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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

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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



WASHINGTON

GOVERNMENT PRINTING OFFICE

1908

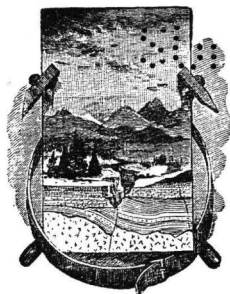
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# TWENTY-NINTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

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GEORGE OTIS SMITH, *Director.*

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The appropriations for the work of the United States Geological Survey for the fiscal year 1907-8 comprised items amounting to \$1,661,420. 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.

### LAND CLASSIFICATION.

In the last few years the Geological Survey has broadened the scope of its work in the classification of the mineral lands of the public domain. At the time of the organization of the Survey the classification intended by Congress was believed to be general in character and such as could be expressed on maps issued for the general information of the people. The present interpretation of the law is that the classification should be more definite, and therefore, during the last year, the Survey has continued its special field surveys of the coal lands belonging to the Government. The geologic, topographic, and technologic branches of the Survey and the General Land Office have cooperated in these surveys, which have provided for the classification and valuation of the coal lands and for their prompt segregation from the noncoal lands. A total of 22,700 square miles of coal fields was thus classified, and the valuation of the coal lands, based not only on the geologic field examination but on chemical and physical tests of coal collected from these lands, was reported to the General Land Office.

Increased demands have also been made on the mining geologists of the Survey for assistance in determining the mineral or nonmineral character of land for which title from the Government is sought. In all this work the sole purpose of the Geological Survey is to deter-

mine the truth of the issue from the viewpoint of an independent and impartial mining engineer, and thus to protect the interests of the people.

#### MINING GEOLOGY.

The development of mining geology, or the application of the science of geology to mining operations, has been to a large extent the result of the activity of the United States Geological Survey, and the practical value of the Survey's contributions in this field has won for it world-wide recognition. The actual results have demonstrated to the mining industry its dependence upon geologic investigations. This record warrants the hope for further development in mining geology.

Incidental to the surveys for the classification of coal lands important results have been secured concerning the stratigraphic and structural relations of the coal fields of the West, and the knowledge of the occurrence and distribution of this most valuable mineral has been greatly increased. Similar systematic investigations of the oil fields of the country would yield results hardly less valuable; but even the increased attention paid to this subject during the last few years, resulting this year in the publication of nine reports relating to the geology of oil, has been insufficient to keep abreast of the development in this single branch of the mineral industry.

The goal to be sought in mining geology is the extension of systematic field surveys of all mineral deposits, so that geologic exploration may keep in advance of economic development. The prosecution of detailed areal mapping in all regions where active development of mineral deposits is in progress would result in making prospecting less expensive and more efficient and in winning a much larger proportion of the ore deposits wherever the areal and structural relations thus became known, and would therefore effect a double economy.

#### MINING TECHNOLOGY.

In January, at the suggestion of the Senate Committee on Mines and Mining and at the request of the Secretary of the Interior, the Director of the Geological Survey submitted a statement relative to the proposed establishment of another bureau in recognition of the mining industry. The part played by the Survey in the development of that industry in the last three decades was reviewed, and the effort was made to suggest legislation that would provide adequately for an increase in the mining work of the Federal Government without duplicating work already authorized. The opinion was expressed that the only true line of cleavage for separating the investigations concerned with the mining industry lies between the pure technology of the industry and those studies which relate to the distribution,

occurrence, origin, and production of mineral deposits. Such studies have formed an increasingly important part of the Geological Survey's work since its organization, so that the whole question resolves itself into the matter of making adequate provision for the other investigations now being conducted by the technologic branch of the Survey. The value of these investigations has been proved and their scope may well be expanded along technologic lines without duplicating or overlapping the work of other branches of the Survey.

On the basis of the historical development and present status of federal work in aid of the mining industry of the United States it was recommended that the function of any organization independent of the Survey should be limited to strictly technologic work, if duplication of work and rivalry are to be avoided. To that end it is important that the name of such an organization should indicate its particular function and nothing more. The word "mining" by itself is inappropriate for a bureau that would conduct only a part of those investigations which relate to mines and mining, and it was recommended that legislation establishing a new bureau should provide not for a "bureau of mining," but for a "bureau of mining technology." Such a bureau would supplement, along purely technologic lines, the geologic work of the Survey, and the two bureaus could cooperate in investigations carried on in behalf of the mining industry.

#### ALASKAN SURVEYS.

The progress of surveys in Alaska is shown in a table on page 41, which clearly sets forth the need for the rapid extension of both geologic and topographic mapping in the Territory. As the geologic mapping must form the basis for any fundamental study of the laws of occurrence and distribution of the mineral resources, it is evident that, with less than a fifth of the Territory mapped, no comprehensive treatment of the subject of its mineral wealth can yet be attempted. Geologic mapping necessitates the preparation of base maps, which in themselves are, indeed, among the most valuable results for the purposes of the prospector and the mine operator.

In addition to the demand for the completion of the topographic and geologic reconnaissance surveys, whose cost can be roughly estimated at \$3 a square mile, there is urgent need for detailed mapping of the important mining districts. Such detailed work costs about ten times as much as the reconnaissance work and need be undertaken only in regions that give promise of becoming important producers of mineral wealth. As soon as a district is established as a producer it is economical to cover it by detailed topographic and geologic surveys at once, as the maps and reports thus become available when they are most needed by the mine operators.

The study of the water resources of Alaska, so far as they bear on the problem of placer mining, is well advanced, for, though only a comparatively small area has actually been surveyed hydrographically, the preliminary work in one of the most important placer districts is nearing completion and similar work in another has been well started.

#### MINERAL STATISTICS.

From the returns already received, it is known that the value of the mineral products of the United States in the calendar year 1907 exceeded a total of \$2,000,000,000, and that, notwithstanding the financial depression which occurred in the latter part of the year, 1907 will be recorded as one of the most prosperous years, if not the most prosperous, in the history of the mining industry. It is interesting to note that the value of the mineral products in 1907 was approximately six times that of 1880, nearly four times that of 1887, and over three times that of 1897, only ten years before. An indication of the wonderful growth of the mineral industry, as recorded by the Survey's division of mineral resources, is afforded by the fact that the value of the coal product of 1907 was almost equal to the value of the entire mineral production of the United States ten years before. The work of keeping in touch with the new development that has caused this immense growth, and of procuring returns from the thousands of new operations, has greatly increased the work of this division of the Survey.

The endeavor to expedite the compilation and publication of the mineral statistics for 1907 has resulted in the issue of five chapters and the transmission of twelve others to the printer during the first half of the calendar year 1908, as contrasted with one issued and five others transmitted in the corresponding period last year.

The plan of cooperation between the divisions of geology and mineral resources, which is referred to in the last report, has continued with even more satisfactory results than were obtained during the two preceding years. This plan was adopted in the preparation of the volume on mineral resources for 1905, and as each geologist has become more acquainted with the statistical work and with the fact that the study of economic development is of coordinate importance with that of geologic conditions, he has entered with more enthusiasm into this work; and the chapters so far presented for publication bear effective testimony to the value of such cooperation. This method of intrusting the supervision of the statistical work to expert economic geologists was originated by Director King, and the return to the original plan is believed to have been fully warranted.

## NATIONAL CONSERVATION.

The congressional enactment establishing the Geological Survey was inspired by an appreciation of the importance to the nation of its mineral resources. Since then the Survey's investigations have not only contributed largely to the development of the mining industry, especially in the public-land States, but have furnished quantitative data that are available at this time of popular awakening to the needs of national conservation.

The last year has been one of those periods through which any scientific work occasionally passes, in which the specific value and definite usefulness of results accomplished have been brought prominently into public notice. The people in general have learned to appreciate certain applications of the Survey's investigations, which heretofore have in large part appealed only to persons who had become familiar with its work by reason of their professions or special interests.

## COAL RESOURCES.

The Survey's most notable contribution to the subject of national conservation during the year was the publication, on the eve of the governors' conference at the White House, of a map of the coal fields of the United States. This map presented both graphically and statistically the extent of the nation's coal reserves. Up to that time it had not been possible to prepare so accurate a map on account of lack of data regarding the shape and extent of many of the western coal fields and the quality of their coal, but during the last few years a large amount of such information has been obtained in connection with the classification and valuation of coal lands in the public-land States of the West. In carrying on this work the United States Geological Survey has mapped most of the important coal fields and has tested many of the coals, so that the information at hand was believed to be sufficiently complete and accurate to warrant its publication.

The table printed with this map shows the size, in square miles, of the coal areas represented on the map; the kind of coal; the production in 1906; the total production to January 1, 1908, including an estimate of production for 1907, to which is added 50 per cent for waste in mining; the estimated original tonnage; and the estimated amount remaining in the ground. The figures given show that the area of the more accessible coal fields of the United States is about 327,000 square miles and that they carry an estimated content available for future use of nearly 2,000 billion tons. This exhibit of the extent of the nation's supply of its most important fuel was timely in connection with the addresses of the President and other speakers at the conference.



The importance of collecting similar data for other minerals is realized, and a beginning has been made in the preparation of quantitative estimates of the nation's reserves of the other mineral fuels and the principal metals. These inventories are especially opportune at this time of unprecedented development of the mineral industry.

#### WATER RESOURCES.

*Need of investigation.*—The public interest in the importance of conserving the natural resources of the nation, aroused by the appointment of the Inland Waterways Commission, and more especially by the governors' conference, has emphasized the value of the country's water resources and the necessity for their thorough investigation.

The idea that water is our most valuable resource, as it is the most active agent in changing or modifying or limiting all those other resources which are so necessary to commercial and economic development, is by no means new. Prominent engineers in this country have long recognized it and have advocated the extension of the government investigations of water resources; and in European countries centuries of experience have demonstrated that water investigations are necessary to a continuance of prosperity. If the United States were to provide for the prosecution of this work on a scale of thoroughness equal to that of the Republic of Switzerland, for example, it would appropriate \$11,000,000 annually, a sum 110 times greater than the present annual appropriation for similar work in this country.

Legislative provision for the investigation of water resources is one of the most important of those necessary acts that may be called anticipatory. The immediate value or application of the results of such investigations is outweighed by their prospective value—a value which will become greater as the passage of years brings increased population and consequent enlarged demands on these resources.

Obviously, if water resources are to be utilized, the first step must be to determine their extent and character. A brief statement of a few of the industrial and social problems of the present day in which the utilization of water is the controlling factor is given in the following paragraphs.

*Floods.*—The average annual damage by floods in the United States has never been accurately determined, but such investigations as have been made indicate that the loss must be at least \$100,000,000 annually. It appears that, in many parts of the United States, the proper expenditure of an amount equal to one year's flood loss would prevent future floods; in other parts of the country the cost would probably equal the flood losses of two or more years, but in every

locality prevention could be accomplished by an expenditure equivalent to the losses from the floods of a few years.

In few flood regions, however, could this result be accomplished except under federal action. Most of the rivers are interstate. Their basins were defined many thousands of years before state boundaries were conceived. The proper treatment of the flood question must therefore follow the limits imposed by nature rather than the artificial lines defining the sovereignty of the various States. Prevention of floods is purely an engineering problem, and the engineers who have thoroughly investigated it realize the necessity for federal regulation.

On another feature of this subject the engineering profession is also agreed; namely, that whatever means may be finally adopted to prevent this great devastation, the results of investigations of rivers must be available to show their habits, flows, seasonal changes, and eccentricities; and, moreover, such investigations must extend over a period of years and be practically completed before remedial measures can be applied.

*Inland navigation.*—Several hundred million dollars have been expended by the Government for river improvement, and it is probable that as much, if not more, must be expended during the next decade. No one will contend that all past expenditures have been wise, as each year brings new knowledge which changes ideas and renders old practice inadvisable. To quote from the address of the President before the conference of governors at the White House on May 13, 1908:

Our natural waterways are not gone, but they have been so injured by neglect, by the division of responsibility and utter lack of system in dealing with them, that there is less navigation on them now than there was fifty years ago.

Whatever may be the process by which inland navigation shall be rehabilitated, whatever may be the system under which the United States shall make its improvements, all engineers agree that thorough investigation of rivers is absolutely necessary to the final solution of the problem.

*Irrigation.*—The United States is spending \$40,000,000 in the construction of irrigation systems. The great factor that will determine the success or failure of this investment is the water supply. It is necessary to deliver to irrigated areas certain amounts of water, and an irrigation project constructed in any region in which there is not sufficient water must fail. A trip through the arid West will disclose thousands of acres in which irrigation systems constructed by private enterprise have failed for lack of proper investigation before construction.

Whether or not there is water sufficient for any irrigation project can not be determined by mere inspection or by measurements cover-

ing a short period of time. When the reclamation act was passed, in 1902, it was possible for the Government to proceed at once with certain projects because the Geological Survey had on file the results of stream measurements showing that sufficient water was available for these projects. Various reclamation projects based on such exact information have been constructed or are under way, and money is being returned to the Treasury under the terms of the reclamation act. This returned money will be available for the construction of other projects, and information concerning the amount of water available for these will be as necessary as it was for the earlier work. The Reclamation Service has no legal power to make general investigations of stream flow, and obviously it would be unjust to charge the cost of general investigations over all the arid West against specific projects. In other words, the continued investigation of the water resources of the arid country will safeguard \$40,000,000 of government expenditure.

*Drainage of wet lands.*—More than 80,000,000 acres of the best agricultural lands in the United States are unproductive because they need drainage. The lands are so widespread that their drainage is being agitated as a national issue, for many believe that these wet lands should be reclaimed under federal authority, as are the arid lands of the West. To the success of this work the investigation of water resources, as well as accurate topographic mapping, is as necessary as it is to the success of irrigation enterprises.

If the sentiment in the United States shall finally become so strong that the Government will be obliged to undertake the work of wetland reclamation, the basic data should be in hand in order that the work may be promptly and properly performed.

*Water power.*—More than half of the present coal consumption in the United States is used for the generation of power. The substitution of water power for this fuel power would result not only in saving the coal but in great financial saving to the people of the whole country, because water power is already cheaper than that derived from fuel. With impoverishment of the coal resources water power will become increasingly important and the investigation of these power resources will be more urgently demanded.

The United States Government is at the present time the largest owner of potential water powers, and investigation of these powers available in the public lands is a matter of public duty. In the absence of specific information concerning its value, a water power may be easily acquired, and water-power rights have thus gone from the control of the Government for a fraction of their real value, not for useful development, but for speculative holding, which involves keeping them for long periods in a nonproductive state. Enormous water powers outside of the public domain are being procured at extremely

low valuations, and although the development of these powers will undoubtedly be of ultimate benefit to the people at large, their extent and value should be matters of public record.

#### TECHNOLOGIC INVESTIGATIONS.

The technologic investigations conducted by the Geological Survey during the last year have been planned to contribute to the conservation of the nation's mineral resources. In the investigations relating to the mineral fuels attention has been given not only to the waste in mining but more especially to the much greater loss in utilization. The promotion of increased efficiency has been sought by steam-engineering investigations, gas-producer and briquetting tests, and smoke-abatement experiments. The extent of mine waste has been studied and plans have been perfected for commencing an adequate investigation of mine explosions and for conducting tests of explosives—a line of practical research that is expected to decrease in some degree the present excessive loss of life in the mines as well as to diminish the waste of coal in mining.

