easiest and best solution of the problem; for instance, the surface rights may be separated from the right to mine underlying beds of coal. The first step in this direction was taken in March of this year in the passage of the Mondell Act for the protection of the surface rights of entrymen, whereby the homeseeker may secure all for which he made entry—all that he swears he is getting—while the coal beneath his tillable land is reserved to the nation for future disposal. Land legislation of the future should strengthen this principle of relative worth where it already exists in law and introduce it further in all new legislation.

As an instance where thorough knowledge of the character of a special public-land tract with its strategic relation to the hydrography of the region enabled the Department of the Interior to aid Congress may be cited the act of February 20, 1909, reserving for public use eight sections of waste land in southern California. The law provides that this land shall be used for the diversion of flood waters into underground storage, thereby replenishing the supply of underground waters in the San Bernardino Valley. While apparently of only local scope, the principle established in this legislation is really of great importance as providing a course of action that will be found adaptable elsewhere in securing effective conservation of flood waters.

Hydrographic and topographic surveys which are now in progress under the instructions of the Secretary of the Interior have as their purpose the collection of information that may be presented to Congress in aid of legislation looking toward the best utilization of the water powers of the public domain. The information available as to the undeveloped water powers of the United States is far from complete, but to a very large extent it represents the work of the

water-resources and topographic branches of the Geological Survey. With these earlier records and surveys as a basis the Survey is now actively engaged in examining power sites to which the Government still retains the title. Those who are making this study of the water-power problem fully realize that economical utilization of these natural stores of energy requires their development on a large scale, with the investment of capital in large amounts. The day is past for inexpensive developments where only the minimum flow is used and that inefficiently. With the present demand for unfailing power in mind, we need not look far into the future to see storage as a universal factor in water-power development. Utilization of the undeveloped water powers on the public domain, therefore, involves either government development or long-time leases of these power sites to strong financial interests, and in the latter event the law must provide for effective government control which will insure that the profit to the capital accomplishing the development can not impose unjust burdens on the users of the power, whether the utilization be for transportation, city lighting, or motive power.

The purpose of the coal land classification surveys is twofold—to expedite complete restoration to agricultural entry of land thus determined to be barren of coal although included in the general withdrawals, and to promote the utilization of the coal lands, which to-day represent the greatest natural resource to which the people retain an unquestioned title. The geologic investigations of the last three field seasons have not only furnished a knowledge of the quantity and quality of the coal on the public domain, but have rendered possible the present policy of obtaining coal prices for coal lands. The General Land Office now depends on the Geological Survey to furnish detailed valuations for every 40-acre tract of coal land that is placed on the market. It is conceded that this policy of basing the price on the quantity and quality of the article sold will discourage purchase by speculators, but there is no reason to believe that the government valuation will impede the disposition of the coal deposits for purposes of utilization. The real development of the West will be promoted, not retarded. The situation is clearly viewed by the editor of a western mining journal, who has recently stated that this increase in valuation "can produce but one result—the lands will be sold only as they are actually needed for mining purposes. This should reduce the danger of monopoly, without promoting overproduction and wasteful competition. In the end it should give future generations cheaper coal. The unearned increment will go in part to the nation rather than to individuals." If a scientific classification and adequate valuation of the coal lands will accomplish all this, what more can be asked?

The scale on which this work is being prosecuted is indicated by the record of the three and a half months following the adoption of the revised scheme of valuation; in this period, which includes July of the next fiscal year, the recommendations to the General Land Office resulted in the release to agricultural entry of approximately 6,875,000 acres of noncoal land in Colorado, Wyoming, and Montana, and placed selling prices on nearly 1,500,000 acres of coal land with an aggregate valuation of nearly $94,000,000, which is an average advance of more than 200 per cent over the minimum prices fixed by law. Under the regulations setting forth the plan of valuation of government coal land the price is determined on the basis of estimated tonnage, and the unit rate varies with the quality of the coal, ranging from half a cent to 3 cents a ton for deposits within 15 miles of a railroad. The prices thus calculated range from 5 to 30 per cent of the usual royalty paid in the West, which is uniform without regard to the quality of the coal, yet this conservative valuation will more than double the average price of public coal lands, not to mention the fact that this policy of land classification has stopped the illegal disposal of coal lands at even less than the minimum coal price. Exceptional cases like one in Wyoming might be cited where the average price based on tonnage represents a fifteenfold increase over the old minimum price. Sales are being made at the new prices, and the reports from one land office already indicate a greater activity in coal lands priced at $25 and $50 an acre than existed a few years ago when they were sold at the minimum price of $10 and $20.

In the western oil fields the classification work by the Survey has resulted in protecting the oil man from the agricultural claimant, and with a better law the reports of the Survey geologists would also protect the oil prospector from the devices of the gypsum entryman. The next move on the part of the Federal Government in its capacity as the present owner of a large acreage of oil lands should be to protect the oil industry from itself by preventing injury to future productiveness through reckless drilling and by discouraging production in advance of possible disposal.

ORGANIZATION OF LAND-CLASSIFICATION BOARD.

When the Survey undertook the classification of the public lands in the West, both field examination and actual classification were made by the field geologists. After several years' experience it was found that the resulting classifications were not consistent among themselves, and the necessity was recognized for a uniform standard which should consistently conform to the policy of the Department. Also the classification work was extended to cover not only coal lands, but oil and gas and phosphate lands, enlarged homestead entries, and water-power sites, and the proper coordination of all this work be-

came important. Furthermore, the records had become cumbersome and complicated, so that it was necessary to provide a common custodian for them. These considerations led to the organization of a land-classification board in December, 1908.

This 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 public lands. The chairman of the general board is also chairman of the several classification sections and is in charge of the office force and records.

The advisory board, which is charged with consideration of questions of policy and approval of standards only, consists of the chairman and the chiefs of sections and branches in charge of the field work on which the classification 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: C. A. Fisher and G. H. Ashley.
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.

When the board was created the records of withdrawals and classifications were incomplete and involved. The increasing complexity of the work demanded readily accessible records, which should show completely and accurately every action taken in regard to any tract of land. Such a record is now in course of preparation. With the hearty and efficient cooperation of the General Land Office the complete records on file in that office are being checked with the records of the Survey, and it is expected that before the end of the next fiscal year the township card catalogue, showing every action taken with regard to any land in each township in the public-land States, will be completed.

With regard to new work in coal, phosphate, oil, enlarged homesteads, and power sites the plan has been adopted of keeping ledger accounts of each class of work, from which the total acreage, classified by months and by States, and in case of coal lands the relation between the prices as fixed by law, can be expeditiously determined. These ledger accounts will be extended to the past work as rapidly as possible, and when completed will give detailed statistics, correct to date and immediately available. As a card record, though necessary to

preserve all the details regarding actions affecting individual tracts, is nothing more than a jumble of numbers which must be plotted on maps to give an idea of relative areas and locations, a system of small-scale graphic index State maps has been installed, which are brought up to date the first of each month. These graphic records have proved of great value and have been freely used by the Department.

INVESTIGATION OF WATER RESOURCES.

Investigation of the water resources of the United States, together with a study of the uses to which they may best be adapted, has been continued by the water-resources branch along the general lines previously laid down. The work and its significance have, however, broadened materially. Many of those who formerly expressed doubt concerning its utility now realize that it is indispensable to the intelligent development of the country's water resources, whether that development be for power, navigation, irrigation, flood control, or domestic water supply. It requires no technical training to appreciate the necessity for finding out what and how much water is available for use, where it is, and how it can best be directed in the course of profitable development and utilization.

During the earlier period almost the only real appreciation of the work shown by even well-informed people was that in connection with its utility in the arid country. To-day the arid West has no monopoly of general interest in water problems. Inland navigation is enthusiastically advocated by the people at large, who have developed a great unanimity with reference to general policy in this matter. But little less interest is shown in the matter of water power, which, by reason of improvements in electric transmission, has been changed in its position in the public economy from a purely local agent to a great public utility. It is therefore no longer necessary to argue that the investigation of water resources is a necessity, and it is becoming more and more apparent that such a study constitutes one continuous problem, which is not confined within state lines and can not be divided up into districts, and that the work therefore, if it is to be efficiently performed, must be performed by the Federal Government.

The timeliness of the work that has been done and the results that have accumulated in past years were well illustrated in the investigations of the National Conservation Commission. All inquiries of the commission concerning stream flow, water power, floods, and underground waters, as well as the greater number of those concerning irrigation and drainage, were referred to the water-resources branch of the Survey. To have procured the information anew would have taken several years and necessitated the expenditure of a very large amount of money. By reason of its previous work, however, the water-resources branch was able to give comprehensive statements and

reports on the topics concerning which information was desired. The contribution to the conservation report was therefore a mere rounding up of material which was available for publication through the regular channels and which would have been so published had not this opportunity for a field of larger usefulness presented itself; in other words, this contribution was neither more nor less than a progress report.

The scope of the water-resources investigations has recently proved to be of national significance in two important respects. The first is the necessity for the data gathered in conection with the administration of the enlarged homestead act, passed by the Sixtieth Congress. This act authorizes the Secretary of the Interior to open to entry, in homesteads of 320 acres, all public lands that are nonirrigable or impracticable of irrigation except with the expenditure of a disproportionate amount of money. It is obvious that the proper administration of this act requires at the outset a knowledge of the available water supplies. Without such information the act is practically nonadministrable. The second national feature dependent on these investigations is the temporary withdrawal, under the authority of the President, pending legislative action, of water-power sites along the rivers of the public domain. The extent and value of any water power depend on the amount of water that the stream furnishes. To withdraw from entry power sites on the public domain intelligently would be impossible without definite information, and, were not available data at hand, the propositions for withdrawal would involve a gigantic piece of investigation that could not be finished for a long term of years. It is true that information is lacking regarding a large number of important sites on the public domain, but it is also true that by the aid of the information which the Survey had collected during past years it has been possible to withdraw a large number of power sites immediately, and many more can be withdrawn in the near future, by reason of the fact that partial information is now available and can soon be made practically complete. It is believed by many that the protection and proper administration of the great water-power sites of the public domain constitute one of the most important projects of the present administration. The people are becoming each day more dependent, for their industrial productivity as well as for their comfort and happiness, on the energy available for development and partly developed in our streams. The circumstances present in a clear fashion one convincing line of evidence as to the necessity for carrying this work forward to a purposeful finish.

TOPOGRAPHIC SURVEYS.

The popular appreciation of topographic surveys, as witnessed by the steady increase in sales of the Survey maps, is believed to be indicative of the increased efficiency of the topographers. Other rec-

ognition of the high standards attained has come in the calls for the topographers of the Survey to take up similar work in other countries. Not only have members of the topographic branch been detailed to work under the international boundary commissions, on the Porto Rico Irrigation Survey, and for the Isthmian Canal Commission, but Survey topographers have resigned or taken leave of absence to make topographic surveys in Mexico, Honduras, Peru, Africa, and China. The latest and possibly most notable instance of appreciation of the topographic work of this Government has been the request from the Director of the Canadian Geological Survey for the temporary assignment of one or more of the most experienced topographers to be employed by the Canadian Survey in the inauguration of similar topographic work. In Canada one topographer is at present on leave of absence and acting in the capacity of field instructor to several of the Canadian parties.

MINE ACCIDENTS.

Within three months after the appropriation by Congress " for the protection of lives of miners in the Territories and in the district of Alaska, and for conducting investigations as to the causes of mine explosions with a view to increasing safety in mining " (approved May 22, 1908), the mine-accidents division of the technologic branch of the Geological Survey had been organized, a large part of its equipment had been installed in the government buildings on the arsenal tract at Pittsburg, and the investigations into the causes of mine explosions were already under way.

With a view to profiting as far as possible by the experience in other countries, two of the Survey engineers visited the coal-mining regions in England, Scotland, and Wales during August, and one of them extended his investigations through the coal-mining regions of France, Belgium, and Germany during September and October. In addition to this, three of the countries which had done most in reducing the loss of life in mining—Great Britain, Belgium, and Germany—were invited by this Government to send to the United States their most experienced officers in mine-safety work to advise this Survey as to its plans for these investigations. The invitation received favorable action; the three experts came to the United States about the end of August, and after examining the plans and equipment of the mine-experiment station that was being established at Pittsburg, visited a number of the more important coal fields of the country and presented to the Secretary of the Interior a report embodying in condensed form their recommendations looking to greater safety in American coal mines. This report was promptly published and widely distributed throughout the United States to persons interested in the mining industry.

The investigations conducted at the Pittsburg station during the fiscal year have included (*a*) an examination of explosives used in coal mining in the United States; (*b*) an examination into the occurrence of explosive gases and inflammable or explosive dust, and a special examination of those mines in which explosions have occurred during the year; (*c*) an examination of so-called safety lamps used in mines in the United States, and of mine rescue apparatus for use in mines filled with poisonous and explosive gases; (*d*) a study of the conditions under which electricity may be safely used in coal mines where either gas or inflammable dust abounds.

In these investigations the Survey has had throughout the year the hearty cooperation of the miners, mine operators, and state inspectors. It is believed that decided progress has been made in determining the causes and means of preventing such disasters.

The manufacturers of explosives used in coal mining have voluntarily submitted their explosives for testing at the station and have withdrawn from the market a number of explosives that failed to pass these tests. They have also made commendable efforts to increase the safety of their explosives even beyond the requirements of these tests, and have shown a desire to carry out the wishes of the state inspectors and the recommendations of the federal engineers and chemists connected with these investigations.

It is hoped that the maximum in the loss of life in coal mining in the United States has been reached and that hereafter, with the basis for intelligent action furnished by these investigations and with the hearty cooperation of all those interested in mining, there will be a steady yearly decline in the loss of life in this country from explosions. But in view of the fact that more than 85 per cent of the fatalities in our coal mines are due not to explosions, but to other though in many cases related causes, it is important that the scope of the investigation be extended to include all conditions which make for greater safety in mining.

TECHNOLOGIC INVESTIGATIONS FOR THE GOVERNMENT.

During the year the demands on the Geological Survey for special services to other branches of the Government have steadily increased. In connection with the fuel resources of the country there has been a call for information concerning not only the fuel supplies on the public lands but also the fuels for use by different branches of the government service. The larger part of the fuel used by the Government (other than that used on board naval vessels), involving an annual expenditure of more than $5,000,000, is now purchased under specifications prepared by the Survey, and this coal is sampled and tested by members of the Survey. The supplies of coal for use on government vessels are to an increasingly large extent being

purchased from mines which have been examined and whose coals have been tested by the Survey. The supplies of crude petroleum and other mineral fuels for the government service are also being subjected to similar examination.

In connection with the building and engineering construction work done by the Government, the materials to be used are now being generally tested by the Survey. These include materials for more than 300 public buildings in various States and Territories, recently authorized by Congress and involving an expenditure of more than $50,000,000. The cement, sand, stone, and other structural materials for use in the engineering work of the Panama Canal, as well as structural materials for use by the Reclamation Service and by several bureaus of the army and the navy, are also being examined at the testing laboratories of the Survey at St. Louis and Pittsburg.

DISTRIBUTION OF PUBLICATIONS.

The realization that the Survey publications which embody the results of the investigations and surveys can serve their purpose only as wise and prompt distribution is effected has caused special attention to be given to this phase of administration. The results attained are gratifying. In the distribution of reports the increase was nearly 10 per cent over that of the preceding year and the number of volumes distributed equaled the number of copies received from the Public Printer. The whole number of topographic maps distributed exceeded that of 1907–8 by over 25 per cent, and the sales of geologic folios and of topographic sheets showed an increase of 25 per cent and 20 per cent, respectively.

SURVEY LIBRARY.

In the Survey library the constant aim has been to make the collection complete in the literature properly belonging to a geologic library; to keep it up to date by promptly procuring all the necessary new publications; and to catalogue punctually the new accessions, thus making them readily available for use. With small funds, a working force necessarily limited, and shelf room so meager that continual shifting of books is necessary to incorporate new accessions in proper order, no remarkable increase in size or achievement is possible. The best efforts of the force are so fully engaged in meeting from day to day the demands for information and publications that only occasional opportunity is left for new undertakings that may increase the library's usefulness. The Survey has a collection of geologic, paleontologic, and mining literature which certainly is not approached in completeness by any other library in this country, and, at least as to American geology, probably not by any other in the

world. It is gratifying to know that practical geologists, professors, and students throughout the country recognize the usefulness and completeness of this collection and frequently avail themselves of its resources, particularly of the rare material not to be found elsewhere in the United States.

INADEQUACY OF RENTED BUILDINGS.

The work of the scientific, technical, and clerical employees of the Survey is becoming more and more hampered through the conditions imposed by the quarters occupied. The two fires within the past fiscal year were fortunately extinguished with an aggregate material loss of less than $20,000, but the work of several divisions was much delayed by reason of these fires. Not only is there this constant danger that public records conservatively valued at nearly $5,000,000 may be destroyed by fire, but the space available is both ill adapted and insufficient for the present needs. The proportion of dark rooms necessitates use of artificial light, which in turn affects the quality and quantity of work and injures the eyesight and health of the employees. Furthermore, the present crowded condition of the rooms is curtailing the efficiency of the geologists and other specialists of the Survey, who are engaged in work of the greatest importance to the nation. The erection of a well-lighted, fireproof building of adequate size, planned to meet the requirements of a scientific bureau, has become the greatest need of the Geological Survey.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey is a bureau of investigation and publication, and the current publications furnish an important index to the nature and value of its work. Summaries of the publications other than topographic maps issued during the last fiscal year follow:

Twenty-ninth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1908. v, 99 pp., 2 pls.

A summary of the work of the year, by branches and divisions, with notes on special features, brief sketches of the publications, and maps showing areas covered by geologic and topographic surveys.

Professional Paper 58. The Guadalupian fauna, by George H. Girty. 651 pp., 31 pls.

An account, with description and figures, of the fauna found in the Texas portion of the Guadalupe Mountains, a facies strikingly individual among known Carboniferous faunas. The introduction contains a summary of literature dealing with other Carboniferous faunas in various parts of the world.

Professional Paper 59. Contributions to the Tertiary paleontology of the Pacific coast. I. The Miocene of Astoria and Coos Bay, Oregon, by William H. Dall. 278 pp., 33 pls., 14 text figures.

The first of a projected series of contributions to a better knowledge of the Tertiary faunas of the Pacific States. Contains descriptions and figures of fossils, including an account by F. W. True of a remarkable fossil sea lion. As appendices are reprinted several rare papers on the paleontology of the Pacific coast Tertiary, followed by a bibliography of publications on the post-Eocene marine mollusks of the northwest coast, 1865–1908.

Professional Paper 60. The interpretation of topographic maps, by Rollin D. Salisbury and Wallace W. Atwood. 84 pp., 170 pls., 34 text figures.

A clear explanation of the features shown on the topographic and geologic maps published by the Survey and of the conventions used to represent those features, accompanied by a large number of illustrative maps with text indicating the inferences as to the topography, geology, and physiographic history that may be legitimately drawn from the maps.

Professional Paper 61. Glaciation of the Uinta and Wasatch mountains, by Wallace W. Atwood. 96 pp., 15 pls., 24 text figures.

An outline of the topography and geology of the two ranges, with detailed notes on the glacial phenomena, illustrated by geologic and topographic maps, half-tone views, and numerous sketch maps and diagrams.

Professional Paper 62. The geology and ore deposits of the Cœur d'Alene district, Idaho, by Frederick L. Ransome and Frank C. Calkins. 203 pp., 29 pls., 23 text figures.

The introduction, by Mr. Ransome, contains an outline of the geography and geology of northern Idaho and adjacent parts of Montana and Washington, a sketch of industries and settlements in the Cœur d'Alene district, and a bibliography, and is followed by detailed accounts of the general geology by Mr. Calkins and of the ore deposits and mines by Mr. Ransome. The report is illustrated by detailed and sketch maps, diagrams, sections, half-tone views, and photomicrographs of ores and rocks.

Professional Paper 63. Economic geology of the Georgetown quadrangle, Colorado, by Josiah E. Spurr and George H. Garrey, with general geology by Sydney H. Ball. 422 pp., 87 pls., 155 text figures.

An elaborately illustrated report on a well-known mining region, containing an account of the general geology, a discussion of the principles governing mineralization in this and related regions, notes on the history and statistics of production of the mines, and detailed descriptions of the mines by districts. The illustrations comprise maps showing the present topography, the geology, and the physiographic history of the region, mine plans and sections, sketches and views of rocks and ores, and numerous half-tone views.

Bulletin 340. Contributions to economic geology, 1907. Part I. Metals and nonmetals except fuels; C. W. Hayes and Waldemar Lindgren, geologists in charge. 482 pp., 6 pls., 26 text figures.

Introductory papers by Messrs. Hayes and Lindgren summarize the publications and field work of the year bearing on nonmetallic mineral resources except coal, lignite, and peat, and on deposits of metalliferous ores. The body of the volume comprises the following papers:

A geological analysis of the silver production of the United States in 1906, by Waldemar Lindgren.

Notes on some gold deposits of Alabama, by H. D. McCaskey.

The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz., by F. C. Schrader.

Gold placer deposits near Lay, Routt County, Colo., by H. S. Gale.

Gold deposits of the Little Rocky Mountains, Montana, by W. H. Emmons.

Geology and mineral resources of the Osceola mining district, White Pine County, Nev., by F. B. Weeks.

The mines of the Riddles quadrangle, Oregon, by J. S. Diller and G. F. Kay.

Notes on copper deposits in Chaffee, Fremont, and Jefferson counties, Colo., by Waldemar Lindgren.

Notes on the Fort Hall mining district, Idaho, by F. B. Weeks and V. C. Heikes.

Mineral resources of northeastern Oklahoma, by C. E. Siebenthal.

Some molybdenum deposits of Maine, Utah, and California, by F. L. Hess.

The Arkansas antimony deposits, by F. L. Hess.

Antimony in southern Utah, by G. B. Richardson.

Carnotite and associated minerals in western Routt County, Colo., by H. S. Gale.

Tungsten deposits in the Snake Range, White Pine County, eastern Nevada, by F. B. Weeks.

Note on a tungsten-bearing vein near Raymond, Cal., by F. L. Hess.

Monazite deposits of the Carolinas, by D. B. Sterrett.

Minerals of the rare-earth metals at Baringer Hill, Llano County, Tex., by F. L. Hess.

Tin ore at Spokane, Wash., by A. J. Collier.

An estimate of the tonnage of available Clinton ore in the Birmingham district, Alabama, by E. F. Burchard.

Three deposits of iron ore in Cuba, by A. C. Spencer.

Iron ores near Ellijay, Ga., by W. C. Phalen.

The Miner ranch oil field, Contra Costa County, Cal., by Ralph Arnold.

Petroleum in southern Utah, by G. B. Richardson.

Gas fields of the Bighorn Basin, Wyoming, by C. W. Washburne.

The Labarge oil field, central Uinta County, Wyo., by A. R. Schultz.

Marble of White Pine County, Nev., near Gandy, Utah, by N. H. Darton.

Concrete materials produced in the Chicago district, by E. F. Burchard.

Portland cement materials near El Paso, Tex., by G. B. Richardson.

Clays in the Kootenai formation near Belt, Mont., by C. A. Fisher.

Tripoli deposits near Seneca, Mo., by C. E. Siebenthal and R. D. Mesler.

Phosphate deposits in the western United States, by F. B. Weeks.

Sulphur deposits at Cody, Wyo., by E. G. Woodruff.

A commercial occurrence of barite near Cartersville, Ga., by C. W. Hayes and W. C. Phalen.

Graphite deposits near Cartersville, Ga., by C. W. Hayes and W. C. Phalen.

Meerschaum in New Mexico, by D. B. Sterrett.

Bulletin 341. Contributions to economic geology, 1907. Part II. Coal and lignite; Marius R. Campbell, geologist in charge. 444 pp., 25 pls., 7 text figures.

Contains an introduction by Mr. Campbell, giving an outline of the geologic work in the coal fields of the country during 1907, followed by the papers named below:

The Sentinel Butte lignite field, North Dakota and Montana, by A. G. Leonard and C. D. Smith.

The Miles City coal field, Montana, by A. J. Collier and C. D. Smith.

The Bull Mountain coal field, Montana, by L. H. Woolsey.

Coal near the Crazy Mountains, Montana, by R. W. Stone.

The Red Lodge coal field, Montana, by E. G. Woodruff.

The Lewistown coal field, Montana, by W. R. Calvert.

The Sheridan coal field, Wyoming, by J. A. Taff.

The Glenrock coal field, Wyoming, by E. W. Shaw.

Coal fields of the northeast side of the Bighorn Basin, Wyoming, and of Bridger, Mont., by C. W. Washburne.

Coal fields of the southwest side of the Bighorn Basin, Wyoming, by E. G. Woodruff.

The eastern part of the Great Divide Basin coal field, Wyoming, by E. E. Smith.

The western part of the Little Snake River coal field, Wyoming, by M. W. Ball.

The northern part of the Rock Springs coal field, Sweetwater County, Wyo., by A. R. Schultz.

Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale.

The Grand Mesa coal field, Colorado, by W. T. Lee.

The coal field between Gallina and Raton Spring, N. Mex., in the San Juan coal region, by J. H. Gardner.

The coal field between Durango, Colo., and Monero, N. Mex., by J. H. Gardner.

The coal field between Gallup and San Mateo, N. Mex., by J. H. Gardner.

The Harmony, Colob, and Kanab coal fields, southern Utah, by G. B. Richardson.

The Rogue River valley coal field, Oregon, by J. S. Diller.

A coal prospect on Willow Creek, Morrow County, Oreg., by W. C. Mendenhall.

The Pocket coal district, Virginia, in the Little Black Mountain coal field, by C. A. Fisher.

Classified list of papers dealing with coal, coke, lignite, and peat, contained in publications of the United States Geological Survey, except those on Alaska, by W. T. Lee and J. M. Nickles.

Bulletin 345. Mineral resources of Alaska, report on progress of investigations in 1907, by Alfred H. Brooks and others. 294 pp., 5 pls., 7 text figures.

Contains fourteen different papers by eleven different authors, including (1) summaries of progress of the mining industry in various parts of the Territory during the year, (2) preliminary accounts of investigations in progress or completed, and (3) statements of the results of minor investigations not to be published elsewhere. A list of the papers with their authors follows:

The distribution of mineral resources in Alaska, by A. H. Brooks.

The mining industry in 1907, by A. H. Brooks.

Prospecting and mining gold placers in Alaska, by J. P. Hutchins.

Lode mining in southeastern Alaska, 1907, by C. W. Wright.

Copper deposits in Kasaan Peninsula, Prince of Wales Island, by C. W. Wright and Sidney Paige.

The building stones and materials of southeastern Alaska, by C. W. Wright.

Mineral resources of the Kotsina and Chitina valleys, Copper River region, by F. H. Moffit and A. G. Maddren.

Notes on copper prospects of Prince William Sound, by F. H. Moffit.

Occurrence of gold in the Yukon-Tanana region, by L. M. Prindle.

The Fortymile gold-placer district, by L. M. Prindle.

Water supply of the Fairbanks district, 1907, by C. C. Covert.

Investigations of the mineral deposits of Seward Peninusla, by P. S. Smith.

The Seward Peninsula tin deposits, by Adolph Knopf.

The mineral deposits of the Lost River and Brooks Mountain region, Seward Peninsula, by Adolph Knopf.

Water supply of the Nome and Kougarok regions, Seward Peninsula, 1906–7, by F. F. Henshaw.

Bulletin 346. Structure of the Berea oil sand in the Flushing quadrangle, Harrison, Belmont, and Guernsey counties, Ohio, by W. T. Griswold. 30 pp., 2 pls.

A report of the results of work undertaken to determine the position in all parts of the Flushing quadrangle of the principal oil sand and thus to ascertain where the conditions are favorable for the accumulation of oil and gas. Contains two maps showing by contours the depth of the oil sand and the structure of the Pittsburg coal, an important key bed.

Bulletin 347. The Ketchikan and Wrangell mining districts, Alaska, by F. E. Wright and C. W. Wright. 210 pp., 12 pls., 23 text figures.

A reconnaissance report on the distribution, character, and relative importance of the ore bodies and ore-bearing formations in this region, with detailed descriptions of the various mines and prospects. The illustrations include three large maps and many smaller ones.

Bulletin 348. Coal resources of the Russell Fork basin in Kentucky and Virginia, by Ralph W. Stone. 127 pp., 8 pls., 25 text figures.

A detailed description of the Elkhorn coal district in Virginia, with sketches of the geography and general geology, illustrated by maps and numerous sections of coal beds.

Bulletin 349. Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia, by W. C. Phalen. 158 pp., 6 pls., 21 text figures.

Descriptions of the topography, geology, and mineral resources by districts, with an account of the transportation facilities and the extent and development of the mines. Contains structure sections of coals and other illustrations.

Bulletin 350. Geology of the Rangely oil district, Rio Blanco County, Colo., with a section on the water supply. 61 pp., 4 pls., 1 text figure.

A review of the geology in detail, with descriptions of the oil fields and water supply and a discussion of the economic development of the district. The illustrations consist of topographic and geologic maps.

Bulletin 351. The clays of Arkansas, by John C. Branner. 247 pp., 1 pl., 20 text figures.

A description of the topography and geology of the State, and of the character, origin, occurrence, and uses of Arkansas clays, with a table showing the value of the clay products and a list of the clay workers. Contains structure sections of various districts.

Bulletin 352. Geologic reconnaissance of a part of western Arizona, by W. T. Lee, with notes on the igneous rocks of western Arizona, by Albert Johannsen. 96 pp., 11 pls., 16 text figures.

Geographic and geologic details of the highlands and valleys of the area, with an account of its geologic history and a sketch of its water supplies. The illustrations consist of maps, cross sections, and half-tone views.

Bulletin 353. Geology of the Taylorsville region, California, by J. S. Diller. 218 pp., 5 pls., 12 text figures.

Detailed descriptions of the topography and geology of the region, with a sketch of its geologic history and an account of the development of its mineral resources. Contains topographic and geologic maps and other illustrations.

Bulletin 354. The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island, by T. Nelson Dale. 228 pp., 9 pls., 27 text figures.

Detailed scientific and economic discussions of granite, including its origin, texture, and physical properties, and descriptions of the granites and quarries

of the three States mentioned, with a glossary of scientific and quarry terms and numerous illustrations. The second publication in a series on the granites of New England.

Bulletin 355. The magnesite deposits of California, by Frank L. Hess. 67 pp., 12 pls., 4 text figures.

A sketch of the occurrence of magnesite in this State, with a description of the deposits and statistics concerning the deposits in foreign countries. Half-tone illustrations show features of structure at different mines.

Bulletin 356. Geology of the Great Falls coal field, Montana, by C. A. Fisher. 85 pp., 12 pls., 2 text figures.

Designed mainly to furnish information regarding the character and extent of the coal resources of the region. Includes a description of the rock formations, indicating their character, distribution, structure, and stratigraphic relations, and a brief statement of mineral resources other than coal. The illustrations show sections of coal in various districts.

Bulletin 357. Preliminary report on the geology and oil resources of the Coalinga district, Fresno and Kings counties, Cal., by Ralph Arnold and Robert Anderson. 142 pp., 2 pls., 1 text figure.

A brief abstract of the report to be issued later as Bulletin 398, prepared to meet the urgent demand for early publication of available facts.

Bulletin 358. Geology of the Seward Peninsula tin deposits, Alaska, by Adolph Knopf. 71 pp., 9 pls., 7 text figures.