The structural-materials investigations have included inquiries into the nature, extent, and distribution of materials needed for use by the Government in its building and construction work (the cost of which now aggregates about \$40,000,000 annually), in order to meet the urgent needs for accurate data concerning the strength and the fire-resisting and other properties of concrete, clay products, stone, and other building materials, with the view not only to make construction secure but to lessen waste due to use of materials in excessive amounts and with poor protection against fire.

#### MAP PUBLICATION.

The increasing popularity among private citizens of the topographic maps issued by the Survey is being paralleled by the growing appreciation of the maps by the government departments. Of the 40,000 maps distributed to the departments last year for official use, more than 5,000 were delivered to the Forest Service and 3,600 to the War Department. The increased use of the maps by the Forest Service, the War College, and the service schools is especially noteworthy. They are used in administering the national forests, in planning military operations, and as bases for military maps, and the textbooks in use at West Point recognize them as the mother maps to which the army officers can add detailed data of purely military value.

The efficiency of the engraving and printing force of the Survey is appreciated by other branches of the government service, and during the last year there has been a notable increase in the amount of map printing done by the Survey, not only for the other bureaus of the

Interior Department, but especially for the Forest Service and the Public Printer. Large contracts have been awarded to the Survey on bids made in competition with outside contractors. Contracts of this character performed during the year for other bureaus and offices aggregated 30 per cent of the work of the engraving division.

#### ORGANIZATION.

Another line of investigation was placed under the administration of the Geological Survey in May by authority of the Secretary of the Interior, upon the appropriation by Congress of \$150,000 for conducting investigations of the causes of mine explosions, with a view to increasing safety in mining. The division of mine accidents was created May 22, 1908, and made a part of the technologic branch. The organization of this new work was immediately begun and authority was obtained from the Secretary of War for the use of a part of the old arsenal tract in Pittsburg as an explosive station. Before the end of the fiscal year plans had been perfected, contracts awarded, and progress made in equipping for this use certain of the government buildings at Pittsburg. It is proposed to concentrate, for the present, the other work of the technologic branch at this testing station.

In August, 1907, David T. Day, who for more than twenty years had been in charge of the division of mineral resources, was, at his own request, relieved of administrative charge of the division in order that he might take up special studies of the character of American petroleum and the statistics of petroleum production. Edward W. Parker was promoted to become the administrative chief of the division, with the title "statistician in charge."

The reorganization of the topographic branch, begun in March, 1907, was completed January 18, 1908, by the promotion of Robert B. Marshall, geographer, to the position of chief geographer.

Other changes in the personnel were the promotion of George M. Wood, assistant editor, to the vacancy caused by the resignation of P. C. Warman as editor, Mr. Warman continuing in the book publication division, and the designation of Miss Julia L. V. McCord as acting librarian on the resignation of Fred B. Weeks, who had been librarian since 1902.

The establishment of local offices in the West for at least a portion of the year has proved to be of advantage, not only in insuring better administration of the field work and in facilitating the discharge of official business, but in encouraging closer relations between the Survey and the public. This has been especially advantageous in the work of the water-resources and topographic branches, as it is important to provide for the engineers in any district every possible opportunity to be informed of and to profit by the investigations of the Survey and to assist the Survey in meeting local needs.



# WORK OF THE YEAR.

## PUBLICATIONS.

The Survey is a bureau of investigation and publication. Its relation to the public requires that the results of the scientific investigations intrusted to it be presented in the form best adapted to serve the purpose of publicity and that these reports of investigations be distributed with the greatest possible care and expedition. The current publications therefore furnish an important index to the nature and value of the work of the Survey. Summaries of the book publications issued during the last fiscal year follow:

Twenty-Eighth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1907. iv, 80 pp., 1 pl.

A summary account of the work of the year, by branches and divisions, with a map showing area covered by topographic surveys.

Monograph XLIX. The *Ceratopsia*, by John B. Hatcher; based on preliminary studies by Othniel C. Marsh; edited and completed by Richard S. Lull. xxx, 300 pp., 51 pls., 125 text figures.

Descriptions of the remains of an order of Cretaceous Reptilia found in Montana, Wyoming, and Colorado, with foreword and sketch of the life and work of Mr. Hatcher by Henry Fairfield Osborn, and prefaces by the author and the editor. Part I, by J. B. Hatcher, comprises the history of discovery of the remains, the classification, the osteology, and the systematic description; Part II, by R. S. Lull, is devoted to the phylogeny, taxonomy, distribution, habits, and environment of the *Ceratopsia*.

Professional Paper 53. Geology and water resources of the Bighorn Basin, Wyoming, by Cassius A. Fisher. vi, 72 pp., 16 pls., 1 text figure.

A description of the topography and stratigraphy of the region, with brief accounts of the structure and geologic history and sections on the water resources and mineral resources, geologic map and sections, diagram representing the structure of the basin, map showing irrigated and irrigable lands, and half-tone plates illustrating the geologic features of the country.

Professional Paper 56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. vi, 178 pp., 26 pls., 9 text figures.

A historical review of exploration in the region (with bibliography); descriptions of the geography, stratigraphy, and structure; and an account of the economic resources, principally coal and oil. Three large pocket maps and a sheet of cross sections show the geology and the land subdivisions, and a large map with the text indicates irrigated and irrigable lands.

Bulletin 304. Oil and gas fields of Greene County, Pa., by Ralph W. Stone and Frederick G. Clapp. 110 pp., 3 pls., 7 text figures.

An account of the geology of southwestern Pennsylvania, with descriptions of the oil and gas sands and fields, brief judgments as to the limits of the productive territory, and table of well records. The large pocket map (scale 1 mile to the inch) shows the location of oil and gas wells and of dry wells and the outcrops of important coals.

Bulletin 309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by George H. Eldridge and Ralph Arnold. xi, 266 pp., 41 pls., 17 text figures.

Descriptions by Mr. Eldridge of the geologic features of the districts and detailed descriptions of the oil fields, with accounts of the oil wells and a bibliography of southern California oils, followed by a report on the physical and chemical properties of southern California oils and descriptions of the fossils of the oil-bearing formations, by Mr. Arnold. The illustrations include geologic maps of the oil fields, geologic sections, and views of fossils.

Bulletin 311. The green schists and associated granites and porphyries of Rhode Island, by Benjamin K. Emerson and Joseph H. Perry. 74 pp., 2 pls., 6 text figures.

A petrographic description of the stratified and igneous rocks, in order of geologic age, with map of the crystalline rocks in the vicinity of Providence and Narragansett Bay.

Bulletin 313. The granites of Maine, by T. Nelson Dale, with an introduction by George Otis Smith; prepared in cooperation with the Maine State Survey Commission. 202 pp., 14 pls., 39 text figures.

The introduction describes the distribution and geologic relations of the granite and states the scope of the report. Part I consists of a scientific discussion of granites proper and of the so-called black granites. Part II includes economic and technologic descriptions of Maine granites and quarries, statistics, bibliography, and glossary. A pocket map shows the distribution of granite in Maine, and illustrations show features of structure at various quarries.

Bulletin 316. Contributions to economic geology, 1906: Part II, Coal, lignite, and peat; Marius R. Campbell, geologist in charge. 543 pp., 23 pls., 6 text figures.

An introduction by M. R. Campbell summarizes the work done in the coal fields of the United States during the year and contains a brief note on technologic and laboratory work on coals. The remainder of the bulletin consists of the following papers:

Coals of the Clarion quadrangle, Clarion County, Pa., by E. F. Lines.

Coal resources of Johnstown (Pa.) and vicinity, by W. C. Phalen.

The Elkhorn (Ky.) coal field, by R. W. Stone.

The Russell Fork (Va.) coal field, by R. W. Stone.

Coal mining at Dante, Va., by R. W. Stone.

The northern part of the Cahaba (Ala.) coal field, by Charles Butts.

Coal investigation in the Saline-Gallatin (Ill.) field and the adjoining area, by F. W. De Wolf.

The Arkansas coal field, by A. J. Collier.

The Great Falls (Mont.) coal field, by C. A. Fisher.

Coals of Carbon County, Mont., by N. H. Darton.

The coal fields of parts of Dawson, Rosebud, and Custer counties, Mont., by A. G. Leonard.

Coal fields in a portion of central Uinta County, Wyo., by A. R. Schultz.

The Lander (Wyo.) coal field, by E. G. Woodruff.

Coal fields of east-central Carbon County, Wyo., by A. C. Veatch.

Coal of Laramie Basin (Wyo.), by C. E. Siebenthal.

Coal fields of the Danforth Hills and Grand Hogback, in northwestern Colorado, by H. S. Gale.

The Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah, by G. B. Richardson.

The Durango (Colo.) coal district, by J. A. Taff.

The Pleasant Valley coal district, Carbon and Emery counties, Utah, by J. A. Taff.

The Iron County (Utah) coal field, by W. T. Lee.

A reconnaissance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico, by M. K. Shaler.

The Una del Gato coal field, Sandoval County, N. Mex., by M. R. Campbell.

Coal in the vicinity of Fort Stanton Reservation, Lincoln County, N. Mex., by M. R. Campbell.

Coal of Stone Canyon, Monterey County, Cal., by M. R. Campbell.

The present status of the producer-gas power plant in the United States, by R. H. Fernald.

Condition of the coal-briquetting industry of the United States, by E. W. Parker.

The importance of uniform and systematic coal-mine sampling, by J. S. Burrows.

List of Survey papers on coal, lignite, and peat, by W. T. Lee and J. M. Nickles.

Bulletin 317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 69 pp., 2 pls., 1 text figure.

A brief abstract of the report issued later as Bulletin 322, issued to meet urgent demand for early publication of available facts.

Bulletin 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 196 pp., 13 pls.

Part I includes a theoretical discussion of the occurrence of petroleum and natural gas, a statement of the method of investigation, and descriptions of the general geology. Part II consists of detailed descriptions of the stratigraphy, with well logs or sections. Maps show the location of oil and gas wells and the depth of the oil sands from the surface.

Bulletin 319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 44 pp., 7 pls., 17 text figures.

A sketch of ground-water conditions, including descriptions of reservoirs and sources of water, and discussions of the nature of artesian circulation and the requisites of artesian flows, with plates and diagrams showing artesian reservoirs and conditions of flow.

Bulletin 320. The Downtown district of Leadville, Colo., by Samuel F. Emmons and John D. Irving. 75 pp., 7 pls., 5 text figures.

A brief description of the general geology, a statement of the economic development and present conditions, a sketch of the faults and the porphyry sheets, and an account of the ores with a discussion of their genesis. The illustrations consist of a geologic map of the district, with cross sections, and text figures showing mine plans, sections, and workings.

Bulletin 321. Geology and oil resources of the Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 93 pp., 17 pls., 3 text figures.

A record of previous publications on the region, a sketch of the topography, descriptions and tentative correlation of the geologic formations, and notes on the wells, with logs or sections, conclusions as to future development, a statement of the physical and chemical properties and composition of the oil, and

a section on technology and production. The illustrations comprise geologic and structural maps, geologic sections, and half-tone reproductions of photographs, including views of fossils of the various formations.

Bulletin 322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 161 pp., 26 pls.

An account of the previous knowledge of the geology of the region, a sketch of the geography and topography, descriptions of the rocks, the geologic history, and the structure and conditions affecting the presence of oil, with detailed notes on the developed territory and a section on the oil, including accounts of its origin, physical and chemical properties, and the associated hydrocarbons, and a brief report on the technology of production and utilization. The illustrations consist of maps and half-tone views.

Bulletin 323. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 49 pp.

A report on investigations of the chemical and physical properties of coal, including results of tests for moisture, showing changes in moisture content under various conditions, determinations of specific gravity, impurities in coal as related to specific gravity and fineness, adaptability of different coals to improvement by washing, and content of volatile matter in coals and lignites.

Bulletin 324. The San Francisco earthquake and fire of April 18, 1906, and their effects on structures and structural materials. Reports by Grove K. Gilbert, Richard L. Humphrey, John S. Sewell, and Frank Soulé, with preface by Joseph A. Holmes. xii, 170 pp., 57 pls., 2 text figures.

The preface states the origin and nature of the investigation. Mr. Gilbert's report considers the earthquake as a natural phenomenon, with respect to its origin and effect on the earth's crust. Mr. Humphrey's, Mr. Sewell's, and Mr. Soulé's reports discuss the effect of the earthquake and fire on structures and structural materials. The illustrations include maps showing the course of the fault or line of earth slippage and the location and extent of the burned district, and half-tone reproductions of photographs exhibiting the nature and extent of the effects of the earthquake and fire on various structures.

Bulletin 325. A study of 400 steaming tests made at the fuel-testing plant, St. Louis, Mo., in 1904, 1905, and 1906, by Lester P. Breckenridge. 196 pp., 76 text figures.

A report on a series of tests made under two water-tube boilers with a hand-fired furnace to determine the relative value of various coals for steaming purposes. The results of the tests are expressed by numerous diagrams, tables, and mathematical equations. The general conclusions and commercial considerations are stated in a few pages at the end of the report, and are followed by a bibliography and a glossary.

Bulletin 326. The Arkansas coal field, by Arthur J. Collier; with reports on the paleontology by David White and G. H. Girty. vi, 158 pp., 6 pls., 29 text figures.

A brief account of the geography and stratigraphy of the field, reports on fossil plants and marine invertebrate fossils, descriptions of geologic structure, coal beds, and conditions of mining development, with classification and analyses of the coals, a section on methods of mining, a table of mines, openings, and exposures, and geologic and economic maps and sections.

Bulletin 327. Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska, by Sidney Paige and Adolph Knopf. 71 pp., 4 pls., 4 text figures.

A sketch of the geography and geology of the region and a description of the deposits of coal, gold, and copper, with topographic and geologic maps and sections and half-tone views.

Bulletin 328. The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarak, Port Clarence, and Goodhope precincts, by Arthur J. Collier, Frank L. Hess, Philip S. Smith, and Alfred H. Brooks. 343 pp., 11 pls., 19 text figures.

A preface, by A. H. Brooks, is followed by reports with titles and authorship as indicated below.

Development of the mining industry, by A. H. Brooks.

Geography and geology, by A. J. Collier.

Outline of economic geology, by A. H. Brooks.

Description of placers, by A. J. Collier and F. L. Hess.

The Bluff region, by A. H. Brooks.

The Kougarak region, by A. H. Brooks.

Geology and mineral resources of Iron Creek, by P. S. Smith.

The illustrations include sketch maps and sections and large pocket maps showing topography, geology, and location of placers.

Bulletin 329. Organization, equipment, and operation of the structural-materials testing laboratories at St. Louis, Mo., by Richard L. Humphrey; with preface by Joseph A. Holmes. xi, 84 pp., 25 pls., 9 text figures.

A brief history of the establishment of the laboratories, with statement of personnel, description of the buildings and equipment, and sketch of work done and projected, illustrated by views and diagrams showing apparatus employed and results of tests.

Bulletin 330. The data of geochemistry, by Frank W. Clarke. 716 pp.

A manual of geologic chemistry, including chapters on the nature, distribution, and relative abundance of the chemical elements, the composition of the atmosphere and of volcanic gases and sublimates, the mineral content of surface and underground waters, the nature of saline residues, the molten magma of the earth's interior, the rock-forming minerals, the composition of igneous, sedimentary, and metamorphic rocks, rock metamorphism and decomposition, metallic ores, natural hydrocarbons, coal, lignite, and peat.

Bulletin 331. Portland cement mortars and their constituent materials; results of tests made at the structural-materials testing laboratories, Forest Park, St. Louis, Mo., 1905-1907, by Richard L. Humphrey and William Jordan, jr. vii, 130 pp., 20 pls., 22 text figures.

Records, tables, diagrams, and views showing nature and results of 25,000 tests of cements, sands, gravels, crushed stone, and other materials.

Bulletin 332. Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907. Joseph A. Holmes, in charge. 299 pp.

An introduction, by J. A. Holmes, states briefly the work done and projected. The body of the report consists of the following papers:

Field work, by E. W. Parker and J. S. Burrows.

Work of the chemical laboratory, by N. W. Lord.

Steaming tests, by L. P. Breckenridge.

Producer-gas tests, by R. H. Fernald.



Washing tests, by G. R. Delamater.

Coking tests, by A. W. Belden.

Cupola tests on coke, by Richard Moldenke.

Briquetting tests, by C. T. Malcolmson.

Results of tests by States.

Bulletin 333. Coal-mine accidents: Their causes and prevention. A preliminary statistical report, by Clarence Hall and Walter O. Snelling, with introduction by Joseph A. Holmes. 21 pp.

Tables showing the number of men killed by accidents in coal mines in the United States during many years, the number of men killed in various other countries for each thousand employed, and the number killed for each million tons of coal mined, with statement of causes of accidents and suggestions as to their prevention.

Bulletin 334. The burning of coal without smoke in boiler plants. A preliminary report, by D. T. Randall. 26 pp.

A sketch of prevailing conditions in the United States as to smoke from furnaces, and of city ordinances for its prevention, and a statement of the causes of smoke and of methods for preventing it, with a bibliography.

Bulletin 335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 141 pp., 10 pls., 2 text figures.

An account of surveys made in the region, of the commercial developments, the general character of the country, climate, vegetation, settlements, harbors, and railway routes; a description of the land forms, the geology, and the coal and petroleum deposits, with results of analyses and tests and prospects of development. The illustrations include maps showing topography, geology, and location of coal beds and oil wells and seepages.

Bulletin 336. Washing and coking tests of coal and cupola tests of coke, conducted by the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to June 30, 1907, by Richard Moldenke, A. W. Belden, and G. R. Delamater, with introduction by J. A. Holmes. 76 pp.

Tables showing the results of 65 washing tests, 192 coking tests of 102 coals, and 172 cupola tests, with statement of equipment and methods of operation.

Bulletin 337. The Fairbanks and Rampart quadrangles, Yukon-Tanana region, Alaska, by L. M. Prindle; with a section on the Rampart placers by F. L. Hess, and a paper on the water supply of the Fairbanks region by C. C. Covert. 102 pp., 5 pls., 3 text figures.

A sketch of the geography, climate, and vegetation, descriptions of the rocks and the economic geology, an account of the hydrography of part of the region and of the placer diggings near Rampart, with maps showing the topography, geology, and timber.

Bulletin 339. The purchase of coal under government and commercial specifications on the basis of its heating value, with analyses of coal delivered under government contracts, by D. T. Randall. 27 pp.

A statement of the advantages of definite specifications in the purchase of coal, of the requirements for proper combustion, and of the valuable constituents of coals, with reprint of specifications used by the United States Government in coal purchases, notes on methods of sampling and testing, analyses of coals delivered to the Government, and a brief bibliography.

Bulletin 342. Results of spirit leveling in California, 1896 to 1907, inclusive, by S. S. Gannett and D. H. Baldwin. 172 pp.

Descriptions and elevations of bench marks in 42 counties, furnishing vertical control for one-third of the State, the engineering data being grouped under the headings "precise leveling" and "primary leveling," according to the degree of refinement in the methods employed. A compilation of the results of field work by several topographers.

Bulletin 343. Binders for coal briquets: Investigations made at the fuel-testing plant, St. Louis, Mo., by James E. Mills. 56 pp., 1 text figure.

A discussion of the characteristics of good briquets and of the conditions governing the use of binders, and an account of laboratory investigations of various binders, of experiments in briquetting without binders, and of results of tests in briquetting coals, with a brief bibliography.

Bulletin 344. The strength of concrete beams: Results of tests of 108 beams (first series) made at the structural-materials testing laboratories, by Richard L. Humphrey. 59 pp., 1 pl., 13 text figures.

A note on the scope of the investigation and a summary of its results, followed by statements of tests of constituent materials, methods of preparing test pieces and of testing, and diagrams and tables showing in detail the results of the tests.

Water-Supply Paper 195. Underground waters of Missouri; their geology and utilization, by Edward M. Shepard. x, 224 pp., 6 pls., 6 text figures.

A statement of the requisite conditions for flowing wells, descriptions of the topography and geology, a brief sketch of the geologic history, a detailed report of the underground waters, by districts and counties, a section on city water supplies, with statistical tables and analyses, and notes on mineral and blowing well. The illustrations include a geologic and artesian well map and geologic cross sections.

Water-Supply Paper 197. Water resources of Georgia, by B. M. Hall and M. R. Hall. 342 pp., 1 pl.

Sketches of the topography and geology and of the uses of water in the State, descriptions of the river basins, tables showing gage heights and flow of the streams, tabulated results of river surveys giving elevations of the water surface of streams at certain points, and detailed notes on water powers.

Water-Supply Paper 198. Water resources of the Kennebec River basin, Maine, by H. K. Barrows; with a section on the quality of Kennebec River water, by George C. Whipple. vi, 235 pp., 7 pls., 17 text figures.

Brief descriptions of the geology, drainage, forest conditions, population, industries, and transportation facilities, sections on precipitation, snow storage and evaporation, detailed accounts of stream flow, floods, water powers and water storage, and the results of examinations of the quality of the water, a section on the typhoid fever epidemic of 1902-3, and a gazetteer of the rivers, lakes, and ponds in the basin.

Water-Supply Paper 199. Underground water in Sanpete and central Sevier valleys, Utah, by G. B. Richardson. 63 pp., 6 pls., 5 text figures.

A sketch of the topography and geology of the region and of the sources, distribution, and quality of the underground water, a statement of methods adopted and suggestions offered for its recovery, and detailed descriptions, by localities, of wells and water resources, with tables giving data concerning wells and springs.

- Water-Supply Paper 201. Surface water supply of New England, 1906 (Atlantic coast of New England drainage); H. K. Barrows, district hydrographer. 120 pp., 5 pls., 2 text figures.
- Water-Supply Paper 202. Surface water supply of Hudson, Passaic, Raritan, and Delaware river drainages, 1906; H. K. Barrows and N. C. Grover, district hydrographers. iv, 77 pp., 2 pls., 2 text figures.
- Water-Supply Paper 203. Surface water supply of Middle Atlantic States, 1906 (Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin river drainages); N. C. Grover, district hydrographer. iv, 100 pp., 4 pls., 2 text figures.
- Water-Supply Paper 204. Surface water supply of Southern Atlantic and Eastern Gulf States, 1906 (Santee, Savannah, Ogeechee, and Altamaha rivers and eastern Gulf of Mexico drainages); M. R. Hall, district hydrographer. v, 110 pp., 5 pls., 2 text figures.
- Water-Supply Paper 205. Surface water supply of Ohio and lower eastern Mississippi river drainages, 1906; M. R. Hall, N. C. Grover, and A. H. Horton, district hydrographers. 123 pp., 3 pls., 2 text figures.
- Water-Supply Paper 206. Surface water supply of Great Lakes and St. Lawrence River drainages, 1906; H. K. Barrows, A. H. Horton, district hydrographers. vi, 98 pp., 3 pls., 2 text figures.
- Water-Supply Paper 207. Surface water supply of upper Mississippi River and Hudson Bay drainages, 1906; A. H. Horton and Robert Follansbee, district hydrographers. v, 94 pp., 4 pls., 2 text figures.
- Water-Supply Paper 208. Surface water supply of Missouri River drainage, 1906; Robert Follansbee, R. I. Meeker, and J. E. Stewart, district hydrographers. vi, 190 pp., 5 pls., 2 text figures.
- Water-Supply Paper 209. Surface water supply of lower western Mississippi River drainage, 1906; R. I. Meeker and J. M. Giles, district hydrographers. iv, 79 pp., 2 pls., 2 text figures.
- Water-Supply Paper 210. Surface water supply of western Gulf of Mexico and Rio Grande drainages, 1906; T. U. Taylor and W. A. Lamb, district hydrographers. 114 pp., 2 pls., 2 text figures.
- Water-Supply Paper 211. Surface water supply of Colorado River drainage above Yuma, 1906; R. I. Meeker, H. S. Reed, district hydrographers. 149 pp., 2 pls., 2 text figures.
- Water-Supply Paper 212. Surface water supply of the Great Basin drainage, 1906; E. C. La Rue, Thomas Grieve, jr., and Henry Thurtell, district hydrographers. iv, 98 pp., 2 pls., 2 text figures.
- Water-Supply Paper 213. Surface water supply of California, 1906; with a section on ground-water levels in southern California (Great Basin and Pacific Ocean drainages in California and lower Colorado River drainage); W. B. Clapp, district hydrographer. In cooperation with California state board of examiners. 219 pp., 4 pls., 2 text figures.
- Water-Supply Paper 214. Surface water supply of the north Pacific coast drainage, 1906; J. C. Stevens, Robert Follansbee, and E. C. La Rue, district hydrographers. Work in Oregon done in cooperation with the state engineer. vi, 208 pp., 3 pls., 2 text figures.

Fourteen papers comprising the results of stream measurements in the United States during the calendar year 1906, continuing the series published in previous years under the title "Report of progress of stream measurements." These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharge for stations maintained on streams in many of the important drainage basins of the country.

**Water-Supply Paper 215.** Geology and water resources of a portion of the Missouri River valley in northeastern Nebraska, by G. E. Condra. 59 pp., 11 pls.

Descriptions of the stratigraphy, structure, and rocks, and of the mineral and water resources, with geologic map and sections and map showing underground water conditions.

**Water-Supply Paper 216.** Geology and water resources of the Republican River valley and adjacent areas, Nebraska, by G. E. Condra. 71 pp., 13 pls., 3 text figures.

Notes on the topography, drainage, and climate, descriptions of the geology and mineral resources, and detailed accounts of the surface and underground waters, of the water supply by counties, and of the water power and agricultural resources, with geologic maps and sections and half-tone illustrations.

**Water-Supply Paper 217.** Water resources of Beaver Valley, Utah, by Willis T. Lee. 57 pp., 1 pl., 3 text figures.

Sketch of the geography and geology, records of rainfall and stream measurements, and an account of the springs and wells, with well sections and statistics of wells and springs, including assays and chemical determinations of content of waters and notes on possibilities of development.

**Water-Supply Paper 218.** Water-supply investigations in Alaska, 1906–1907, Nome and Kougarak regions, Seward Peninsula; Fairbanks district, Yukon-Tanana region, by Fred F. Henshaw and C. C. Covert. 156 pp., 12 pls., 2 text figures.

Descriptions of the areas and of the conditions affecting water supply, lists of gaging stations, tables showing stream flow, and meteorological records, with maps indicating the location of gaging and rainfall stations.

**Mineral Resources of the United States, calendar year 1906.** 1,307 pp., 2 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 45 separate chapters, each treating of a separate mining industry, published in pamphlet form in advance of the publication of the volume.

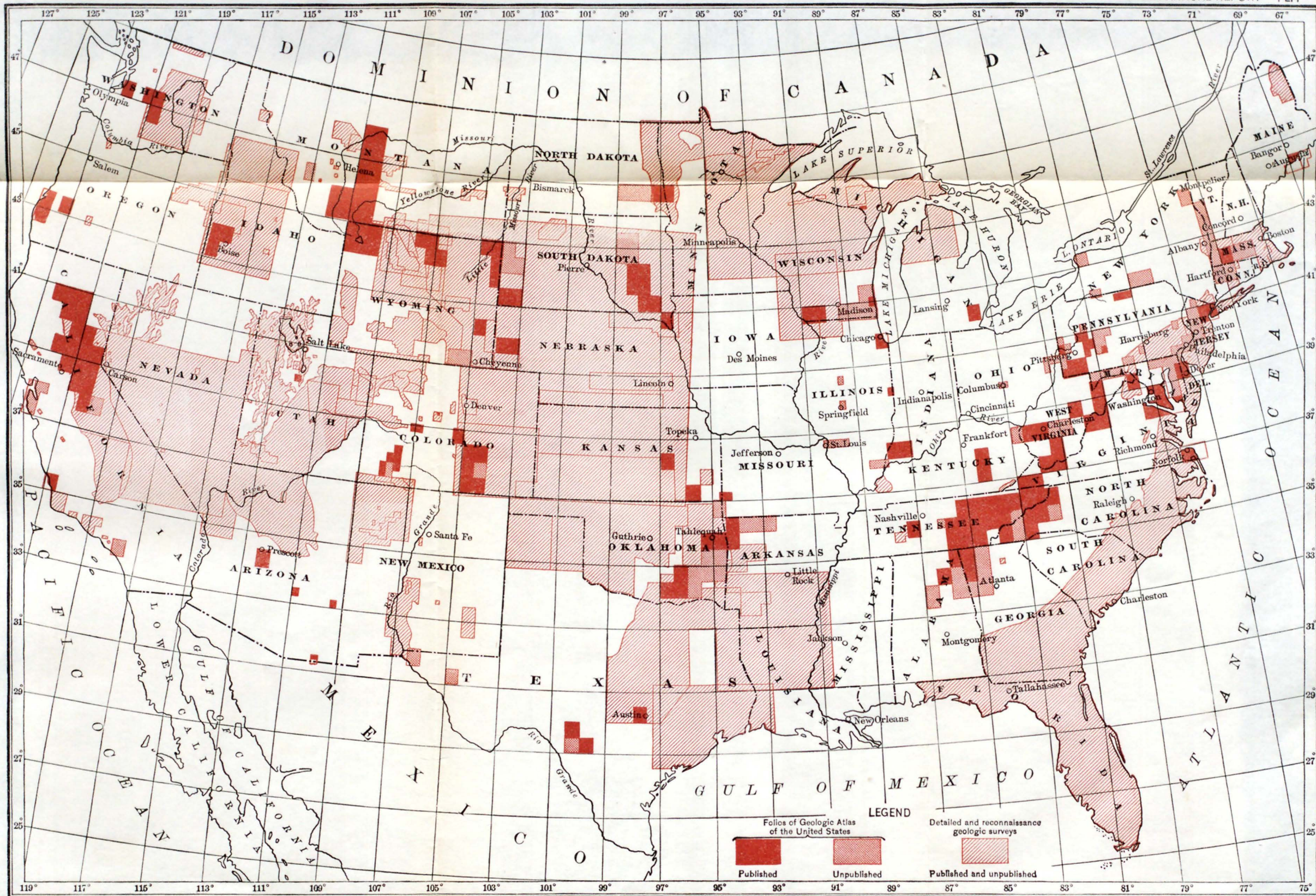
Advance chapters from "Mineral Resources of the United States, calendar year 1907," as follows: The production of bauxite and aluminum, by W. C. Phalen. 15 pp. The cement industry in the United States in 1907, by Edwin C. Eckel. 19 pp. The production of monazite and zircon in 1907, by Douglas B. Sterrett. 12 pp. The production of phosphate rock in 1907, by F. B. Van Horn. 9 pp. The production of asbestos in 1907, by J. S. Diller. 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 151.** Description of the Roan Mountain quadrangle, comprising 963 square miles in Washington, Sullivan, Carter, and Unicoi counties, Tenn., and Yancey and Mitchell counties, N. C.; by Arthur Keith. 11 folio pages of text, 4 maps showing topography, geology, and mineral resources, a sheet of columnar and structure sections, and 2 pages of reproductions of photographs illustrating physiography and geology.