A presentation of the chief facts regarding the mineralogy and geology of the tin deposits of the peninsula, with an account of the developments and geologic and topographic maps.

Bulletin 359. Magnetite deposits of the Cornwall type in Pennsylvania, by Arthur C. Spencer. 102 pp., 20 pls., 21 text figures.

A sketch of the geology of eastern Pennsylvania, with a general description of the ore deposits in Berks and York counties and in the vicinity of Cornwall. Contains structure and cross sections of some of the mines and geologic maps.

Bulletin 361. Cenozoic mammal horizons of western North America, by H. F. Osborn, with faunal lists of Tertiary Mammalia of the West by W. D. Matthew. 138 pp., 3 pls., 15 text figures.

An outline of the geologic and climatic history of the Tertiary period in the West, a discussion of correlation, and a description, in order of age, of the horizons at which fossil mammals have been found and of the characteristics of the faunas occurring at these horizons.

Bulletin 362. Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907, by John S. Burrows. 23 pp.

A report on the analyses of coals made on the grounds of the Jamestown Exposition.

Bulletin 363. Comparative tests of run-of-mine and briquetted coal on locomotives, including torpedo-boat tests and some foreign specifications for briquetted fuel, by W. F. M. Goss. 57 pp., 4 pls., 35 text figures.

A report on tests of coal and briquets at a railroad testing plant, in locomotives on the road, and on a torpedo boat, with notes on the briquet industry.

Bulletin 364. Geology and mineral resources of Laramie Basin, Wyoming; a preliminary report by N. H. Darton and C. E. Siebenthal. 81 pp., 8 pls., 1 text figure.

A sketch of the geography and geology of the basin and a description of its mineral resources. Contains a geologic map, structure sections, and views showing characteristic features of the topography and rock outcrops.

Bulletin 365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram, under the supervision of D. T. Day. 33 pp., 3 text figures.

A report on experiments in which crude petroleum was allowed to diffuse upward through tubes packed tightly with fuller's earth.

Bulletin 366. Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall. 44 pp., 3 pls., 2 text figures.

An account of tests of raw and washed coal and of briquets in three boilers of a size commonly used in residences, with deductions from the results obtained.

Bulletin 367. The significance of drafts in steam-boiler practice, by W. T. Ray and Henry Kreisinger. 61 pp., 26 text figures.

A theoretical discussion, based on experiments at the Survey testing plants and tests on a railway locomotive, with numerous diagrams.

Bulletin 368. Washing and coking tests of coal at the fuel-testing plant, Denver, Colo., July 1, 1907, to June 30, 1908, by A. W. Belden, G. R. Delamater, and J. W. Groves. 54 pp., 2 pls., 3 text figures.

Details of the tests, with chemical analyses of the coals used, both before and after testing.

Bulletin 369. The prevention of mine explosions, report and recommendations, by Victor Watteyne, inspector-general of mines, Belgium; Carl Meissner, councillor for mines, Germany; and Arthur Desborough, H. M. inspector of explosives, England, with letter of transmittal by James Rudolph Garfield, Secretary of the Interior. 11 pp.

A report made at the request of the Secretary of the Interior by three mining experts from Belgium, Germany, and England.

Bulletin 370. The fire-resistive properties of various building materials, by Richard L. Humphrey. 99 pp., 39 pls., 32 text figures.

Results of tests of 30 panels to determine the effect of fire and subsequent quenching with water. Contains numerous reproductions of photographs showing the condition of the panels before and after testing, diagrams showing temperature conditions, and tables giving results of compression tests on fragments remaining after fire tests.

Bulletin 371. Reconnaissance of the Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah, by G. B. Richardson. 54 pp., 10 pls., 1 text figure.

An account of the topography, climate, and geology of the area and a description of its coal resources, including statements as to occurrence, amount, and character of the coal and notes on the mining development. Contains a geologic map, numerous sections, and views of typical geologic and other features.

Bulletin 372. Bibliography of North American geology for 1906 and 1907, with subject index, by F. B. Weeks and J. M. Nickles. 317 pp.

A bibliography, arranged by authors, of publications relating to North American geology, with descriptive notes, and an index by subjects, with special lists of chemical analyses, geologic formations, rocks, and minerals.

Bulletin 373. The smokeless combustion of coal in boiler plants, with a chapter on central-heating plants, by D. T. Randall and H. W. Weeks. 188 pp., 40 text figures.

A report of an investigation at nearly 500 industrial plants in 13 cities, the data from 284 plants being incorporated in the tables. Contains descriptions of representative boiler plants that burn coal practically without smoke, including plants with mechanical stokers and plants with hand-fired furnaces, illustrated by many diagrams of boiler and stoker settings; notes on smoke observations at Survey testing plants; and details of operations at 57 central heating plants. Concludes that smoke prevention is both possible and economical.

Bulletin 374. Mineral resources of the Kotsina-Chitina region, Alaska, by F. H. Moffit and A. G. Maddren. 103 pp., 10 pls., 9 text figures.

An account of the general geology, with illustrations showing characteristic rock outcrops, is followed by a detailed description of the mineral resources, chiefly copper but including a few gold placers. Contains two large geologic and topographic maps of the region.

Bulletin 375. The Fortymile quadrangle, Yukon-Tanana region, Alaska, by L. M. Prindle. 52 pp., 5 pls., 2 text figures.

Sketches of the geography and geology of the quadrangle, with reconnaissance maps, and description of the gold placers.

Bulletin 376. Peat deposits of Maine, by E. S. Bastin and C. A. Davis, prepared in cooperation with the Maine State Survey Commission. 127 pp., 3 pls., 20 text figures.

A general discussion of the nature, origin, conditions of growth, and uses of peat and methods of preparing it for domestic and commercial purposes, followed by detailed descriptions, arranged by counties, of Maine peat bogs, analyses of many Maine peats, and a short bibliography.

Bulletin 378. Results of purchasing coal under government specifications, by J. S. Burrows, with a paper on burning the small sizes of anthracite for heating and power purposes, by D. T. Randall. 44 pp.

An outline of the results accomplished by establishing specifications to govern the purchase of coal on the basis of its heating value. The paper on small anthracite is based on an investigation as to the coals most suitable for use in government buildings.

Bulletin 379. Mineral resources of Alaska; report on progress of investigations in 1908, by A. H. Brooks and others. 418 pp., 10 pls., 21 text figures.

The administrative report by A. H. Brooks is followed by the papers named below:

The mining industry in 1908, by Alfred H. Brooks.

The possible use of peat fuel in Alaska, by C. A. Davis.

Mining in southeastern Alaska, by C. W. Wright.

Copper mining and prospecting on Prince William Sound, by U. S. Grant and D. F. Higgins, jr.

Gold on Prince William Sound, by U. S. Grant.

Notes on geology and mineral prospects in the vicinity of Seward, Kenai Peninsula, by U. S. Grant.

Mineral resources of southwestern Alaska, by W. W. Atwood.

Mining in the Kotsina, Chitina, Chistochina, and Valdez Creek regions, by F. H. Moffit.

Mineral resources of the Nabesna-White River district, by F. H. Moffit and Adolph Knopf.

The Fairbanks gold-placer region, by L. M. Prindle and F. J. Katz.

Water supply of the Yukon-Tanana region, 1907–8, by C. C. Covert and C. E. Ellsworth.

Gold placers of the Ruby Creek district, by A. G. Maddren.

Placers of the Gold Hill district, by A. G. Maddren.

Gold placers of the Innoko district, by A. G. Maddren.

Recent developments in southern Seward Peninsula, by P. S. Smith.

The Iron Creek region, by P. S. Smith.

Mining in the Fairhaven precinct, by F. F. Henshaw.

Water-supply investigations in Seward Peninsula in 1908, by F. F. Henshaw.

Bulletin 385. Briquetting tests at the United States fuel-testing plant, Norfolk, Va., 1907–8, by Charles L. Wright. 41 pp., 9 pls.

Details of manufacture and various tests of the briquets which were used in the combustion tests reported in Bulletin 363, with a bibliography of Survey publications and other recent literature on briquetting.

Water-Supply Paper 219. Ground waters and irrigation enterprises in the foothill belt of southern California, by W. C. Mendenhall. 180 pp., 9 pls., 16 text figures.

A sketch of the geography and physiography, a record of the distribution and amount of rainfall, suggestions concerning the conservation of waters, a description of the ground-water districts with measurements of water levels in the wells, and an account of the various irrigation enterprises which have sprung up in the region. The illustrations include maps showing irrigated lands and artesian areas and sections of wells.

Water-Supply Paper 220. Geology and water resources of a portion of south-central Oregon, by Gerald A. Waring. 86 pp., 10 pls., 1 text figure.

A discussion of the present water resources and the development of a greater supply, a statement of the agricultural possibilities, and a summary of the data collected concerning the geology, with reconnaissance topographic and geologic maps of the region and other illustrations.

Water-Supply Paper 221. Geology and water resources of the Great Falls region, Montana, by Cassius A. Fisher. 89 pp., 7 pls.

A description of the different geologic formations, with statements concerning their structure, general distribution, and water capacity, and an account of the surface waters, including their present and proposed uses for irrigation, water power, etc. Contains maps showing the geology and the water resources of the region and the area of irrigated land.

Water-Supply Paper 222. Preliminary report on the ground waters of San Joaquin Valley, California, by Walter C. Mendenhall. 52 pp., 1 pl.

A brief outline of the water resources, chiefly underground, with notes on the supply by counties and suggestions as to future development in relation to agricultural products, accompanied by a map showing the artesian areas and ground-water levels.

Water-Supply Paper 223. Underground waters of southern Maine, by Frederick G. Clapp, with records of deep wells by W. S. Bayley. 268 pp., 24 pls., 4 text figures.

Descriptions of the general water resources, the dependence of quality and quantity on character of rocks, and the location and type of wells, including a

detailed discussion of the conditions in the various counties, with maps showing distribution of rocks and water and a table of deep wells.

Water-Supply Paper 224. Some desert watering places in southeastern California and southwestern Nevada, by Walter C. Mendenhall. 98 pp., 4 pls.

Notes on the topography of the region, especially as concerns the location of known watering places and the possibilities for finding and developing water at other favorable points, with descriptions of the main routes of travel and hints on desert traveling, accompanied by a map showing the location of the watering places described.

Water-Supply Paper 225. Ground waters of the Indio region, California, with a sketch of the Colorado Desert, by Walter C. Mendenhall. 56 pp., 12 pls., 5 text figures.

A geologic sketch of the district, an account of its water resources, and a brief history of its development, with a list of the producing wells. The illustrations include half-tone views of the region and a map showing wells, artesian areas, and irrigated lands.

Water-Supply Paper 226. The pollution of streams by sulphite pulp waste—a study of possible remedies, by Earle B. Phelps. 37 pp., 1 pl.

A discussion of the injurious effects of sulphite pulp waste on streams and of possible methods of purifying it and of making use of its valuable contents, with a description of the manufacture of wood pulp and a diagram illustrating the various steps in the process.

Water-Supply Paper 228. Water-supply investigations in. the Yukon-Tanana region, Alaska, 1907 and 1908, Fairbanks, Circle, and Rampart districts, by C. C. Covert and C. E. Ellsworth. 108 pp., 7 pls.

An account of the stream-measurement work and the establishment of gaging stations, with an explanation of the methods of carrying on the work and collecting the data and tables showing the daily gage height and estimated discharge of the various streams. Contains maps and other illustrations showing the hydraulic development of the region.

Water-Supply Paper 229. The disinfection of sewage and sewage-filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 91 pp., 1 pl.

A discussion of the necessity for sewage purification, with an account of the methods and costs of disinfection, experimental investigations, and practical applications. Contains disinfection and relative stability tables.

Water-Supply Paper 230. Surface-water supply of Nebraska, by J. C. Stevens. 251 pp., 6 pls., 5 text figures.

A report of stream measurements in Nebraska to the end of 1908, with descriptions of the several drainage basins and tables showing the daily gage height and discharge of the streams. Contains illustrations typical of the rivers of the State.

Water-Supply Paper 231. Geology and water resources of the Harney Basin region, Oregon, by G. A. Waring. 93 pp., 5 pls.

A sketch of the topography, geology, and physiography of the district and of the sources and distribution of both surface and underground water, with suggestions as to conservation of the water supply and details of the several basins. Contains geologic and topographic maps of the region and other illustrations.

Mineral resources of the United States, calendar year 1907. Part I, Metallic products, 743 pp., 1 pl., 1 text figure. Part II, Nonmetallic products, 897 pp., 1 pl., 6 text figures.

Statistics of production of mineral substances in the United States, including an account of the chief features of mining progress, and comparisons of past and present conditions. This report is a consolidation of 50 separate chapters, each treating of a separate mining industry, published in pamphlet form in advance of the publication of the volume.

Advance chapters from "Mineral resources of the United States, calendar year 1908" as follows: The production of monazite and zircon in 1908, by Douglas B. Sterrett, 6 pp. The production of salt and bromine in 1908, by W. C. Phalen, 18 pp. The production of bauxite and aluminum in 1908, by W. C. Phalen, 14 pp. The production of phosphate rock in 1908, by F. B. Van Horn, 16 pp. The production of slate in 1908, by A. T. Coons, with general note on the classification and characteristics of slate, by T. Nelson Dale, 15 pp. The production of mica in 1908, by Douglas B. Sterrett, 14 pp.

Statistics of production of the minerals, chief features of mining progress, and comparisons of past and present conditions as in previously published reports.

Geologic folio 160. Description of the Accident and Grantsville quadrangles, comprising 460 square miles, of which the greater part is in the northwest corner of Maryland, but including also portions of Fayette and Somerset counties, Pa., and Preston County, W. Va. Prepared under the supervision of William Bullock Clark, state geologist of Maryland, by G. C. Martin. 14 folio pages of text, 6 maps, 2 structure sections, and 2 columnar sections.

Geologic folio 161. Description of the Franklin Furnace quadrangle, comprising an area of about 225 square miles in northwestern New Jersey, by A. C. Spencer, H. B. Kümmel, J. E. Wolff, R. D. Salisbury, and Charles Palache. Surveyed in cooperation with the State of New Jersey. 27 folio pages of text, 5 maps, and 1 structure-section sheet.

Geologic folio 162. Description of the Philadelphia district, an area 915 square miles in extent, consisting of four quadrangles—the Germantown, Norristown, Philadelphia, and Chester. The district lies in three States—Pennsylvania, New Jersey, and Delaware. Surveyed in cooperation with the State of New Jersey. The description is by F. Bascom, W. B. Clark, N. H. Darton, H. B. Kümmel, R. D. Salisbury, B. L. Miller, and G. N. Knapp. 23 folio pages of text, 8 maps, 2 structure sections, 2 columnar sections, and 1 sheet of illustrations exhibiting geologic features.

Geologic folio 163. Description of the Santa Cruz quadrangle, embracing a land area of 712 square miles in west-central California and a water area of 332 square miles in the adjoining part of the Pacific Ocean, by J. C. Branner, J. F. Newsom, and Ralph Arnold. 11 folio pages of text, 3 maps, 1 structure-section sheet, 1 columnar-section sheet, 1 page of illustrations exhibiting geologic features, and 1 page showing fossils found in the quadrangle.

Geologic folio 164. Description of the Belle Fourche quadrangle, an area 849 square miles in extent in northwestern South Dakota, by N. H. Darton and C. C. O'Harra. 9 folio pages of text, 4 maps, 1 structure section, and 1 columnar section.

Geologic folio 165. Description of the Aberdeen-Redfield district, which includes the Northville, Aberdeen, Redfield, and Byron quadrangles, covering 1,692 square miles near the central part of South Dakota, by J. E. Todd. 13 folio pages of text and 12 maps.

Geologic folio 166. Description of the El Paso quadrangle, comprising 894 square miles in the northwestern corner of that part of Texas which lies west of Pecos River, by G. B. Richardson. 11 folio pages of text, 2 maps, and 1 sheet of illustrations showing geologic features.

NOTE.—Folios 164, 165, and 166 are published also in octavo form for field use.

FIELD WORK BY THE DIRECTOR.

During the field season of 1908 the Director visited geologic parties in Wyoming, Montana, and New Mexico and topographic parties in Mississippi. He also had field conferences with the administrative officers of the Survey, geologists, engineers, and cooperating state officials. He attended the irrigation congress at Albuquerque, the mining congress at Pittsburg, and meetings of the West Virginia Coal Miners' Association at Charleston, W. Va., of the Illinois Coal Conference at Urbana, and of the Geological Society of America at Baltimore.

GEOLOGIC BRANCH.

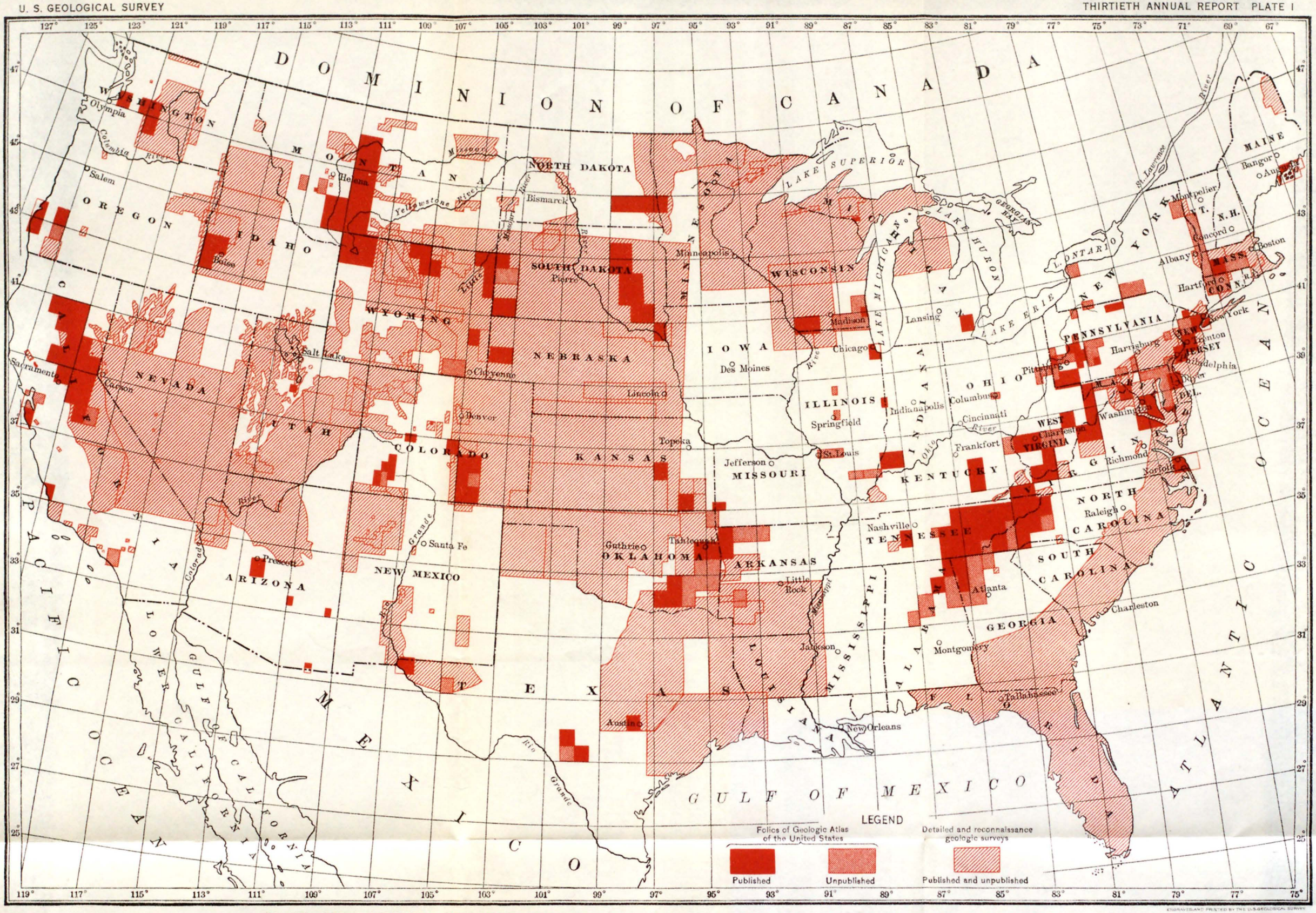
ADMINISTRATION.

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

General supervision of the work of the geologic branch is exercised by the chief geologist, C. W. Hayes, with a view to securing proper cooperation between the several divisions and coordination of the several lines of work. It is often to the advantage of the Survey to employ the members of one division in the work of another and the form of organization facilitates such transfers when exigencies demand it. The cooperation between the divisions of geology and mineral resources is especially close, and a large proportion of the annual volume issued by the latter division is prepared by members of the division of geology who are detailed for this work during a part of each year.

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 7 geologic folios, 5 professional papers, 25 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



MAP OF UNITED STATES, SHOWING AREAS COVERED BY GEOLOGIC SURVEYS

Scale
100 0 100 200 300 miles

1909

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

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.

PERSONNEL AND ORGANIZATION.

The scientific force at the beginning of the year consisted of 51 geologists and paleontologists, 48 assistant geologists, and 31 junior geologists. During the year there were 13 resignations and 13 appointments. Of the total number on the rolls, 86 were continuously employed, 27 gave only a portion of their time to Survey work, and 17 were not employed during the year. In addition to the above regular force, 45 temporary field assistants were employed for a portion of the year.

For purposes of scientific supervision, to which in some cases is added direct administrative control, the work of the division is organized under a number of sections, viz:

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 functions of the section chiefs include the preparation of plans and supervision of field and office work as well as review and revision of results. They are directly responsible for keeping the Survey work up to a high scientific standard.

FIELD WORK BY THE CHIEF GEOLOGIST.

During July, 1908, the chief geologist visited field parties in Arkansas, Oklahoma, and New Mexico. He also made an examination of the geologic conditions at the site of the proposed Elephant Butte dam, at the request of the Reclamation Service. In October he visited a party in Tennessee and made a brief examination of geologic conditions in the Louisiana oil fields where work was in progress in cooperation with the State Survey. In November he visited a number of State geologists and mining engineers in different parts of the country in connection with the preparation of estimates of iron-ore reserves of the United States. In March and April he visited the principal oil fields of Mexico for the purpose of obtaining information of value in planning and directing work in the oil fields of the United States. In June he visited the oil fields of Oklahoma in connection with work there in progress.

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—In Maine cooperative geologic work was continued under the supervision of E. S. Bastin. The mapping of the Eastport quadrangle was conducted by Mr. Bastin, assisted by C. L. Breger, the paleontologic studies being made by H. S. Williams. The preparation of this folio was well advanced.

Some additional work was done in the Frenchmans Bay quadrangle by C. W. Brown.

A report on the peat deposits of Maine (Bulletin 376) was completed by E. S. Bastin in cooperation with C. A. Davis, of the technologic branch, and considerable progress was made on a report on the pegmatites of Maine by Mr. Bastin.

The report on the fauna of the Chapman sandstone of Maine was nearly completed by H. S. Williams.

The inspection of the granite quarries of Connecticut was completed by T. N. Dale, and his report thereon is nearly finished. Mr. Dale also made considerable progress on the Mettawee, Fort Ticonderoga, and Fort Ann folios. In the spring he was transferred temporarily to the technologic branch, for the purpose of inspecting materials for eight government buildings in Massachusetts, Connecticut, and Rhode Island.

The text to accompany the general map of Massachusetts and Rhode Island, which has been prepared on a scale of 4 miles to the inch, was completed by B. K. Emerson. A preliminary map of the Keene (N. H.) and Warwick (Mass.) quadrangles was also prepared by Professor Emerson, and the maps and text covering the eastern half of the Housatonic quadrangle were completed and submitted for publication.

The survey of the surficial geology of the Taconic quadrangle, in Massachusetts, was substantially completed by F. B. Taylor.

In Vermont a field study of the stratigraphy and structure of the north end of the Taconic Mountains and adjacent areas was made by Arthur Keith, E. O. Ulrich, and T. N. Dale. Reconnaissances were also made by Mr. Keith in the Burlington, Middleburg, and Rutland quadrangles, particularly with reference to the structure of the Green Mountains. In these reconnaissances special consideration was given to the Ordovician and Cambrian limestones.

Considerable time has been devoted by Arthur Keith and others to general studies of the geology of Massachusetts and Vermont, with special reference to correlating the work of the different geologists in the New England field. This work will be supplemented during the coming year.

Atlantic and Gulf coastal plains.—In cooperation with the various state geological surveys, the studies of the Atlantic and Gulf coastal plains were continued throughout the year. W. B. Clark was in

charge of the investigations in the northern part of the area and T. W. Vaughan in charge of those in the southern part of the area. In addition to office supervision, Messrs. Clark and Vaughan from time to time made visits to various districts for the purpose of studying some special features, with the view of correlating so far as possible the work in the different States. Under their direction a general survey of the geology and underground waters of the coastal plain of Virginia has been made by B. L. Miller, E. W. Berry, and Samuel Sanford. A similar survey of the coastal plain of North Carolina has been made by B. L. Miller and L. W. Stephenson. Special reports on these surveys are practically completed. They will be published as bulletins of the North Carolina and Virginia state geological surveys.

The greater part of the field work for the report on the coastal plain of Georgia has been completed, by L. W. Stephenson on behalf of the Federal Survey and by Otto Veatch on behalf of the Georgia Geological Survey. The report on the stratigraphy and underground waters of Florida, by G. C. Matson and Samuel Sanford, has been completed and submitted. It will be published as a bulletin of the Florida Geological Survey. The data accumulated in regard to the stratigraphy and underground waters of South Carolina will be utilized in a report, now in preparation, by the state geologist, Earl Sloan.

In addition to the general surveys above mentioned, the detailed survey of the Choptank quadrangle in Maryland was completed by B. L. Miller and H. P. Little, and the report is now in preparation. Considerable progress was also made in the detailed survey of the Tolchester quadrangle in Maryland and of the Elkton and Wilmington quadrangles in Delaware and Maryland.

A report on the geology of Long Island was completed and submitted by M. L. Fuller. A special study of the Lower Cretaceous formations of Delaware and Maryland was made by Arthur Bibbins, E. W. Berry, and H. P. Little.

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 Miss Julia A. Gardner, of Johns Hopkins University, and Dr. R. S. Lull, of Yale University.

Along the Gulf coast the work has included the preparation of a report in cooperation with the State on the geology of the Caddo oil fields of northwestern Louisiana, by G. D. Harris, state geologist, and a report on the geology and underground waters of the coastal plain of Texas east of Brazos River and south of Jefferson, by Alexander Deussen. This study is now being extended to the region of Brazos River.

Northern Appalachian region.—The Ordovician rocks on the west flank of the Adirondack uplift were studied by E. O. Ulrich, in association with H. P. Cushing and Rudolph Ruedeman, of the New York State Survey, and H. M. Ami, of the Canadian Survey. Instructive sections of the Ordovician in Rensselaer County, N. Y., were also studied by Mr. Ulrich and Doctor Ruedeman. One of the results was the acquirement of important data bearing on the stratigraphic relations of the horizons containing graptolite faunas.

Geologic mapping in Pennsylvania was conducted in cooperation with the State, which made an appropriation of $4,500 for the purpose. The work was in charge of G. H. Ashley, who was assisted by Charles Butts, M. J. Munn, E. W. Shaw, W. C. Phalen, and E. F. Lines.

A progress report reviewing the geology of all the quadrangles studied by this Survey in cooperation with the State was prepared by Mr. Ashley, assisted by Messrs. Butts, Munn, and R. W. Stone. This report has been published as a bulletin of the State Survey.

The areal and economic survey of the Hollidaysburg quadrangle, Pennsylvania, was finished by Charles Butts, and the resulting maps and folio text were carried nearly to completion. Mr. Butts also spent several weeks in the Barnesboro and Patton quadrangles studying recent mining developments and ascertaining their bearing on obscure geologic features in that region.

The survey of the Foxburg quadrangle was completed by E. W. Shaw, and the maps and text for the Foxburg-Clarion folio were prepared for publication. The survey of the Burgettstown quadrangle was also carried to completion by Mr. Shaw, and the text of a folio on the Burgettstown and Carnegie quadrangles was practically finished.

The preparation of the Johnstown folio, by W. C. Phalen, was completed. Mr. Phalen also prepared a special economic report on the mineral resources of this quadrangle.

The survey of the Sewickley quadrangle, by M. J. Munn, was finished, and the texts for a folio and an economic bulletin on that quadrangle were submitted. A bulletin on the economic resources of the Carnegie and Clarion quadrangles was also completed by Mr. Munn. The economic bulletins on the Sewickley and Clarion quadrangles will be published by the State.

The text for the Claysville folio is nearly finished, and work has been started in the Pittsburg, New Kensington, and Freeport quadrangles.

An investigation of the mineral-paint ores of eastern Pennsylvania was made by B. L. Miller and E. F. Burchard, assisted by four senior students of the Lehigh University. An abstract of the results of this work will be found in the report on the production of mineral

paints in 1908. A more detailed report, which is now completed, will be included in the next annual economic bulletin.

The survey of the Gettysburg quadrangle was completed by G. W. Stose. The results of the survey of this quadrangle will be combined with those for the adjoining Fairfield quadrangle, to be surveyed during the present season, as a single folio.

The maps and text for the Pawpaw-Hancock (W. Va.-Md.-Pa.) folio were nearly completed by Mr. Stose, and that folio will soon be ready for publication.

Progress was made in the areal and economic survey of the Phoenixville and Honeybrook quadrangles, Pennsylvania, by Florence Bascom. This survey will be combined with that of the Reading and Boyertown quadrangles to furnish the material for one folio of the geologic atlas.

The survey of the crystalline formations of the Wilmington, West Chester, Coatesville, and Elkton quadrangles, covering parts of Pennsylvania, New Jersey, and Delaware, was completed by Miss Bascom.

Paleobotanic and stratigraphic studies were made by David White in the coal fields of the Beaver Falls quadrangle, Pennsylvania, and in the Short Mountain Pocono region of West Virginia. Preliminary reports embodying the results were submitted to the geologists in charge of the mapping.

The field survey of that portion of the Easton quadrangle, Pennsylvania, which lies west of Delaware River was completed by W. S. Bayley.

In cooperation with the New Jersey Geological Survey, Professor Bayley made a special study of the magnetite iron ores of New Jersey. His report will be published as a bulletin of the State Survey.

Considerable progress was made by Professor Bayley in the preparation of his report on the crystalline rocks and the economic resources of the Highlands area in the Raritan quadrangle, New Jersey.

A reconnaissance survey of the iron ores of the Appalachian region in Virginia was made by E. C. Harder, whose report will be found in Bulletin 380.

Southern Appalachian region.—The study of the iron ores of the Birmingham district, Alabama, was completed during the year, and the report, by Charles Butts, E. F. Burchard, and E. C. Eckel, is now in press as Bulletin 400. The maps and text for the Birmingham folio were also practically completed by Mr. Butts.

The areal and economic survey of the Brookwood quadrangle, Alabama, was carried nearly to completion by Mr. Butts, and considerable progress was made in the preparation of the maps and folio text. These can not, however, be completed until the new topographic base map is finished.

In the Dalton quadrangle, Georgia, half of the metamorphic area was mapped by W. C. Phalen.

Special studies were made of the metamorphosed sedimentary formations in the Suwanee and Cartersville quadrangles of Georgia by Arthur Keith, and in the Kings Mountain and Gaffney quadrangles of North Carolina and South Carolina by Mr. Keith and D. B. Sterrett. The latter area is considered the key to the geology of the Piedmont Plateau of North Carolina and South Carolina.