- Geologic folio 152. Description of the Patuxent quadrangle, comprising 931.5 square miles, of which 24 square miles are in the District of Columbia and the remainder in Maryland. Prepared under the supervision of William Bullock Clark, state geologist of Maryland, by George B. Shattuck, Benjamin L. Miller, and Arthur Bibbins. 12 folio pages of text, 3 maps, and 1 columnar section.
- Geologic folio 153. Description of the Ouray quadrangle, an area 234.87 square miles in extent in southwestern Colorado, with the mining town of Ouray in the southwest part of the quadrangle; geography and general geology by Whitman Cross and Ernest Howe; economic geology by J. D. Irving and Whitman Cross. 20 folio pages of text, 3 maps, 1 columnar section sheet, and 1 sheet of illustrations exhibiting physiographic features.
- Geologic folio 154. Description of the Winslow quadrangle, comprising 940 square miles of the Ozark region of western Arkansas and about 29 square miles of Oklahoma; by A. H. Purdue. 6 folio pages of text, 2 maps showing topography and areal geology, and 1 sheet of columnar sections.
- Geologic folio 155. Description of the Ann Arbor quadrangle, embracing an area 884.85 square miles in extent in the southeastern part of the Southern Peninsula of Michigan, the city of Ann Arbor being near its geographic center. General geology, marl deposits, and mineral waters described by I. C. Russell; topography and drainage, Quaternary geology, and water resources by Frank Leverett; peat deposits by Charles A. Davis; Paleozoic history by E. M. Kindle. In the preparation of this folio the Michigan State Geological Survey rendered much assistance. 15 folio pages of text and 3 maps representing topography, geology, and artesian waters.
- Geologic folio 156. Description of the Elk Point quadrangle, comprising about 878 square miles in the Missouri Valley, on the western slope of the Mississippi basin, mainly in Union and Clay counties, S. Dak., but including also portions of Dixon and Dakota counties, Nebr., and Plymouth and Sioux counties, Iowa; by J. E. Todd. 8 folio pages of text and 3 maps of topography, geology, and artesian waters.
- Geologic folio 157. Description of the Passaic quadrangle, comprising an area of about 905 square miles, the greater part of which lies in New Jersey, although Staten Island, the west end of Long Island, the south end of Manhattan Island, and several smaller islands belonging to New York are also included. The New York area is all in New York City; the New Jersey area includes the counties of Union and Essex and portions of Hudson, Passaic, Bergen, Morris, Middlesex, and Somerset counties; surveyed in cooperation with the State of New Jersey; by N. H. Darton, W. S. Bayley, R. D. Salisbury, and H. B. Kummel. 27 folio pages of text, 3 maps—topography, areal geology, and surficial geology—a sheet of structure sections, and a sheet of illustrations exhibiting geologic features.
- Geologic folio 158. Description of the Rockland quadrangle, comprising about 215 square miles (of which only about two-thirds is land) on the western side of Penobscot Bay, Maine; surveyed in cooperation with the State of Maine by Edson S. Bastin, under the supervision of George Otis Smith. 15 folio pages of text, 4 maps—topography, surficial geology, areal geology, and economic geology—and 1 sheet of structure sections.
- Geologic folio 159. Description of the Independence quadrangle, an area 950 square miles in extent, located near the middle of the well-known Kansas-Oklahoma oil and gas field, of which it forms an important part; by F. C. Schrader. 7 folio pages of text; 3 maps, showing topography, areal geology, and structural and economic geology; and 1 sheet of structure sections; also sheet showing names that have been applied to the geologic formations in this region in various publications issued since 1866.





MAP OF UNITED STATES, SHOWING AREAS COVERED BY GEOLOGIC SURVEYS

Scale  
100 0 100 200 300 miles  
1908



## FIELD WORK BY THE DIRECTOR.

During the field season of 1907 the Director visited geologic, topographic, and hydrographic parties in California, coal-land classification parties in Wyoming, and the testing plants in Denver, St. Louis, and Norfolk. He also accompanied the Inland Waterways Commission on its Mississippi River trip and attended the public-land, irrigation, and mining congresses at Denver, Sacramento, and Joplin, respectively.

## GEOLOGIC BRANCH.

## ADMINISTRATION.

The geologic branch consists of four divisions, viz, (1) geology and paleontology, (2) Alaskan mineral resources, (3) mining and mineral resources, and (4) chemical and physical research.

Each division is in charge of an administrative chief, while the cooperation between the divisions and the coordination of the several lines of work are in the hands of the chief geologist, C. Willard Hayes. 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 the organization readily permits such transfer when exigencies demand it.

## PUBLICATIONS.

The publications of the year prepared in the geologic branch included 9 geologic folios, 1 monograph, 2 professional papers, 18 bulletins, and the annual volume on mineral resources. Besides these a large number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies, and some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications. Such publications are ordinarily restatements of results in a more technical form, and are usually prepared by members of the Survey without compensation.

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

## DIVISION OF GEOLOGY AND PALEONTOLOGY.

## ORGANIZATION.

The scientific force of the division at the beginning of the year consisted of 50 geologists and paleontologists, 45 assistant geologists, and 26 junior geologists. During the year there were 7 resignations and 19 appointments, resulting in a net gain of 12, or a total of 133 at the end of the year. Of this number 85 were continuously employed; 33, carried on the per diem roll, gave only a portion of their time to Survey work; and 22 were not employed during the year. In addition to the above regular force 44 field assistants were employed for a portion of the year.

## GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

*New England.*—The State of Maine cooperated in geologic work to the extent of \$2,100. The detailed geologic survey of the Eastport 30-minute quadrangle was continued by Edson S. Bastin, assisted by C. L. Breger. Prof. Henry S. Williams cooperated in investigations of Devonian paleontology and stratigraphy.

The detailed mapping of the areal geology of the Frenchman Bay quadrangle was continued by Charles W. Brown, and a study of the hard-rock road materials of Maine was made by Henry Leighton, under the direction of Mr. Bastin. The Office of Public Roads of the United States Department of Agriculture cooperated in the testing of samples and in the publication of the report.

During the winter Prof. H. S. Williams, assisted by C. L. Breger, continued the preparation of a manuscript on the Chapman fauna of Maine. A paper entitled "Revision of the mollusk genus *Pterinea*" was published in April by the United States National Museum preliminary to the publication of this monograph.

Brief studies of some of the molybdenite deposits of Maine were made by Frank L. Hess.

A detailed study of the Branford Light-House Point area, Connecticut, was made under Prof. Herbert E. Gregory's direction by Freeman Ward.

Field work on the Ware and Quinsigamond (Mass.) quadrangles was completed by Prof. B. K. Emerson. The text of the Ware folio is in final form, and that of the Quinsigamond folio is nearly ready. The glacial deposits of these quadrangles have been studied by W. C. Alden, and chapters on the Pleistocene geology for the folios have been prepared by him. Professor Emerson also compiled a general geologic map of the States of Massachusetts and Rhode Island, on the scale of 4 miles to the inch. The map is ready for publication and a brief text which will accompany it is well advanced.

All the granite quarries in Vermont, 79 in number, were visited by T. Nelson Dale, and similar work was begun in Connecticut. Mr. Dale also completed a bulletin on the chief commercial granites of Massachusetts, New Hampshire, and Rhode Island (Bulletin 354) and a bulletin on the granites of Vermont, an abstract of which he has furnished for publication in the report of the state geologist of Vermont for 1908.

*Atlantic Coastal Plain.*—A geologic study of the Atlantic Coastal Plain is being carried on in cooperation with the official Surveys of the various States concerned. Although the need for such work was long recognized, the plans for it were not perfected until about a year ago, when, in response to an invitation sent out by the Director of the National Survey, the state geologists from the various States came to

Washington and met in conference those members of the federal organization that were most directly interested in the proposed investigation. At this meeting, which was held December 31, 1906, it was decided that a cooperative survey of the geology of the Coastal Plain should be undertaken, with special reference to the underground water resources of the region.

In accordance with the views expressed at the conference a supervising board was formed, with Prof. William Bullock Clark, of Johns Hopkins University, as chairman, the other members being the state geologists of the cooperating States and, from the National Survey, the chiefs of the geologic and water-resources branches, the geologist in charge of the section of paleontology, and the geologist selected to supervise the investigation.

The state geologist of each State has general supervision of the work in his State, and the chief geologist, chief hydrographer, and chief paleontologist of the federal Survey act in their respective official capacities. T. Wayland Vaughan, the geologist selected to supervise the investigation, has charge of the coordination of the work between the different States represented and of the geologic correlations.

Prof. W. B. Clark was in immediate charge of the Coastal Plain district extending from Massachusetts to and including North Carolina. Field operations were continued under his direction during the last fiscal year in New Jersey, Delaware, Maryland, Virginia, and North Carolina. He had the assistance of Messrs. B. L. Miller, E. W. Berry, L. W. Stephenson, M. W. Twitchell, and A. Bibbins and Miss Gardner.

In New Jersey the geology of certain portions of the Philadelphia quadrangle was revised in cooperation with the state geologist of New Jersey, preparatory to the publication of the Philadelphia folio, work on which was completed some years ago.

In Pennsylvania further work was done on the Cretaceous deposits, preparatory to the publication of the Philadelphia folio.

Work in Delaware has been confined largely to reconnaissance surveys in the Wilmington quadrangle. The Cretaceous, Tertiary, and Quaternary formations were provisionally platted as the result of work along the stream channels in the district.

In Maryland a systematic study of the Potomac floras, including the revision of the synonymy, was begun by Mr. Berry.

The work in Virginia consisted of a study of the stratigraphy and a laboratory study of the Tertiary fossils. Particular attention was given to the stratigraphy of the Tertiary formations. The leading divisions recognized in Maryland were found, and their extension across the State was mapped in a preliminary way. Mr. Berry began an exhaustive study of the Potomac floras in conjunction with the

Maryland materials, with the idea of making a complete revision of the synonymy and carefully determining the horizons from which the various forms come.

The North Carolina work was continued by Doctor Clark, in cooperation with Messrs. Miller, Berry, Twitchell, and Stephenson, and Miss Gardner. Extensive collections were made from the Lower Cretaceous beds, and the deposits have been correlated with those of regions farther north. A preliminary map showing the distribution of the several formational units has been prepared, and also a report on North Carolina Coastal Plain stratigraphy.

T. Wayland Vaughan was in immediate charge of the Coastal Plain district extending from the North Carolina-South Carolina line southward.

In South Carolina, in company with Earle Sloan, state geologist of South Carolina, Mr. Vaughan reviewed the Tertiary stratigraphy of the State, making at numerous localities collections of fossils, which were subsequently studied, in order to establish geologic correlations between South Carolina and adjoining States. L. W. Stephenson spent several weeks in South Carolina for the purpose of correlating the Cretaceous formations of the State with those of the other Coastal Plain States and of determining the Eocene or Cretaceous age of certain beds. Considerable progress was made in the study of the geology of South Carolina, and as a result of the cooperative work Mr. Sloan will soon issue a report on the Coastal Plain formations of that State. This report will be followed by a special report on the underground waters of the State, for which most of the data have already been collected.

An arrangement, contingent on receiving the necessary appropriations, was made with S. W. McCallie, state geologist of Georgia, for the detailed study of the Coastal Plain of Georgia, with especial reference to underground water resources. In accordance with this arrangement L. W. Stephenson, on the part of the United States Geological Survey, spent some time in the study of the stratigraphy and correlation of the Cretaceous formations. The Georgia Geological Survey assigned Otto Veatch as its representative in the work. Mr. Vaughan, in company with Earle Sloan, visited critical localities in Georgia near Savannah River.

An agreement was made between the Director of the United States Geological Survey and E. H. Sellards, state geologist of Florida, for cooperative work in that State. According to this arrangement Mr. Sellards and an assistant, Herman Gunter, conducted the field researches regarding the underground waters in 16 counties, comprising the central portion of the State, while the underground water investigations in the remainder of the State, as well as the stratigraphic work, were carried on by representatives of the United States

Geological Survey. Mr. Vaughan supervised the investigation on behalf of the federal Survey, and F. G. Clapp and George C. Matson were assigned to the field work and completed it as planned.

Mr. Vaughan had several conferences with Prof. Eugene A. Smith, state geologist of Alabama, with reference to stratigraphic correlations, and Professor Smith was also visited by Messrs. Clapp and Stephenson for similar consultations. A few of the more important exposures of Cretaceous formations were visited by Mr. Stephenson for the purpose of comparing the geologic sections in the more eastern States with the section in Alabama.

In Texas Alexander Deussen undertook field work and the preparation of a report on the stratigraphy and underground waters of the region extending eastward from the Sabine to the Brazos and lying south of a line crossing Marion, Upshur, Wood, Van Zandt, and Kaufman counties. The field work for this area was completed and the report is almost ready for publication.

A preliminary study was made by L. W. Stephenson, under the supervision of T. W. Stanton, of collections of Cretaceous fossils from North Carolina, South Carolina, Georgia, and Alabama, obtained in the course of work on the stratigraphy of the Atlantic Coastal Plain.

The stratigraphy and paleontology of a part of Staten Island, New York, was investigated by E. C. Jeffrey and Arthur Hollick under the direction of F. H. Knowlton, and much valuable material bearing on the stratigraphy of the Cretaceous formations of the Atlantic coast was obtained.

*Northern Appalachian region.*—A detailed study of the Dalmanellas of the Devonian of New York was made by H. S. Williams to illustrate the amount and kind of modification of species coordinate with geologic sequence in time. A preliminary paper by Professor Williams on the Dalmanellas of the Chemung formation was published in April, 1908, by the National Museum.

A paper on the correlation of the Devonian section of the Tioughnioga and Chenango valleys with the standard Ithaca section was finished in August, 1907, but was withheld from publication awaiting the settlement of questions of nomenclature for the Watkins Glen and Catatonk quadrangles.

Geologic work in Pennsylvania was done in cooperation with the State, which made an appropriation of \$5,500 for this purpose. Detailed areal and economic surveys of the Carnegie and Warren quadrangles were completed, and the text of the Warren folio has been submitted. The areal survey of the Claysville quadrangle was completed and areal work was carried on in the Sewickley quadrangle. The work on the Clarion quadrangle was completed and additional studies were made in the Johnstown, Punxsutawney, and Houtzdale quad-



rangles. The work in Pennsylvania was in charge of George H. Ashley, with whom were associated George C. Martin, Charles Butts, M. J. Munn, Frederick B. Peck, W. C. Phalen, and Edwin F. Lines.

A. C. Spencer continued the study of the magnetite deposits of the Cornwall type in Dauphin, Lancaster, and York counties, and the final report on this work is ready for publication.

The mapping of the New Jersey Highlands was continued by W. S. Bayley, the field work being completed for the Ramapo quadrangle. Doctor Bayley spent the remainder of the field season in revising the mapping of the Raritan quadrangle and in extending the mapping of the Easton quadrangle west of Delaware River in Pennsylvania.

George W. Stose completed and transmitted for publication the Mercersburg-Chambersburg (Pa.) folio, completed the field work in the Pawpaw and Hancock (W. Va.-Md.-Pa.) quadrangles and began preparation of the folio in cooperation with the Maryland Geological Survey, and partly surveyed the Carlisle (Pa.) quadrangle.

Frank W. De Wolf nearly completed an economic bulletin and a folio for the Newcastle (Pa.) quadrangle.

E. O. Ulrich spent the month of July in the Champlain and Mohawk valleys in New York. Through the courtesy of Dr. John M. Clarke, state geologist of New York, Dr. Rudolph Ruedemann, of his staff, was detailed as guide and associate to Mr. Ulrich in a study of typical outcrops in these classic areas of American early Paleozoic stratigraphy. During about half of the time Prof. H. P. Cushing, also of the New York State Survey, accompanied Messrs. Ruedemann and Ulrich. It is believed that this association of state and federal geologists will lead to a clearer appreciation of the composition of the New York section and to greater exactitude in correlations with it.

The month of August was devoted to a continuation of stratigraphic studies in the Mississippi and Appalachian valleys, begun several years ago. Those in the Appalachian area were resumed in May, 1908. In the early part of this month Mr. Ulrich, in association with Mr. Stose, extended these studies through the Carlisle (Pa.) quadrangle, and thence northward to Harrisburg, Pa.

*Southern Appalachian region.*—In the Cowee (N. C.) quadrangle field work, done for the most part jointly with the state Survey, consisted in the examination of deposits of ruby, mica, and kaolin, by D. B. Sterrett, together with a review of the base of the Ocoee strata by Arthur Keith.

In the Morgantown (N. C.) quadrangle field work included the mapping of the monazite and gold-bearing sands, mainly by Mr. Sterrett. In the Dahlonega (Ga.) district the mapping of the auriferous gravels and similar deposits was completed by Mr. Keith.



For the determination of the sequence of gneisses and schists in the Dahlonga, Suwanee, and Dalton quadrangles, in Georgia, and the Walhalla quadrangle, in South Carolina, a brief reconnaissance was made by Mr. Keith.

W. C. Phalen carried on revisional work in the Ellijay (Ga.) quadrangle and in adjacent portions of the Suwanee and Dalton quadrangles.

The iron-ore deposits that appeared to be of economic interest were visited and brief accounts of them were prepared for publication in Bulletin 340 (Contributions to Economic Geology, 1907, Part I). The known bauxite deposits in Georgia, Alabama, and Tennessee were visited by Messrs. Hayes and Phalen, partly in the interest of work for the annual report on mineral resources and partly to extend the knowledge of the geology of the deposits.

Work was continued in the Birmingham (Ala.) district by Mr. Butts, in the preparation of folios, special reports, and a paper on the coal fields of Alabama.

Selected outcrops of Ordovician and late Cambrian rocks in the Appalachian Valley between Clinchport, Va., and Knoxville, Tenn., were studied by E. O. Ulrich and R. S. Bassler. The immediate object of these investigations was to determine the causes of the well-known local variations in lithologic and faunal characters of the great series of dolomites and limestones commonly referred to as the Knox dolomite. In June an areal survey was made of the Woodbury (Tenn.) quadrangle by Messrs. Ulrich and Bassler.

#### GEOLOGIC WORK IN CENTRAL STATES EAST OF 97°.

Areal and economic surveys in the coal fields of southern Illinois were continued in cooperation with the state Geological Survey. T. W. Savage, Stuart Weller, and J. H. Udden were employed on this work by the State, and Frank W. De Wolf, E. C. Lines, and David White by the federal Survey. Three quadrangles, the Belleville, Breese, and Galatia, were surveyed with the assistance of members of the state Survey. These quadrangles form parts of two belts of 15-minute areas, which will extend across the State at a distance of 36 miles apart. In connection with the field work systematic collection and analysis of face samples from shipping coal mines has been carried on. Preliminary reports on these quadrangles have been submitted, and final reports on the Belleville and Breese quadrangles are in preparation. A bulletin on the Peoria quadrangle was submitted by the state Survey, in accordance with an agreement made in the previous year.

The results of the Illinois surveys will be available for publication in folio form after the general correlation studies planned for the following year have been completed.

A reconnaissance study of the stratigraphy and structure of the Henderson (Ky.) and the Evansville (Ind.) coal fields and of part of the southern Illinois field was made by George H. Ashley and Frank W. DeWolf.

As part of the cooperation with the state Survey of Illinois the field study of the fossil floras of the basal "Coal Measures" in that State was continued by David White, who at the same time worked out the age and number of the coals laid down in the early Pennsylvanian basin. During the two months available this work was extended along the greater part of the western border of the coal field.

In Arkansas work was done by the United States Geological Survey in cooperation with the Geological Survey of Arkansas, Prof. A. H. Purdue, state geologist, being in charge of the work. The mapping of the slates of Arkansas and of such part of the Caddo Gap quadrangle as time would permit, for folio publication, was the object in view. E. O. Ulrich accompanied Professor Purdue to Crystal Springs, Montgomery County, for the purpose of making paleontologic studies to determine the age of the rocks in the slate region.

A reconnaissance of portions of the Cherokee and Creek Nations was made by C. E. Siebenthal to ascertain more exactly the relations of the Pennsylvanian formations in the Wyandotte (Okla.-Mo.), Independence (Kans.), and Muskogee (Okla.) quadrangles. Mr. Siebenthal subsequently took up the collection of lead and zinc statistics for the calendar year 1907, for publication in the annual report on mineral resources, and carried on this work throughout the remainder of the fiscal year.

Previous study of the critical relations of the several parts of the Keewatin and Labradoran glacial formations on the north and west sides of the Driftless Area in Wisconsin, Minnesota, and Iowa was continued by Frank Leverett, who during the winter prepared a report of progress on this work and continued the preparation of manuscript on the formations of the Michigan glacial lobe.

Areal glacial work was continued by W. C. Alden in Wisconsin, chiefly in the townships of Monroe, Bellville, Cross Plains, Baraboo, Denzer, Dells, and Briggsville, in the south-central part of the State. In June, 1908, Mr. Alden resumed field work in northern Illinois on subjects related to his previous work in Wisconsin.

Supplementary studies of the area of the Michigan glacial lobe and related tracts were made by Frank B. Taylor, who directed his attention particularly to the former beach lines and other lacustrine phenomena. Mr. Taylor made some studies in correlation on the south side of Lake Erie in Ohio and New York, and, without expense to the Survey, extended his examinations to related phenomena in Ontario. His office work was devoted chiefly to the preparation of



manuscript on the lacustrine formations associated with the Michigan glacial lobe.

Careful spirit-level surveys of the elevated beach lines of the glacial Lake Michigan were made by J. W. Goldthwait to determine the nature of the former movements of the lake level. This work was done in close association with and supplementary to that of Messrs. Taylor and Leverett. The work of Messrs. Leverett, Alden, Taylor, and Goldthwait was carried on under the general supervision of Prof. T. C. Chamberlin.

C. R. Van Hise and C. K. Leith gave a large amount of time during the winter to the completion of the final monograph on the Lake Superior region. Doctor Van Hise devoted the months of July and August to this work, which involved the writing of several new chapters, the radical revision of others, a large amount of chemical and physical investigation of the ores and the iron formations, and the direction of a draftsman continuously during the year in the revision of maps.

An extensive series of physical and chemical tests of the iron ores of the Lake Superior region was made by W. J. Mead in connection with the discussion of the origin of the iron ores forming a chapter in the forthcoming monograph.

A study of the physiographic features of the Lake Superior region was made by Lawrence Martin in connection with the preparation of a chapter on the surface features of the region for the monograph.

Some corrections of the map in the Mesabi iron region were made by Doctor Leith, who also conferred with Mr. Mead in reference to the latter's work.

A topographic and geologic model of the Lake Superior region has been prepared under direction of C. K. Leith and Lawrence Martin, by E. H. J. Lorenz, mechanic and model maker, of the University of Wisconsin. A reproduction of a large photograph of this model, which shows many interesting features, will be included in the monograph.

A. N. Winchell gave some time to the collection of available information concerning the petrography of Keweenawan lavas and intrusives.

W. S. Bayley, of the University of Illinois, gave a little time to the revision of the chapter and map on the Calumet trough of Michigan for this monograph.

The summaries of literature for a bulletin on the North American pre-Cambrian rocks were brought up to January 1, 1908, by Doctor Leith, and a revision of the general discussion was made by Doctors Van Hise and Leith. This work touches closely subjects discussed by them at a conference in Chicago on the geologic map of North America with Messrs. Chamberlin, Willis, Adams, Brock, and Miller.

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

*Rocky Mountain region.*—M. R. Campbell continued in charge of the coal-land classification and valuation in the Western States, carrying on this work in addition to supervising the surveys of various oil and gas fields in the United States.

The plans provided for the classification of about 20,000 square miles of supposed coal territory in the Rocky Mountain region. To carry out this work sixteen field parties were organized, and groups of parties working in close proximity were placed in charge of subordinates, C. A. Fisher having direct supervision of five parties in south-central Montana and north-central Wyoming, and A. C. Veatch having charge of four parties in south-central Wyoming. The other parties worked independently, with only such supervision as Mr. Campbell was able to give them.

A party under the direction of Max W. Ball carried on a geologic survey of the western part of the Little Snake River coal field, in southern Wyoming, beginning at Rawlins, on the Union Pacific Railroad, and extending southward to the Colorado line.

A party under the direction of W. R. Calvert made a survey of the Lewistown (Mont.) coal field, from July 1 to October 1, 1907. Mr. Calvert's work extended from the Great Falls coal field on the west, which was examined by Mr. Fisher during the previous year, to a point as far east of Lewistown as the workable coal beds appeared to continue.

A party under the direction of Arthur J. Collier surveyed the Miles City (Mont.) coal field, beginning work before the 1st of July and continuing until September 5, 1907, when Mr. Collier was detailed to examine mineral claims in the national forests, and Carl D. Smith assumed charge of the party in the Miles City field.

A party under the direction of Hoyt S. Gale made an examination of the northern rim of the Uinta coal basin in Colorado and Utah, working from the Danforth Hills in Colorado westward as far as Vernal, Utah. At the close of this examination Mr. Gale crossed the Uinta Mountains and made a brief survey of the Henrys Fork coal field, which lies partly in Utah and partly in Wyoming.

A party under the direction of James H. Gardner made an examination of the eastern rim of the San Juan River coal basin of north-western New Mexico and southwestern Colorado, from July 1 to October 5, 1907. Most of this work was done in a field already described by Mr. Schrader, but the reexamination was made necessary by the fact that in the previous work the lands had not been classified according to legal subdivisions. On February 15 Mr. Gardner was again detailed to New Mexico to make an examination of several isolated coal fields in the Rio Grande Valley. From February 15 to

July 1 he was engaged in this work, examining in that time the Carthage, Hagan, Cerrillos, Santa Fe, Glorieta, and Cabezón fields.

C. A. Fisher was placed in charge of five parties operating in the vicinity of Billings, Mont. The heads of these parties were Messrs. Calvert, Stone, Woolsey, Washburne, and Woodruff. From July 1 to October 31 Mr. Fisher was engaged in supervising the work of these parties.

A party under the direction of Willis T. Lee was engaged in the examination of the Grand Mesa coal field of Colorado from July 1 to September 30, 1907. This field is the eastern continuation of the Book Cliffs coal field, examined during the previous year by George B. Richardson. From October 1 to October 7 Mr. Lee was engaged in the study of the "Red Beds" in the vicinity of Las Vegas, N. Mex.

A party under the direction of George B. Richardson made a survey of the coal fields of southwestern Utah, including the so-called anthracite field of New Harmony and the bituminous fields of the Colob Plateau. Mr. Richardson was engaged in this work from July 1 to October 1, after which he proceeded to Texas and continued his work in the El Paso and Van Horn quadrangles.

A party under the direction of A. R. Schultz was engaged in the survey of the Rock Springs (Wyo.) coal field from July 1 to December 23, 1907. The geologic work in this field was carried on in conjunction with a resurvey of the land lines of a part of this region and the inspection of land surveys in another part of the same region under the General Land Office.

A party under the direction of E. Wesley Shaw was engaged in the survey of the Glenrock (Wyo.) coal field from July 1 to October 16, 1907.

A party under the joint direction of Carl D. Smith and Prof. A. G. Leonard, state geologist of North Dakota, made a survey of the Sentinel Butte coal field of North Dakota and eastern Montana. Professor Leonard was able to be with the party only a few weeks, and consequently the major portion of the work devolved upon Mr. Smith. He was engaged in this work from July 1 to September 5, when, owing to the transfer of Mr. Collier to other fields of work, Mr. Smith was detailed to Miles City to continue the unfinished work in that field.

A party under the direction of E. E. Smith made a geologic survey of the Great Divide Basin coal field of Wyoming from July 1 to November 15, 1907. The work of this party connects with that of Mr. Ball on the south, that of Mr. Schultz on the west, and that of Mr. Veatch, done during the previous year, on the east.

A party under the direction of R. W. Stone made a geologic survey of a large territory north and west of the Crazy Mountains, Montana, from July 1 to October 18, 1907. This work was done on



the supposition that large bodies of coal occur in this region, but the work of Mr. Stone shows that coal of workable thickness is entirely absent, and that there is no reason for regarding this area as a coal field.

A party under the direction of Joseph A. Taff made a geologic survey of the Sheridan (Wyo.) coal field from July 1 to October 31, 1907.

A. C. Veatch was placed in charge of the parties of Messrs. Schultz, Shaw, Smith, and Ball in central Wyoming. In addition to supervising the geologic work of these parties Mr. Veatch was authorized by the General Land Office to make a resurvey of a small area north of Rock Springs and to inspect certain contract surveys in the same locality. This work engaged Mr. Veatch's attention from July 1 to September 19, 1907, when he was transferred to the office of the President to investigate the mining laws of Australasia.