A reconnaissance of that part of the Dahlonega gold belt in Georgia which lies in Cherokee County, to the southwest of Dahlonega, was made by H. D. McCaskey. This district contains a larger number of mines and prospects than any other in the State. In cooperation with the State Geological Survey a preliminary geologic map of this district has been prepared for publication in the state report.

A study of the Clinton iron-ore deposits in the Chattanooga district of Tennessee and Georgia was made by E. F. Burchard, and a brief report published in Bulletin 380.

The maps and manuscript for the Woodbury (Tenn.) folio have been nearly completed by E. O. Ulrich, but it has been decided to withhold publication until the study of the adjoining Murfreesboro quadrangle is finished, the geology of the two quadrangles being closely related.

GEOLOGIC WORK IN THE CENTRAL STATES EAST OF 97°.

Geologic investigations in Illinois were continued in cooperation with the State Geological Survey, F. W. DeWolf being in charge of the work for the Federal Survey. Areal and economic maps of the West Frankford and Herrin quadrangles were completed, and additional studies of the surficial geology of the Galatia quadrangle were made. A report on the economic resources of the St. Louis quadrangle (Ill.-Mo.) was completed and submitted by N. M. Fenneman. A similar report on the Belleville and Breese quadrangles is in an advanced state of preparation.

In addition to the detailed surveys, reconnaissance surveys were made with reference to the correlation of the " Coal Measures " formations and the preparation of a structural contour map of the State. David White participated in the stratigraphic studies and devoted considerable time to paleobotanic and stratigraphic studies in the coal fields of Illinois and Indiana, and to the preparation of reports thereon. About 2,000 drill and shaft records were collected and studied by Mr. DeWolf.

In cooperation with the State of Indiana, G. H. Ashley, assisted by E. F. Lines and J. A. Udden, reviewed the geology of the coal fields of that State, collecting records of hundreds of recent drillings and

visiting all areas of new development where the geology was in doubt. The report on this work has been published as a bulletin of the State.

Considerable progress was made in the study of the areal geology of the East Cincinnati and West Cincinnati quadrangles (Ohio-Ky.), which is being conducted under the supervision of E. O. Ulrich. The map of the Ordovician formations, chiefly by R. S. Bassler and J. M. Nickles, was completed. The delineation of the Pleistocene geology, which was assigned to N. M. Fenneman, is in progress.

The monograph on the Lake Superior region, a monumental work on which C. R. Van Hise and C. K. Leith, with the aid of various assistants, have been engaged for a long time, was brought to completion and transmitted for publication. This is an exhaustive study of one of the most complicated regions in the country, which is of special interest to both the scientific and the commercial world because of its intricate structure and its enormous deposits of iron and copper.

Detailed study and areal mapping of the glacial drift in Wisconsin were continued by W. C. Alden, chiefly in Sheboygan, Fond du Lac, Calumet, Manitowoc, Dodge, Washington, and Ozaukee counties and in parts of Columbia and Dane counties. This work was done under the supervision of T. C. Chamberlin. Considerable progress was made by Mr. Alden in the preparation of the report on the glacial geology of southeastern Wisconsin.

At the opening of the fiscal year Frank Leverett was in Europe—on a trip made at his own expense—for the purpose of making a comparison of the drift sheets there with those in North America. These studies were pursued in each of the large centers of glaciation, namely, Scandinavia, Great Britain, and the Alps, as well as in two small areas of glaciation, the Riesengebirge and the Black Forest of southern Germany. Much light was obtained on the variations in the amount of weathering and erosion displayed by the European drift sheets, which will be very helpful in interpreting the glacial history of America. A report on the principal results of these European studies has been prepared.

Considerable progress was made on the monograph on the Pleistocene of Indiana and Michigan, of which Mr. Leverett and F. B. Taylor are joint authors. This report now awaits the completion of the base maps, which are in course of preparation. During the year Mr. Taylor spent some time in a special study of the lake history and drift formations in the southwestern part of Ontario for the Canadian Geological Survey. This region has an important bearing on the glacial and lake history of America in general, and the studies have furnished data that will be of value in the completion of the monograph on the Pleistocene of Indiana and Michigan and

in other investigations which are in progress. In connection with work on this monograph, additional field studies were made of certain beaches and moraines related to Lake Maumee, in northwestern Ohio.

An investigation of the existing condition of the lead and zinc industry of the Mississippi Valley was made by C. E. Siebenthal, who spent a month in the various lead and zinc camps in that region.

A field review of the complicated stratigraphic and faunal relations of the Paleozoic rocks in the Ouachita uplift of Arkansas and eastern Oklahoma was made by C. W. Hayes, E. O. Ulrich, J. A. Taff, and A. H. Purdue, for the purpose of obtaining data for an improved classification of the rocks of that region. During this conference parts of the Caddo Gap quadrangle in Arkansas and of the Tuskahoma, Atoka, and Ardmore quadrangles in Oklahoma were visited. On its conclusion Mr. Taff, assisted by W. J. Reed, reviewed the stratigraphy and structure of the McAlester, Tuskahoma, and Windingstair quadrangles, Oklahoma, with reference to the completion of the folios of those areas. A survey of the Mid-Continent oil field in Oklahoma was then begun, and the examination of the Morris-Bald Hill district was completed. As a result of these investigations, Mr. Taff, assisted by Mr. Reed, submitted brief reports on the grahamite of southeastern Oklahoma (in Bulletin 380) and on the Madill oil pool in Oklahoma (in Bulletin 381). He also has in preparation a more detailed report on the oil resources of Oklahoma and folios descriptive of the McAlester, Tuskahoma, and Windingstair quadrangles. In addition considerable time was devoted by Mr. Taff to the classification of the coal lands of Utah and Colorado.

The mapping of the Caddo Gap and Harrison quadrangles, Arkansas, was completed by A. H. Purdue, assisted by H. D. Miser and R. D. Mesler, and progress has been made in the preparation of the folios.

A report on the fauna of the Moorefield shale of Arkansas was completed by G. H. Girty.

Considerable progress was made by G. D. Harris in the preparation of a report on the Caddo oil field in Arkansas, Louisiana, and Texas. This work is being done in cooperation with the State Survey.

GEOLOGIC WORK IN THE WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Rocky Mountain region.—One of the tasks assigned to the geologic branch at the beginning of the last fiscal year was the examination, for the purpose of classification and valuation, of about 16,000 square miles of supposed coal territory in the Rocky Mountain region. This work was placed in charge of M. R. Campbell, with C. A. Fisher as chief assistant. In order to cover this territory properly twelve field parties were organized and three independent workers were sent

out. In addition there was undertaken, for the Bureau of Indian Affairs and in cooperation with the Reclamation Service, as provided in the act of May 30, 1908, an examination of the lignite beds of the Fort Peck Indian Reservation. For this investigation one large field party was organized and put in charge of C. D. Smith, making a total of thirteen field parties and three independent workers. During the winter the results of these field examinations were compiled in the office. This involved the preparation of geologic maps, of township plats showing the classification and valuation of the coal lands examined, and of preliminary reports on the geology of the regions. The following is a list of the areas examined and of the geologists in charge of the work:

Newcastle coal field, Wyoming. R. W. Stone.
Cambria coal field, Black Hills region, Wyoming. R. W. Stone.
Northwestern part of Great Divide coal basin, Wyoming. E. E. Smith.
Coal fields in southeastern part of Bighorn Basin, Wyoming. E. G. Woodruff.
Coal fields on north and east sides of Bighorn Mountains, Wyoming. H. S. Gale.
Coal fields in Wind River Basin, Wyoming. E. G. Woodruff.
Southeastern extension of the Hanna coal field, near Arlington, Wyo. M. W. Ball.
Southern part of Rock Springs coal field, Wyoming. A. R. Schultz.
Coal field in northern Wyoming which adjoins on the east the Sheridan coal field. R. W. Stone.
Eastern part of Little Snake River coal field, southern Wyoming. M. W. Ball.
Livingston coal field, Montana. W. R. Calvert.
Coal field in vicinity of Electric, Mont. W. R. Calvert.
Portion of Milk River coal field, northern Montana. L. J. Pepperberg.
North-central part of Bull Mountain coal field, Montana. R. W. Richards.
Fort Berthold Indian Reservation, N. Dak. (examination made for the Reclamation Service). C. D. Smith.
Vicinity of Washburn, N. Dak. (examination made for Reclamation Service). C. D. Smith.
Trinidad coal field, southern Colorado. G. B. Richardson.
Colorado Springs coal field, Colorado. M. I. Goldman and G. C. Martin.
Coal fields in vicinity of Canon City and South Park, Colo. C. W. Washburne.
Coal fields of north-central Colorado between Sedalia and the Wyoming state line. G. C. Martin.
Part of the Raton coal field east of the Maxwell land grant, in southern Colorado and northern New Mexico. W. T. Lee.
Several small coal fields in central New Mexico. J. H. Gardner.

In all the foregoing fields the special stratigraphic and paleontologic studies necessary for the correlation of the rocks of the different regions were made by T. W. Stanton and F. H. Knowlton.

At the request of the Bureau of Indian Affairs an examination of the Standing Rock and Cheyenne Indian reservations of North Da-

kota and South Dakota was undertaken April 1, 1909. This survey, which is provided for in the act of May 29, 1908 (35 Stat. L., 460–462), was placed in charge of W. R. Calvert. It will cover an area of 4,150 square miles, of which nearly one-half is supposed to be underlain by valuable lignite deposits. This investigation is still in progress. Three well-equipped field parties, under the personal direction of V. H. Barnett, A. L. Beekly, and M. A. Pishel, are engaged on the work.

In addition to the foregoing surveys, which were made for the purpose of classifying the lands with reference to their value as coal-producing territory, the following other surveys and investigations were carried on in the Rocky Mountain region during the last fiscal year:

The map and text for the Laramie-Sherman folio, Wyoming, were completed by N. H. Darton, C. E. Siebenthal, and Eliot Blackwelder, and submitted for publication.

A field study of the pre-Cambrian rocks of parts of British Columbia, Alberta, and Montana lying between the Crows Nest division of the Canadian Pacific Railway on the north and the main line of the Great Northern Railway on the south was made by C. D. Walcott, assisted by L. D. Burling. The object of this study, carried on chiefly at the expense of the Smithsonian Institution, was to ascertain the true relations of the rocks of that area to the pre-Cambrian rocks of central Montana and to the Cambrian rocks of the section along the main line of the Canadian Pacific Railway farther to the north.

The areal survey of the Philipsburg quadrangle, Montana, was completed by F. C. Calkins. Considerable progress was made in the preparation of the report, which will include a chapter on the ore deposits, by W. H. Emmons, who made a special study of that feature of the district. Mr. Emmons's report has been completed and submitted.

An areal survey of the Frisco (Utah) mining district was well advanced by B. S. Butler, under the supervision of Waldemar Lindgren, chief of the section of metalliferous deposits.

The report on the Park City mining district, Utah, is nearing completion. It has been delayed by the resignation, in September, 1908, of J. M. Boutwell, who had the matter in charge.

F. L. Hess spent a few weeks in a study of the tin, tantalum, and tungsten deposits of South Dakota. A brief report on these investigations will be found in Bulletin 380.

An examination of deposits of mica in South Dakota was made by D. B. Sterrett, and a brief report thereon prepared for Bulletin 380.

A study of the phosphate deposits of Idaho and Wyoming was begun in June by H. S. Gale, assisted by R. W. Richards and C. E.

Breger. The object of this work is the classification of land temporarily withdrawn from entry on account of its phosphate deposits. The report of G. H. Girty on the fauna of the Carboniferous phosphate beds of Utah, Idaho, and Wyoming, based on collections made in previous years, has been completed.

Progress was made in the preparation of a supplementary report on the complicated geology of the Leadville district, Colorado, by S. F. Emmons and J. D. Irving.

The study of the Breckenridge (Colo.) mining district was started during the fall by F. L. Ransome and will be continued during the present season.

An examination of the mining districts of eastern Gunnison County, Colo., was made by J. M. Hill. A brief report will be found in Bulletin 380.

Geologic mapping in the San Juan region of Colorado was continued by Whitman Cross, assisted by H. Bancroft and J. P. Iddings. During the season field work in the Lake City quadrangle was completed and the northern portion of the San Cristobal quadrangle was surveyed. The revision of the map and text for the Engineer Mountain folio, made necessary by the study of adjacent areas, was finished and the folio is now in process of publication. The reports on the Lake City and San Cristobal quadrangles await the completion of field work in adjoining districts. A bulletin on the ore deposits of the Lake City quadrangle is, however, well advanced.

A study of the Florence oil field, Colorado, was made by C. W. Washburne. A brief report on the investigation will be found in Bulletin 381.

A report on the metalliferous deposits of New Mexico was completed by Waldemar Lindgren.

An examination of the magnetite deposits of Hanover, N. Mex., was made by Sidney Paige, and a map of the area in which the principal mines are located was prepared. A report on this examination appears in Bulletin 380.

During the early part of the fiscal year a report on the mining districts of Mohave County, Ariz., was completed by F. C. Schrader and is in press as Bulletin 397. In March Mr. Schrader began an investigation of the mineral deposits of the Patagonia and Nogales quadrangles, Arizona, in which he was assisted by J. M. Hill.

A reconnaissance of the geology and mineral deposits in the northern part of Yuma County, Ariz., was made by H. Bancroft.

The Whetstone Mountains, south of Benson, Ariz., were visited by F. L. Hess, for the purpose of studying the tungsten deposits. A brief report on these deposits will be found in Bulletin 380.

At the request of the Supervising Architect of the Treasury Department, an investigation of the marble prospects near Bowie, Ariz.,

was made, with reference to the geologic conditions which might affect the availability of these marbles for building or decorative purposes. This work was in charge of Sidney Paige, whose report has been submitted.

Geologic mapping in central Texas was placed in charge of A. C. Spencer. The detailed mapping of the complicated pre-Cambrian area of the Llano 30-minute quadrangle was completed and considerable progress was made in the study of the crystalline rocks of the adjoining Burnet quadrangle. In connection with this mapping a careful study has been made of the metallic iron ores of the district. In this work Mr. Spencer has been assisted by Sidney Paige, and during a part of the time by H. Bancroft and F. H. Kay. A brief visit to the region was also made by E. O. Ulrich, for the purpose of assisting in the differentiation of the Paleozoic formations.

In cooperation with the technologic branch David White devoted considerable time to studies of the western coal fields and to collecting material bearing on the origin of certain coals.

Pacific coast.—The field study of the geology and ore deposits of the Goldfield (Nev.) district was completed by F. L. Ransome in July. His detailed report, which was prepared during the winter, is now ready for distribution (Professional Paper 66).

A reconnaissance of the mining regions between parallels 40° and 41° and meridians 117° and 119° was made by Mr. Ransome. This reconnaissance resulted in the preparation of several short reports on the geology and mineral resources of various areas in Nevada. These reports cover the Bullfrog (Bulletin 407); Yerington, Hornsilver, and Round Mountain (Bulletin 380); and Humboldt County (Bulletin 414) districts. In the field work on the Bullfrog district Mr. Ransome was assisted by W. H. Emmons and G. H. Garrey.

A reconnaissance of the mining districts in northeastern Nevada between meridians 116° and 117° and parallels 40° and 42° was made by W. H. Emmons, whose report is nearly ready for publication (Bulletin 408).

A brief examination of the platinum deposits in southern Nevada was made by H. Bancroft, and a study of oil prospects in Nevada by Robert Anderson. Brief reports upon the oil prospects near Reno, in Mason and Smith valleys, and near Palisade were published in Bulletin 381.

Surveys in the oil region of southern California were in charge of Ralph Arnold, assisted by H. R. Johnson. These surveys included the McKittrick, Midway, Sunset, Temblor, Devils Den, and Carrizo Plain districts and adjacent parts of western Kern and eastern San Luis Obispo counties. Special attention was given to the details of the underground geology in the proved territory, in order to discover the laws governing the occurrence of the petroleum in the

various fields, and also to a study of the structure and stratigraphy of the adjacent region, with a view to furnishing information as to the extension of the productive area and to decreasing the cost of exploitation by reducing the number of dry holes drilled. A study of the paleontology, which bears a peculiarly important relation to the interpretation of the structure and stratigraphy in this region, was carried on simultaneously with the economic work. A preliminary report on the region has been completed and is in press as Bulletin 406.

The detailed report on the Coalinga oil district, California (Bulletin 398), was completed by Ralph Arnold, assisted by Robert Anderson. The paleontology of this district was made the subject of a special report (Bulletin 396) by Mr. Arnold. Both of these reports are now in press. During the year a report on the sodium sulphate deposits in the Carrizo Plain, by Ralph Arnold and H. R. Johnson, was issued as an advance chapter of Bulletin 380.

On the resignation of Mr. Arnold, June 1, 1909, Mr. Anderson was assigned to continue the investigations of the California oil fields, and field work in the Carrizo Plain region—an undeveloped territory adjoining the McKittrick-Sunset district—was resumed.

Geologic work in the Randsburg quadrangle, California, was prosecuted by F. L. Hess, who gave special attention to the study of the gold deposits of that area.

The report on the copper-mining districts in Shasta County, Cal., is nearing completion. It has been delayed by the resignation, in February, of L. C. Graton, who made the investigations and who had the matter in charge. The work has been taken up by B. S. Butler, and will be pushed to completion as soon as possible.

On June 1, 1909, a detailed study of the iron-ore deposits of southern California was commenced by E. C. Harder and J. L. Rich. This work will be continued during the summer and fall.

The Bohemia mining district of Oregon was examined by D. F. MacDonald, who spent two weeks in a study of the district and made a brief report thereon (in Bulletin 380).

Considerable progress was made by F. C. Calkins and J. T. Pardee in the areal mapping of the Sumpter quadrangle in Oregon. A brief report on the faulting and vein structure in the Cracker Creek mining district, in this quadrangle, was prepared by Mr. Pardee and appeared in Bulletin 380.

Satisfactory progress was made by J. P. Smith on the report on the Upper Triassic of California, Oregon, and Nevada. Field work bearing on this subject was confined to the Blue Mountains of Oregon.

A special reconnaissance of the Grants Pass quadrangle and bordering region in Oregon was made by J. S. Diller, assisted by G. F. Kay. A brief report will be found in Bulletin 380.

National forests.—An important work carried on by the geologic branch is the examination of contested mineral claims in the national forests. This work is under the immediate supervision of Waldemar Lindgren. To it there were detailed during the year a number of geologists as well as temporary assistants. Contested claims in the Cabinet and Black forests were examined and reported on by F. C. Schrader. Claims in the Holy Cross, La Salle, Gunnison, Jemes, Montezuma, Ozark, Pecos, Rio Grande, Taos, Teton, and Leadville forests were examined and reported on by J. M. Hill; claims in the Sawtooth and Snoqualmie forests by E. E. Bugbee; claims in the Rainier forest by E. E. Bugbee and J. B. Umpleby; claims in the Umpqua, Black Hills, and Crater forests by D. F. MacDonald; and claims in the Trinity and Plumas forests by H. W. Turner. In all 131 claims or groups of claims were examined, and reports as to their mineral or nonmineral character were transmitted to the Forest Service. Of the total number of locations examined 76 were recommended to be canceled as nonmineral land.

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 not only in connection with 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 essential for the symmetrical development of the Survey work. Additional assistants in the section of paleontology are urgently needed.

In addition to the supervision of the paleontologic work, Mr. Stanton visited 17 parties in the field in Montana, Wyoming, and Colorado, chiefly engaged in the 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. Field study on the same general problems was resumed by Mr. Stanton early in June.

The study 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 visited numerous points in Montana, Wyoming, Colorado, and New Mexico, for the purpose of collecting fossil plants and determining the stratigraphy of the coal beds.

Under the joint direction of F. H. Knowlton and C. D. White a compendium of paleobotany is being prepared by Miss C. H. Schmidt, and satisfactory progress is reported.

W. H. Dall has continued during the year his studies on the Tertiary paleontology of the Pacific coast.

The work of the other paleontologists has been noted in connection with the geologic work with which it is intimately related.

Considerable progress was made on the monograph of Cambrian Brachiopoda by C. D. Walcott. The technical descriptions and most of the tables were completed. The chapters dealing with the classification, evolution, and biologic relations of the Brachiopoda were also completed.

A study of graptolite faunas, with special reference to their value in stratigraphic correlation, was made by E. O. Ulrich. This has been found of great service in the classification of shale and sandstone formations in which other classes of fossils are practically absent.

Progress was made on the monographs on Cambrian bivalved Crustacea and on fossil Ostracoda, which are in course of preparation by E. O. Ulrich and R. S. Bassler.

A special monographic study of the Mesozoic and Cenozoic Echinodermata of the United States is being made by W. B. Clark and M. W. Twitchell. In this work particular attention has been given to the geologic distribution of the forms, as an aid in the interpretation of the Cretaceous and Tertiary deposits of the Atlantic and Gulf coastal plains.

The collection of fossils from the celebrated "silex" beds of Florida was greatly augmented during the year. As they are of importance in correlating the Oligocene of the Antilles, a special study is being made of them by W. H. Dall. The results will later be incorporated in a bulletin.

The preparation of the general geologic map of North America, which is being compiled in cooperation with the geological surveys of Canada and Mexico, has been continued by Bailey Willis. The map and accompanying descriptive text are approaching completion. They will be published as a professional paper, entitled "Index to the stratigraphy of North America." In connection with this work studies in paleogeography were carried on, in the course of which fifteen maps of the continent have been drawn to represent its geographic aspect at as many periods, from Lower Cambrian to Quaternary.

During the prosecution of the coal-land surveys in the States of Montana, Wyoming, and Colorado, important stratigraphic data

bearing on the late Cretaceous and early Tertiary history of that region were obtained. From these data a general geologic map of the region has been prepared by Bailey Willis.

Studies of the Pleistocene glaciation of the Sierra Nevada were continued by W. D. Johnson, who, in company with G. K. Gilbert and with E. C. Andrews, of the New South Wales Department of Mines, made an excursion to the alpine district of the Sierra, where a joint field study of the mechanics of glacial erosion and the principles of glacial sculpture was conducted.

The catalogue of earthquakes in the United States, which is in charge of H. F. Reid, was during the year augmented by records of some early earthquakes, as well as records of earthquakes which occurred during the year.

A general report on the manganese deposits of the United States was prepared by E. C. Harder, and a bulletin on the economic geology of the feldspar deposits of the United States (Bulletin 420) was completed by E. S. Bastin.

Considerable progress was made in the classification of the physiographic features shown on topographic maps, a study which is being conducted by W. W. Atwood.

A comprehensive geologic exhibit was prepared for the Alaska-Yukon-Pacific Exposition at Seattle. The work of assembling and classifying the exhibit was in charge of J. S. Diller.

The important investigation of problems connected with the overloading of California rivers by mining débris was continued by G. K. Gilbert, in cooperation with the water-resources branch.

WORK OF LAND-CLASSIFICATION BOARD.

The organization of the land-classification board has already been discussed on pages 10–12. The work accomplished by the board to the close of the fiscal year has been as follows:

Coal land.—Soon after its organization the coal section of the board found that it was confronted with many questions which required a decision by the Secretary. The matter was therefore presented to him with the statement that, until he should rule on the questions presented, it was deemed unwise to transmit further classifications. New regulations covering the classification of coal land were approved by the Secretary on April 10, 1909, and classification was immediately resumed.

In these regulations the selling price of the government coal land is fixed on the basis of tonnage and quality of the coal, the rate ranging, except for lignite, from half a cent to 3 cents a ton, about 5 to 30 per cent of the royalties prevailing in the West. This low percentage is adopted in order to allow for the cost of carrying the investment while mining, as opposed to the royalty paid when the coal is

mined, and for the extra hazard of a coal-land purchase over that of a lease paying a royalty on coal actually recovered. These unit rates are further reduced where the land contains more than one bed, and these reductions, with allowances for depth and other factors, make the actual price fixed usually less than 10 per cent of royalty prices.

Since the adoption of these regulations 5,155,194 acres of land have been classified with respect to their coal values. Of this total area, 742,573 acres were classified as coal land, and the selling price fixed on this area is approximately $30,000,000, representing an advance over the minimum price fixed by law of more than $16,000,000. Of this land, over 50 per cent belongs to the Government, and if this coal land were leased it would ultimately yield about $150,000,000 instead of the $15,000,000 which will be received by sale.

The area classified is divided among the States as follows:

Coal-land classification under Secretary's regulations of April 10, 1909.

State.	Area in acres.		Total value of coal land at prices fixed.	Total value of coal land at minimum price.
	Coal.	Noncoal.		
Colorado	104,298	331,865	$2,325,330	$2,085,960
Montana	493,931	2,241,210	12,026,847	9,739,919
Wyoming	144,344	1,839,546	16,136,174	2,316,833
	742,573	4,412,621	30,488,351	14,142,712

All coal-land classifications heretofore made by the Geological Survey will be reviewed by the coal section and the lands reclassified.

The results obtained by the 13 parties now surveying the public coal lands will also come to the section for action.

In addition to the above, the coal section has classified 19 coal claims in national forests.

Phosphate.—On December 10, 1908, the Secretary, in aid of proposed legislation covering the disposal of phosphate lands, temporarily withdrew from all forms of disposal the unpatented lands in tracts covering 4,699,160 acres in the States of Wyoming, Idaho, and Utah. These withdrawals were made by the township unit, because of the uncertainty of the location of the phosphate-bearing beds with reference to the smaller legal subdivisions. A review of this withdrawal by the phosphate section of the board led to the restoration of 231,040 acres of nonphosphate lands in areas where the location of the deposits with reference to the land corners was known with sufficient definiteness to warrant such action. It is expected that examination will show that a large per cent of the land now withdrawn is nonphosphate, and the release of such areas will immediately follow the completion of the field work now in progress.

Power sites.—Upon data furnished by the Geological Survey, the Secretary, between May 4 and June 30, 1909, made 26 temporary

power-site withdrawals covering rivers in Colorado, Montana, Idaho, Oregon, Utah, and Wyoming. These withdrawals were made in aid of proposed legislation affecting disposal of power sites and resulted in the removal from all forms of disposal and temporary suspension of existing entries, claims, and filings in the following areas:

Power-site withdrawals.

[Acres.]

State.	Entered land.	Vacant land.	Total.
Colorado	360	21,880	22,240
Montana	6,066	39,979	46,045
Idaho	3,402	56,480	59,882
Oregon	5,849	75,269	81,118
Utah	15,200	19,680	34,880
Wyoming	7,754	27,629	35,383
	38,631	240,917	279,548

Other withdrawals are being made as rapidly as data becomes available.

Enlarged homestead designations.—The enlarged homestead act became a law on February 19, 1909, and the first designation under this law was made by Secretary Garfield in eastern Wyoming on March 3, 1909.

The total areas designated in each State up to the end of the fiscal year are given below:

Designations under enlarged homestead law.

	Acres.		Acres.
Wyoming	10,676,280	Oregon	8,346,560
Arizona	26,657,280	Utah	7,044,480
Colorado	20,299,840	Washington	3,576,960
Montana	19,957,960		
Nevada	49,512,960		160,880,840
New Mexico	14,808,520		

Since the passage of the enlarged homestead act 91 petitions have been received. The action taken on these is indicated below:

Enlarged homestead designations in March, April, May, and June, 1909.

Favorably considered	16
Partly refused	21
Refused	12
Pending:	
Field work in progress	16
Under consideration	26

Oil.—The oil section of the board classified 974,820 acres in the McKittrick-Sunset (California) oil withdrawal. Of this area 430,340 acres were classified as oil land.

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of $80,000 for "continuation of the investigation of the mineral resources of Alaska," work of the following classes having been done: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigations of water resources in reference to supply available for placer mining; and collection of statistics on mineral production.

PERSONNEL.

The personnel of the division varies greatly during the year by transfers of technical employees to and from other divisions of the Survey and by the employment of temporary clerks as the work demands. Throughout the year 1 geologist in charge, 7 other geologists, 3 topographers, and 3 clerks have been employed. In addition to these 1 geologist was employed on annual salary until April 20, when he was transferred to the per diem force; 1 geologist on an annual salary gave about half his time to the Alaska work; and 3 others were employed a part of the time on a per diem compensation. On May 1, 1909, 1 additional geologist on annual salary and 1 topographer on monthly salary were added to the force by transfer from other divisions. Five engineers were detailed to the division from the water-resources branch for varying periods of time.

During the season of 1908 the field force included also 1 topographic and 1 geologic field assistant, together with about 28 teamsters, cooks, etc. The temporary assistants in the field force, as already organized for 1909, include 2 geologic and 2 topographic field assistants, with about 30 laborers. One temporary clerk has been employed in the office for six months and a clerical assistant for short periods of time. On June 30, 1909, the division included 1 geologist in charge, 9 geologists on annual salaries and 5 geologists employed at a per diem compensation, 2 geologic field assistants, 3 engineers, 30 camp hands, and 3 clerks.

FIELD OPERATIONS IN SEASON OF 1908.

Allotments and areas covered.—Thirteen parties were engaged in Alaskan surveys and investigations during the field season of 1908 for varying periods between March and November. Some of these parties were subdivided in the field, making a total of 17 parties that were engaged in various kinds of investigation. The geologist in charge also spent a part of the summer in Alaska, carrying on geologic investigations and visiting field parties.

The area covered by topographic reconnaissance surveys during 1908 aggregated 3,975 square miles; by detailed topographic surveys,

427 square miles; by detailed geologic surveys, 604 square miles; and by geologic reconnaissance surveys, 4,850 square miles. In addition to the actual areal mapping most of the geologists 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 6,700 square miles and included the maintenance of 53 gaging stations and 556 measurements of stream volumes. Of the 28 mining districts of Alaska that are being developed 18, including all but 3 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, 1908.

Southeastern Alaska	$9,800
Prince William Sound and southwestern Alaska	9,100
Copper River region	20,000
Yukon basin	27,950
Seward Peninsula	13,150
	80,000

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:

Approximate allotment of Alaskan funds to different classes of surveys and investigations, 1908.

Geologic reconnaissance surveys	$14,100
Detailed geologic surveys	10,000
Special geologic investigations	8,900
Topographic reconnaissance surveys	12,200
Detailed topographic surveys	14,200
Investigation of water resources	9,900
Collection of statistics of mineral production	1,500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	9,200
	80,000

The geologic reconnaissance surveys of the above table include all those published on a scale of 1:250,000 to 1:625,000, or approximately 4 to 10 miles to the inch. The detailed geologic surveys are for

publication on a scale of 1:62,500, or approximately 1 mile to the inch. The special geologic investigations are chiefly those directed to the study of problems connected with the occurrence of mineral deposits. The topographic reconnaissance surveys are chiefly for publication on a scale of 1:250,000, usually with 200-foot contours, though some exploratory surveys are published on a scale of 1:625,000. The detailed topographic surveys are for publication on a scale of 1:62,500, with 25, 50, or 100 foot contours. The water-resources investigations have for their purpose the determination of the water supply available for placer mining.

The cost per square mile of the various types of surveys is determined by many factors varying greatly in different parts of the Territory. Chief among these is the item of transportation, which ranges in cost from 5 to 30 per cent of the total expenditure for surveys. The cost of the topographic reconnaissance surveys is from $2 to $4 per square mile and of the detailed topographic mapping from $25 to $40 per square mile. The variations are partly due to differences in cost of transportation, but also to character of topography, vegetation, rainfall, length of open season, etc.