A party under the direction of C. W. Washburne made a geologic survey of the coal fields on the northeast side of the Bighorn Basin, Wyoming, from July 1 to October 31, 1907. This work, although principally in Wyoming, extended northward from Montana for 20 or 30 miles, including all of the so-called Bridger coal field in the valley of Clark Fork.

Carroll C. Wegemann was engaged during the field season of 1907 and much of the office season of 1907-8 as an assistant to Arthur J. Collier and Carl D. Smith. On April 20, 1908, Mr. Wegemann was instructed to proceed to Miles City, Mont., and join a party from the Forest Service in the examination and classification of coal lands in the Otter National Forest. This work occupied his time until May 29, when he returned to Helena, Mont., for the purpose of collecting data regarding the land surveys of the Bull Mountain region. Mr. Wegemann completed this work by June 10, and then proceeded to Sheridan, Wyo., to assist Mr. Gale in the survey of the Buffalo coal field.

A party under the direction of L. H. Woolsey made a geologic survey of a portion of the Musselshell Valley, including the southern part of the Bull Mountain field, Montana, from July 1 to October 29, 1907. A large part of the area examined was found to be barren of workable coal beds, so that the energy of the party was largely centered on the Bull Mountain field, which contains a great many coal beds and doubtless will become an important coal producer. In order to complete the survey of this field at an early date, so that the lands might soon be restored to coal entry, R. W. Richards, who has been associated with Mr. Woolsey in the work, returned to the field on May 1, 1908, and with a small party continued the surveys of the previous season. This work is in progress July 1 and will soon be completed.



A party under the direction of E. G. Woodruff made a geologic survey of the coal fields on the southwest side of the Bighorn Basin, Wyoming, including the Red Lodge field in Montana.

T. W. Stanton, paleontologist, spent the months of July, August, and September in field work on the stratigraphy and paleontology of the coal-bearing formations of the Rocky Mountain region, in cooperation with the geologic parties that were doing areal and economic work in the various coal fields. Visits of sufficient length to determine the important features of the sections were made to the parties near Rawlins, Rock Springs, Casper, Sheridan, and Cody, in Wyoming, and near Red Lodge, Crazy Mountains, and Judith Mountains, in Montana.

F. H. Knowlton, assisted by A. C. Peale, spent the field season in the study of stratigraphic and paleontologic problems along Missouri and Yellowstone rivers in North Dakota and Montana, in connection with the coal work, procuring much paleobotanic material for use in the correlation of various Upper Cretaceous and Tertiary formations. Mr. Knowlton also visited the Bighorn Basin, Wyoming, and the northern side of the Crazy Mountains, Montana, studying the stratigraphy and paleontology of these regions.

A detailed survey of the central pre-Cambrian area of the Black Hills, South Dakota, was begun by A. Johannsen. The areal distribution of the slates, schists, and intrusives of a portion of the area was mapped and a large number of specimens were collected. The key to the structure was obtained.

Some revision work in the Black Hills was done by N. H. Darton, in the Hermosa, Rapid, and Deadwood quadrangles.

During the field season of 1907 S. F. Emmons, under leave of absence without pay, took charge of a geologic survey of the important copper-mining district of Cananea, in Sonora, Mexico, not far south of the international boundary. The product of this district is entirely tributary to the United States and its geologic structure presents some phenomena not hitherto observed in mining districts within our boundaries, so that its study serves to round out investigations of natural processes of ore distribution that have been carried on by this Survey.

Whitman Cross did no field work during the summer of 1907, being absent for several months on leave of absence without pay. He was assisted by Howland Bancroft from December 1 to June 30 in office work connected with the Ouray and Engineer Mountain folios of Colorado.

Work was resumed by Mr. Cross in June, 1908, on the geology of the San Juan region, Colorado, particularly on that of the Lake City and San Cristobal quadrangles, where work had been done in previous seasons. The survey of the former area will be completed during

the coming season, and that of the latter will be carried as far as possible toward completion.

Frank C. Schrader spent several months in examining mining claims in the national forests of Colorado and occupied the remainder of the year in field and office work on a report on the mineral deposits of western Arizona.

F. B. Weeks continued the reconnaissance of the western phosphate field in Idaho, Wyoming, and Utah, and spent about a month at Osceola, Nev., in a study of the mineral resources of the Osceola and Tungsten mining districts. He also, in company with V. C. Heikes, devoted a few days to a reconnaissance of the Fort Hall mining district, Idaho.

In Nevada F. L. Ransome revisited the Goldfield and Bullfrog districts to gather supplementary data. Reports embodying these data were nearly completed during the year and require only the insertion of information afforded by recent mining developments to be ready for publication. The Goldfield report is by Mr. Ransome, and the Bullfrog report by Messrs. Ransome, W. H. Emmons, and G. H. Garrey.

The final report on the geology and ore deposits of the Cœur d'Alene district, Idaho, by F. L. Ransome and F. C. Calkins, was completed and submitted for publication in August, 1907. It is now available for distribution.

A detailed study was made of the region in the vicinity of the Canadian Pacific Railway between Castle Mountain, Alberta, and Field, British Columbia, by Charles D. Walcott and L. D. Burling. The sections of Castle Mountain, Lake Louise, Mount Bosworth, and Mount Stephen were measured in detail, and numerous collections of fossils were obtained, which have an important bearing on the early Paleozoic succession in Montana, Idaho, and Utah. During the field season of 1908 Doctor Walcott will continue this investigation by making a detailed study of the section along the line of the forty-ninth parallel between Montana and British Columbia, in an attempt to correlate, if possible, the rocks studied by him in Canada with those in the United States. During September, 1907, Doctor Walcott spent two weeks in making a collection of Cambrian fossils in southeastern Idaho. The office work of Doctor Walcott for the fiscal year ended June 30, 1908, has been the completion of a monograph on the Cambrian Brachipoda.

The pre-Cambrian rocks of the Laramie Hills of southeastern Wyoming were studied in detail and mapped within the limits of the Sherman quadrangle by Eliot Blackwelder. It is believed that these studies will materially aid an understanding of the ancient rocks that occur generally in the cores of many western mountain ranges. An examination of similar rocks in the Laramie quadrangle was

made by Mr. Blackwelder, and the final manuscript for the Laramie-Sherman folio was submitted for publication.

Detailed mapping of the geology of the Shasta County copper region, in California, begun by L. C. Graton in 1906, was extended by B. S. Butler during two months of the summer of 1907, when Mr. Graton was on leave in Mexico. The mapping was completed in November, and Mr. Graton completed the underground investigation of the mines in January. Progress has been made on the final report.

The investigation of the copper resources of the country, which was begun by Mr. Graton in 1906, was continued during the year, and trips were made to nearly all the important copper districts not already visited.

The final joint report on the mining districts of New Mexico by Messrs. Lindgren, Graton, and Gordon was carried nearly to completion.

F. C. Calkins continued detailed areal mapping in the Philipsburg district, Montana. The work has been virtually completed, but it was determined that a visit to the field in company with a paleontologist would be necessary for the correlation of the Mesozoic formations.

W. H. Emmons, after completing the survey of the metalliferous deposits of the Philipsburg quadrangle, made a study of the gold deposits of the Little Rocky Mountains, Montana.

J. M. Boutwell was engaged in the preparation of the annual reports on the production of zinc, lead, and quicksilver during the year 1906. He also visited the Park City mining district, Utah, and procured valuable data on mining developments there during the last year. In the office he has since prepared sections on gold-bearing gravels in Calaveras County, Cal., and resumed the preparation of the report on the Park City mining district, Utah, with a view to completing it this year.

T. Wayland Vaughan resurveyed a portion of the Brackett (Tex.) quadrangle. The survey of this area is now completed and the manuscript, including text and geologic map, will soon be submitted for publication as a folio of the Geologic Atlas.

*Pacific coast.*—Detailed surveys were made of the Coalinga oil district, Fresno County, and the region as far south as Dudley, Kings County, Cal., by Ralph Arnold, assisted by Robert Anderson. Special attention was given to the details of the underground geology in the proved territory in order to discover the conditions of the occurrence of petroleum in this particular field, and also to a study of the structure and stratigraphy of the adjacent regions with a view to obtaining information as to the extension of the productive area, so as to decrease the cost of development 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 district, was carried on simultaneously with the strictly economic work. Both a preliminary and a final report on the district were prepared. A continuation southward to Sunset, Kern County, of the investigations begun in the Coalinga district will be carried forward during the field season of 1908. Mr. Arnold also spent a short time in the Santa Cruz quadrangle, doing some supplementary mapping and attending a field conference with George D. Louderback relating to the Franciscan-Knoxville question, and made a brief visit to the Miner ranch oil field, in Contra Costa County, on which he prepared a short report.

A bulletin on the magnesite deposits of California was prepared by Frank L. Hess and is in course of publication.

The detailed mapping of the Riddles quadrangle, in Oregon, was completed and work on the Grants Pass quadrangle was begun by J. S. Diller, assisted by G. F. Kay. Mr. Diller also investigated, for the Forest Service, the coal in the northern part of the Siskiyou National Forest and reported later that a large number of coal claims that have been taken up are nonworkable under present conditions. In response to numerous requests by citizens of Oregon, a reconnaissance was made by Mr. Diller about Mount Bolivar, in Douglas County, to determine the mineral character of the land. With James Storrs, Mr. Diller visited Oroville, Cal., to study the Mesozoic plant beds of that region. This study was continued in Curry County, Oreg., and Trinity and Tehama counties, Cal., to determine more closely the epoch of greatest deformation and mineralization in the Klamath Mountains, where mining is extensive. In studying the asbestos deposits of the United States Mr. Diller visited Sall Mountain, Georgia; Rocky Mount and Bedford, Virginia; Lowell, Vermont; Casper Mountain, Wyoming; Grand Canyon, Arizona; and Towle, California.

The investigation of Pleistocene glaciation in the Sierra Nevada has been continued by Willard D. Johnson, attention being given to contemporary deformation and volcanism as locally complicating and radically affecting the glacial record. The resulting studies have been carried far enough, it is believed, to warrant a general statement of results, and a report is now well advanced.

In June, 1907, Prof. James Perrin Smith spent three weeks in the West Humboldt Range of Nevada, studying the Triassic stratigraphy and collecting Triassic fossils to illustrate a monograph. Later he visited the Klamath Mountains of Shasta County, Cal., and spent three weeks in collecting Upper Triassic fossils. In Nevada he collected several new species of Middle Triassic cephalopods, which have been included in a monograph on that fauna. In California Professor Smith found several new species of cephalopods and discovered in the Upper Triassic limestone a coral reef that forms an important

lithologic horizon and gives a new element to the faunas of that series in America.

Progress was made in arranging the material collected and in preparing a monograph on the marine Middle Triassic faunas of America, which is not completed.

The work of Waldemar Lindgren has consisted largely of administrative duties in connection with the section of metalliferous deposits and the section of metal statistics (the larger part of the time having been given to the latter), and with the examination of mining claims in national forests. The remaining time has been given to geologic field work and office work and to testimony before the United States court in connection with prosecutions instituted by the Post-Office Department for the abuse of mailing privileges.

In cooperation with the technologic branch N. H. Darton made an examination of the geology of Portland, Oreg., and Tacoma and Seattle, Wash., especially in relation to structural materials.

#### GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

The important investigations relating to river hydraulics with special reference to laws of detrital load were continued by G. K. Gilbert in cooperation with the water-resources branch. In studying the obstruction of Sacramento River, rough measurements were made of the pits formed by past hydraulic-mining operations, from which estimates were made of the amount of material removed in the basin of Yuba River. In order to elucidate the conditions affecting the surcharged river and the possibilities of its treatment, the relations of load to gradient and volume in stream flow were studied. This work, the application of which is much broader than the specific and local problems here involved, was carried forward in the laboratory of the University of California. The results thus far obtained include the relations of load to slope, of load to discharge, of load to coarseness of detritus, and of load to form of cross section of channel.

The partial submergence of shell mounds about the shores of San Francisco Bay, as determined by the University of California, led to an investigation by Mr. Gilbert of such mounds near the mouth of Sacramento River, in order to discover if such subsidence had taken place there.

Prof. Harry Fielding Reid has continued to collect all available data relative to earthquakes in the United States. The International Seismological Association, of which this country is a member, held its first general assembly last September at The Hague. Professor Reid attended the meeting as delegate from this country. The assembly voted to continue Strassburg as the location of its central bureau for the next four years and elected Professor Schuster, the delegate from Great Britain, as the president of the association for



the same period. A number of important scientific questions were debated and the central bureau presented a compilation of all the earthquakes in the world for the year 1904. The association promises to be a great stimulus to seismologic investigation.

W. H. Dall identified between 3,000 and 4,000 fossils for field parties of the Survey. He also continued his studies of the post-Eocene fauna of the Pacific coast. The report on the Miocene of Oregon is now in course of publication.

George H. Girty, in addition to preparing reports on material referred to him, made preliminary studies of some Arkansas collections of fossils and described the fauna with which the phosphates were associated in Idaho and Utah. He spent a month in the study of the types of Winchell's Carboniferous species preserved at Alma and Ann Arbor, Mich., and devoted another month to collecting paleontologic and stratigraphic data in the Carboniferous rocks of Arkansas and Kansas.

From July 1 until August 15 T. Wayland Vaughan was on leave of absence without pay, studying Paleozoic fossil corals for the New York State Museum, in accordance with an arrangement between the director of that museum and the Director of the United States Geological Survey. In April, 1908, in response to an invitation from the Carnegie Institution of Washington, he undertook special investigations of the geology of the Florida keys and reefs, of the near-shore bottom deposits of the ocean, and of the recent corals of the region, with reference to environmental conditions, and initiated a series of experiments for the purpose of procuring data on the factors influencing variation and determining distribution, the information obtained from the last two investigations to be used as a basis for the reconstruction of the physical conditions under which fossil faunas lived. Valuable information was procured on each of the subjects to which attention was paid.

Work in vertebrate paleontology has been continued under the direction of Prof. Henry Fairfield Osborn. The monograph on the Ceratopsia, begun by O. C. Marsh, continued by J. B. Hatcher, and edited and completed by R. S. Lull, has been published. The monograph on the Stegosauria, originally assigned to F. A. Lucas, but transferred to R. S. Lull, is slowly progressing through simultaneous studies in the National, Yale, and American museums. No allotment has been made by the Survey during the present year for the work of Professor Lull.

Except during two periods of absence abroad and in the field, Professor Osborn has been engaged continuously in completing the monograph on the titanotheres. The study of the stratigraphy of the Eocene of the Rocky Mountain region, reported last year as under way, has been finished, Professor Osborn having made a special



journey to the Washakie to complete his observations. This stratigraphic and paleontologic correlation forms the subject of a special paper now in course of publication by the Survey and will contribute to the geologic section of the titanotherium monograph. It is expected that the manuscript of this monograph will be finished in November, 1908.

The Sauropoda in the Paris and British museums have recently been briefly studied by Professor Osborn, who has done some work on the Sauropoda monograph, with the assistance of W. K. Gregory.