All the variations which affect the cost of topographic work also influence that of geologic mapping. In addition there is a more important factor in the knowledge of the characteristics of the geology and of the problems involved, before the work has been begun. If the general features of the geology of any province are known, areal mapping can be carried on much more rapidly there than in an unexplored province. Obviously, also, where the stratigraphic and areal relations are simple mapping can be carried on far more rapidly than where they are complex. It is not surprising, therefore, that the cost of geologic reconnaissance surveys varies from 75 cents to $3.50 per square mile. In Alaska detailed geologic surveys have been carried over only a few small areas, so that there are few data on which to base estimates of cost. The evidence in hand, however, indicates a cost of $14 to $34 per square mile for work of this class. Water-resources investigations, involving the measurement of stream volumes in the same district for a period of years, can not be estimated per square mile.

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

Progress of surveys in Alaska, 1898–1908.[a]

Year.	Appropriation.	Areas covered (square miles).				Water-resources investigations.	
		Geologic.		Topographic.		Gaging stations maintained part of year.	Stream-volume measurements made.
		Reconnaissance.	Detailed.	Reconnaissance.	Detailed.		
1898	$46,189.60	9,500	.....	14,912	.....	.....	.....
1899	25,000.00	6,000	.....	8,688	.....	.....	.....
1900	25,000.00	10,000	.....	11,152	.....	.....	.....
1901	35,000.00	12,000	.....	15,664	.....	.....	.....
1902	60,000.00	17,000	.....	20,304	336	.....	.....
1903	60,000.00	13,000	336	15,008	.....	.....	.....
1904	60,000.00	6,000	.....	6,480	480	.....	.....
1905	80,000.00	8,000	550	8,176	948	.....	.....
1906	80,000.00	9,000	414	10,768	40	14	286
1907	80,000.00	4,000	400	6,125	501	48	457
1908	80,000.00	4,850	604	3,975	427	53	556
	631,189.60	99,350	2,304	121,252	2,732	.....	.....
Percentage of total area of Alaska	.....	16.94+	0.39+	20.85—	0.47—	.....	.....

[a] In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey and other government bureaus have covered an area of approximately 50,000 square miles. Most of this work is along the coast line, and has been carried on with a high degree of refinement. The inland surveys are chiefly of a reconnaissance character, except for a narrow strip along the international boundary.

The progressive decrease in the area covered annually by reconnaissance surveys is largely due to the fact that since 1903 a considerable part of the appropriation has been spent for detailed surveys, in order to meet the growing demand for detailed maps. As the detailed surveys cost from five to twenty times as much as reconnaissance surveys, the total area surveyed for the same money is necessarily very much less. Another reason for the decrease is the fact that during the first five years practically the entire appropriation was devoted to explorations, whereas now much of it is spent on special investigations. Moreover, early exploratory surveys were not executed with the same degree of refinement as the present reconnaissance work.

To meet the demands of the mining industry, it does not seem advisable to devote any larger percentage of the appropriations to reconnaissance surveys at the expense of detailed surveys and investigations, and therefore, with funds available, the general work can not be extended any more rapidly than it has been during the last decade. As approximately a fifth of the Territory has been covered by reconnaissance maps, both topographic and geologic, it appears that it will require at least fifty years to cover the whole Territory with the preliminary mapping. It should be added, however, that the areas that have been chosen for survey are those of most importance to the mining industry, and that a fifth or a quarter of the

remaining area may not require survey for many years to come. The fact remains, however, that there are about 200,000 square miles in Alaska which should be surveyed at an early date, and that under the present appropriation it will be impossible in less than two or three decades to accomplish this and at the same time carry on the detailed work demanded by the mining developments.

General investigations.—The field investigations of Alfred H. Brooks, geologist in charge of the division, covered the period from about the end of July till the middle of October. Of the time actually devoted to field work, about two weeks was spent with Mr. Wright on the geology of Kasaan Peninsula, Karta Bay, and the Copper Mountain region—all on Prince of Wales Island. At the same time Mr. Sargent's topographic party, then surveying the Copper Mountain region, was visited. About ten days was spent at Fairbanks with Mr. Covert, Mr. Prindle, and Mr. Katz in becoming familiar with the problems connected with the detailed geology and mining development of the Fairbanks district. The latter part of the season was spent with Mr. Smith in a review of the areal geology of the Solomon and Casadepaga region, together with some reconnaissance work in adjacent areas.

In the office Mr. Brooks has given most 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 compilation of the mineral statistics of Alaska. Most of the month of July was devoted by Mr. Brooks to a continuation of the report on the Mount McKinley region. During the month of December he prepared a summary of the existing knowledge of the mineral resources of Alaska for the Conservation Commission. He also prepared a report entitled "Mining and mineral wealth of Alaska" for distribution at the Alaska-Yukon-Pacific Exposition and a report on the gold, silver, and copper production of Alaska for the "Mineral resources" volume of 1908.

By instructions of the Secretary of the Interior Mr. Brooks prepared a comprehensive scheme for subdivisional surveys in Alaska, reporting that there was a great need for additional land surveys in the Territory. He also prepared a plan for an agricultural reconnaissance of Alaska, which was approved by the Secretary of Agriculture, and Mr. Brooks was thereupon called into conference by the Chief of the Bureau of Plant Industry for consultation on the best methods of carrying out such survey. Realizing the desirability of educating the public on the physical features and resources of Alaska, Mr. Brooks suggested to Secretary Walcott, of the Smith-

sonian Institution, the wisdom of installing a special Alaska exhibit, and at Mr. Walcott's request he outlined a plan for such an exhibit.

Mr. Sargent devoted about four months to the preparation of an exhibit for the Alaska-Yukon-Pacific Exposition. This exhibit included 10 large maps and about 20 small ones showing the geology and mineral resources of Alaska, a large number of photographs and transparencies illustrating methods of mining in the Territory, a complete set of Survey publications relating to Alaska, and a set of about 600 specimens of typical rocks, ores, and minerals. Mr. Sargent was assisted in this work by P. S. Smith, who devoted about six weeks to it, and by other geologists for shorter periods of time. Five draftsmen were employed for periods of one to four months in preparing the maps, their salaries being met by allotment from the federal appropriation for the Alaska building. The preparation of this exhibit seriously interfered with the regular work of the division, and as a consequence two maps and two reports which under ordinary circumstances would have been finished before the field season opened had to be left over until next winter.

Southeastern Alaska.—The detailed geologic mapping of Kasaan Peninsula and the copper-bearing belts of Copper Mountain begun in 1907 was completed in 1908 by C. W. Wright. About 90 square miles have been mapped. These investigations represent the first detailed studies made south of Juneau and form a part of the general plan to make similar studies of all the important producing mining districts. The base maps needed for this detailed geologic work were begun in 1907 by D. C. Witherspoon and were completed in 1908 by R. H. Sargent, who also mapped an area of 53 square miles in the Copper Mountain region. These surveys were made for a publication scale of 1 inch to a mile (1:62,500) with 50-foot contours.

Copper River region.—F. H. Moffit, associated with Adolph Knopf and assisted by S. R. Capps, in 1908 made a reconnaissance survey of the copper and gold bearing belt extending from the head of Copper River across to White River. About 1,800 square miles have been mapped geologically and Mr. Capps, who devoted about one month to topographic surveys, covered an area of 450 square miles.

As detailed study of the copper deposits of this general province must be undertaken before the laws of their occurrence can be determined, and as such detailed studies require a base map, it was decided to prepare such a map of the east end of the Kotsina-Chitina belt. To this work D. C. Witherspoon, assisted by R. M. La Follette, was assigned and surveyed an area of 325 square miles for publication on a scale of 1 mile to the inch, with contour intervals of 50 feet.

Prince William Sound.—The Prince William Sound region has been the scene of several investigations by the Geological Survey, the latest previous to 1908 having been made by U. S. Grant in

1905. The extensive prospecting done in this field and the fact that it has been a large shipper of copper ore made further work imperative. Mr. Grant assisted by D. F. Higgins, was therefore engaged to continue his investigations of this field and to complete the general reconnaissance of the ore deposits of Prince William Sound. The party made geologic reconnaissance surveys of about 600 square miles and a detailed topographic and geologic map of 8 square miles at the north end of Latouche Island. At the close of the season Mr. Grant also made a hasty examination of some of the ore deposits near Seward, on Kenai Peninsula.

Southwestern Alaska.—The general study of the coal fields of Alaska, which was commenced in 1906, was continued during 1908 by a reconnaissance survey of the coal fields of Alaska Peninsula. This work was in charge of W. W. Atwood, assisted by H. M. Eakin. Topographic and geologic reconnaissance surveys of the more important parts of the Herendeen Bay, Unga Island, and Chignik coal fields were made. The total area surveyed was about 1,500 square miles.

Yukon basin.—Last year a topographic survey was made of the Fairbanks placer district for the purpose of obtaining a base map for detailed geologic studies. These studies were carried on this year by L. M. Prindle, assisted by F. J. Katz. They completed the geologic survey of the area covered by the base map (436 square miles) and made a detailed study of the occurrence of auriferous gravel.

To J. W. Bagley was assigned the task of completing the topographic reconnaissance map of the region lying north of and adjacent to Tanana River. He carried a survey eastward along the north side of the Tanana as far as the mouth of Healy River. The latter part of the summer was devoted to topographic mapping near the mouth of the delta, south of Tanana River. In all, an area of 1,725 square miles was covered.

The investigation of the water resources of the Yukon-Tanana district, begun in the Fairbanks region in 1907, was extended by C. C. Covert, assisted by C. E. Ellsworth, in 1908. For the purpose of obtaining data regarding the spring run-off when the melting of the snow takes place in March Mr. Covert proceeded to Fairbanks over the ice. He devoted the early part of the season to a study of the water conditions of the streams tributary to the Chatanika and later proceeded overland to the Circle district, where he met Mr. Ellsworth and party, who came inland by way of White Pass. The balance of the season was devoted to stream gaging in the Circle, Fairbanks, and Baker regions. Twenty-one gaging stations were maintained during the whole or part of the season and 273 measurements of stream volume were made. This work furnishes data in regard to the run-off of about 4,690 square miles.

The great influx of prospectors into the Innoko and lower Yukon region led to a demand for a survey of that district. As funds were not available for a large party, it was decided to make a preliminary examination of the region. This work was intrusted to A. G. Maddren, who spent about a month in examining the creeks tributary to the Yukon reported to be auriferous. He then proceeded to the Innoko and spent the remainder of the season in this field. His work included the making of a sketch map of the region visited, by means of a rough triangulation and foot traverses. A general knowledge of an area including about 1,000 square miles was thus obtained.

Seward Peninsula.—The geology of Seward Peninsula is exceedingly complex, and though its general features have already been determined and the results published, progress has been but slow in deciphering the details of structure and stratigraphy. These problems have an important bearing on the distribution and occurrence of the mineral deposits, especially of metalliferous lodes.

During 1908 two parties were engaged in detailed stratigraphic studies in this region. One of these, in charge of P. S. Smith, spent the summer in completing the detailed mapping of the Casadepaga quadrangle, in continuing the stratigraphic studies of the Kigluaik Mountains, and in making a reconnaissance across the Bendeleben Mountains, 90 square miles being mapped in detail and 150 square miles in reconnaissance.

The stratigraphy of the northwestern part of the peninsula was the subject of investigations by E. M. Kindle, assisted by R. D. Mesler. In connection with this work Mr. Kindle also made a trip to Cape Lisburne and Point Hope for the purpose of establishing stratigraphic correlations.

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 and 1908. In 1908 the work was in charge of F. F. Henshaw, assisted by A. T. Barrows, and observations were continued at some of the gaging stations in the Nome district and also at those established in the Kougarok district. Other stations were maintained in the Iron Creek district, the upper Casadepaga basin, and the Solomon region. In July Mr. Henshaw extended the work into the Fairhaven district, where observations were continued up to the close of the season. These investigations throw light on the available water supply in about 2,000 square miles of the more important placer districts of the peninsula. During the field work 273 measurements of stream volume were made and 21 gaging stations maintained.

Collection of statistics.—The work of collecting statistics from the operators, begun three years ago, was continued through 1908. 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 fur-

nishing the desired information in regard to production. Though the statistical data are by no means yet complete, it is hoped that within another year the figures of production from every important operation may be procured for the purpose of making up the totals. During 1908 the operators of practically every lode mine 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. It is expected, however, that as soon as these men fully realize the purpose of collecting the data and understand that the individual returns are carefully guarded from the public they will be willing to cooperate.

FIELD OPERATIONS FOR SEASON OF 1909.

Under the increased appropriation of $90,000, fourteen 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. Another is engaged in making a detailed geologic survey of the Nizina copper-bearing region. A geologic reconnaissance survey of the eastern part of the Kenai Peninsula has also been begun. Two other parties are making a detailed topographic survey of the Matanuska coal field. Two parties have begun a topographic and geologic reconnaissance survey of the Iliamna Lake region. Geologic reconnaissance surveys in the Yukon-Tanana region are being continued. Further investigation of the water resources of the Fairbanks, Birch Creek, and Rampart region is being made. A party is also engaged in making an exploratory survey from Nulato, on the Yukon, to Council, in Seward Peninsula. The survey of the Koyukuk and Chandalar placer district made in 1899 is being extended. In Seward Peninsula two men are engaged in continuing the reconnaissance of the water resources available for placer mining. Mr. Brooks left Washington on June 24 en route to Copper River and Fairbanks.

OFFICE WORK.

During the fiscal year five bulletins have been issued, and there are in press one water-supply paper and one professional paper, all embodying results of the work of the Alaska division. In addition to these reports, which contain maps, one general map of Alaska and one detailed topographic map of the Controller Bay region have been issued as sale publications.

The following manuscripts were submitted for publication in May and June: "The Nabesna-White River copper region," by F. H. Moffitt and Adolph Knopf, including geologic and topographic reconnaissance maps (Bulletin 417); "Geology of the Solomon and Casa-

depaga quadrangles," by P. S. Smith, including detailed geologic map; "The geology and mineral resources of the Prince William Sound region," by U. S. Grant, including geologic reconnaissance map; "The Yakutat Bay earthquake, September, 1899," by R. S. Tarr and Lawrence Martin; "The Innoko gold-placer district, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers," by A. G. Maddren, including geologic and topographic reconnaissance maps (Bulletin 410). The reconnaissance maps of the Fairbanks and Rampart quadrangles have also been submitted for issue as sale publications.

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, held for further field work); "Geology of the Fairbanks district," by L. M. Prindle (75 per cent completed, held for further field investigations); "Geology and mineral resources of parts of the Alaska Peninsula," by W. W. Atwood (10 per cent completed); "An exploration in the Mount McKinley region," by Alfred H. Brooks and L. M. Prindle (90 per cent completed); "Geology and ore deposits of Kasaan Peninsula and Copper Mountain region, Prince of Wales Island," by C. W. Wright (60 per cent completed.) The maps in hand are as follows: Nizina special, scale 1:62,500 (completed); Circle quadrangle, scale 1:250,000 (95 per cent completed); Upper Tanana quadrangle, scale 1:250,000 (40 per cent completed); Copper Mountain special, scale 1:62,500 (75 per cent completed); Kasaan Peninsula, scale 1:62,500 (75 per cent completed).

GEOLOGIC RESULTS.

Among the most important results of the last season's work are the definite proof of the presence of Cambrian rocks in Seward Peninsula, by E. M. Kindle, and the finding of a marine Eocene fauna in association with plant-bearing beds of the Kenai formation on Alaska Peninsula, by W. W. Atwood and E. M. Eakin. Mr. Grant and Mr. Higgins procured definite proof of the unconformable relations between the Valdez and Orca groups of rocks, and the subdivision of the Orca group into formations is an important fact bearing on the geology of Prince William Sound and the adjacent area. In the upper White River region Mr. Moffit and Mr. Knopf proved the Mesozoic age of the intrusive rocks, thus establishing synchroneity with the granites of the Coast Range. They also showed two types of mineralization; in the one native copper occurs in an amygdaloidal greenstone similar to that of the Chitina Valley; in the other gold and copper ores are found in association with Mesozoic intrusive rocks and are similar in character to the mineral occurrences of southeastern Alaska. Mr. Maddren's work shows a

southwestern extension of the Paleozoic and metamorphic rocks of the Yukon-Tanana region into the Innoko and Kuskokwim valleys. The results of the investigations of the Yakutat Bay earthquake of September, 1899, completed during the year, are of far-reaching geologic significance. The surface dislocation produced by the earth's movement is one of the most extensive which has ever been measured.

DIVISION OF MINERAL RESOURCES.

The preparation of reports on the mineral resources of the United States is carried on in the division of mineral resources under an appropriation of $75,000, and in accordance with the organic law of the Survey, which includes a provision that the Geological Survey shall examine the "mineral resources and products of the national domain."

The first of these annual reports was published in 1883 and covered the calendar year 1882. The volume is an annual statistical compilation, but it also contains discussions of the occurrence, development, and uses of the mineral products, the object being to make it a complete compendium of the country's mineral resources. Each annual report covers a calendar year and must therefore necessarily be distributed through two fiscal years.

The report for 1907 was completed, published, and distributed in January, 1909. The report for 1908 was prepared in part, twenty chapters having been completed before the close of the fiscal year 1908–9 and submitted for publication in advance of the volume. The chapters completed and distributed to the public are as follows: Bauxite and aluminum; monazite and zircon; phosphate rock; salt and bromine; and slate. Those submitted for publication but not yet issued are as follows: Asbestos; barytes and strontium; cement; chromic iron ore; fluorspar and cryolite; silver, copper, lead, and zinc in the Central States; gypsum; manganese ores; mica; petroleum; quartz (flint) and feldspar; sand-lime brick; sulphur and pyrite; talc and soapstone; and tin. At the close of the previous fiscal year the manuscript of seventeen chapters had been completed and transmitted for publication.

During January and February preliminary statements of production in 1908, with a review of the conditions prevailing during the year, were given to the press in the form of special bulletins for the following subjects: Gold and silver mining in the United States; copper, lead, and zinc production; the cement industry; a review of the coal-mining industry; and petroleum.

A considerable part of the time of the experts employed in this division is consumed in answering technical inquiries and making visual examinations of mineral specimens that are submitted by

numerous persons for determination. Inquiries for information as to the character of ores are answered as promptly as possible, and such information is given freely where a chemical analysis or assay is not required.

Since August, 1907, the work of the division has been carried on under the supervision of Edward W. Parker, statistician in charge. At the same time Waldemar Lindgren was placed in charge of the section relating to metalliferous statistics (except iron).

Mr. Parker, in addition to his duties as administrative officer, prepares the reports on the production of coal and the manufacture of coke. D. T. Day continues with the division as expert in charge of the work on petroleum. The preparation of the report on the clay-working industries is carried on under the supervision of Jefferson Middleton. E. C. Harder, junior geologist, supervises the reports on production of iron and manganese, and E. F. Burchard, assistant geologist, has charge of the reports on building stones and other structural materials, the intention being to cooperate with the division of geology and the technologic branch, so as to make the reports on these products comprehensive studies of their occurrence, utilization, and markets. F. B. Van Horn, assistant geologist, has charge of the work on phosphate rock and fuller's earth, and the following members of the Survey have been designated to prepare reports on the minor but at the same time important mineral substances: J. S. Diller, asbestos and talc and soapstone; W. C. Phalen, abrasive materials, aluminum and bauxite, bromine, grindstones and whetstones, salt, sodium salts and potash, and sulphur and pyrite; J. A. Taff, asphaltum and bituminous rock; E. S. Bastin, flint and feldspar and graphite; D. B. Sterrett, mica, monazite and zircon, and precious stones; Samuel Sanford, mineral waters; C. A. Davis, peat.

In the metalliferous statistics section, under the charge of Waldemar Lindgren, assisted by H. D. McCaskey, C. E. Siebenthal, F. L. Hess, and B. S. Butler, statistics of the annual production of all metals, except iron, are collected. Three local offices are maintained in Denver, Salt Lake, and San Francisco, in charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively, whose duty it is to collect data of mine production by direct correspondence with the producers. Reports were issued on the production of gold, silver, copper, lead, zinc, quicksilver, platinum, tungsten, tin, arsenic, antimony, and a number of rarer metals. The reports on the more abundant metals 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 of all the more important mining camps in the

country. This service, which has been in operation since 1904 for the Western and Eastern States, was extended during the last fiscal year so as to include the Central States. Thus the volume "Mineral resources" contains, in addition to the figures of actual smelter production, a summary of the condition of the metal industry throughout the United States. Preliminary statements of the production of copper, lead, and zinc in 1907 were issued in July, 1908. The detailed mine reports were, unfortunately, somewhat delayed by the vast amount of material to be gathered and were not issued until late in the fall. On January 1, 1909, preliminary statements were issued as to the approximate production in 1908 of copper, lead, and zinc, and also, in conjunction with the Bureau of the Mint, of gold and silver. The smelter production of zinc was made public in April, and the production of copper and lead was announced in final figures at the beginning of June. The report for 1907 contains a map of the mining districts of the United States, which is believed to be a useful addition to the volume.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The work of the chemical laboratory was seriously crippled by the fire which occurred in the Survey building on December 18, 1908. Although the fire barely touched the laboratory itself, it invaded the corridor leading to the laboratory, destroyed the ventilating plant, and injured the cases containing chemicals and apparatus. The inevitable delays incurred in making the necessary repairs seriously interfered with the work of the laboratory for nearly four months. In all 119 quantitative analyses were reported during the year and 652 qualitative determinations were made.

The personnel of the laboratory has undergone some change. W. F. Hillebrand and E. C. Sullivan resigned from the Survey, to accept positions elsewhere. The vacancies thus created were filled by the appointment of R. C. Wells and Chase Palmer.

Routine work in the laboratory has necessarily followed well-established lines. As in previous years, much of it has devolved on George Steiger and W. T. Schaller. The analyses made have covered the usual ground, and with the following exceptions have shown nothing particularly novel. A telluride and sulphide of antimony, copper, and bismuth was discovered by Chase Palmer in material sent in from the Goldfield (Nev.) district, and a new titanite of iron in material received from Arizona. These minerals are still under investigation.

Some time has been given by F. W. Clarke to the recalculation of the atomic weights. He has also completed the preparation of a bulletin containing the analyses of rocks and minerals made by the Survey laboratory to January 1, 1909. This volume (Bulletin

419), which is now in the hands of the editor, contains more than 2,400 analyses. A résumé of the chemical work of the Geological Survey was also prepared by Mr. Clarke for the International Congress of Applied Chemistry which was held in London on May 31.

Investigations relative to the formation of metallic sulphides have been conducted by R. C. Wells, the hydrolysis of the sulphates of iron being particularly studied.

The sodium-potassium ratio in Ohio River water was determined by Mr. Palmer, thus completing the study of this ratio in typical rivers of the United States. Mr. Palmer also devoted some time to ascertaining the solubility of silica in various organic compounds.

A monographic report on the minerals of the tourmaline region of southern California is in preparation. Some of the material forming the basis of this report was destroyed by fire, but has been replaced by Mr. Schaller, who visited the region for that purpose.

The report on the mercury minerals of Terlingua, Tex., by Messrs. Hillebrand and Schaller has been completed and is in press as Bulletin 405.

For several weeks during the spring M. F. Conner, a chemist from the Canadian Geological Survey, occupied a desk in the laboratory for the purpose of becoming better acquainted with the methods used by this bureau.

In the physical laboratory the experiments on the elasticity of metals at high temperatures have been continued throughout the year under the direction of C. E. Van Orstrand. Preliminary investigations on the diffusivity of solids, sufficient to establish the proper method of procedure, have been completed. Some work has also been done preliminary to an investigation into the formation of rock cleavage. This investigation is to be conducted in cooperation with F. E. Wright, of the Carnegie Institution.

Researches on geophysical problems were continued by G. F. Becker, chief of the division. He also prepared a paper (Bulletin 401) on the relations between local magnetic disturbances and the genesis of petroleum.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year, and is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

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

Rocky Mountain division, E. C. Barnard, geographer in charge.

Pacific division, T. G. Gerdine, 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 33 junior topographers, 5 assistant topographers, and 34 draftsmen. It was reduced by 11 through death, transfers, and resignations. With these changes, it now includes a chief geographer, 9 geographers, 44 topographers, 48 assistant topographers, 48 junior topographers, and 31 draftsmen. Eight topographers and 5 assistant topographers are on leave without pay. In addition to the above, 175 technical field assistants were employed during a whole or a part of the field season.

SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1909, 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 23,831 square miles, making the total area surveyed to date in the United States 1,074,957 square miles, or about 35½ per cent. In addition, 11,200 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 35,031 square miles.

Triangulation stations to the number of 157 were occupied, of which 121 were permanently marked; and in addition 13 points were located by intersections. There were run 2,121 miles of primary traverse, in connection with which 256 permanent marks were set. In the course of this work 22,700 square miles were covered by primary control.

In connection with these surveys 6,597 linear miles of primary levels and 470 miles of precise levels were run, making the total amount of primary and precise spirit leveling done since the authorization of this work by Congress, in 1896, 219,216 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1908–9, as reported in detail on pages 47–55, was about 4,402 square miles—427 for publication on the scale of 1:62,500 and 3,975 for publication on the scale of 1:250,000.

The results of primary triangulation and primary traverse in all States in which field work was in progress during the years 1906, 1907, and 1908 were summarized and prepared for publication as a bulletin.

Present condition of topographic surveys of the United States and new areas surveyed in 1908–9.

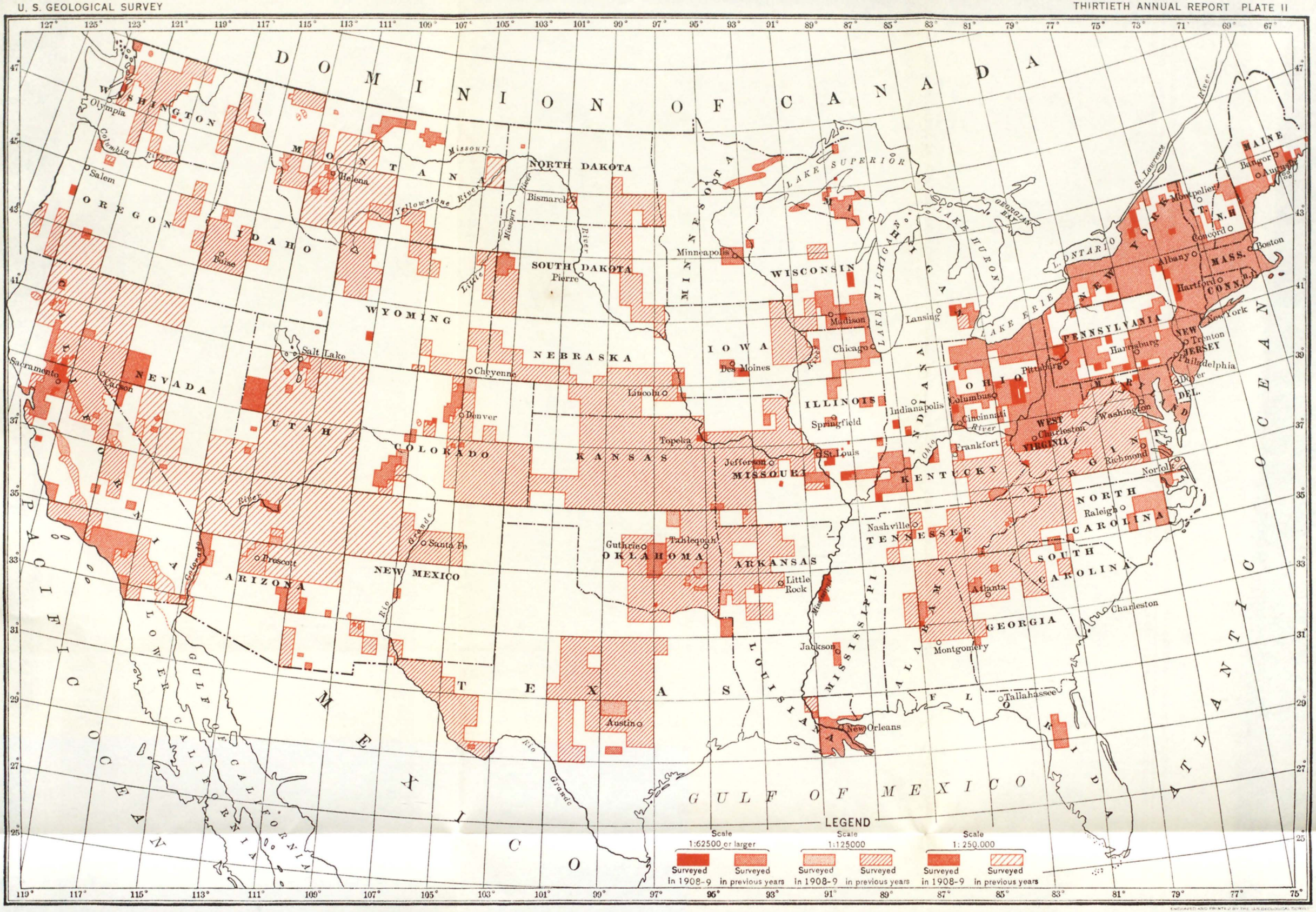
State or Territory.	New area surveyed in 1908–9.	Total area surveyed to July 1, 1909.	Percentage of total area of State surveyed to July 1, 1909.
	Sq. miles.	*Sq. miles.*	
Alabama	.....	18,283	35
Arizona	471	63,433	56
Arkansas	329	20,798	39
California	2,352	84,731	54
Colorado	1,634	40,530	39
Connecticut	.....	4,965	100
Delaware	.....	1,008	43
District of Columbia	.....	70	100
Florida	.....	1,821	3
Georgia	.....	17,087	29
Idaho	642	16,000	19
Illinois	775	8,946	16
Indiana	323	2,941	8
Iowa	174	10,266	18
Kansas	.....	64,159	78
Kentucky	302	16,147	40
Louisiana	.....	7,923	16
Maine	214	7,399	22
Maryland	156	10,450	84
Massachusetts	.....	8,266	100
Michigan	241	4,485	8
Minnesota	.....	3,087	4
Mississippi	746	1,749	4
Missouri	126	34,372	49
Montana	406	49,383	34
Nebraska	.....	25,974	34
Nevada	4,482	48,703	44
New Hampshire	.....	3,376	36
New Jersey	.....	8,224	100
New Mexico	184	30,174	25
New York	764	39,572	80
North Carolina	.....	17,418	33
North Dakota	56	8,975	13
Ohio	2,230	25,297	61
Oklahoma	1,014	38,677	55
Oregon	341	17,674	18
Pennsylvania	1,155	22,184	49
Rhode Island	.....	1,248	100
South Carolina	.....	5,640	18
South Dakota	.....	17,956	23
Tennessee	.....	20,345	48
Texas	.....	66,314	25
Utah	3,732	67,052	79
Vermont	.....	3,537	37
Virginia	.....	29,980	70
Washington	128	18,526	27
West Virginia	.....	24,120	99.8
Wisconsin	416	11,789	21
Wyoming	438	23,903	24
	23,831	1,074,957	.....

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Delaware, Georgia, Maine, Maryland, Mississippi, North Carolina, New York, Pennsylvania, Tennessee, Virginia, and West Virginia. This work comprised the survey of 20 quadrangles and the revision of 3 quadrangles. In addition, 32 quadrangles were partly surveyed, 2 were partly resurveyed, and large-scale traverse



MAP OF UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE SCALE EMPLOYED FOR EACH AREA

Scale
100 0 100 200 300 miles

1909

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

surveys were made of 2 districts. The total new area mapped was 3,035 square miles—2,289 for publication on the scale of 1:62,500 and 746 for publication on the scale of 1:31,680. The area resurveyed was 3,219 square miles—553 for publication on the scale of 1:125,000 and 2,666 for publication on the scale of 1:62,500. In connection with this work 1,774 miles of primary levels and 58 miles of precise levels were run and 500 permanent bench marks were established.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by eight parties, the work being distributed over portions of Louisiana, Mississippi, New York, Pennsylvania, Tennessee, Virginia, and West Virginia. The total area covered by this primary control was about 6,400 square miles, of which 2,700 were controlled by primary traverse, 558 miles being run and 88 permanent marks set. The result of this work was to make control available in 26 15-minute quadrangles.

Topographic surveys in Atlantic division from July 1, 1908, to June 30, 1909.

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.
		Resurvey.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Alabama	50	131	.....	105	236	12	.....	.....	.....
Delaware	.....	.....	.....	.....	.....	107	24	.....	.....
Louisiana	.....	.....	.....	.....	.....	.....	.....	45	15
Maine	20	.....	214	.....	214	91	18	.....	.....
Maryland	20	.....	156	128	284	52	14	.....	.....
Mississippi	5	.....	.....	.....	[a]746	390	120	285	52
New Jersey	20	.....	.....	275	275	.....	.....	.....	.....
New York	20	.....	764	391	1,155	181	40	122	15
North Carolina	100	20	.....	.....	20	.....	.....	.....	.....
Pennsylvania	20	.....	1,155	.....	1,155	154	42	26	2
Tennessee	20–100	60	.....	177	237	70	17	80	4
Virginia	20–100	342	.....	48	390	181	45	.....	.....
West Virginia	50	.....	.....	1,542	1,542	594	180	.....	.....
		553	2,289	2,666	6,254	1,832	500	558	88

[a] 746 square miles in Mississippi for publication on the scale of 1:31,680.

DETAILS OF WORK BY STATES.

Alabama.—The resurvey of the Montevallo quadrangle, in Shelby, Bibb, and Chilton counties, was completed by R. W. Berry, 105 square miles being mapped for publication on the scale of 1:62,500, with a contour interval of 50 feet. Mr. Berry also revised 131 square miles of the Brookwood quadrangle in Bibb, Hale, Jefferson, and Tuscaloosa counties, and completed the secondary control on the Seale quadrangle, in Russell and Lee counties. For the control of the Columbiana quadrangle, in Chilton and Shelby counties, William Oram ran 12 miles of primary levels.

Delaware.—For the control of the Seaford and Georgetown quadrangles, in Sussex County, H. M. Gillman, jr., ran 107 miles of primary levels and established 24 permanent bench marks.

Georgia.—Secondary control for the Milledgeville quadrangle, in Baldwin, Hancock, and Washington counties, was completed by F. Harrison.

Louisiana.—The president of the board of commissioners of the fifth Louisiana levee district allotted $20,000 for the inauguration of cooperative topographic surveys in the Tensas Basin, and the United States Geological Survey allotted $6,700 for the same work during the next year. For the control of this area C. B. Kendall ran 45 miles of primary traverse and set 15 permanent marks in Madison Parish, in June.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted $2,500 and the United States Geological Survey allotted a like sum. The survey of the Ellsworth quadrangle, in Hancock County, was continued, and that of the Fryeburg quadrangle, in Oxford and Cumberland counties, was commenced by Hersey Munroe, F. E. Matthes, R. T. Evans, Ray Purington, E. B. Hillegass, and S. L. Ruggles, the total area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas, including the Kezar Falls quadrangle in the same counties, 91 miles of primary levels were run and 18 permanent bench marks were established by C. K. Alexander and E. B. Hillegass.

Maryland.—For the continuation of cooperative topographic surveys in Maryland the state geologist and the Federal Survey each allotted $4,000. The resurvey of the Frederick quadrangle was continued and resulted in the completion of work on the Middletown quadrangle, in Washington and Frederick counties, the area mapped being 128 square miles. The survey of the Taneytown quadrangle in Carroll and Frederick counties was commenced, the total new area mapped being 156 square miles. All the work in Maryland was for publication on the scale of 1:62,500, with a contour interval of 20 feet, and was done by J. H. Wheat, S. P. Floore, J. S. B. Daingerfield, Robert Muldrow, A. M. Walker, F. R. B. Waters, and J. D. Forster. For the control of the Williamsport and Hagerstown quadrangles, in Washington, Berkeley, and Jefferson counties, J. Morrison Harris ran 52 miles of primary levels and established 14 permanent bench marks. Mr. Wheat commenced the secondary control on the Emmitsburg quadrangle, in Carroll and Frederick counties.

Mississippi.—Topographic surveys in the Tallahatchie drainage district were continued under the agreement of June 15, 1908, whereby $27,000, more or less, was allotted by the Tallahatchie drainage commission for topographic surveys in that district, to be met by $9,000 on

the part of the Federal Survey. The mapping of the Dundee, Coahoma, Jonestown, and Walnut Lake quadrangles was completed and that of the Lula, Hollywood, Clarksdale, Lake Cormorant, Banks, Sabina, Robinsonville, Moon Lake, Lambert, Prichard, Crenshaw, Tunica, Belen, Shirard, Friars Point, Norfolk, Sledge, Tibbs, and Helena quadrangles was commenced. This work lies in parts of Coahoma, Quitman, Tunica, De Soto, Tate, and Panola counties and was done under the direction of Van. H. Manning by E. P. Davis, R. L. Harrison, S. P. Floore, R. J. Schleich, L. L. Lee, J. R. McMillen, C. C. Gardner, J. M. Rawls, W. H. Monahan, B. Knock, W. H. S. Morey, J. D. Forster, Olin Smith, Duncan Hannegan, and R. H. Reineck, the total area surveyed being 746 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Tallahatchie drainage district 390 miles of primary levels were run and 120 permanent bench marks were established by W. H. Monahan, W. H. Gray, and K. W. Trimble. C. A. Clunet and F. J. McMaugh also ran 225 miles of primary traverse, in connection with which 47 permanent marks were set. In addition to the cooperative work, Mr. McMaugh ran 60 miles of primary traverse and set 5 permanent marks for the control of the Burnsville quadrangle, in Tishomingo and Alcorn counties.

New York.—The state engineer and surveyor allotted $8,000 for the continuation of cooperative topographic surveys in the State, and the Federal Survey allotted a like amount for the same purpose. The survey of the Bath quadrangle, in Steuben County, and the Monticello and Neversink quadrangles, in Sullivan and Ulster counties, was completed; that of the Delhi quadrangle, in Delaware and Otsego counties, was nearly completed; that of the Antwerp quadrangle, in St. Lawrence, Jefferson, and Lewis counties, and the Hartwick quadrangle, in Otsego County, was commenced. The total area mapped was 764 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, the work being done by T. M. Bannon, R. H. Chapman, L. C. Fletcher, Albert Pike, R. C. Seitz, W. H. S. Morey, R. C. McKinney, and J. M. Whitman. In addition, the revision of the Watertown quadrangle, consisting of 216 square miles in Jefferson and Lewis counties, was completed by Albert Pike. For the control of the above-named areas and for the Canton and Hammond quadrangles, in St. Lawrence and Jefferson counties, 181 miles of primary levels were run and 40 permanent bench marks were established by R. C. Seitz and 122 miles of primary traverse were run and 15 permanent marks were set by F. J. McMaugh.

New York-New Jersey.—The Ramapo and Greenwood Lake quadrangles, in Orange and Rockland counties, N. Y., and Bergen, Passaic, Sussex, and Morris counties, N. J., were revised for culture by C. C. Gardner and R. L. Harrison, the area covered being 450

square miles, 175 of which were in New York, to be republished on the scale of 1:62,500, with a contour interval of 20 feet.

North Carolina.—The state geologist of North Carolina allotted $500 for the continuation of cooperative topographic surveys, for which the Federal Survey allotted a like sum. A traverse survey of Beaufort County, on the scale of 1:24,000, was completed by M. W. Gray and R. F. Irwin.

Pennsylvania.—The Geologic and Topographic Survey Commission of Pennsylvania allotted $12,000 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 Zelienople quadrangle, in Butler, Lawrence, and Beaver counties; the Bedford quadrangle, in Bedford, Somerset, and Cambria counties; the Bellefonte quadrangle, in Center County; the New Kensington and Butler quadrangles, in Butler, Allegheny, and Westmoreland counties; and the Fairfield quadrangle, in Adams, Franklin, and Cumberland counties, was completed; and that of the Franklin and Stoneboro quadrangles, in Mercer, Forest, and Venango counties; the Hamburg quadrangle, in Berks, Lehigh, and Schuylkill counties; the Quarryville quadrangle, in Lancaster and Chester counties; the Hilliards quadrangle, in Venango and Butler counties; the McCalls Ferry quadrangle, in Lancaster and York counties; and the Mercer quadrangle, in Butler and Mercer counties, was commenced. The total area mapped was 1,155 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, the work being done by W. O. Tufts, R. H. Reineck, R. D. Cummin, J. D. Forster, Hersey Munroe, J. I. Gayetty, and E. B. Hillegass. For the control of these areas 154 miles of primary levels were run and 42 permanent bench marks were established by H. M. Gillman, jr., and H. W. Peabody. For the control of the Franklin and Stoneboro quadrangles C. B. Kendall ran 26 miles of primary traverse and set 2 permanent marks. For the control of the Confluence, Myersdale, and Hyndman quadrangles, in Somerset and Fayette counties, George T. Hawkins occupied 4 triangulation stations and established 3 permanent marks.

Tennessee.—The resurvey of the Pikeville 30-minute quadrangle was continued by Oscar Jones and Olin Smith, and 177 square miles of the Pikeville 15-minute quadrangle, in Rhea and Bledsoe counties, were completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 80 miles of primary traverse were run and 4 permanent marks were set by Mr. Jones, and 70 miles of primary levels were run and 17 permanent bench marks were set by J. B. Metcalfe. Secondary control for the Hollow Springs quadrangle, in Coffee and Cannon counties, was also completed by Mr. Jones.

Tennessee-North Carolina.—J. I. Gayetty completed the revision of 80 square miles of the Mount Guyot quadrangle, 60 of which are in Cocke, Jefferson, and Sevier counties, Tenn., and 20 in Haywood and Swan counties, N. C., 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 and Mecklenburg counties, was commenced by J. Morrison Harris on the field scale of 1:24,000. For the control of this area 79 miles of primary levels were run and 24 permanent bench marks were established by E. O. Halbert. In addition to the cooperative work, the resurvey of the Abingdon quadrangle, in Smyth, Russell, and Washington counties, was commenced by Duncan Hannegan, R. W. Berry, J. B. Metcalfe, and R. A. Kiger, the total area mapped being 342 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle 102 miles of primary levels were run and 21 permanent bench marks were established by J. B. Metcalfe. The Virginia portion of the Middletown quadrangle, in Loudoun County, was completed by Robert Muldrow and A. M. Walker. The area mapped, which was a resurvey of a portion of the Harpers Ferry quadrangle, was 48 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Triangulation control was extended by Oscar Jones, E. L. McNair, and R. C. Seitz from West Virginia into Tazewell and Buchanan counties.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the state geologist allotted $15,000, which was met by an allotment of $12,000 from the Federal Survey. The resurvey of areas previously mapped resulted in the completion of the survey of the Sutton special, Gassaway, Clay, Fayetteville, and Montgomery quadrangles, in Braxton, Nicholas, Webster, Gilmer, Clay, Fayette, and Kanawha counties, and in the completion of parts of the Peytona and Madison quadrangles, in Kanawha, Boone, and Lincoln counties. The survey of the Matewan, Williamson, and Pocahontas quadrangles, in Mingo, Logan, Mercer, and McDowell counties, was also commenced. This work was done by E. I. Ireland, J. R. Eakin, F. E. Matthes, W. L. Miller, E. P. Davis, Fred McLaughlin, F. O. Leonard, R. H. Kilmer, C. P. McKinley, Orr Meredith, L. D. Law, J. H. Wilson, and C. F. Koppisch, the total area mapped being 1,542 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining areas 536 miles of primary levels and 58 miles of precise levels were run and 180 permanent bench marks were established by C. H. Semper, T. A. Green, A. J. Dailey, S. E. Taylor, and E. S. Dawson. Trian-

gulation control for the Madison, Peytona, and Montgomery quadrangles was established by R. H. Chapman, P. W. McMillen, Geo. T. Hawkins, and C. B. Kendall, 12 stations being occupied and 11 permanent marks set. E. L. McNair, Oscar Jones, R. C. Seitz, and C. P. McKinley also secured triangulation control for the Holden, Gilbert, Logan, Matewan, Williamson, Welch, Iaeger, Bald Knob, Mullen, Pineville, Pocahontas, and Eccles quadrangles, in Mingo, Logan, Boone, Mercer, Wyoming, Raleigh, and McDowell counties, 25 stations being occupied and 25 permanent marks established.

OFFICE WORK.

The drafting of the following sheets was completed: Watertown, Stony Creek, and Bath, N. Y.; York, Bellefonte, Bedford, Fairfield, New Kensington, and Zelienople, Pa.; Middletown, Md.; Gassaway, Clay, Montgomery, Fayetteville, and Sutton special, W. Va.; Coahoma, Jonestown, Dundee, and Walnut Lake, Miss.; Montevallo, Ala.; Virgilina district, Va.; Beaufort and Granville counties, N. C.; Gold Hill and Cid districts, N. C.; Brookwood revision, Ala. The adjustment and drawing of maps of the following counties was completed in cooperation with the Bureau of Soils: Lamar, Henry, Bibb, and Autauga, Ala.; Thomas and Grady, Ga.; Bienville and East and West Carroll parishes, La.; Monroe, Miss.; Robeson, N. C.; Center, Pa.

Progress in the drafting of additional sheets was made as follows: Ellsworth, Me., 77 per cent; Delhi, N. Y., 78 per cent; Neversink and Monticello, N. Y., each 80 per cent; Butler, Pa., 25 per cent; Taneytown, Md., 36 per cent; Peytona and Madison, W. Va., each 85 per cent; Pikeville, Tenn., 55 per cent; Lula and Hollywood, Miss., 88 per cent; Clarksdale, Miss., 72 per cent; Lake Cormorant, Banks, Sabino, Robinsonville, Moon Lake, and Lambert, Miss., each 66 per cent; Pritchard, Miss., 55 per cent; Crenshaw, Miss., 52 per cent; Tunica, Miss., 45 per cent; Belen, Miss., 42 per cent; Friars Point, Miss., 32 per cent; Sherard, Miss., 22 per cent; Norfolk, Miss., 20 per cent; Sledge, Miss., 17 per cent; Tibbs, Miss., 10 per cent; Helena, Miss., 8 per cent.

The following sheets were completely adjusted: Hamburg, McCalls Ferry, Quarryville, and Hilliards, Pa.; Fryeburg, Me.; Seale, Ala.; Hollow Springs, Tenn. The following were partly adjusted: Stoneboro, Pa., 30 per cent; Franklin, Pa., 5 per cent; Mercer, Pa., 45 per cent; Emmitsburg, Md., Hammond, N. Y., and Iuka, Miss., each 50 per cent; Canton, N. Y., 80 per cent; Antwerp, N. Y., 70 per cent; Milledgeville, Ga., 25 per cent.

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

Level circuits were adjusted in the Georgetown and Seaford (Del.) quadrangles.

Level circuits were adjusted in the Emmitsburg, Hagerstown, and Taneytown (Md.) quadrangles. Latitudes, departures, and geographic positions were computed for the Taneytown quadrangle.

Level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Tallahatchie drainage district (Miss.). Geographic positions were computed in the Burnsville (Miss.) quadrangle.

Level circuits were adjusted in the Antwerp, Bath, Canton, and Hammond (N. Y.) quadrangles, and latitudes, departures, and geographic positions were computed in the Antwerp and Hammond quadrangles.

For the additional control of the Mount Guyot and Knoxville (Tenn.-N. C.) quadrangles, geodetic positions were computed.

Level circuits were adjusted in the Bellefonte, Franklin, Hamburg, Hilliards, and Stoneboro (Pa.) quadrangles. Latitudes, departures, and geographic positions in the Franklin, Hilliards, Stoneboro, and Mercer (Pa.) quadrangles were computed. Geodetic positions in the Berlin, Confluence, Hyndman, and Myersdale (Pa.) quadrangles were computed.

Level circuits were adjusted in the Memphis and Pikeville (Tenn.) quadrangles, and latitudes, departures, and geographic positions were computed in the Pikeville and Hollow Springs (Tenn.) quadrangles.

Level circuits in the Virgilina district (Va.) were adjusted.

Level circuits were adjusted in the Bald Knob, Charleston special, Clay, Clendennin, Dublin, Fayetteville, Gassaway, Gilbert, Hinton, Logan, Madison, Montgomery, Midkiff, Pocahontas, St. Albans, Wayne, Welch, and Peytona (W. Va.) quadrangles. Geodetic positions were computed in the Fayetteville, Logan, Madison, Montgomery, and Peytona quadrangles.

Level lists covering the work done in the entire State of West Virginia were assembled, computations and readjustments being made where necessary, preparatory to issuing a bulletin (Bulletin 399).

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, Oklahoma, and Wisconsin. This work comprised the survey of 24 quadrangles and the revision of 1 quadrangle. In addition, 12 quadrangles and 1 special area were partly surveyed and 1 special area was partly resurveyed. The total new area

mapped was 4,957 square miles—370 for publication on the scale of 1:125,000, 4,521 for publication on the scale of 1:62,500, and 66 for publication on the scale of 1:24,000. The area resurveyed was 483 square miles—283 for publication on the scale of 1:62,500 and 200 for publication on the scale of 1:24,000. In connection with this work 1,807 miles of primary levels and 45 miles of precise levels were run and 431 permanent bench marks were established.

Triangulation, primary traverse, and precise leveling were carried on at various times by three parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Minnesota, Missouri, and Ohio. The area covered by primary traverse was approximately 5,000 square miles, and by triangulation approximately 1,000 square miles, furnishing control for 24 15-minute quadrangles, 1,278 miles of primary traverse being run and 132 permanent marks set.

Topographic surveys in central division from July 1, 1908, to June 30, 1909.

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.
		New.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Arkansas	50	329	.....	.....	329	169	31	.....	.....
Illinois	5-20	.....	775	.....	775	459	97	432	43
Indiana	20	.....	323	.....	323	52	13	.....	.....
Iowa	20	.....	174	.....	174	73	22	28	3
Kansas	20	.....	.....	.....	[a] 151	107	.....	.....	.....
Kentucky	20	.....	302	.....	302	53	9	149	13
Michigan	20	.....	175	.....	[a] 241	68	17	.....	.....
Minnesota	.....	.....	.....	.....	.....	77	13	166	17
Missouri	20	.....	126	65	[a] 240	161	43	80	8
Ohio	20	.....	2,230	.....	2,230	495	146	423	48
Oklahoma	50	41	.....	.....	41	.....	.....	.....	.....
Wisconsin	10	.....	416	218	634	138	40	.....	.....
		370	4,521	283	5,440	1,852	431	1,278	132

[a] 200 square miles of resurvey (151 in Kansas and 49 in Missouri) and 66 square miles in Michigan, all for publication on the scale of 1 : 24,000.

DETAILS OF WORK BY STATES.

Arkansas-Oklahoma.—The survey of the De Queen quadrangle, in Sevier, Howard, and Polk counties, Ark., and McCurtain County, Okla., was commenced by C. G. Anderson, F. W. Hughes, H. H. Hodgeson, and C. L. Sadler. The total area mapped was 370 square miles, 41 being in Oklahoma, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area W. A. Gelbach ran 169 miles of primary levels and established 31 permanent bench marks.

Illinois.—The governor of Illinois allotted $8,000 for the continuation of cooperative topographic surveys in the State and the United States Geological Survey allotted a like sum for the same purpose.

The survey of the Murphysboro quadrangle, in Jackson and Perry counties; the Okawville quadrangle, in Clinton, Washington, and St. Clair counties; the Hardinville quadrangle, in Crawford, Lawrence, and Jasper counties; and the Carlyle quadrangle, in Clinton and Bond counties, was completed; that of the Galena and Apple River quadrangles, in Jo Daviess County; the Baldwin quadrangle, in Randolph County; the Lasalle quadrangle, in Lasalle, Bureau, and Putnam counties, and the Vandalia quadrangle, in Fayette County, was continued; and that of the Bridgeport quadrangle, in Lawrence and Wabash counties; the Hennepin quadrangle, in Putnam, Bureau, and Lasalle counties; the New Athens quadrangle, in St. Clair and Monroe counties; and the Carmi quadrangle, in White, Edwards, Wayne, and Posey counties, was commenced. This work was done by W. J. Lloyd, M. Hackett, E. W. McCrary, Lee Morrison, E. L. Hain, G. L. Gross, J. W. Lowell, S. K. Atkinson, A. L. Hambrecht, A. T. Fowler, J. A. Duck, Frank Tweedy, B. A. Jenkins, J. F. McBeth, and G. R. Hoffman, the total area mapped being 775 square miles, for publication on the scale of 1:62,500, with contour intervals of 20 and 5 feet. For the control of these areas 459 miles of primary levels were run and 97 permanent bench marks were established by W. A. Gelbach. For the control of the Baldwin quadrangle, in St. Clair, Randolph, and Monroe counties; the Shawneetown quadrangle, in Gallatin and Hardin counties; the Waterloo, Sparta, Crystal City, and Renault quadrangles, in Union, Washington, Randolph, and Perry counties; the Lincoln quadrangle, in Logan County; and for the Lasalle, Hennepin, Carmi, and Bridgeport quadrangles mentioned above, J. R. Ellis and C. B. Kendall ran 432 miles of primary traverse and set 43 permanent marks.

Indiana.—The survey of the Bloomington quadrangle, in Monroe, Owen, and Green counties, was completed by C. L. Sadler, who, assisted by L. P. Jerrard, also completed the survey of the Clay City quadrangle, in Clay, Vigo, Owen, and Putnam counties, the total area mapped being 323 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Clay City quadrangle 52 miles of primary levels were run and 13 permanent bench marks were established by Mr. Jerrard.

Iowa.—The state geologist 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 Milo quadrangle, in Marion and Warren counties, was completed, and that of the Knoxville and Pella quadrangles, in Marion and Mahaska counties, was commenced by A. T. Fowler, J. G. Staack, and M. Hackett, the total area mapped being 174 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas 73 miles of primary levels were run and 22 permanent bench marks were estab-

lished by G. E. Heebink, and 28 miles of primary traverse were run and three permanent marks were set by J. R. Ellis.

Kentucky.—For the continuation of the cooperative topographic survey of the State, the state geologist allotted $3,000 and the Federal Survey allotted a like sum. The survey of the Princeton quadrangle, in Caldwell, Lyons, and Hopkins counties, was completed, and that of the Riverview quadrangle, in Jefferson and Bullitt counties, was commenced. This work was done by A. O. Burkland, C. D. S. Clarkson, and R. E. Johnson, the total area mapped being 302 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Princeton quadrangle 53 miles of primary levels were run and 9 permanent bench marks were established by E. C. Bibbee. Primary triangulation was extended through Lewis and Rowan counties by E. L. McNair, and furnished partial control for the Vanceburg, Olive Hill, Soldier, Quincy, and Morehead quadrangles, 8 stations being occupied and 9 permanent marks set. Primary triangulation for the Kentucky portion of the Williamson quadrangle, in Pike and Martin counties, was completed, and that for the east half of the old Prestonburg quadrangle, in Floyd, Johnson, and Lawrence counties, was begun by E. L. McNair and R. C. Seitz, 3 permanent marks being set. For the control of the Shawneetown quadrangle, in Union and Crittenden counties, J. R. Ellis ran 11 miles of primary traverse and set 1 permanent mark. For the control of the Horsebranch, Rochester, and Morgantown quadrangles, in Ohio, Grayson, Butler, Warren, and Logan counties, C. B. Kendall ran 138 miles of primary traverse and set 12 permanent marks.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted $1,000. The survey of the Fowlerville quadrangle, in Ingham and Livingston counties, was completed, and that of the Mason quadrangle, in Ingham County, was commenced. This work was done by C. D. S. Clarkson and A. M. Walker, the total area mapped being 175 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to the cooperative work, the survey of the Calumet special quadrangle, in Houghton County, was commenced by A. M. Walker, who mapped 66 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this area 68 miles of primary levels were run and 17 permanent bench marks were established by F. H. West. Revision of culture on an irregular area included in the Crystal Falls, Iron River, and Ishpeming quadrangles and adjoining areas was accomplished by A. T. Fowler.

Minnesota-Wisconsin.—For the control of the Center City, Stillwater, and Afton quadrangles, in Washington, Chisago, Ramsey, and

Dakota counties, Minn., and Polk, St. Croix, and Pierce counties, Wis., J. R. Ellis ran 166 miles of primary traverse and established 17 permanent marks.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the state geologist and the United States Geological Survey each allotted $5,000. The resurvey of the Ste. Genevieve quadrangle was continued, and resulted in the completion of the Higdon quadrangle, in Ste. Genevieve, Perry, Madison, St. Francois, and Bollinger counties. This work was done by C. G. Anderson and F. W. Hughes, who also partly completed the survey of the Rolla quadrangle, in Phelps and Dent counties. The new area mapped was 126 square miles and that resurveyed was 65 square miles, all being for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Rolla and Sullivan quadrangles 45 miles of precise levels were run by E. L. McNair and 43 miles of primary levels by C. H. Swift, in connection with which 23 permanent bench marks were established, and 80 miles of primary traverse were run and 8 permanent marks set by J. R. Ellis. Leigh D. Townsend ran 37 miles of primary levels and set 10 permanent bench marks for the control of the Kennett quadrangle, in Dunklin County.

Kansas-Missouri.—The resurvey of an area comprising the Fort Leavenworth special quadrangle, in Jefferson, Atchison, and Leavenworth counties, Kans., and Platte County, Mo., was continued by J. G. Staack, the total area mapped being 200 square miles, of which 49 are in Missouri, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this area G. E. Heebink ran 143 miles of primary levels, of which 36 miles, with the 10 permanent bench marks established, were in Missouri.

Ohio.—The governor of Ohio allotted $19,000 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 Frazeysburg, Conesville, Zanesville, Philo, New Lexington, McConnellsville, and Granville quadrangles, in Knox, Licking, Muskingum, Coshocton, Morgan, Perry, Hocking, and Athens counties; the Cambridge quadrangle, in Guernsey, Coshocton, and Tuscarawas counties; and the Eaton quadrangle, in Preble and Butler counties, was completed. That of the Caldwell, Cumberland, and Antrim quadrangles, in Morgan, Washington, Noble, Coshocton, Muskingum, Harrison, and Tuscarawas counties; and the Delphos quadrangle, in Van Wert and Allen counties, was partly completed; and that of the Navarre, Canal Dover, Carrollton, Coshocton, New Comerstown, and Uhrichsville quadrangles, in Wayne, Stark, Holmes, Coshocton, Tuscarawas, Carroll, Columbiana, and Harrison counties; and the Laurelville quadrangle, in Hocking

and Vinton counties, was commenced. This work was done by J. H. Jennings, J. H. Renshawe, Chas. Hartmann, jr., A. O. Burkland, Fred Graff, jr., O. H. Nelson, H. H. Hodgeson, C. W. Goodlove, J. A. Duck, L. R. Ebert, and C. D. S. Clarkson, the total area mapped being 2,230 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet For the control of these quadrangles 495 miles of primary levels were run and 146 permanent bench marks were set by C. E. Bibbee, S. K. Archer, and H. B. Hoel. For the control of the Eaton quadrangle 23 miles of primary traverse were run and 4 permanent marks were set by J. R. Ellis. For the control of the Berne, Celina, Decatur, Delphos, Loramie, Covington, Troy, Spencerville, and Van Wert quadrangles, in Mercer, Van Wert, Putnam, Allen, Paulding, and Auglaize counties, J. R. Ellis ran 400 miles of primary traverse and set 44 permanent marks.

Wisconsin.—The survey of the Fond du Lac and Neenah quadrangles, in Fond du Lac, Winnebago, and Calumet counties, was completed by H. L. McDonald and W. C. Penn, the total area mapped being 416 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these areas 93 miles of primary levels were run and 25 permanent bench marks were set by Edward Bandli. The revision of the Waterloo quadrangle, consisting of 218 square miles in Dodge and Jefferson counties, was completed by A. T. Fowler, E. L. Hain, and W. C. Penn. For the control of this quadrangle 45 miles of primary levels were run and 15 permanent bench marks were set by Edward Bandli.

DRAINAGE SURVEYS IN MINNESOTA.

A further appropriation of $10,000 was made by Congress under the Indian act for the completion of the survey of the swamp areas in the ceded lands of the Chippewas in Roseau, Beltrami, Marshall, Red Lake, and Koochiching counties, the work being assigned by the Secretary of the Interior to the United States Geological Survey. The work was completed by A. P. Meade, approximately 1,700 square miles being covered by a network of levels; 77 miles of primary levels were also run, in connection with which 13 permanent bench marks were established. The maps have been completed and transmitted with the final report to the Secretary of the Interior to be submitted to Congress.

OFFICE WORK.

The drafting of the following sheets was completed: Milo, Iowa; Herrin, Murphysboro, Hardinville, Carlyle, and Okawville, Ill.; Granville, Zanesville, Philo, Conesville, Frazeysburg, McConnellsville, and New Lexington, Ohio; Bloomington and Saline City, Ind.; Princeton, Ky.; Milford and Fowlerville, Mich.; Higdon and Macon,

Mo.; Waterloo, Fond du Lac, and Neenah, Wis.; Leavenworth, Kans.; map of the ceded Chippewa lands of the Red Lake Indian Reservation, Minn.

Progress in the drafting of additional sheets was made as follows: Knoxville, Iowa, 50 per cent; De Queen, Ark., 5 per cent; Fort Leavenworth special, Kans.-Mo., 80 per cent; Calumet special, Mich., 30 per cent; Rolla, Mo., 55 per cent; Antrim, Cumberland, and Eaton, Ohio, 15 per cent.

The following sheets were adjusted: Galena, Apple River, La Salle, Hennepin, and New Athens, Ill.; Caldwell, Summerfield, Uhrichsville, Carrollton, and Laurelville, Ohio; Riverview, Ky.-Ind., 80 per cent; Mason, Mich.

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

Level circuits were adjusted in the De Queen (Ark.) quadrangle.

Level circuits were adjusted in the Kennett quadrangle (Ark.-Mo.).

Level circuits were adjusted in the Apple River, Beardstown, Bridgeport, Carmi, Clinton, Dawson, Decatur, Hennepin, Kenney, La Salle, Lincoln, Mason City, Mount Carmel, Niantic, Petersburg, and Saidora (Ill.) quadrangles. Latitudes, departures, and geographic positions were computed in the Baldwin, Bridgeport, Carmi, Hennepin, La Salle, and Shawneetown (Ill.) quadrangles. Level lists covering the work done in the entire State of Illinois were assembled, computations and readjustments being made where necessary, preparatory to issuing a bulletin (Bulletin 421).

Level circuits were adjusted in the Clay City (Ind.) quadrangle.