David White was engaged during the larger part of the year in studying the kind, quality, and physical and chemical composition of coals of various epochs and areas, the conditions of deposition, the nature of the original material, and the present state of the organic matter. In the study of the microscopic structures of the coals he has had the aid of Reinhart Thiessen for most of the year. This work has been carried on at the request of the technologic branch, which has borne the expense of field work for two and a half months in the western areas and has paid one-half of Mr. White's salary and the entire salary of his assistant. A paper by Mr. White, discussing the relation of oxygen in coal to its calorific value, is now in preparation for publication.

F. H. Knowlton, besides performing field work, has studied and reported on more than 700 collections of fossil plants for the use of geologists in locating and correlating horizons in the Mesozoic and Tertiary, mainly in Alaska and the Rocky Mountain region. A little time was also devoted to preparing a report on the stratigraphy and paleontology of the Livingston formation in Montana.

Work on the bibliography and compendium of paleobotany has been carried on by Miss L. M. Schmidt, who for about two-thirds of the year has had the aid of Miss I. P. Evans. This work was done under the joint supervision of Messrs. White and Knowlton.

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 basis of compilation is the map prepared in 1906 for the geological congress at the City of Mexico and printed at the expense of the Mexican Government, but it has been found desirable to revise a great deal of the material incorporated in that map in order to bring it up to date. The work includes also the preparation of a general description of the map and of the sources of the information it embodies, an account of the several geologic provinces of North America, and maps showing the geography of the continent at different geologic periods—all to be published in a professional paper of the Survey.

E. C. Harder made a reconnaissance examination of the principal manganese and manganiferous-ore deposits of the United States,

giving special attention to their commercial aspect and preparing a report on them.

For many years N. H. Darton has been collecting data on underground temperatures. During the last year a number of very important observations were made and the preparation of a list of all deep underground temperatures determined in the United States was continued.

#### 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; and investigations of water resources in reference to supply available for placer mining.

#### 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, according to the demands of the work. Throughout the year 1 geologist in charge, 7 other geologists, 3 topographers, and 3 clerks have been employed. In addition 5 geologists were employed a part of the time on a per diem compensation. In May, 1908, 2 additional geologists, on annual salaries, were added to the force by transfer from other divisions. One additional topographer was employed up to the 1st of March, and 2 engineers were detailed to the division from the water-resources branch, giving about two-thirds of their time to the Alaskan work. In May, 1908, 2 additional engineers were temporarily detailed to the division.

During the season of 1907 the field force included also 1 topographic and 1 engineering field assistant and about 24 teamsters, cooks, etc. The temporary assistants in the field force for 1908 included 2 geologic and 2 topographic field assistants, with 25 laborers. Two temporary clerks have been employed in the office for three and six months. On June 30, 1908, the division included 1 geologist in charge, 9 other geologists on annual salaries and 3 geologists employed at a per diem compensation, 2 geologic field assistants, 3 topographers and 2 topographic field assistants, 4 engineers, 25 camp hands, and 3 clerks.

#### FIELD OPERATIONS IN SEASON OF 1907.

*General outline.*—Twelve parties engaged in Alaskan surveys and investigations during the field season of 1907. Six of these were car-

rying on geologic work, four were making topographic surveys, and two were engaged in stream gaging. The aggregate area covered by geologic reconnaissance surveys is 4,000 square miles; by detailed geologic surveys, 400 square miles; by topographic reconnaissance surveys, 6,125 square miles; and by detailed topographic surveys, 501 square miles. In addition, reconnaissance investigations of water resources were carried over an area of 1,000 square miles and studies were made in considerable detail over 400 square miles. Eleven of the 28 mining districts of Alaska in which developments are going on, including all but two of the most important, were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. The figures include the cost of both field and office work as well as of inspection.

*Allotment to Alaskan surveys and investigations, 1907.*

Continuation of general investigation of coal resources-----	\$4, 700
Surveys and investigations in—	
Southeastern Alaska -----	5, 300
Copper River region -----	12, 000
Yukon region -----	41, 000
Seward Peninsula -----	17, 000
	<hr/> 80, 000

The following table shows the progress of Alaskan surveys since the beginning of systematic work in 1898 and the need for extending the map work:

*Progress of surveys in Alaska, 1898-1907, in square miles.*

Year.	Appropriation.	Geologic.		Topographic.		Hydrographic.	
		Reconnaissance.	Detailed.	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	1,000	200
1907.....	80,000.00	4,000	400	6,125	501	1,000	400
	<hr/> 551,189.60	<hr/> 94,500	<hr/> 1,700	<hr/> 117,277	<hr/> 2,305	<hr/> 2,000	<hr/> 600
Percentage of total area of Alaska.....	.....	16.11+	.3—	20	.4	.8+	.1+

*Administration.*—As in previous years, the administration of the Alaskan division was in the hands of Alfred H. Brooks, who also devoted considerable time to various geologic problems connected with the investigation of the mineral wealth of the Territory. He also supervised personally the collection of statistics of the precious metals in the Territory and carried on some field work in southeast-

ern Alaska and the Fairbanks district. The general supervision of the topographic work, as in previous years, was in charge of T. G. Gerdine until June, when he was succeeded by R. H. Sargent in this work. During the absence of the chief of the division E. M. Aten was left in charge of the office.

In pursuance of a general plan outlined two years ago, the study of the coal-bearing rocks of the Territory has been continued by W. W. Atwood and H. M. Eakin, who in 1907 visited the coal-bearing areas of southeastern Alaska and the Yukon and in connection with this work did some topographic and geologic mapping.

*Southeastern Alaska.*—The most important part of the geologic reconnaissance mapping in southeastern Alaska having been completed, detailed surveys were begun in 1907. A large part of the copper-producing district of Kasaan Peninsula, on Prince of Wales Island, including an area of 64 square miles, was mapped topographically by D. C. Witherspoon and J. W. Bagley in May, 1908, on a scale of 1:62500, and the same area was subsequently covered with geologic surveys made by C. W. Wright and Sidney Paige. Unfortunately, the weather conditions and other interruptions prevented the completion of these surveys, which are, however, now being continued.

*Copper River region.*—Though the geologic and topographic mapping in the Copper River basin was practically completed in 1902, the important industrial advancement in this field made it urgent that a reexamination of the copper-bearing belts should be undertaken, in order to collect the data bearing on the mineral wealth which had become available by the mining developments, and to embody it in a second edition of the report on this field. The Kotsina-Chitina copper belt, the most important, was chosen for investigation in 1907 and the work was carried to completion by F. H. Moffit and A. G. Maddren.

*Yukon basin.*—In view of the large gold production and important mining developments in the Fairbanks district, a detailed survey of this district was determined upon. This survey was made by T. G. Gerdine and R. H. Sargent, who mapped an area of 436 square miles for publication on a scale of 1 mile to the inch, with 25-foot contours.

In the Yukon region, where the water supply is an all-important feature of the placer-mining industry, the rainfall is slight and the stream flows are small. As there was urgent need for hydrographic investigation in this region, C. C. Covert, hydrographer, was detailed to begin work in the Fairbanks district, the largest producer of placer gold in the region. A single season's stream measurements can not be conclusive, yet the results are of considerable value in estimating the amount of water available for mining purposes.

As part of the plan to carry a topographic reconnaissance map over the most important parts of Alaska as soon as means permit, it was determined to continue the mapping in the Yukon-Tanana region

during 1907. To this end D. C. Witherspoon and J. W. Bagley mapped an area of about 6,000 square miles lying between the international boundary, the Tanana, the Yukon, and the mouth of the Delta.

In the same general field geologic studies of the mineral resources were continued by L. M. Prindle, who completed the geologic mapping of the Fortymile quadrangle (submitted for publication) and also visited a number of other localities which promise to throw light on the geology and mineral resources.

*Seward Peninsula.*—As part of the plan to map geologically the important mining districts of Seward Peninsula in detail, the Solomon and Casadepaga districts were covered during the last season. This work was carried on by P. S. Smith, F. J. Katz, and George I. Findlay over an area of 400 square miles of exceedingly intricate geology, and important clues were obtained in regard to the structure and mineral resources of the peninsula. The complexity of the field, however, makes it necessary to supplement this work by further investigations before the report can be published. For this reason also the report on the geology of the Nome and Grand Central quadrangles has been withheld from publication, it being necessary to settle certain problems by further field investigations.

In accordance with the general plan made for the investigation of the water resources of Seward Peninsula two years ago, F. F. Henshaw, assisted by Raymond Richards, was detailed to continue stream measurements in this area. By this work additional data were obtained in the area previously examined. The work was also extended both northward into the Kougarok district, where important mining developments are going on, and eastward into the Solomon River region. It is expected that this preliminary study of the water resources of Seward Peninsula can be brought to a close during another field season.

#### FIELD OPERATIONS IN SEASON OF 1908.

Thirteen parties were dispatched to Alaska in March, April, May, and June, and another party will be sent early in July. One of these parties is carrying on detailed topographic surveys in southeastern Alaska. Another party is doing detailed geologic work in the same region, and still another is engaged in studying the copper-bearing region at the headwaters of White, Tanana, and Copper rivers. A detailed topographic survey of the eastern and best-developed portion of the Kotsina-Chitina copper belt was begun in April. The reconnaissance of the copper-bearing area of Prince William Sound is being completed. The coal-bearing rocks on Herendeen Bay are being investigated, and incidentally some reconnaissance surveys of this area are to be undertaken.



In the Yukon region a detailed geologic survey of the Fairbanks special area and an investigation of the water resources of the Fairbanks, Birch Creek, and Rampart regions have been begun. A party is also engaged in continuing the topographic reconnaissance survey of the Yukon-Tanana region, including a small area lying north of the Tanana between Fairbanks and the Delta, and a large area lying south of the Tanana between the Delta and the Nenana. A preliminary survey of the newly discovered Innoko placer district has been undertaken.

In Seward Peninsula two men are completing a reconnaissance of the water resources available for placer mining, and two parties are engaged in general studies of the stratigraphy and areal geology to obtain information needed in investigating the mineral resources.

#### OFFICE WORK.

It is gratifying to state that the office work bearing on the study of notes and specimens and also the preparation of manuscripts has been brought up to date, with the single exception of a report on the Mount McKinley region, by the geologist in charge.

In addition to the reports issued, there have been submitted for publication the following manuscripts: "The Ketchikan and Wrangell mining districts," by F. E. and C. W. Wright (Bulletin 347); "Physiography and glacial geology of the Yakutat Bay region, Alaska," by R. S. Tarr, with a chapter on the bed-rock geology, by R. S. Tarr and B. S. Butler; "Geology of the Seward Peninsula tin deposits," by Adolph Knopf (Bulletin 358); "Mineral resources of the Kotsina-Chitina copper belt," by F. H. Moffit and A. G. Maddren; and "Description of the Fortymile quadrangle, Yukon-Tanana region," by L. M. Prindle.

Two manuscripts bearing on the geology and mineral resources of Seward Peninsula, entitled "Geology of the Nome and Grand Central quadrangles," by F. H. Moffit, F. L. Hess, and P. S. Smith (nine-tenths completed), and "Geology of the Solomon and Casadepaga quadrangles," by P. S. Smith and F. J. Katz (three-fourths completed), are awaiting the solving of some general stratigraphic problems in Seward Peninsula. The report on "Copper deposits of the Kasaan Peninsula," by C. W. Wright, is about half done, but a month more of field work will be required before office work is undertaken. Mr. Atwood's summary report dealing with the Cretaceous and Tertiary coals of Alaska is about half done. The report entitled "An exploration in the Mount McKinley region," by Alfred H. Brooks, is three-fourths completed.

#### GEOLOGIC RESULTS.

It is difficult to summarize the geologic results of one year's work, as these may embody much previous preparation and study and are



usually attained by gradual evolution. Worthy of record, however, is the additional knowledge gained on the genesis and distribution of the copper deposits of southeastern Alaska by C. W. Wright, and on the tin and other metal-bearing lodes of Seward Peninsula by Adolph Knopf. L. M. Prindle's studies in the Yukon-Tanana region point to the conclusion that large batholithic masses of intrusive rocks are there mantled by a comparatively thin shell of metamorphic sediments and that the gold deposits are closely connected with the intrusions. W. W. Atwood's investigations indicate that there was more than one extensive period of base-leveling in the Yukon basin. In Seward Peninsula Messrs. Smith and Katz have obtained evidence of exceedingly intricate folding of the metamorphic sediments of the Nome group. The Chitistone limestone in the Copper River region, long believed to be Carboniferous, has been proved to be Triassic by fossils collected by Messrs. Moffit and Maddren and determined by T. W. Stanton. This adds at least 4,000 feet of strata, and probably double that amount, to the Triassic section of central Alaska.

The report on the geology and mineral resources of the Controller Bay region, by G. C. Martin (Bulletin 337), describes the geography and the bed-rock, glacial, and economic geology of this region, which lies on the Pacific coast of Alaska between meridians  $143^{\circ} 45'$  and  $144^{\circ} 40'$ . Most of the bed-rock formations fall into two groups, one of which is known to be Tertiary (Miocene?), and the other is probably Tertiary. There is also a small area of metamorphic rocks of unknown age. The sediments are closely folded and profoundly faulted. Igneous rocks are represented solely by a few dikes. The mineral resources include some oil seepages, with two wells that have made a small production. Of far greater importance are the coal beds. These coals are anthracite and semibituminous and include some coking coals. They are known to underlie an area of 56.4 square miles, and the field probably extends to the northeast, beyond the area mapped.

#### DIVISION OF MINERAL RESOURCES.

The work of the division of mineral resources consisted in the preparation of reports on the mineral resources of the United States for 1906 and 1907. The report for 1906 was completed, published, and distributed, and the report for 1907 was prepared in part, seventeen chapters of it having been completed before the close of the fiscal year 1907-8 and transmitted for publication separately in advance of the volume. The chapters on aluminum and bauxite, cement, asbestos, monazite and zircon, and phosphate rock were printed and distributed before June 30, and the manuscript for the reports on asphalt and bituminous rock, barytes, anthracite coal, fluorspar and cryolite, fuller's earth, gypsum, manganese ores, mica, mineral paints, salt and bromine, tin, and slate was submitted for publication. The

production statistics for many other minerals were announced to the press for publication in advance of the full report.

Waldemar Lindgren, geologist in charge of economic geology of metalliferous ores (except iron), has given about one-half of his time to the administrative work on the same subjects for this division. During July and August, 1907, Mr. Lindgren spent some time in the Denver office, having been detained in that city as witness in the suit instituted by the postal authorities against the Lost Bullion Mining Company of New Mexico. During March and April Mr. Lindgren made a tour of inspection covering the three suboffices, San Francisco, Salt Lake City, and Denver.

Congress having failed to make specific appropriations for continuing the investigation of the black sands of the Pacific coast and other portions of the United States, this investigation was discontinued July 1, 1907.