Levil circuits were adjusted in the Knoxville (Iowa) quadrangle and latitudes, departures, and geographic positions were computed in the Knoxville and Pella (Iowa) quadrangles.

Level circuits were adjusted in the Marion, Princeton, and Providence (Ky.) quadrangles. Geographic positions were computed in the Shawneetown, Soldier, and Vanceburg (Ky.) quadrangles. The reduction of azimuth observations in the Horsebranch, Morgantown, and Rochester (Ky.) quadrangles was accomplished.

Level circuits were adjusted in the Calumet special, Fowlerville, and Mason (Mich.) quadrangles. Latitudes, departures, and geographic positions were computed in the Fowlerville and Mason quadrangles.

Latitudes, departures, and geographic positions were computed in the Afton, Center City, and Stillwater (Minn.) quadrangles.

Level circuits were adjusted in the Hayti, Higdon, Knobview, New Madrid, Rolla, St. James, and Weingarten (Mo.) quadrangles. Geographic positions were computed on the Rolla quadrangle. The office computation was made of the precise-level line extending over the De Soto, Rolla, St. James, and Sullivan (Mo.) quadrangles.

Level circuits were adjusted in the Antrim, Caldwell, Cambridge, Conesville, Coshocton, Cumberland, Eaton, McConnellsville, New Comerstown, Philo, Summerfield, and Zanesville (Ohio) quadrangles. Latitudes, departures, and geographic positions were computed in the Berne, Covington, Delphos, Eaton, Loramie, Sidney, Spencerville, and Van Wert (Ohio) quadrangles. Level lists covering the work done in the entire State of Ohio were assembled, computations and readjustments of level circuits being made where necessary, preparatory to issuing a bulletin (Bulletin 411).

Level circuits were adjusted in the Fond du Lac, Neenah, and Waterloo (Wis.) quadrangles.

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 five quadrangles and four special areas and the revision of six quadrangles. In addition, eight quadrangles and two national forests were partly surveyed and one quadrangle was partly revised. The total new area mapped was 3,691 square miles—134 for publication on the scale of 1:250,000, 3,268 for publication on the scale of 1:125,000, 239 for publication on the scale of 1:62,500, and 50 for publication on the scale of 1:24,000. The area resurveyed was 6,114 square miles—6,091 for publication on the scale of 1:125,000, 18 for publication on the scale of 1:12,000, 2 for publication on the scale of 1:6,000, and 3 on the field scale of 400 feet to 1 inch. In connection with this work 632 miles of primary levels and 344 miles of precise levels were run and 281 permanent bench marks were established.

Triangulation and precise leveling were carried on by four parties. This work was distributed over portions of Colorado, Montana, New Mexico, and Wyoming, covering an area of about 4,600 square miles and furnishing control for five 30-minute quadrangles and two special areas.

Topographic surveys in Rocky Mountain division from July 1, 1908, to June 30, 1909.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.	
		1:125,000.		1:62,500.		Distance run.	Bench marks.
		New.	Resurvey.	New.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Colorado	20–50–100	1,584			[a] 1,634	591	195
Montana	20–100	406			[b] 409		
New Mexico	10–100–200	150			[c e] 202	32	12
North Dakota	50	56			56		
Oklahoma	10–20–50	957	3,193	16	[d] 4,168	229	44
Texas	25–50		2,049		2,049		
Wyoming	50–100–200	115	849	223	[e] 1,287	124	30
		3,268	6,091	239	9,805	976	281

[a] 50 square miles in Colorado for publication on scale of 1:24,000.
[b] 3 square miles resurvey in Montana on field scale of 400 feet to 1 inch.
[c] 18 square miles resurvey in New Mexico for publication on scale of 1:12,000.
[d] 2 square miles resurvey in Oklahoma for publication on scale of 1:6,000.
[e] 134 square miles (34 in New Mexico, 100 in Wyoming) for publication on scale of 1:250,000.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Eaton quadrangle, in Larimer and Weld counties, was completed by Frank Tweedy, Gilbert Young, H. S. Starr, and G. W. Lucas, the area mapped being 856 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet. The survey of the Breckenridge special quadrangle, consisting of 50 square miles in Summit County, was completed by C. E. Cooke and D. F. C. Moor, for publication on the scale of 1:24,000, with a contour interval of 50 feet. Primary triangulation for this area was done by Mr. Moor, who established 3 stations and set 2 permanent marks. The survey of the Uncompahgre Peak quadrangle, including a small portion of the Cochetopa, Gunnison, and Uncompahgre national forests, in Gunnison and Hinsdale counties, was completed by Gilbert Young and S. T. Penick, the area mapped being 703 square miles, as the Lake City 15-minute quadrangle, which had been previously mapped, was included within it. Primary triangulation for this area was done by Mr. Moor, who occupied 2 stations and set 2 permanent marks. The survey of the Montrose quadrangle, in Montrose, Gunnison, San Miguel, and Ouray counties, was commenced by Mr. Young, no area being mapped. The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Pitkin, Eagle, and Gunnison counties, was continued by S. T. Penick and E. R. Bartlett, the area mapped being 25 square miles. The Uncompahgre Peak and Mount Jackson quadrangles were mapped for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of all the areas surveyed in Colorado, 247 miles of primary and 23 miles of precise levels were

run by C. H. Semper, F. J. McMaugh, W. R. Winstead, and R. P. Thompson, 75 permanent bench marks being established. A line of precise levels 321 miles in length, commencing near Denver and extending through Douglas, Denver, Park, Summit, Lake, Eagle, Mesa, and Garfield counties, was run by Mr. Semper, in connection with which 120 permanent bench marks were established.

Montana.—The survey of the Missoula quadrangle, in the Lolo National Forest, in Missoula, Flathead, and Ravalli counties, was continued by Arthur Stiles, William J. Forster, W. M. Kent, and Lee Morrison, the area mapped being 294 square miles. Primary triangulation for this area was done by Mr. Stiles, who occupied 4 stations and set 6 permanent marks. The survey of the Pacific Junction and Avery quadrangles, in Chouteau County, was begun by W. L. Miller, Basil Duke, and G. W. Lucas, the area mapped being 19 square miles. The survey of the Cutbank quadrangle, in Teton County, was commenced by R. W. Berry and H. G. Parry, 93 square miles being completed. All the above work in Montana was for publication on the scale of 1:125,000, with contour intervals of 20 and 100 feet. The survey of a special area in the vicinity of Fort Missoula was made by E. C. Barnard and Arthur Stiles, the area mapped being 3 square miles on the field scale of 400 feet to 1 inch, with a contour interval of 5 feet.

New Mexico.—The survey of the Fort Bayard special area, in Grant County, was completed by C. E. Cooke and S. T. Penick, the area mapped being 18 square miles, for publication on the scale of 1:12,000, with a contour interval of 10 feet. For the control of this area Mr. Cooke located six secondary triangulation stations. The survey of the Graham quadrangle, in Grant and Socorro counties, was commenced by A. B. Searle, A. P. Meade, and R. S. Van Atta, the total area mapped being 150 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Alamo National Forest, in Otero and Lincoln counties, was begun by Van. H. Manning and J. H. Wilke, the area mapped being 34 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. Primary triangulation for this area was commenced by R. B. Robertson, who set 6 permanent marks. K. W. Trimble also ran 32 miles of primary levels and established 12 permanent bench marks.

North Dakota.—The survey of the Nesson quadrangle, in Williams and Stark counties, was begun by Glenn S. Smith, Chester Irvine, Conrad Ecklund, and J. H. Van Wagenen, the area mapped being 56 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Oklahoma.—The survey of the Pawhuska quadrangle, in Osage County, was completed by H. G. Parry, D. F. C. Moor, Lee Morrison,

H. S. Starr, J. E. Tichenor, D. B. Penick, William J. Forster, and J. S. Rohrer, the area mapped being 957 square miles, for publication on a scale of 1:125,000, with a contour interval of 50 feet. For the control of this area 220 miles of primary levels were run and 39 permanent bench marks were established by H. G. Parry. The survey of the McComb quadrangle, in Cleveland County, was completed by Lee Morrison, the area mapped being 16 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Platt National Park, in Murray County, was completed by B. A. Jenkins, the area mapped being 2 square miles, for publication on the scale of 1:6,000, with a contour interval of 10 feet. For the control of this park Mr. Jenkins ran 9 miles of primary levels and established 5 permanent bench marks. The revision of the culture on the McAlester, Tuskahoma, and Winding Stair quadrangles, in Pittsburg, Latimer, and Le Flore counties, was completed, and that on the Sallisaw quadrangle, in Le Flore County, was partly completed. The total area revised was 3,193 square miles, to be republished on the scale of 1:125,000, with a contour interval of 50 feet.

Texas.—The revision of the culture in the Llano quadrangle, in Llano County, and in the Burnet quadrangle, in Burnet County, was completed by D. B. Penick and C. P. Jamerson, the area covered being 2,049 square miles, for republication on the scale of 1:125,000, with a contour interval of 25 and 50 feet.

Wyoming.—The survey of the Rock Springs quadrangle, in Sweetwater County, was completed by Glenn S. Smith, Lee Morrison, and H. S. Starr, the total area mapped being 223 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Primary triangulation for this area was secured by R. B. Robertson, who occupied 7 new stations, intersected 12 stations, and set 11 permanent marks. J. D. Weems also ran 84 miles of primary levels and established 20 permanent bench marks. The survey of the Sheridan quadrangle, in Sheridan County, was commenced by Charles E. Cooke, assisted by P. W. McMillen and F. H. West, the total area mapped being 115 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area F. H. West ran 14 miles of primary levels and established three permanent bench marks. The survey of an irregular area in the Shoshone National Forest, in Bighorn County, was commenced by E. I. Ireland, the area mapped being 100 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this area Otto Meredith ran 26 miles of primary levels and established 7 permanent bench marks. R. B. Robertson extended primary triangulation for the purpose of locating a point on the one hundred and sixth meridian, this being the boundary line between

Crook and Sheridan counties, 12 stations being occupied and 1 point located by intersection. The revision of the culture in the Gallatin quadrangle, in Bighorn County, was completed by Frank Tweedy, the area covered being 849 square miles, to be republished on the scale of 1:125,000, with a contour interval of 100 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Breckenridge special, Eaton, and Uncompahgre Peak, Colo.; New Boston, Linden, Atlanta, and San Marcos, Tex.; Rock Springs, Wyo.; McComb, Pawhuska, and Platt National Park, Okla.; Fort Bayard special, N. Mex.; Fort Missoula special, Mont.; revision of the Tuskahoma, McAlester, and Winding Stair, Okla.; Burnet and Llano, Tex.; Gallatin, Wyo. Progress to the extent of 25 per cent was made in the drafting of the Missoula, Mont., sheet.

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

The readjustment of primary-level circuits in the Engineer Mountain, Needle Mountains, San Cristobal, and Silverton (Colo.) quadrangles was accomplished. Level circuits in the Uncompahgre Peak, Eaton, and Montrose (Colo.) quadrangles were adjusted and geodetic positions in the Uncompahgre Peak quadrangle were computed. Computations were made for the determination of the elevation of Pikes Peak, in the Pikes Peak special (Colo.) quadrangle. The office computation of the precise-level line extending from Petersburg to Ridgeway (Colo.) was made.

Geodetic positions in the Missoula (Mont.) quadrangle were computed.

Precise-level lists in the Albuquerque, Deming, Eagle, Gallina, Jemes, and Rincon (N. Mex.) quadrangles were revised and prepared.

Level circuits in the Newcomb, Newalla, Pawhuska, and Platt National Park (Okla.) quadrangles were adjusted.

Level circuits in the Bassett, Bogota, Boxelder, and Daingerfield (Tex.) quadrangles were adjusted.

Geodetic positions were computed in the Arvada, Cora, Fremont, Grays River, Grosventre, Hoback, Rock Springs, and Sheridan (Wyo.) quadrangles.

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. This work comprised the survey of 8 quadrangles and the resurvey of

11 quadrangles and 2 special areas. In addition, 9 quadrangles and 3 special areas were partly surveyed, and 5 quadrangles were partly resurveyed. The total new area mapped was 12,148 square miles—8,179 for publication on the scale of 1:250,000, 3,198 for publication on the scale of 1:125,000, 577 for publication on the scale of 1:62,500, and 194 for publication on the scale of 1:31,680. The area resurveyed was 1,384 square miles—396 for publication on the scale of 1:125,000, 202 for publication on the scale of 1:62,500, 779 for publication on the scale of 1:31,680, and 7 for publication on the scale of 1:24,000. In connection with this work 2,384 miles of primary levels and 23 miles of precise levels were run and 558 permanent bench marks were established.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by five parties, the work being distributed over portions of Califonia, Oregon, Utah, and Washington. The total area covered by this primary control was about 5,700 square miles, of which 1,400 were controlled by primary traverse, 285 miles being run and 36 permanent marks set.

Topographic surveys in Pacific division from July 1, 1908, to June 30, 1909.

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.
		New.	Resurvey.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Arizona	50–100	471	396	.....	.....	867	.....	.....	.....	.....
California	5–25	2,050	.....	122	.....	[a] 3,131	1,242	298	120	18
	50–100									
Idaho	50–100	581	.....	61	.....	642	96	23	.....	.....
Nevada	20–100	.....	.....	.....	.....	[b] [c] 4,489	319	68	.....	.....
Oregon	5–10–50	.....	.....	327	.....	[a] 341	333	84	.....	.....
Utah	100	45	.....	.....	.....	[b] 3,732	248	41	.....	.....
Washington	25–50–100	51	.....	67	202	[b] 330	169	44	165	18
	.....	3,198	396	577	202	13,532	2,407	558	285	36

[a] 973 square miles (779 resurvey and 180 new area in California, 14 new area in Oregon) for publication on the scale of 1:31,680.
[b] 8,179 square miles (4,482 in Nevada, 3,687 in Utah, 10 in Washington) for publication on the scale of 1:250,000.
[c] 7 square miles resurvey in Nevada for publication on scale of 1:24,000.

DETAILS OF WORK BY STATES.

Arizona.—The resurvey of the area covered by the San Francisco Mountains reconnaissance map was continued by T. Foster Slaughter, M. T. Noyes, and J. W. Muller, and resulted in the completion of the work in the Flagstaff quadrangle, in Coconino County, the area mapped being 396 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Arizona-California.—The survey of the Parker quadrangle, in Yuma County, Ariz., and San Bernardino and Riverside counties, Cal., was completed by W. C. Guerin, E. C. Guerin, and J. W. Muller, the area mapped being 635 square miles, 164 of which are in California, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

California.—The Department of Engineering of California allotted $12,000 for the continuation of the 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 portions of the Sacramento, Marysville, and Smartsville quadrangles resulted in the completion of the mapping of the Arcade, Antelope, Brighton, Mills, Sheridan, Lincoln, Roseville, Pleasant Grove, New Hope, and Wheatland quadrangles, and in the partial completion of the work in the Folsom, Deer Creek, Scott Ranch, Spencerville, and Yuba City quadrangles. The survey of the Marcuse, Nicolaus, Knights Landing, and Vernon quadrangles, comprising new area, was also completed. The total new area mapped was 180 square miles, in Sutter and Yuba counties, and that resurveyed was 737 square miles, in Placer, Sacramento, Sutter, Yuba, and San Joaquin counties, all being for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by W. H. Griffin, W. R. McKean, J. H. Sinclair, M. A. Knock, B. Knock, E. C. Williams, E. R. Bartlett, T. H. Moncure, E. L. Sellon, John L. Lewis, A. J. Ogle, and W. B. Kern. On account of the interest of the federal geologists in the Salinas, Mariposa, and Mount Goddard quadrangles, additional cooperation for their partial survey was entered into, the amount appropriated being $6,000 each by the Department of Engineering and the United States Geological Survey. The survey of the Salinas quadrangle, in Santa Clara, San Benito, Monterey, and Santa Cruz counties, was commenced by B. A. Jenkins, E. R. Bartlett, T. H. Moncure, W. H. Griffin, and M. A. Knock, 122 square miles being completed, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Mount Goddard quadrangle, in the Sierra National Forest, in Fresno and Inyo counties, was continued by George R. Davis, assisted by Edward Hyatt, jr., the area mapped being 485 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Orestimba-Panoche-Cantua special area, in Merced, Stanislaus, Fresno, and Monterey counties, was commenced by George R. Davis, T. H. Moncure, J. H. Sinclair, R. M. La Follette, and J. E. Blackburn, the total area mapped being 1,299 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the cooperative areas and for the Mariposa quadrangle 1,206 miles of primary levels and 23 miles of precise levels were run and

294 permanent bench marks were established by B. A. Jenkins, W. H. Monohan, W. H. Barringer, and L. F. Biggs; 120 miles of primary traverse were run and 18 permanent marks were set by M. A. Knock. Primary triangulation for the control of the Sacramento Valley areas, the Salinas and Mariposa quadrangles, and the Orestimba-Panoche-Cantua special area was done by C. F. Urquhart, 56 stations being occupied and 31 permanent marks set. In addition to the cooperative work in California, the survey of the Smartsville special area, in Yuma and Nevada counties, was completed by J. P. Harrison, W. R. McKean, and C. F. Eberly, the area resurveyed being 42 square miles, on the field scale of 1:31,680, with contour intervals of 5 and 25 feet. The survey of the Mariposa quadrangle, which lies partly in the Sierra National Forest, in Mariposa and Madera counties, was commenced by C. H. Birdseye, assisted by T. P. Pendleton, the area mapped being 102 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, in the Trinity National Forest, in Trinity County, was continued by J. P. Harrison, no area being mapped. Leveling for the Bridgeport quadrangle, in Mono County, was commenced by C. M. Weston, who ran 13 miles and established 4 permanent bench marks.

Idaho.—The survey of the Meadows quadrangle, in the Weiser National Forest, in Boise and Washington counties, was continued by J. E. Blackburn, A. O. Burkland, and E. A. Lincoln, the total area mapped being 466 square miles. The survey of the Montpelier quadrangle, in the Bear River and Caribou national forests, in Bear Lake County, was commenced by A. E. Murlin and M. A. Knock, the area mapped being 104 square miles. For the control of this area L. F. Biggs ran 96 miles of primary levels and established 23 permanent bench marks. The survey of the Cataldo quadrangle, in the Cœur d'Alene National Forest, in Shoshone, Bonner, and Kootenai counties, was continued by W. O. Tufts, J. W. Muller, and O. G. Taylor, the area mapped being 11 square miles. All the work in Idaho was for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet.

Nevada.—The survey of the Carson Sink quadrangle, in Churchill, Lyon, Nye, and Esmeralda counties, was completed by W. M. Beaman, J. P. Harrison, J. E. Blackburn, and Fred McLaughlin, the total area mapped being 3,687 square miles. The survey of the Hawthorne quadrangle, in Esmeralda County, was commenced by C. G. Anderson, who surveyed 795 square miles. The mapping of both of these quadrangles was done for publication on the scale of 1:250,000, with a contour interval of 100 feet. For their control T. A. Green ran 284 miles and C. M. Weston 35 miles of primary levels, in connection with which 68 permanent bench marks were set. The revision of the Gold-

field special area, consisting of 7 square miles in Esmeralda and Nye counties, was completed by W. M. Beaman, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Oregon.—The state engineer allotted $2,500 for the continuation of cooperative topographic surveys in Oregon, which was met by a like sum from the United States Geological Survey. The Eugene quadrangle, in Lane County, was completed by J. P. Harrison, C. E. Giffin, B. A. Jenkins, and R. M. LaFollette, the area mapped being 213 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The survey of the Willamette Valley quadrangle, in Benton and Polk counties, was commenced by Robert Muldrow, who mapped 14 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas C. E. Giffin, W. R. Chenowith, and W. B. Kern ran 95 miles of primary levels and established 19 permanent bench marks. Triangulation control was established by Pearson Chapman, who occupied 10 stations and set 6 permanent marks. In addition to the cooperative work, the survey of the Crater Lake quadrangle, in Klamath County, was commenced by Mr. Chapman, the area mapped being 114 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining areas 238 miles of primary levels were run from Ashland, through Crater Lake National Park, to Prineville, in connection with which 65 permanent bench marks were set by L. F. Biggs.

Utah.—The survey of the Fish Springs quadrangle, in Millard and Juab counties, was completed by Fred McLaughlin, the area mapped being 3,687 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. For the control of this area T. A. Green ran 248 miles of primary levels and established 41 permanent bench marks. The survey of the Randolph quadrangle, which lies partly in the Bear River National Forest, in Rich and Cache counties, was commenced by Albert Pike, the area mapped being 45 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Primary triangulation for this area was done by C. F. Urquhart, who occupied 8 stations and set 6 permanent marks.

Washington.—The Board of Geological Survey of Washington allotted $10,000 for the purpose of beginning cooperative topographic surveys in the State, which was met by a like sum for the same purpose by the United States Geological Survey. The survey of the Mount Vernon quadrangle, in Skagit and Snohomish counties, was begun by J. R. Eakin and G. V. Brown, the area mapped being 51 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area W. A. Gelbach ran 70 miles of primary levels and set 15 permanent bench marks,

and C. A. Clunet ran 165 miles of primary traverse and set 18 permanent marks. The survey of the Quincy and Morrison quadrangles, in Grant County, was begun by C. F. Eberly and H. L. McDonald, the area mapped being 67 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas C. H. Semper ran 99 miles of primary levels and established 29 permanent bench marks. In addition to the cooperative work, the survey of the Mount Baker quadrangle and adjoining areas in the Washington National Forest, in Skagit County, was continued by J. E. Blackburn, the area mapped being 10 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. The revision of the Seattle quadrangle, in King County, was completed by C. F. Eberly and J. G. Hefty, the area covered being 202 square miles, for republication on the scale of 1:62,500, with a contour interval of 25 feet.

IDAHO-WASHINGTON BOUNDARY LINE.

An appropriation of $25,000 was made by Congress for the survey of the Idaho-Washington boundary line, and the work was placed under the charge of the United States Geological Survey by the Secretary of the Interior. The survey was undertaken by S. S. Gannett, C. L. Nelson, and S. G. Lunde, who completed 135 miles of the line, which was marked by 112 iron monuments 6 feet long, 4 inches in diameter, filled with concrete, and by 21 granite monuments 6 feet long and 10 inches square. In addition to these, 174 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 1 mile in width along 61 miles of the line was mapped by Mr. Nelson and Bayard Knock, for publication on the scale of 1:62,500. The rest of the boundary line surveyed lies in country already mapped by the United States Geological Survey.

OFFICE WORK.

The drafting of the following sheets was completed: Flagstaff, Ray, and Parker, Ariz.; Eugene, Oreg.; Carson Sink, Nev.; Fish Springs, Utah; Rio Vista, Isleton, Jersey, Bouldin, New Hope, Headreach, Woodbridge, Castile, Galt, Bonceville, Roseville, Pleasant Grove, Lincoln, Sheridan, Vernon, Knights Landing, Nicolaus, Marcuse, Wheatland, and Deer River, Cal.; cultural revision for the Goldfield special, Nev.; Seattle, Wash.; and Smartsville special, Cal.

Progress in the drafting of additional sheets was made as follows: Folsom, Cal., 40 per cent; Meadows, Idaho, 50 per cent.

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

Level circuits were adjusted in the Benson, Blaisdell, San Simon, Tucson, and Williams (Ariz.) quadrangles. Geodetic positions were computed in the Cochise, Chiricahua, Pearce, and San Simon (Ariz.) quadrangles.

Level circuits were adjusted in the Antioch, Auburn, Cambria, Capitola, Clarksburg, Coalinga, Dunnigan, Etna, Fairoaks, Folsom, Fresno, Grimes, Hatchville, Hollister, Hoopa, Knights Landing, Lincoln, Loma Prieta, Los Banos, Mariposa, Merced, Newman, Panoche, Pejero, Preston, Rio Vista, Salinas, San Martin, San Jose, Santa Cruz, Sawyer Bar, Seiad, Smartsville, Stockton, Wheatland, Woodbridge, Yuba City, and Yreka (Cal.) quadrangles. The computation of triangulation done in the State during 1908 was made in the Sacramento office.

The computation of the field notes of the resurvey of the Washington-Idaho boundary line was made.

Level circuits in the Carson Sink (Nev.) quadrangle were adjusted.

The office computation of the level line extending from Ashland to Prineville (Oreg.) and over the Crater Lake and Jacksonville (Oreg.) quadrangles was made.

Level circuits in the Fish Springs (Utah) quadrangle were adjusted.

Level circuits in the Mount Adams, Mount Baker, Simcoe, and Zillah (Wash.) quadrangles were adjusted. Level lists, including circuits of level lines, in the Moses Lake (Wash.) quadrangle were revised. Computations of latitudes, departures, and geographic positions on the Mount Vernon (Wash.) quadrangle were made.

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 six 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 that of private surveys, was incorporated in the maps. The status of all lands inside of the forests was obtained in greatest detail from the records of the General Land Office by expert status clerks, and the land classification and the improvements in the forests from the maps of the Forest Service, all these data being shown in colors and symbols on the compiled maps.

Folios were finished during the fiscal year 1908–9 for the following forests: Luquillo, Angeles, Holy Cross, Lolo, Las Animas, Kansas,

La Sal, Sitgreaves, Battlement, Coronado, Pocatello, Beartooth, Cheyenne, Teton, Medicine Bow, Absaroka, Sioux, Gunnison, Kaibab, Shoshone, Caribou, Custer, Apache, Sundance, Targhee, Arapaho, Wyoming, Routt, Pecos, and Nebraska, all of which have been lithographed and delivered to the Forest Service.

The following were compiled and are now in the hands of the engraver: Fillmore, Cœur d'Alene, Dixie, Arkansas, Chiricahua (New Mexico portion), San Isabel, Garces, Jefferson, Coconino, Montezuma, Moapa, Minidoka, Bonneville, Tonto, Missoula, Carson, Jemez, Humboldt, White River, Bighorn, Cochetopa, and Uncompahgre.

Folios of the following forests were practically completed: Nezperce, Datil, Modoc, Stanislaus, Powell, Uinta, Cleveland, Tahoe, Pend Oreille, Idaho, Payette, Weiser, Toiyabe, Oregon, Alamo, Prescott, Challis, Kootenai, and Sevier.

The Ashley, Ocala, Caldwell, Inyo, Sierra, Fish Lake, Nebo, and Gila folios were compiled, but the final tracings were not finished; the Ozark, Deerlodge, Beaverhead, Deschutes, Crook, Mono, and Santa Barbara folios were partly compiled; and the San Luis, Sequoia, Umpqua, Cascade, and Cabinet folios were commenced.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the season only a small amount of field inspection of topographic mapping was done, as the inspectors were engaged for the greater part of the season in regular topographic field work. J. H. Renshawe, after the completion of his field work in Ohio on the Granville quadrangle, was engaged for the balance of the season in the inspection of work in the Central and Atlantic divisions. After the completion of the revision of the Goldfield special area in Nevada, W. M. Beaman did a small amount of inspection in California. F. E. Matthes devoted his whole time in the field to the demonstration of methods and style of topographic mapping applicable to the country worked in Maine and West Virginia.

During the office season careful attention was given by Messrs. Renshawe and Beaman to the final drawing of topographic sheets, for the purpose of eliminating personal mannerisms and errors of expression, also to the examination of the finished sheets. Mr. Matthes's time was devoted to the inking of his field sheets, to the completion of the report on the Yosemite National Park, and to the revision of the book of instructions for field and office work.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

During the year all the topographic instruments in the office were examined, and all that were found to be worn out, useless, or of obso-

lete types were condemned by a committee appointed by the Director. Some of these were deposited in the National Museum, and the remainder were sold at auction. All minor repairs to instruments were made in the Survey shop, the extensive repairs and remodeling being done by outside contractors, as heretofore. In December, 1908, Survey instruments to the value of about $15,000 were destroyed by fire, but all of them were replaced by authorization of Congress, which made a special appropriation therefor.

Thirty-one hundred items were added to the files of topographic records during the year. The triangulation and level plats of all States, the card catalogue of triangulation and primary-traverse stations, and the card catalogue of bench-mark descriptions and elevations were brought up to date.

MAP OF THE UNITED STATES.

Work on the 1:1,000,000 scale map of the United States was begun in July under the direction of A. F. Hassan, and the following progress was made:

The Florida portions of sheets G, H–14, and H–15 were completed; about 90 per cent of the coastal-plain area in North Carolina (sheets I–13, I–14, and J–13) was compiled and about 15 per cent inked and lettered; about 75 per cent of South Carolina (sheet I–14) was compiled; about 95 per cent of the land lines of Illinois (sheets J–15, J–16, K–15, and K–16) were adjusted, about 40 per cent being compiled and 15 per cent inked; about 90 per cent of sheet K–12 (portions of New Hampshire, Massachusetts, Connecticut, and Rhode Island) was compiled and inked; about 30 per cent of sheet K–13 (parts of New York, Vermont, Massachusetts, Connecticut, Pennsylvania, and New Jersey) was compiled; a special sheet of Wisconsin (K–15), latitude 42° 00′ to 44° 00′, longitude 87° 30′ to 90° 00′, was completely compiled and inked, and about 70 per cent of the lettering finished.

WATER-RESOURCES BRANCH.

The work of the water-resources branch during the year has consisted of investigations of (*a*) surface water, (*b*) underground water, (*c*) the quality of water, and (*d*) the effect of mining débris.

SURFACE-WATER INVESTIGATIONS.

The principal work in the investigation of surface waters is the determination of stream flow. For this purpose permanent stations are established on chosen rivers at selected points and the daily discharge is determined by proper engineering means, a description of which is not necessary to this report. Such work, carried on for a series of years, results in a continuous record of the flow of the rivers that covers all extremes of high and low water. So far it has not been possible with the money available to conduct this work in all parts of the country, or indeed in any part, with the thoroughness that is necessary to obtain the results that the importance of the work demands. To do the work as it should be done would require an appropriation at least twenty times that now made, or, in other words, $2,000,000 annually instead of the $100,000 that has been available during each of the last two years and has been appropriated for the next fiscal year.

It is not necessary, however, to expend such an amount in order to procure results of enormous value. If $200,000 were appropriated, as in the four years from 1902 to 1906, a very good showing could be made, and, although the work would have to continue for a longer period than if a larger amount were made available, nevertheless in the course of time all the necessary facts could be gathered.

During the last fiscal year the Survey has maintained 347 gaging stations in the United States. The stations are well scattered over the entire country, except in certain low-lying portions. The greatest number per unit of area are located in the high mountains, where critical conditions of run-off exist. In addition to these stations 128 stations have been maintained in cooperation with the Reclamation Service, 82 stations in cooperation with private persons, and 272 stations in cooperation with States. The cooperating States, under special or general legislative authority, have furnished the funds necessary to maintain these stations, which have been established for their own particular purposes. The results obtained are, of course, useful in general and special ways for the purposes of the Geological Survey, and they contribute largely to the sum total of information available.

The following is a list of stations by States:

Gaging stations maintained wholly or in part by United States Geological Survey.

State.	Number of stations maintained during fiscal year 1908–9.				
	By the Survey.	In cooperation with—			Total.
		States.	Reclamation Service.	Private persons.	
Alabama	8			1	9
California	38	24		[a] 18	80
Colorado	6	18	5	21	50
Connecticut	1			1	2
District of Columbia	1				1
Georgia	23				23
Idaho	7	3	12		22
Illinois	2	18			20
Indiana	2				2
Iowa	1	1			2
Maine	4	10		11	25
Maryland	1	7			8
Massachusetts		2		4	6
Michigan	7			9	16
Minnesota	2	33		1	36
Mississippi	2	8			10
Missouri	1				1
Montana	23	20	50		93
Nebraska		7			7
Nevada	5		8		13
New Hampshire				6	6
New Jersey	3				3
New Mexico	13	3	7		23
New York	16	28		3	47
North Carolina	13	12			25
North Dakota	10	8	2		20
Ohio	2	1			3
Oregon	40	40	8		88
South Carolina	4				4
Tennessee	10				10
Utah	24	7	7		38
Virginia	18			2	20
Vermont		9			9
Washington	18	10	26		54
West Virginia	24				24
Wisconsin	4			5	9
Wyoming	14	3	3		20
	347	272	128	82	829

[a] Maintained by the city of Los Angeles.

Other features of the surface-water investigations consist of the survey of rivers to determine their slope and the survey of sites for reservoirs. These surveys, however, have been few in number and are not at the present time regarded as so important as the determination of stream flow.

GROUND-WATER INVESTIGATIONS.

The investigation of the water resources that exist below the surface of the ground equals in importance that of surface waters. The soil and the rocks are our greatest reservoirs. They supply more people with domestic water than all the streams, and in certain sections of the country underground water has been the chief source of the prosperity that they now enjoy. The determination of ground-

water supplies is largely a geologic study, for the water that sinks into the ground is governed in its course and occurrence by the character of the rock formations which it encounters and through which it passes.

The total allotment made for ground-water investigations for the fiscal year 1909 was $12,650, of which $4,150 was transferred for expenditure under the chief geologist in the investigation of the geology and ground waters of the Coastal Plain of the Atlantic and Gulf States. The remaining allotment of $8,500 was insufficient to maintain the regular members of the staff and to continue the investigations under way by the special experts from various universities. In order, therefore, that the division might not be disorganized, two supplementary agreements were entered into. By the terms of one of these agreements H. R. Johnson was assigned to the geologic branch for one-half of the fiscal year to assist in the investigation of the oil fields of California, the water-resources branch agreeing to employ him during the remainder of the year. Under the second agreement the State of Utah, through Caleb Tanner, state engineer, agreed to pay the field expenses of O. E. Meinzer while he carried on an investigation in that State, his salary and a few incidental expenses to be borne by the Federal Survey. By virtue of these adjustments it became possible to hold together the force throughout the year and to take up three new problems.

G. A. Waring, who at the close of the fiscal year 1908 had completed his reports on the geology and ground waters of south-central Oregon, was assigned to make a systematic study of the springs of California, especially those that are reputed to have medicinal properties and are the principal attraction of pleasure and health resorts. It is estimated that this work will require two years for completion.

The second new investigation undertaken was that of the occurrence, distribution, and quantity of the underground waters in the Antelope Valley and adjacent parts of the Mohave Desert in Los Angeles and San Bernardino counties. H. R. Johnson was assigned to this field for such portion of his time as was to be given to the water-resources branch. He entered the field early in November and completed the field investigations in January, reaching the Washington office about the middle of February. By a supplementary agreement he was assigned to the geologic branch for an additional two months. At the close of the fiscal year the preparation of Mr. Johnson's report on the field work was well under way, and he expected to complete it by August 1.

The third of the new investigations undertaken was that supported jointly by the United States Geological Survey and the State of Utah. O. E. Meinzer received this assignment, his particular field being Juab, Millard, and Iron counties in southwestern Utah. This

work was so distributed as to supplement and coordinate with that done in earlier years by G. B. Richardson and W. T. Lee. Mr. Meinzer's field work closed about the 1st of November, 1908, and soon thereafter he returned to the Washington office, where he was directed to complete the preparation of a report on the ground waters of southern Minnesota begun some years ago by M. L. Fuller and C. W. Hall. He was occupied through practically all of the last half of the fiscal year with this work, and the manuscript of the report was submitted about the middle of June, 1909.

The responsibility for the classification of irrigable and nonirrigable lands, thrown upon the Survey by the passage of the " enlarged homestead act," made advisable the examination of particular areas. On the completion of the Minnesota report Mr. Meinzer was sent to New Mexico to make certain of these examinations and to supplement his work of the summer of 1908 in the Utah field, it having been found that additional information was required before a satisfactory report could be prepared.

Prof. C. H. Gordon, of Knoxville, Tenn., has continued the preparation of two reports on the geology and ground waters of portions of northern Texas. The first of these reports was submitted to the Survey early in the calendar year 1909, and at the close of the fiscal year some progress had been made on the second report.

Prof. W. H. Norton and Prof. W. S. Hendrixson, of Iowa, have made some progress during the year on their report on Iowa's ground waters; but university duties require the greater part of their time and energy, and during the coming fiscal year Mr. Meinzer, who is familiar with the Iowa field, will be assigned thereto for a short time in order that some delayed field work may be done and the report completed.

W. C. Mendenhall, in charge of ground-water investigations, remained in the Washington office until the latter part of August, 1908, completing a preliminary report on the ground waters of the San Joaquin Valley, California, which was submitted for publication about the 1st of September. He then joined Mr. Waring in California, and early in October spent several weeks with Mr. Meinzer in southwestern Utah reviewing his work there. Later Mr. Mendenhall went to Tucson, Ariz., to go over with Professor Smith, of the University of Arizona, a field in the Santa Cruz and Rillito valleys, in which certain experiments had been conducted to determine the amount and availability of the underflow.

In the spring of 1909, at the suggestion of W. H. Code, chief engineer of the Indian Service, an agreement was entered into by the terms of which the Geological Survey has undertaken to investigate the underground-water conditions in the Moki and Navajo reservations. The Office of Indian Affairs has set aside $3,000 for the work,

and Prof. H. E. Gregory, of Yale University, has been assigned to the field. He and Mr. Mendenhall spent the month of May with M. R. Campbell, of the geologic branch, and H. F. Robinson, of the Indian Service, superintendent of irrigation for Arizona and New Mexico, visiting the reservations and determining the fields to be specially investigated and the best methods of carrying out the work. Professor Gregory will complete his researches in August or September and will prepare a final report some time thereafter, the agreement being that preliminary reports shall be sent to the Office of Indian Affairs from the field immediately after the completion of each important unit in the problem.

INVESTIGATIONS OF THE QUALITY OF WATER.

The water resources are not determined on the completion of studies concerning the amount of water. A complete inventory, adaptable for use, requires that the quality of the waters also be considered. No investigations of this sort have been made during the past year, except those in cooperation with the State of California. In previous years a large amount of data had been accumulated, and the effort of the past year has been concentrated on the compilation and assembling of these data and the making of proper deductions for reports. These reports relating to the quality of water in various parts of the country and its industrial usefulness are in preparation and will be published at an early date.

DÉBRIS INVESTIGATION.

The investigation of problems connected with the overloading of California rivers by mining débris was continued under the charge of G. K. Gilbert. The work included additional measurements of pits excavated by hydraulic mining and additional studies of the contributions to the detrital load of streams through the cultivation of the soil and the grading and use of wagon roads. In the hydraulic laboratory of the Survey at the University of California further study was made of the laws controlling the transportation of detritus by running water. Experiments with assorted detritus washed through straight channels were supplemented by others with mixed detritus and by a series with crooked channels. The general series of experiments representative of natural stream work, in which the bed of the channel is composed of detritus and its form is determined by the stream itself, was carried to completion, and a second series was begun representative of flumes and other artificial channels in which the form of the channel bed is rigid and unchanging. Incidental to this work was an experimental study of a specially constructed Pitot or Darcy current gage. A report on the overloaded rivers is in hand.

STATE COOPERATION.

It has been the custom during previous years for States which so desired to cooperate with the Geological Survey along certain lines of investigation, for the purpose of procuring the final results at an earlier time than would be possible under the limited allotments that the Survey is obliged to make. Such cooperation has been helpful and has figured largely in the scope of the work. The States, either by special legislative appropriation or from a general fund that may be so expended, make allotments to be used for this work, under the general supervision of the Director of the Federal Survey.

In some States the amounts allotted by each party are equal; in others the Survey pays a larger or smaller part, according to its estimate of the comparative importance of the work or the limit of the Survey's appropriation. The practice is to give due consideration to the demands and needs of the various States for such investigations and to allot the appropriation according to their relative merits. Such allotments having been made, the States determine the amounts that they can afford to contribute. All arrangements are made under formal agreement, and the following is a statement of the extent of such cooperation during the fiscal year 1908–9 and the character of the work performed.

California.—An agreement in continuation of previous ones with this State was entered into on July 1, 1908, providing that during the fiscal year then beginning cooperative investigations of the flow of rivers in the State should be made, together with the survey of reservoir and dam sites for impounding flood water; the survey of main diversion canals and their headworks for the purposes of development of irrigation, navigation, municipal water supply, and water power; the study of underground waters; and the necessary computations and estimates for all these investigations. The Geological Survey contributed $11,500 and the State $8,500. A similar agreement, covering the same investigations for the year beginning July 1, 1909, has been executed, the two parties thereto contributing $9,000 each.

Colorado.—On July 1, 1908, an agreement was entered into whereby the state engineer of Colorado consented to pay the salaries of observers at 16 stations, the remainder of the expense thereof to be paid by the Survey. The total amount expended by the state engineer during the year was about $750. During the same period the Survey expended approximately $5,000.

Idaho.—A cooperative agreement was entered into with the state engineer of Idaho on April 1, 1909, to continue in effect until June 30, 1910, providing for a determination of the flow of the rivers of the State, together with investigations and observations necessary or

related thereto, for the purpose of development of irrigation, municipal water supply, and water power. The amounts contributed by the two parties are $2,000 each.

Illinois.—During the past year 16 gaging stations have been maintained in Illinois at the expense of the Illinois Improvement Commission. These stations were maintained for the purpose of determining facts necessary to the establishment of an intelligent drainage system throughout the State, and about $1,800 was expended during the year.

Massachusetts.—An agreement to take effect July 1, 1909, with the governor of Massachusetts, under the authority of a law passed by the Commonwealth for that purpose, provided for the determination of the flow of rivers in the State and allied investigations relative to water powers, each party contributing the sum of $1,050.

New York.—Two agreements have been in force in this State. The first is with the state engineer, to whom the legislature grants an annual appropriation of $1,500 for stream-flow measurement work. This is met by a like amount allotted by the Geological Survey. The state appropriation is used to maintain purely intrastate investigations; the allotment of the Survey is expended on interstate streams. The second feature of cooperation involved an agreement with the New York State Water Supply Commission, which allotted from its general appropriation the sum of $2,700 for the maintenance of 11 stations on rivers that were being studied by it.

Maine.—An agreement with the State of Maine involved the expenditure of $2,500 by the Geological Survey and $3,500 by the State, the money being used for the maintenance of gaging stations and the survey of rivers to determine their profiles, for water-power purposes. Sixteen gaging stations were maintained and a survey of the East Branch of Penobscot River was made.

North Carolina.—Under an agreement with the state geologist, the salaries of observers at 12 stations in North Carolina were paid out of state funds.

Maryland.—Under an agreement with the state geologist, the salaries of observers at seven stations in Maryland were paid from state funds.

Minnesota.—An agreement to take effect May 15, 1909, provided for the determination of the flow of rivers, the survey of rivers and reservoir sites, and allied investigations necessary to the determination of the water resources of the State, which was represented by the State Drainage Commission and contributed $12,500, against $2,750 allotted by the Geological Survey; and further provided that on June 30, 1910, a new agreement shall be made, under which the Geological Survey shall contribute to the work as large a sum as is possible under an equitable distribution of the federal

appropriation, due regard being given to the appropriations made by Congress for such work, it being understood that said Survey shall during subsequent years make the allotments necessary to complete the work, which shall eventually equal in the aggregate the contributions made by the State of Minnesota, all being contingent on the action of the Congress of the United States in continuing this feature of the Survey's work.

Nebraska.—An agreement, entered into on July 1, 1908, provided for the maintenance of 30 gaging stations throughout the State, each party contributing the sum of $650.

Oregon.—The agreement with the State of Oregon during the past year was in continuation of similar agreements maintained during several years previous, providing for an expenditure by each party of $2,500 for the determination of the flow of the rivers of the State and investigations and observations necessary for purposes of irrigation, municipal water supply, and water power.

Utah.—An agreement made with the state engineer of Utah, under authority of a special act of the legislature, was entered into on April 1, 1909, and will continue until June 30, 1910. It provides for an expenditure by each party of $2,000 and contemplates the measurement of stream flow and the study of irrigation, municipal water supply, and water-power problems. A similar agreement, informal in character, was made to cover ground-water investigations, and has already been described. (See p. 91.)

Vermont.—Under an act of the legislature of Vermont, the governor was authorized to enter into an agreement with the Director of the Geological Survey for making an investigation and report on the water resources of that State. This agreement was entered into April 1, 1909, and provides for the expenditure of $1,000 by each party.

Washington.—The State of Washington, under authority of the legislature, entered into an agreement with the Director of the Geological Survey on May 1, 1909, for the maintenance of gaging stations and the determination of water powers within the State, each party contributing the sum of $5,000.

PUBLICATIONS.

The following manuscripts are ready for publication or were in preparation at the close of the fiscal year:

SURFACE WATER SUPPLY PAPERS.

No. 234. Conservation of water resources. Reprints from the report of the National Conservation Commission. In press.

Progress Report, 1907–8, in twelve parts: Parts I and III to XI, 78 per cent completed; Part II (No. 242), in press; Part XII, 98 per cent completed.

Hydrography of Penobscot River drainage, 85 per cent completed.

UNDERGROUND-WATER PAPERS.

No. 227. Underground-waters of South Dakota, by N. H. Darton. In press.
No. 232. Underground-water resources of Connecticut, by H. E. Gregory and E. E. Ellis. In press.
No. 233. Underground waters of the Blue Grass region of Kentucky, by G. C. Matson. Submitted.
Underground waters for farm use, by M. L. Fuller. Submitted.
Well-drilling methods, by Isaiah Bowman. Submitted.
Underground-water papers, 1907–8, by M. L. Fuller et al. 85 per cent completed.
Ground waters of north-central Indiana, by S. R. Capps. 95 per cent completed.
Ground waters of eastern Arkansas, by A. F. Crider. Completed and being examined.
Ground waters of Iowa, by Prof. W. H. Norton and Prof. W. S. Hendrixson. 80 per cent completed.
Underground waters of southern Minnesota, by C. W. Hall, O. E. Meinzer, and M. L. Fuller. 90 per cent completed.
Ground waters of southwestern Utah, by O. E. Meinzer. 50 per cent completed.
Geology and water resources of northeastern Texas, by C. H. Gordon. 85 per cent completed.
Ground waters of north-central Texas, by C. H. Gordon. 50 per cent completed.
Geology and underground waters of the coastal plain of Texas, east of Brazos River, by Alexander Deussen. Completed and being examined.
Denudation and erosion in the southern Appalachians, by L. C. Glenn. Returned to author for revision.
Underground waters of southwestern Ohio, by M. L. Fuller. Submitted.
Ground waters of the Mohave Desert, by H. R. Johnson. 60 per cent completed.
California springs, by G. A. Waring. 30 per cent completed.
Geology and water resources of San Luis Valley, Colorado, by C. E. Siebenthal. Returned to author for revision.

PAPERS ON THE QUALITY OF WATER.

No. 236. Surface waters of the United States, Part I, by R. B. Dole. Submitted.
Surface waters of the United States, Part II, by R. B. Dole. 15 per cent completed.
No. 237. The quality of surface waters of California, by Walton Van Winkle. Completed and awaiting revision.
The quality of waters of Kansas, by H. N. Parker. 92 per cent completed.
The quality of waters of Illinois, by W. D. Collins. 90 per cent completed.
The industrial uses of water, by Herman Stabler. 45 per cent completed.
No. 235. The purification of some textile and other factory wastes; a report based on investigations near Providence, R. I., by Herman Stabler and G. H. Pratt. Submitted.
Chemical denudation in the United States, by Bailey Willis, F. W. Clarke, and R. B. Dole, to be published as Professional Paper. 60 per cent completed.

PERSONNEL.

The water-resources branch has continued under the direct administrative charge of M. O. Leighton, chief hydrographer, assisted by J. C. Hoyt, assistant chief hydrographer. W. C. Mendenhall is geol-

ogist in charge of ground-water investigations and R. B. Dole is assistant chemist in charge of investigations of quality of water.

The district engineers in charge of field work of stream gagings, river surveys, etc., are H. K. Barrows, New England; C. C. Covert, New York; R. H. Bolster, middle Atlantic States; M. R. Hall, southern Atlantic and eastern Gulf States; A. H. Horton, Ohio Valley and Central States; Robert Follansbee, Minnesota; J. E. Stewart, Montana, North Dakota, and northern Wyoming; W. B. Freeman, southern Wyoming, Colorado, New Mexico, Kansas, and Nebraska; E. C. La Rue, Utah, Idaho, and Nevada; J. C. Stevens, Oregon and Washington; and W. B. Clapp, California. The computation work is under the charge of R. H. Bolster, assistant engineer.

The geologists engaged in the investigation of ground-water resources, under the direction of W. C. Mendenhall, are H. R. Johnson, G. A. Waring, and O. E. Meinzer.

In addition to these regular employees, occasional services have been rendered by Prof. C. W. Hall, University of Minnesota; Prof. W. H. Norton, Cornell College, Mount Vernon, Iowa; Prof. W. S. Hendrixson, Iowa College, Grinnell, Iowa; and Prof. C. H. Gordon, University of Tennessee, Knoxville, Tenn.

The chemists and engineers who have been engaged in investigations of the quality of water, under the direction of R. B. Dole, are H. N. Parker, Herman Stabler (for part of the year), and Walton Van Winkle.

The débris investigation at the hydraulic laboratory at Berkeley, Cal., has continued under the charge of G. K. Gilbert, assisted by E. C. Murphy.

TECHNOLOGIC BRANCH.

ORGANIZATION AND SCOPE.

The technologic branch of the Survey includes three divisions organized under three separate appropriations—(1) the mine-accidents division, which has for its purpose the protection of the lives of miners in the Territories and in the district of Alaska and the conducting of investigations as to the cause of mine explosions with a view to increasing safety in mining; (2) the fuel division, which has for its purpose the investigation of coals, lignites, and other mineral fuels; and (3) the structural-materials division, which has for its purpose the investigation of structural materials belonging to and for the use of the United States.

The general supervision of the work has remained, as during the previous fiscal year, under J. A. Holmes, expert in charge, and H. M. Wilson, chief engineer.

The technical force of this branch during the fiscal year was as follows: In the mine-accidents division, 6 mining engineers, 5 assist-

ant mining engineers, 1 explosives engineer, 1 electrical engineer, 1 chemist, 5 assistant chemists, and 3 consulting mining engineers employed temporarily as needed; in the fuel division, 9 mechanical engineers, 33 assistant and junior engineers, 5 chemists, 23 assistant chemists, 1 physicist, 2 consulting engineers, and 2 consulting chemists; in the structural-materials division, 4 engineers, 19 assistant and junior engineers, 1 ceramic chemist, 1 assistant ceramic chemist, 1 building-stone expert, 1 chemist, 13 assistant chemists, and 3 consulting engineers employed temporarily as needed.

LABORATORIES AND TESTING FACILITIES.

The scope of the work to be done has rendered necessary the enlargement of the facilities for testing and research; and the interrelations existing between the different lines of investigation authorized by Congress, together with the common need for light, power, and heat, rendered advisable, in the interest of both economy and efficiency, the concentration of the researches at some central station. The fact that at Pittsburg, Pa., and not elsewhere, ample buildings and grounds owned by the Government and not otherwise used were available for such concentration, and the further fact that there was no appropriation available to provide new buildings and grounds for this purpose elsewhere, rendered necessary the establishment of the several testing and investigating laboratories at Pittsburg. Accordingly, and with the approval of the Quartermaster-General of the War Department, the new equipment provided for the investigation of mine explosives was installed under the supervision of J. C. Roberts, assistant chief engineer, in and about seven government buildings on the arsenal tract at Pittsburg, and the equipment of the fuels division which had been in use at Norfolk, Va., during the previous fiscal year was transferred to an adjacent building (No. 13) on the same tract. The chemical work on fuels which had been carried on during the previous fiscal year at the University of California, the Ohio State University, the University of Chicago, and the Carnegie Technical Schools in Pittsburg was, at the beginning of the year, transferred to another special building (No. 21) provided for this purpose on the same tract, and the chemical laboratories for the structural-materials investigations and the investigation of mine explosions and the physical laboratory for fuel investigations were established in other portions of the same building. The equipment for the investigations of clays and clay products under the structural-materials division was installed in and about another building (No. 10) on the arsenal tract, and to this was added certain equipment for other structural-materials investigations, including one 600,000-pound, two 200,000-pound, and one 100,000-pound testing machines, and a variety of other equipment. A 10,000,000-

pound testing machine for testing full-size architectural columns and various engineering materials is now in course of erection.

With these grounds and buildings furnished through the courtesy of the War Department and now well equipped for extensive practical work; with the equipment at St. Louis for the structural-materials investigations connected with the Government's engineering construction and building work in the Mississippi Valley and Western States; and with the smaller special laboratories at Atlantic City, N. J., Northampton, Pa., and Washington, the technologic branch is far better prepared than ever before for conducting in a satisfactory manner the investigations of structural materials, fuels, and mine explosives authorized by Congress.

Under the structural-materials division the investigations of concrete, sands, gravels, stone, and other structural materials at St. Louis were continued in the same buildings and grounds until nearly the end of the fiscal year, when they were temporarily discontinued owing to the necessity of removing from Forest Park the buildings which had been occupied during the last three years for these investigations. Early in June a portion of the equipment was temporarily stored in a building provided by the city of St. Louis, and shortly thereafter it was transferred to a government building in St. Louis under the control of the Corps of Engineers and the Mississippi River Commission. It is expected that the investigations will be continued in this building as soon as adequate funds can be provided. The laboratory for investigating the injurious influence of sea water on concrete and the methods of preventing it was early in the fiscal year transferred from Norfolk, Va., to Atlantic City, N. J., where a suitable and well-located building for this purpose has been leased at a nominal price, and the investigations in this new locality are already under way.

The laboratory for testing cement for use in the construction work of the Panama Canal has during the last four months of the fiscal year been located at Northampton, Pa., where the cement is being manufactured and shipped.

PUBLICATIONS.

During the fiscal year 10 bulletins have been issued, 6 bulletins are in press, and 11 additional bulletins are either in different stages of preparation or have been submitted for publication.

MINE-ACCIDENTS DIVISION.

ORGANIZATION.

The mine-accidents division was organized near the close of the preceding fiscal year under an appropriation approved May 22, 1908.

In addition to the investigations mentioned on pages 14–15, during

April and May, 1909, J. W. Paul, mining engineer, and Axel Larsen, explosives engineer, visited the mine explosives stations and mine rescue stations in England, France, Belgium, Germany, and Austria and made a careful study of the equipment and methods used in investigating mine explosions and in training men in rescue work at mine disasters.

The researches of the mine-accidents division include (*a*) investigations of conditions in mines, under G. S. Rice, chief mining engineer; (*b*) investigations of mine lamps and rescue apparatus for use in mine investigations, under J. W. Paul; (*c*) investigations and physical tests to determine the proper explosives for use in gaseous and dusty mines and the best manner of using such explosives in order to insure safety in mining, under Clarence Hall, explosives engineer; (*d*) investigations and analyses of explosives used in coal mining, under W. O. Snelling, explosives chemist; (*e*) investigations of the conditions under which electricity may be safely used in coal mines where dust or explosive gases are present, under the direction of H. H. Clark, electric engineer; (*f*) investigations of the nature, extent, and distribution of explosive mine gases, under R. T. Chamberlin and N. H. Darton. The primary studies under each of these sections are conducted at the mine experiment station in Pittsburg; but these studies are supplemented by examinations made in selected mines in the important coal fields.

The mine-accidents division also conducts the inspection of coal mines in the Territories, which during the fiscal year was limited to New Mexico. This work was under J. E. Sheridan, mine inspector, who after the latter part of January was assisted by J. W. Groves, assistant mining engineer.

G. S. Rice, assisted by A. C. Ramsey and R. Y. Williams, assistant mining engineers, during the year examined a number of mines in Pennsylvania, West Virginia, Ohio, and Illinois, where explosions or mine fires have occurred, and investigated the influence of moisture from sprinkling or steam, etc., as a means of preventing dust explosions in mines. In this work Mr. Rice was joined by J. W. Groves in January, 1909; J. J. Rutledge in March, 1909; and H. M. Wolflin June 6, 1909.

J. W. Paul, assisted by F. F. Morris, F. W. Horton, and L. N. Jones, assistant mining engineers, has conducted investigations into the different systems of lighting mines and the efficiency of different types of rescue apparatus for use in entering mines filled with poisonous gases, and supervised the training of practical miners to use the rescue apparatus with a view to assisting in these investigations in the different coal fields. One day of each week was devoted to giving public demonstrations of the use of the rescue apparatus and of

the training in its use of miners sent in for this purpose from the different mining regions.

As soon as the appropriation for this work became available, the necessary equipment for the investigation of explosives used in coal mining was ordered, and much of this was in place and ready for use at the beginning of the fiscal year. Clarence Hall, explosives engineer, with S. P. Howell, assistant engineer, and E. L. Stenger and A. B. Coates, junior engineers, conducted during the first six months of the year the preliminary tests of explosives with a view to training men in the adjustment of the equipment connected with the large testing gallery. This work was supplemented by tests by C. H. Cordie, assistant chemist, and H. M. Wolflin and F. F. Morris, assistant engineers, concerning the various physical properties of explosives. The chemical analysis of explosives and of the gases resulting from explosions of natural gas, coal dust, and other materials used in conducting the investigations was carried on throughout the fiscal year under W. O. Snelling, assistant chemist, in charge, aided by C. G. Storm, A. L. Hyde, H. Schlatter, W. C. Cope, and G. A. Burrell.

Early in the fiscal year the general equipment of the Pittsburg station was increased by a portion of the apparatus needed for the investigations into the uses of electricity in mining and its relations to mine explosions, and certain investigations into this subject were begun. The electric engineer in charge of these investigations, H. H. Clark, was appointed April 1, and continued in service through the remainder of the fiscal year. He has been assisted by L. M. Jones, junior engineer, and G. R. Wood, consulting engineer.

R. Y. Williams, assistant mining engineer, was during March, April, May, and June stationed at Urbana, Ill., in charge of a mine rescue station established there under a cooperative arrangement between the Illinois State Geological Survey, the University of Illinois, and the United States Geological Survey. During April, May, and June A. C. Ramsey was stationed at Birmingham, Ala., for the special purpose of investigating the causes of mine explosions in that region and the best methods of preventing them.

RESULTS OF INVESTIGATIONS.

Among the results of this work may be mentioned the establishment of a well-equipped laboratory and testing station at which there have been made during the fiscal year more than 1,000 chemical analyses of explosives used in mining, and of natural gas, coal dust, and various explosion products, and nearly 5,000 physical tests of explosives in the gas and dust galleries; a large number and variety of mine lamps have been examined; and experiments have been made with a number of different types of mine rescue apparatus. Some 40

inspection trips have been made to explosives manufacturing plants with a view to investigating the different types of explosives used in mining.

In January, 1909, the manufacturers of explosives used in coal mines were invited to bring to the testing station at Pittsburg such explosives as they desired to have tested with a view to their use in mines where explosive gases and inflammable dust were known to occur under conditions indicative of danger. In response to this invitation 28 requests were received for the testing of 61 explosives, of which, up to the end of the fiscal year, 31 have been tested. Of these, 18 have passed all the tests satisfactorily and have been placed on what is designated the "permissible list" of explosives for use in such mines. On May 15 a circular (No. 1) was distributed to persons interested in coal mining, giving the names of the 17 explosives which at that date had passed all the tests and had been placed on the permissible list.

The engineering force for the investigation of mine conditions in relation to explosions has during the year visited 54 mines, representative of the several important coal fields—especially the mines which were considered dangerous owing to the presence of gas and dust and in which either mine explosions or mine fires occurred. At 14 of these explosions had occurred and at a number of others fires were raging which could not be easily extinguished except through the use of the special breathing apparatus with which these mining engineers were equipped.

Many tests have been made as to the type of lamps and of electric equipment of various kinds which may or may not be used safely in mines containing gas or inflammable dust under conditions likely to cause mine explosions.

The value of moisture in coal dust in preventing dust explosions in mines has been demonstrated in a series of laboratory investigations, which it has been arranged to supplement by tests made underground with actual mining conditions. Another series of investigations has demonstrated the conditions under which the use of improper explosives and the improper use of any explosive may cause a dust or gas explosion. The use of a small coal mine has been obtained in which it has been arranged to conduct a series of experiments concerning the influence of moisture and explosives in causing mine explosions, thus repeating under actual mine conditions the experiments conducted in the laboratory.

FUEL DIVISION.

ORGANIZATION.

The organization of the fuel division is practically the same as during the preceding fiscal year. Its work comprises the analyzing

and testing of the fuels belonging to or for the use of the United States and general investigations with a view to the increased efficiency or the prevention of waste in the mining and use of coal and other mineral-fuel substances. The equipment was practically the same as that used during the investigations of the preceding year at Norfolk, Va., except that a 250-horsepower Taylor producer and a 250-horsepower vertical three-cylinder Westinghouse gas engine, used at Norfolk, were replaced by a 150-horsepower Loomis-Pettibone producer and a 150-horsepower vertical three-cylinder Westinghouse gas engine; with this equipment was installed in government building No. 17 on the arsenal tract at Pittsburg a special combustion chamber 40 feet long with a 150-horsepower mechanical stoker, attached to one of the 220-horsepower Heine boilers, with a view to conducting special investigations into combustion problems.

In the chemical section N. W. Lord continued to serve as consulting chemist, with general supervision over all chemical work. The work of the laboratory in making general coal analyses remained under the immediate supervision of F. M. Stanton, chemist, assisted by A. C. Fieldner, G. A. Burrell, I. H. Bower, D. I. Brown, E. M. Dawson, jr., W. W. Karnan, B. G. Macintire, C. J. Monahan, J. A. Scherrer, R. E. Vennum, Perry Barker, and W. E. Surbled, assistant chemists. The routine work of the section included the determination of the heat value and chemical composition of samples of coal collected from public lands throughout the West.

H. C. Porter, assisted by F. K. Ovitz, continued during the year the special chemical investigations concerning the nature of the gases given off in the distillation of typical coals at different temperatures, the character and fuel value of the volatile matter given off from these coals, and the nature and possible prevention of spontaneous combustion of coals.

J. C. W. Frazer continued his special laboratory researches into the chemistry of the combustion of coals in the different types of furnaces used in government heating and power plants and into the methods of dissolving the hydrocarbons in coal, with a view to their complete chemical analysis.

I. C. Allen, assisted by C. C. Draper and W. A. Jacobs, has continued during the year his chemical and physical examinations into the character and fuel value of the different varieties of crude petroleum, concerning which information was desired by the Navy, Treasury, and Interior Departments.

J. K. Clement, assisted by L. K. Adams, cooperated with Doctor Frazer and Henry Kreisinger in the investigation of special combustion problems, and also assisted W. T. Ray in certain boiler-furnace investigations, C. L. Wright in certain briquetting investigations, and R. L. Humphrey in certain structural-materials investigations.

The fuel-efficiency investigations in connection with heating and power plants of the Government, with a view to determining the fuels best adapted for use for these purposes in different parts of the country and the methods by which they may be used most efficiently by the Government, were conducted under the advisory supervision of R. H. Fernald, L. P. Breckenridge, and W. F. M. Goss, by D. T. Randall, H. W. Weeks, S. B. Flagg, Henry Kreisinger, W. T. Ray, and the assistant engineers.

Special lines of investigation were followed under this section in connection with the testing of fuels under boiler furnaces, such as are used in government power and heating plants, under D. T. Randall, H. W. Weeks, and S. B. Flagg; the investigation of gas fuels under producer furnaces as to their adaptability for naval purposes and for utilizing the low-grade bituminous coals and lignites, such as are found on the public lands, under the supervision of R. H. Fernald, assisted by C. D. Smith, D. F. Smith, L. Stone, and F. E. Woodman; the investigation of fuel oils as to their chemical and physical properties, with a view to determining the most efficient methods of use, under I. C. Allen, and as to their availability for use in fuel engines, under R. M. Strong; the investigation of combustion problems with reference to furnaces for government heating and power plants, under Henry Kreisinger, W. T. Ray, J. C. W. Frazer, and J. K. Clement; investigations into the briquetting, coking, and washing properties of coal, under A. W. Belden and G. R. Delamater at Denver, Colo., July to December, 1908, inclusive, and under C. L. Wright at Pittsburg, January to June, 1909; and heat-propagation investigations under W. T. Ray and Henry Kreisinger.

In connection with the investigation of fuels for the War Department, the small boiler and equipment which for several years has been in use in that department under the direction of the Quartermaster-General of the Army near Washington was early in May shipped to the Pittsburg station, and at the same time the assistant engineer in charge, A. S. Rowe, was transferred to the Survey to continue in charge of this plant, which will hereafter be operated as part of the equipment of the technologic branch.

W. T. Ray has devoted his attention largely to experiments connected with heat transmission in furnaces such as are used by the Government for power and heating purposes. Charles L. Wright during the latter half of the fiscal year continued experiments looking to the briquetting of lignites without the use of external binding materials, and succeeded in making briquets of lignites from four different localities in the Western States. Otto Lehman, of Magdeburg, Germany, was employed during the months of April and May to aid in the installation and operation of the large German briquetting machine.

A. W. Belden and G. R. Delamater continued washing and coking investigations at Denver and the preparation of a report on them until February. At that time Mr. Delamater resigned and Mr. Belden was transferred to the Pittsburg plant, where he cooperated with Mr. Wright in the lignite-briquet investigation.

The inspection of fuels used by the Government was under the supervision of J. S. Burrows from the beginning of the year to March 16, and subsequently under G. S. Pope. It embraced the drawing up of specifications for use in the purchase of coal used by the Government in its heating and power plants in the city of Washington and elsewhere, and the sampling and testing of fuels delivered to the Government in different parts of the country. Mr. Burrows and Mr. Pope were assisted in this work by P. M. Riefkin, N. H. Snyder, E. W. Miller, L. Loeb, A. A. Straub, and F. J. Simington, assistant engineers, and J. W. Peters, junior chemist. The samples of coals collected by the inspecting force or sent in from different parts of the country by local representatives of the Government were analyzed in the Washington laboratory under S. S. Voorhees, aided by G. O. Spitler and J. D. Davis, chemists, and H. M. Cooper, J. S. McCune (after Nov. 4, 1908), A. C. Cooper (after Dec. 20, 1908), W. J. Buttner (after Feb. 9, 1909), Wood Freeman (after Mar. 11), J. A. Scherrer (after May 17), and H. G. Elledge (after June 21), assistants.

FIELD INVESTIGATIONS.

The field work of the fuel division during the fiscal year consisted of investigations into the chemical and microscopic structure of coal, with reference to its origin and its coking qualities, conducted by David White, assisted by Rhinehard Thiessen; field investigations into the character and distribution of peats and certain lignitic coals, conducted by C. A. Davis; and the inspection of coals in connection with government purchases, conducted by Messrs. Burrows, Pope, and Rice, and other mining engineers.

RESULTS OF INVESTIGATIONS.

Among the results of the fuel investigations conducted during this and the preceding fiscal year is the fact that the purchase of nearly half the coal used by the Government is based on some form of specifications prepared by the technologic branch of the Survey. During the present year 3,299 samples of coal have been collected, 19,727 chemical and calorimeter determinations have been made, and more than 100 mines have been examined with a view to determining the possibility of obtaining coal deliveries in accordance with proposed contracts. For the government coals purchased without definite specifications the fuel division is making, at the request of different

branches of the government service, examinations of the mines from which it is expected that this coal will be delivered, and also from time to time chemical analyses and calorimeter tests of the coal delivered, with a view to determining whether or not the deliveries are in accordance with the contracts under which the purchases are made.

The special chemical investigations have made known the character and value of the coal underlying several million acres of public land, have thrown light on the properties of coal and processes of combustion, and will aid in rendering possible increased efficiencies in the burning of coal. The investigations at Denver have shown the possibilities of making commercial coke for metallurgical purposes from the coal of a number of coal fields which were not heretofore believed to yield coking coal, and have indicated how the quality of this coke may be decidedly improved through washing processes. The briquetting investigations have demonstrated the possibility of making commercial briquets from lignites collected at two localities in Montana, one in California, and one in Texas.

In connection with the producer investigations during the latter half of the fiscal year 15 tests have been made, ranging from sixty to one hundred and thirty-nine hours each, involving nearly 40,000 observations. In the investigations of the use of fuel oils for power purposes 234 tests were made, involving some 2,500 observations. Under the investigations into fuel efficiency for government heating and power plants 60 tests have been made, involving 31,500 observations, the tests relating primarily to coals for use by the Quartermaster's Department of the Army.

F. M. Stanton and his assistants at the Pittsburg laboratory analyzed 1,365 samples of coal, involving more than 20,000 determinations. These samples were forwarded from different departments of the Government and to a large extent collected from the public land.

In the investigation of the coals from the public lands in the Rocky Mountain region during the first half of the fiscal year 69 coking tests, 49 washery tests, and 532 chemical analyses were made, involving 3,253 calorimeter and other determinations.

The total cost of these investigations is but a small percentage of the aggregate financial value of these results to the Government itself, through increase in value of its coal lands and through greater economy in purchasing and greater efficiency in using fuels.

STRUCTURAL-MATERIALS DIVISION.

ORGANIZATION.

Investigations under the structural-materials division during the fiscal year had a double purpose—(*a*) to determine the nature and extent of and the most efficient methods of utilizing the structural

materials belonging to and for the use of the Government of the United States; (*b*) to investigate such materials with a view to determining their suitability for the special purposes for which their use is proposed in the building and engineering construction work of the Government. The organization of this work was much the same as during the preceding year, with the addition of the clay-products section. Investigations were conducted during the year not only at the central experiment station at Pittsburg and the structural-materials laboratory at St. Louis, but also at the special laboratories at Atlantic City, N. J., Northampton, Pa., and Washington.

Under the immediate direction of R. L. Humphrey investigations in concrete and reinforced concrete were continued by L. H. Losse, with the aid of five assistant engineers and skilled laborers at the St. Louis laboratory in Forest Park; investigations into the fire-resisting properties of structural materials were continued by E. B. Tolsted at Chicago and later at Pittsburg, and investigations into the behavior of reinforced concrete beams under static loads were made by Mr. Tolsted at Pittsburg during May and June.

The chemical researches associated with structural-materials investigations were conducted by P. H. Bates, assisted by A. J. Phillips, at Pittsburg, and by S. S. Voorhees, with J. S. Miller, L. M. Law, A. C. Nothstine, and W. Freeman, assistant chemists, in the laboratory at Washington.

Investigation of clays and clay products for use in government buildings and engineering construction work were conducted in the structural-materials laboratory at Pittsburg by A. V. Bleininger, assisted by H. E. Ashley, G. H. Brown, and E. Thomas. Mr. Bleininger has also supervised the investigation of lime for use in government buildings, in which he was assisted by W. E. Emley.

The field investigations of stone, sand, gravel, and associated structural materials available for use in the construction of government buildings and other public works were carried on by E. F. Burchard at intervals throughout the larger part of the year, and by N. H. Darton in the Middle and South Atlantic States during April, May, and June. These investigations have been made at the special request of the Secretary of the Treasury for the Supervising Architect, with a view to determining the nature and extent of the structural materials for use in more than 300 public buildings provided for by Congress during the last two years. For a number of public buildings these materials have been carefully examined in the field, and samples of the different types of sand, gravel, crushed stone, clay products, etc., available for use in the construction of these buildings have been forwarded to the laboratories at St. Louis and Pittsburg, where they have been carefully tested as to their suitability for such use.

The investigations into the behavior of concrete exposed to water and into the methods of counteracting the injurious influence, which were undertaken at the request of the War and Navy departments, have been conducted at the marine structural-materials laboratory at Atlantic City, N. J., by R. J. Wig, under the supervision of Mr. Humphrey. Investigations as to the causes and methods of preventing injuries to concrete from alkaline waters in the arid States are being carried on at the Pittsburg station.

The testing of cement shipped to Panama was done in the well-equipped laboratory at Northampton, Pa., where the cement is being manufactured. W. A. Campbell, with six assistants, was in charge of the work. Investigations conducted at the Washington laboratory related to the structural materials purchased for use by the several branches of the government service in Washington, especially the cement and other structural materials purchased for use by the Supervising Architect in the construction and repairs of government buildings. The laboratory formerly maintained by the Supervising Architect for testing materials purchased for use in the construction and maintenance of public buildings was transferred from the Treasury Department to the Department of the Interior in November, 1908. This laboratory was associated with the Washington laboratory of the technologic branch and S. S. Voorhees, as engineer of tests, was placed in charge of both.

RESULTS OF INVESTIGATIONS.

Among the results of the structural-materials investigations during the fiscal year may be mentioned the making of nearly 6,000 and the testing of nearly 4,000 forms of constituent materials (sands, gravels, stone, etc.); the making of more than 400 and the testing of more than 700 beams; and the making of 78 and the testing of 54 samples of steam-cured forms, mainly for the Supervising Architect and for the Quartermaster-General and Chief of Engineers of the Army.

In addition to the above, analyses have been made of 630 different samples of structural materials, involving nearly 9,000 chemical determinations. In the testing of cement shipped from Northampton, Pa., for the Isthmian Canal Commission 2,207 determinations were made, including the time of set, specific gravity, fineness, etc., and at the close of the fiscal year the testing of this cement was proceeding at the rate of 2,000 barrels a day. In connection with the testing of structural materials for departmental purchases in the District of Columbia nearly 3,000 samples were received for analysis, involving nearly 33,500 chemical determinations and tests. A number of miscellaneous investigations have been carried on during the year at the request of the Supervising Architect's office, Isthmian Canal Commission, Corps of Engineers of the Army, Bureau of Yards and

Docks of the Navy, and Reclamation Service relative to the waterproofing of concrete and other engineering structures; the reinforcing and protection of concrete; the relative strength and durability of columns of concrete, brick, terra cotta, and other structural materials; the behavior of clays and clay products under different conditions; and the fire-resisting qualities of different structural materials.

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 6 professional papers, 36 bulletins (one of which was also published in 3 separate chapters), and 12 advance chapters from one other bulletin, 12 water-supply papers, 1 annual report on mineral resources for 1907 (also published in 50 chapters), 6 advance chapters from the annual report on mineral resources for 1908, and 7 geologic folios. These publications were the Twenty-ninth Annual Report; Professional Papers 58 to 63; Bulletins 340, 341, 345 to 359, 361 to 376, 378, 379, 12 separates from 380, and 385; Water-Supply Papers 219 to 226 and 228 to 231; Mineral Resources for 1907 (volume and 50 separate pamphlets) and 6 separate chapters from Mineral Resources for 1908; Geologic Atlas, folios 160 to 166. Summaries of these publications are given on pages 17–28 of this report. They comprise 10,180 pages, those of the last fiscal year covering 10,149 pages. In addition to the publications of the regular classes a "Handbook for field geologists," a revised edition of "Geographic tables and formulas" (formerly issued as Bulletin 234), a pamphlet of "Suggestions to authors of papers submitted for publication by the United States Geological Survey, with directions to typewriters," and many miscellaneous circulars and pamphlets, most of them relating to administration, were published.

During the year 19,775 pages of manuscript were prepared for printing, and proof sheets for 11,840 final printed pages were read and corrected, this work involving the handling of 4,139 galley and 23,748 page proofs. The corresponding figures for last year were 20,691 pages of manuscript, 10,827 final printed pages, 4,479 galley proofs, and 16,140 page proofs.

The make-up was prepared for 538 plates, the proofs of which were also read, as against 369 plates so prepared last year.

Indexes were prepared for 47 publications, covering 9,730 pages, the corresponding figures for last year being 39 publications and 7,538 pages.

George M. Wood, editor, has charge of the work of this section, and 5 other persons have been employed during the year. Material assistance has been rendered at different times in the work of the section of distribution.

SECTION OF ILLUSTRATIONS.

During the year 5,171 illustrations were prepared for 41 bulletins, 14 water-supply papers, 5 professional papers, 2 reports on mineral resources, and 1 annual report. These illustrations included 181 maps, 956 diagrams, 3,222 paleontologic drawings, 629 photographs retouched, and 183 miscellaneous.

Proofs to the number of 1,745 were received and compared critically, and an examination was made of the printed editions of all illustrations furnished by contract during the year, as heretofore.

During the year 109 electrotypes were furnished to outside applicants, as compared with 182 furnished last year.

The committee on illustrations rejected 149 illustrations submitted with manuscripts offered for publication.

At the close of the year material for the illustration of 27 reports is in hand.

At present the personnel consists of 4 geologic draftsmen, 3 paleontologic draftsmen, 1 classified laborer, and the draftsman in charge.

SECTION OF GEOLOGIC MAPS.

During the year a change in the form of the geologic folio has been made to meet the demand of the practical user of the maps in the field. In addition to the large folio form, which is inconvenient to carry about, a field edition of octavo size with folded maps in a pocket will hereafter be published for all, and the last three folios published during the fiscal year appear in this form as well as in the other.

Besides the preparation of folios for publication and reading proof, the section of geologic maps has been engaged in the preparation of the geologic map of North America and other geologic data for publication in reports other than folios of the geologic atlas.

Of the 10 folios in hand July 1, 1908, seven were published during the fiscal year (see pp. 27–28) and the three others—Trenton (N. J.-Pa.), Mercersburg-Chambersburg (Pa.), and Watkins Glen-Catatonk (N. Y.)—are very nearly completed. The Jamestown-Tower (N. Dak.), Warren (Pa.), Engineer Mountain (Colo.), Sewickley (Pa.), and Johnstown (Pa.) folios, which were transmitted to the section during the year, are in course of publication.

SECTION OF TOPOGRAPHIC MAPS.

A year ago the editor of topographic maps reported 54 new topographic atlas sheets and special maps which had not yet been put into

the hands of the engravers and 37 in process of engraving. The corresponding figures on June 30, 1909, were 76 and 59. The accessions during the year numbered 103 maps; 85 maps were published.

The manuscripts edited, including verification or correction of all geographic names, comprise 83 new atlas sheets and special maps; corrections for 224 sheets hitherto published; and 214 map illustrations which are or will be included in 35 volumes of Geological Survey reports. The proof read comprises 78 new atlas sheets and special maps and corrections to 66 maps.

Compilations were made for a revision of the western half of the large United States base map to provide a base for a map of the mining districts of the western United States, published in Mineral Resources, 1907. Additional material was compiled for the base "Carte géologique de l'Amérique du Nord." For the Department of the Interior, three administrative maps—"Yosemite National Park," "Sequoia and General Grant National Parks, Cal.," and "Platt National Park, Okla."—were prepared. The first two, being made up of extracts from Geological Survey atlas sheets, were prepared and proof read in this section; the last—surveyed, engraved, and printed by the Geological Survey—received the same attention in the way of editing and proof reading as any Survey map.

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 127 new books, 7 new folios, 85 new maps, and 204 reprints of maps, a total of 423; the totals of all editions were 360,472 books, 34,971 folios, and 773,607 maps; grand total 1,169,050. During the year 360,616 books, 39,170 folios, and 597,361 maps (including 444,230 sold), a total of 997,147, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was $19,899.28, an increase of $2,885.72 over the amount received during the year 1907–8.

During the year 79,315 letters were received, answered, and filed, an increase of 2,645 over the number in the preceding year.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 117 atlas sheets and special maps were on hand for publication and the accessions during the year were 103 maps. The status of these 220 maps on June 30, 1909, was as follows:

Published during the year	85
In process of engraving	59
Not taken up	76

Besides the engraving of new maps, corrections were made on the plates of 228 maps hitherto published. Editions of 289 maps were printed and delivered to the map room, including new maps and reprints or new editions.

Seven geologic folios were published and 34,971 copies were printed. Eight other geologic folios had been partly completed at the close of the year.

Under contracts with the Government Printing Office, map illustrations were printed for the following Survey publications: Bulletins 349, 351, 356, 358, 360, 364, 371, 374; Water-Supply Papers 220, 221, 222, 224, 225, 231; Mineral Resources, 1907. For the Government Printing Office, also, maps of 13 bird reservations, 2 national monuments, 8 national forests, and some odd items were printed and delivered; for the Forest Service, maps of 54 national forests, the "Forest Service Atlas" for 1907, the "Forest Atlas legend plate," and a map of the United States showing all the national forests; for the General Land Office, 1,091 township plats; for the Department of the Interior, maps of three national parks and a number of maps for exhibition at the Alaska-Yukon-Pacific Exposition; for the Reclamation Service, a large amount of miscellaneous work. Work was also done for the War Department, the Cuban Government, the Weather Bureau, the Bureau of Standards, the Isthmian Canal Commission, the Bureau of Education, the Office of Indian Affairs, the Civil Service Commission, and the Biological Survey. 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 miscellaneous matter of all kinds the total number of copies printed was nearly a million and a third and required nearly three and one-half million printings. The total number of copies printed of maps, folios, and miscellaneous matter was 2,123,973, requiring over eight and one-half million impressions. On requisition of the Government Printing Office, 212 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 in making copperplates and electrotypes. More than 2,700 repairs were made to instruments and 258 new copperplates and 37 electrotypes were finished.

PHOTOGRAPHIC LABORATORY.

The output of the laboratory included 18,199 negatives, of which 3,172 were wet, 1,148 paper, and 13,879 dry; 38,935 prints, of which

12,270 were chloride prints, 692 bromides, and 25,973 prints for illustrations; and 1,147 lantern slides made and 131 colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Correspondence, records, appointments, supplies, and shipments.—The work of this section was considerably heavier during 1908–9 than in the preceding year, as shown by the figures given below. The general character and scope of the work and the routine of carrying it out have been the same, with the exception of an important change in the work of the appointment desk. In compliance with the department order of January 15, 1909, all papers in connection with the personnel are prepared in this section. This change not only involves the preparation of all appointment papers in this office, but it allows direct communication with the Civil Service Commission in all matters preliminary to appointments. It also puts upon this section the duty of preparing reports to the Treasury, through the disbursing clerk, of all changes in the personnel affecting pay, and also the preparation of reports to the Civil Service Commission each month of all changes in the personnel. While these changes have all served to expedite the accomplishment of results, they have added very much to the work of the section. This condition has been recognized by the Department, and it has detailed a clerk expert in appointment matters to assist in the work.

Mails, files, and records.—During the year 121,351 pieces of incoming mail were handled in this section, a gain of more than 13 per cent over the preceding fiscal year. The increase in 1908 over 1907 was but 2 per cent. Of this mail, 25,258 pieces, an increase of 25 per cent over the number for 1908, contained remittances for publications of the Survey. The amount of money received in this mail was $22,546.33.

The recording, referring, and filing of correspondence required most of the services of four clerks throughout the greater part of the year. The number of letters mailed through the section was 91,450, of which 17,333 were registered. This is an increase of about 37 per cent over 1908 in the total number of pieces mailed and practically the same in the outgoing registered mail.

Personnel.—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 955 persons, an increase of 115, or 14 per cent, over the preceding year. In this roll 1,322 changes, including appointments, separations, promotions, and changes of status of every kind, were made during the year, which was an increase over the preceding year of nearly 45 per cent and is more than in any previous year in the Survey's history. Of these

changes 390 were new appointments, an increase of 16 per cent; 275 were separations (including 6 caused by death); 432 were promotions; and 3 were reductions. The remaining changes included 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.

In the foregoing no account is taken of the cases of temporary employment based on authorization from the Civil Service Commission. In this class of cases there is no Secretarial appointment, the work being essentially correspondence, with a temporary record of the particulars of the case.

During the year 13,890 days of annual leave and 2,763 days of sick leave were granted, being 49 per cent of the amount of annual leave and 10 per cent of the amount of sick leave which it is permissible to grant under the law; also 6,866 days of leave without pay. In addition to the above there were also 134 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 and, in addition, a custodian of office property was designated to make an inventory of all nonexpendable property in Washington. This inventory was completed, and a list of the office property submitted to the Department near the close of the calendar year 1908.

Express and freight.—During the year 3,313 pieces of freight and express were handled by the shipping clerk, of which 1,109 were outgoing and 2,204 were incoming; 716 freight and express accounts were examined and checked. This is a decrease of 30 per cent in the number of pieces handled, but an increase in the number of accounts handled.

Purchase and distribution of supplies.—The system of employing a general purchasing clerk to look after the details of all purchases made in Washington, established during the previous year, was continued and is working satisfactorily. The work of procuring bids, issuing orders, and preparing vouchers required the services of three persons during the entire year. The number of requisitions handled during the year was 2,847, an increase of 28 per cent over the preceding year. The number of orders drawn was slightly less and the number of vouchers passed considerably more than in the preceding year.

Stationery.—In the stationery room the services of three men are required for handling mails, delivering supplies throughout the office and packing and shipping them to the field parties, and keeping an account of the charges for stationery supplies. During the year

9,043 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand and 442 requisitions were drawn on the Department for supplies. In addition to this work 677 requisitions for printing were made on the Department and 424 requisitions for furniture and supplies. These figures are, with one exception, slightly larger than for the previous year. The practice of limiting the dates on which requisitions may be forwarded has reduced the number of requisitions since the order went into effect, which accounts for the apparently small increase in this phase of the work in the stationery room.

Administrative bookkeeper.—Throughout the year the administrative bookkeeper continued to handle all Survey transactions of an administrative character and to examine, check, and record such items as related solely to the administrative branch. He acted in an advisory capacity with respect to accounting methods of the branch, passed on all requisitions for supplies to be procured from the Department of the Interior, determined the amount payable therefor from Survey appropriations, and arranged and submitted for settlement the accounts covering charges arising for these purposes.

The following table shows the classified net disbursements by the Survey for the fiscal year 1909, the repayments shown in the table on page 119 having been deducted:

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1909.

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	$64,505.62	$64,505.62								
Skilled laborers, etc	19,794.32	19,794.32								
Gaging streams, etc	99,545.94	77,654.53	$9,838.62	$1,629.82	$922.31	$1,004.17		$575.55	$1,913.03	$266.11
Paleontologic researches	9,989.75	9,293.40	333.09	5.35	74.58	37.45		9.00	8.55	19.27
Chemical and physical researches	19,497.93	17,566.87	.70	87.94	223.45	63.40		14.45	2.25	
Preparation of illustrations	18,066.75	16,664.04	2.80	2.52	85.50	87.34				6.68
Mineral resources of the United States	74,507.27	63,458.53	3,761.46	532.87	1,860.00	1,566.99	$2.70	105.28	281.72	489.13
Books for the library	1,396.84						1,375.47	21.37		
Topographic surveys	296,338.31	187,239.08	23,714.50	211.98	559.30	3,891.56	4.40	4,796.77	2,875.64	510.74
Geologic surveys	199,340.58	157,128.66	13,658.94	136.05	2,285.58	1,519.13	9.75	1,499.35	1,423.89	210.31
Mineral resources of Alaska	79,418.87	42,722.58	14,228.61	5.05	216.77	663.91		4,849.13	867.55	89.33
Geologic maps of the United States	87,188.83	59,823.31	66.50	1,907.42	395.26	240.10		124.14		87.71
Surveying forest reserves	74,517.88	61,089.12	1,949.94	25.45	122.32	376.16		150.11	82.42	12.00
Testing fuel	246,914.87	164,860.86	9,160.59	2,514.70	2,323.77	1,306.68	105.60	4,651.51	63.30	407.89
Testing structural materials	78,255.79	46,181.44	2,712.63	358.13	455.84	456.74	79.68	1,164.32	10.92	94.30
Inspecting mines in territories	3,185.98	2,000.00	809.02							.55
Investigating mine accidents	148,226.90	34,185.68	4,293.97	193.63	2,193.72	714.10	50.61	1,045.82	493.62	296.24
Improving and safeguarding electric wiring	1,999.53	915.67			1,083.86					
Replacing articles destroyed by fire	14,309.22	1,283.00	259.73		4,266.03	466.46		5.75	6,013.18	
	1,537,001.18	1,026,366.71	84,791.10	7,610.91	17,068.29	12,394.19	1,628.21	19,012.55	14,036.07	2,490.26

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory										
Skilled laborers, etc										
Gaging streams, etc	$777.04	$3,386.28	$638.87	$649.27		$283.60	$6.74			
Paleontologic researches	13.50	3.00	10.45	127.32		54.79				
Chemical and physical researches				9.40		1,529.47				
Preparation of illustrations				962.85			255.02			
Mineral resources of the United States	6.35	1,448.00	6.50	372.72		614.01	1.01			
Books for the library										
Topographic surveys	6,616.11	44,870.06	15,834.74	2,723.78		28.88	309.15	$2,151.62		
Geologic surveys	3,064.93	9,637.25	2,615.77	5,149.37		731.63	269.97			
Mineral resources of Alaska	6,107.41	7,589.41	1,100.78	740.67		114.85	105.87	16.95		
Geologic maps of the United States		20.10			$24,524.29					
Surveying forest reserves	2,165.31	2,980.20	3,087.77	2,266.12		6.03	91.72	113.21		

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1909—Continued.

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Testing fuel	$120.75	$5,779.71	$164.63	$616.16	.....	$10,902.81	$51.95	.....	$35,802.18	$8,081.78
Testing structural material	2.25	1,442.00	.50	106.90	.....	6,064.65	20.80	.....	16,978.92	2,125.77
Inspecting mines in the Territories	.....	375.71	.70	.....	.....	.....	.....	.....	.....	.....
Investigating mine accidents	16.65	2,381.36	.....	465.00	.....	8,965.35	125.06	.....	88,785.14	4,020.95
Improving and safeguarding electric wiring	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Replacing articles destroyed by fire	76.55	95.20	18.00	5 75	.....	1,634.05	89.89	$95.63	.....	.....
	18,966.85	80,008.28	23,478.71	14,195.31	$24,524.29	30,930.12	1,327.18	2,377.41	141,566.24	14,228.50

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 ended June 30, 1909.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director.	$35,340.00	.....	$35,340.00	$34,772.34	$567.66
Salaries, scientific assistants.	29,900.00	.....	29,900.00	29,733.28	166.72
Skilled laborers, etc.....	20,000.00	.....	20,000.00	19,794.32	205.68
Gaging streams.....	100,000.00	$31,261.00	131,261.00	130,806.94	454.06
Paleontologic researches.....	10,000.00	.....	10,000.00	9,989.75	10.25
Chemical and physical researches.....	20,000.00	.....	20,000.00	19,497.93	502.07
Preparation of illustrations..	18,280.00	.....	18,280.00	18,066.75	213.25
Mineral resources of the United States.....	75,000.00	26.56	75,026.56	74,533.83	492.73
Books for library.....	2,000.00	.35	2,000.35	1,397.19	603.16
Replacing articles destroyed by fire.....	15,810.00	.....	15,810.00	14,309.22	1,500.78
Improving and safeguarding electric wiring system.....	2,000.00	.....	2,000.00	1,999.53	.47
Topographic surveys.....	300,000.00	39,991.25	339,991.25	336,329.56	3,661.69
Geologic surveys.....	200,000.00	34,178.07	234,178.07	233,518.65	659.42
Mineral resources of Alaska..	80,000.00	.45	80,000.45	79,419.32	581.13
Geologic maps of United States.....	100,000.00	67,076.37	167,076.37	154,265.20	12,811.17
Surveying forest reserves....	75,000.00	111.28	75,111.28	74,629.16	482.12
Testing fuel.....	250,000.00	827.46	250,827.46	247,742.33	3,085.13
Testing structural materials.	100,000.00	5,023.46	105,023.46	83,279.25	21,744.21
Inspecting mines in Territories.....	7,350.00	.....	7,350.00	3,185.98	4,164.02
Investigating mine accidents.	150,000.00	2,707.50	152,707.50	150,934.40	1,773.10
	1,590,680.00	181,203.75	1,771,883.75	1,718,204.93	53,678.82

LIBRARY.

The library received during the year 11,761 book publications and 512 maps. This includes all purchases made with the appropriation of $2,000 and all material received by exchange and gift. The publications of scientific societies and of state and national surveys are procured by exchange whenever possible, the library funds being reserved to purchase the necessary scientific periodicals, reference books, monographs published independently, and out-of-print publications, particularly paleontologic works, which are needed to complete the Survey sets. A number of valuable works have been presented by their authors. About 2,000 pamphlets were received from Prof. Charles Schuchert, of Yale University. The library now contains 64,084 numbered volumes exclusive of the unbound periodicals received during the year. All new material is placed on the exhibition shelves for one week, thus enabling those who so desire to keep posted on the new literature.

The persons consulting books and maps in the library during the year numbered 8,717. Besides this, 9,460 books and 528 maps were loaned for use outside of the library.

The cataloguing of current accessions has been kept up to date and the publications of the geological surveys of Great Britain and of the Australian States (about 1,500 items), of which the library has nearly full sets, have been completely catalogued. These catalogue entries have been sent to the Library of Congress, where they are printed on cards which are placed on sale. As in previous years, the Survey library has continued to furnish to the Library of Congress catalogue entries of geologic books. Librarians and others interested in making geologic collections are by the use of these cards relieved of the labor of cataloguing. Sets of these titles, which may be had from the Library of Congress, form the only complete, up-to-date list in existence of the publications of national and state surveys.

The alphabetical subject catalogue now includes about 8,500 cards and is progressing at the same rate as the author catalogue.

The exchange list, which is supervised in the library, includes the names of 835 libraries, of which 260 are in the United States and 575 in foreign countries. These libraries receive all book publications of the Survey as issued. They are chiefly those maintained by scientific societies and institutions, by universities, and by government bureaus devoted to mining and geologic research. Persons are not included in this exchange list and no list is maintained of persons to whom all the Survey publications are regularly forwarded. Individuals receive only such publications as they request. During the year 37 bulletins, 10 water-supply papers, 7 professional papers, the Twenty-ninth Annual Report, Monograph XLIX, and Mineral Resources for 1907, in all 58 volumes, were issued to regular exchanges, making an exchange distribution of nearly 48,500 volumes.

The bibliography of North American geology for 1906 and 1907, consisting of 2,672 titles and a comprehensive index, was compiled during the year and published as Bulletin 372. The bibliography for 1908 (Bulletin 409) is well advanced.

The correspondence, which refers largely to the exchange and the purchase of books, consisted of 3,300 letters received and 3,835 letters sent. Ninety-four letters and other papers were translated by members of the library force for other branches of the Survey.

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