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.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the physical laboratory George F. Becker continued his investigations on geophysical problems, with particular reference to their application to geology. C. E. Van Orstrand has remained in immediate charge of the work on elasticity. In addition to theoretical investigations and the reduction of observations made at the Washington Monument, systematic observations have been made on the elastic after-effect of steel tapes maintained at a constant temperature. The problem presents many difficulties from either a theoretical or an experimental standpoint; but the possibility of its application to a precise discussion of the stress-strain relation, the variation of electric resistance, the condition of isostasy which probably exists in the crust of the earth, the internal resistances of solids, etc., would seem to justify a general investigation of high precision. A few experiments on the diffusivity of solid metals are being conducted, partly with the hope of throwing some light on the mechanism of the elastic after-effect, but chiefly for the purpose of investigating a very interesting property of matter which has hitherto received but little attention from scientific men. The following publications indicate the scope of these investigations:

Becker, G. F., Current theories of slaty cleavage. (*Am. Jour. Sci.*, July, 1907.)

Becker, G. F., and Van Orstrand, C. E., Tables of hyperbolic functions. (Now in course of publication by the Smithsonian Institution.)

- Van Orstrand, C. E., Inverse interpolation by means of a reversed series. (Philos. Mag., May, 1908.)
- Becker, G. F., Age of a cooling globe in which the initial temperature increases directly as the distance from the surface. (Science, February 7, 1908.)
- Becker, G. F., Relations of radioactivity to geology and cosmogony. (Bull. Geol. Soc. America.)

In the chemical laboratory during the year 116 quantitative analyses were reported, and also 826 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey. F. W. Clarke completed and published during the year his bulletin (No. 330) entitled "The data of geochemistry." He also published a paper on the composition of two marine sediments—the average "red clay" and the intermediate terrigenous clay. W. F. Hillebrand published an important paper on vanadium minerals from Peru, and a joint paper with W. T. Schaller on the mercury minerals of Texas. He also made a considerable number of analyses of lead bullets, furnishing data for use of the United States Senate committee in the Brownsville investigation. He conducted and completed an investigation on the determination of ferrous iron and water in rock analyses. E. C. Sullivan continued his work on the chemistry of ore deposition until April 1, when he severed his connection with the Survey, having accepted an invitation to engage in work for a private firm. George Steiger, whose time was largely occupied with routine work, completed and published the results of two investigations on analytical methods, one on a new form of colorimeter and the other on the estimation of small quantities of fluorine. He also did some work on the dehydration of gypsum and on the precipitation of zirconium as phosphate. W. T. Schaller, in addition to his necessary routine work, including a large number of mineral determinations, published several papers on mineralogical subjects. A paper by Messrs. Hillebrand and Schaller on the mercury minerals from Terlingua, Tex., is nearly ready for publication as a bulletin of the Survey.

## TOPOGRAPHIC BRANCH.

### ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year until January 18, 1908, when R. B. Marshall was appointed chief geographer and T. G. Gerdine succeeded Mr. Marshall as geographer in charge of the Pacific division. The organization is as follows:

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. Renshaw, geographer; W. M. Beaman and F. E. Matthes, topographers.

E. M. Douglas, geographer in charge of office prior to the appointment of the chief geographer, retains immediate supervision of the computing and instrument sections, and is in general charge of the office administration of the topographic branch in the absence of the chief geographer. During April, May, and June Mr. Douglas was in charge of the survey of the boundary of the Luquillo National Forest in Porto Rico.

Henry Gannett, geographer, was absent on leave during the whole year while assistant director of the Cuban census.

#### PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 16 junior topographers, 4 assistant topographers, and 1 draftsman. It was reduced by death, transfers, and resignations amounting to 12. With these changes the technical force now includes a chief geographer, 9 geographers, 40 topographers, 38 assistant topographers, 4 topographic aids, 20 junior topographers, and 4 draftsmen. Four of the topographers and 1 geographer are on leave without pay. In addition to the above regular force 167 technical field assistants were employed during the whole or a part of the field season.

#### SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1908, distinguished as to scale, etc., is shown on Pl. II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total area mapped was 25,658 square miles, making the total area surveyed to date in the United States 1,051,126 square miles, or about 35 per cent. In addition, 6,979 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 32,637 square miles.

Triangulation and primary-traverse stations to the number of 504 were occupied, located, and marked and 19 were intersected, and 3,468 miles of primary traverse were run. In the course of this work 35,325 square miles were covered by primary control.

In connection with these surveys 7,543 linear miles of primary levels and 843 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, 212,149 miles.

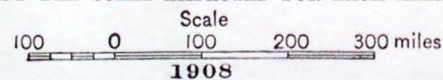
The area covered by topographic surveys in Alaska during the fiscal year 1907-8, as reported in detail on pages 40-43, was about 6,626 square miles, 501 of which were mapped for publication on the scale of 1:62,500 and 6,125 for publication on the scale of 1:250,000.





MAP OF UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE SCALE EMPLOYED FOR EACH AREA





The results of primary triangulation and primary traverse in all States in which field work was in progress were summarized and prepared for publication as a bulletin.

*Present condition of topographic surveys of the United States and new areas surveyed in 1907-8.*

State or Territory.	New area surveyed in 1907-8.	Total area surveyed to July 1, 1908.	Percent- age of total area of State surveyed to July 1, 1908.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Alabama .....	18,283	18,283	35
Arizona .....	250	62,962	55
Arkansas .....		20,469	38
California .....	2,998	82,379	52
Colorado .....	1,130	38,896	37
Connecticut .....		4,965	100
Delaware .....		1,008	43
District of Columbia .....		70	100
Florida .....		1,821	3
Georgia .....	232	17,087	29
Idaho .....	162	15,358	18
Illinois .....	771	8,171	14
Indiana .....	160	2,618	7
Iowa .....	197	10,092	18
Kansas .....		64,159	78
Kentucky .....	1,330	15,845	39
Louisiana .....		7,923	16
Maine .....	380	7,185	22
Maryland .....		10,294	84
Massachusetts .....		8,266	100
Michigan .....	491	4,244	7
Minnesota .....	211	3,087	4
Mississippi .....	97	1,003	2
Missouri .....	229	34,246	49
Montana .....	1,788	48,977	33
Nebraska .....		25,974	34
Nevada .....	3,739	44,221	40
New Hampshire .....	216	3,376	36
New Jersey .....		8,224	100
New Mexico .....	1,255	29,990	24
New York .....	599	38,808	79
North Carolina .....	344	17,418	33
North Dakota .....	144	8,919	13
Ohio .....	3,070	23,067	56
Oklahoma .....	1,168	37,663	54
Oregon .....	1,053	17,333	18
Pennsylvania .....	1,421	21,029	47
Rhode Island .....		1,248	100
South Carolina .....	144	5,640	18
South Dakota .....		17,956	23
Tennessee .....	242	20,345	48
Texas .....	469	66,314	25
Utah .....		63,320	75
Vermont .....		3,537	37
Virginia .....	151	29,980	70
Washington .....	170	18,398	27
West Virginia .....		24,120	99.8
Wisconsin .....	176	11,373	20
Wyoming .....	871	23,465	24
	25,658	1,051,126	.....

## ATLANTIC DIVISION.

## FIELD WORK.

## SUMMARY.

During the season topographic mapping was carried on in Alabama, Georgia, Kentucky, Maine, Maryland, Mississippi, New Hampshire, New York, North Carolina, South Carolina, Ohio, Penn-



sylvania, Tennessee, Virginia, and West Virginia. This work comprised the survey of 33 quadrangles and the resurvey or revision of 11 quadrangles and 1 special area. In addition, 18 quadrangles were partly surveyed and 5 quadrangles partly resurveyed. The total new area mapped was 8,226 square miles—8,129 square miles for publication on the scale of 1:62,500, and 97 square miles for publication on the scale of 1:31,680. The area resurveyed was 3,046 square miles—248 for publication on the scale of 1:125,000, 2,710 for publication on the scale of 1:62,500, and 88 for publication on the scale of 1:36,000. In connection with this work 2,993 miles of primary levels and 304 miles of precise levels were run and 898 permanent bench marks were established.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by eight parties. This work was distributed over portions of Alabama, Kentucky, Maine, Maryland, Mississippi, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The total area covered by this primary control was about 8,550 square miles, of which 6,300 square miles were controlled by primary traverse. The result of this work was to make control available in forty-one 15-minute quadrangles.

*Topographic surveys in Atlantic division from June 1, 1907, to July 1, 1908.*

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Levels.	
		1:125,000.		1:62,500.	Distance run.		Bench marks.	
		Resur-vey.	New.	Resur-vey.				
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>		
Alabama .....	50	248		145	393	31	31	
Georgia .....	20-50		232	247	a 501	96	28	
Kentucky .....	20		1,330		1,330	483	86	
Maine .....	20		380		380	82	23	
Maryland .....	20			684	684	101	26	
Mississippi .....					b 97	246	65	
New Hampshire .....	20		216		216			
New York .....	20		599		599	231	57	
North Carolina .....	20		344		a 349			
Ohio .....	20		3,070		3,070	965	298	
Pennsylvania .....	20		1,421	58	1,479	456	117	
South Carolina .....	20		144		144			
Tennessee .....	20		242		a 303	72	14	
Virginia .....	20-50		151	72	223	53	10	
West Virginia .....	50			1,504	1,504	481	143	
		248	8,129	2,710	11,272	3,297	898	

<sup>a</sup> 88 square miles of resurvey, 5 in North Carolina, 22 in Georgia, 61 in Tennessee, for publication on the scale of 1:36,000.

<sup>b</sup> 97 square miles in Mississippi for publication on scale of 1:31,680.

#### DETAILS OF WORK BY STATES.

*Alabama.*—The resurvey of the Opelika quadrangle, in Chambers and Lee counties, was completed by R. W. Berry, 248 square miles being mapped for publication on the scale of 1:125,000, with a con-

tour interval of 50 feet. The resurvey of the Montevallo quadrangle, in Shelby, Chilton, and Bibb counties, was commenced by Mr. Berry, 145 square miles being completed, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining areas 31 miles of primary levels were run and 31 permanent bench marks were established by A. K. Gilman and J. B. Metcalf. The control of the Seale quadrangle, in Lee and Russell counties, was completed by F. J. McMaugh, who ran 38 miles of primary traverse.

*Georgia.*—The resurvey of the Acworth quadrangle, in Cherokee, Bartow, and Cobb counties, and the survey of the Columbus quadrangle, in Chattahoochee and Muscogee counties, were completed by Duncan Hannegan. The total area resurveyed was 247 square miles and the new area surveyed was 232 square miles, all for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet. For the control of the Columbus quadrangle 96 miles of primary levels were run and 28 permanent bench marks were established by J. B. Metcalf.

*Kentucky.*—For the continuation of cooperative topographic surveys the state geologist allotted \$8,000 and the federal Survey allotted a like sum. The Providence, Earlington, Madisonville, Central City, Hartford, and Whitesville quadrangles, in Webster, Hopkins, Caldwell, Crittenden, Daviess, Ohio, Hancock, McLean, Muhlenberg, and Butler counties, were completed by Van. H. Manning, A. O. Burkland, C. C. Gardner, R. L. Harrison, T. H. Moncure, and R. W. Berry. The total area surveyed was 1,330 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles 408 miles of primary spirit levels were run and 61 permanent bench marks were established by H. W. Peabody and G. W. Crane, and in addition 178 miles of primary traverse were run and 10 stations established by C. B. Kendall. A line of precise levels 75 miles in length was run by W. H. Monahan from Center along the Illinois Central Railroad to Cerulean Springs, crossing Caldwell, Crittenden, Elmore, and Trigg counties, and furnishing control for the Eddyville, Marion, Morganfield, Princeton, Providence, and Shawneetown quadrangles. In connection with this line 25 permanent bench marks were established.

*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 Eastport quadrangle, in Washington County, and the Poland quadrangle, in Androscoggin, Oxford, and Cumberland counties, was completed, and that of the Ellsworth quadrangle, in Hancock County, was commenced. This work was done by Hersey Munroe, R. Purington, and F. E. Matthes, the total area surveyed being 380 square miles,

for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Eastport quadrangle 82 miles of primary levels were run and 23 permanent bench marks were established by H. M. Gilman, jr. The Ellsworth quadrangle, in Hancock County, was controlled by S. S. Gannett by means of triangulation, 5 stations being occupied and 2 points located by intersections.

*Maryland.*—For the continuation of cooperative topographic surveys in Maryland the state geologist allotted \$5,000 and the federal Survey allotted \$4,000. The resurvey of the Ijamsville and Mount Airy quadrangles and the Maryland portion of the Seneca quadrangle was completed, and that of the Middletown and Taneytown quadrangles was commenced. The total area resurveyed was 684 square miles, in Montgomery, Frederick, Carroll, Howard, and Jefferson counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by W. Carvel Hall, J. H. Wheat, Fred Graff, E. W. McCrary, J. S. B. Daingerfield, J. D. Forster, L. C. Fletcher, and S. P. Floore. For the control of these and adjacent areas 101 miles of primary levels were run and 26 permanent bench marks were established by W. R. Winstead and J. E. McCorkle. The Emmitsburg and Taneytown quadrangles, in Frederick, Carroll, and Montgomery counties, and the Seneca quadrangle, in Montgomery County, Md., and Fairfax County, Va., were controlled by 119 miles of primary traverse run and 9 stations established by F. J. McMaugh.

*Mississippi.*—For cooperative topographic surveys in Mississippi the state Geological Survey and the United States Geological Survey each allotted \$1,600. An irregular area of 323 square miles in the vicinity of Clarksdale, in Coahoma, Bolivar, Quitman, Tallahatchie, Panola, and Tunica counties, was controlled, under the direction of C. D. S. Clarkson, by 80 miles of primary levels run by J. E. McCorkle and W. W. Boone, who established 18 permanent bench marks; and by 158 miles of primary traverse and 15 stations established by F. J. McMaugh and C. A. Clunet.

On May 11 a tentative agreement was entered into with the governor of the State and the president of the Tallahatchie drainage commission, which empowered the federal Survey to undertake the mapping of the Tallahatchie drainage district. On June 15 a final agreement was made which provided that the Geological Survey should expend \$9,000 for this work and the Tallahatchie drainage commission \$27,000, more or less, to complete the survey of the district. Work was commenced by Van. H. Manning, E. P. Davis, R. L. Harrison, C. C. Gardner, and J. R. McMillen on the Belen, Coahoma, and Evansville quadrangles, in Coahoma, Quitman, and Tunica counties, the survey of 97 square miles being completed, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For

the control of this district 101 miles of primary and 65 miles of precise levels were run by L. L. Lee, C. C. Gardner, and W. H. Monahan, in connection with which 47 permanent bench marks were established and 172 miles of primary traverse were run and 58 stations established by F. J. McMaugh and C. A. Clunet.

*Alabama-Mississippi-Tennessee.*—The Iuka quadrangle, in Colbert and Lauderdale counties, Ala., Tishomingo County, Miss., and Hardin County, Tenn., was controlled by 84 miles of primary traverse run by F. J. McMaugh.

*New Hampshire.*—The survey of the Lake Winnepesaukee quadrangle, in Belknap and Carroll counties, was completed by J. I. Gayetty, for publication on the scale of 1:62,500, with a contour interval of 20 feet; the area mapped being 216 square miles.

*New York.*—The state engineer and surveyor allotted \$8,000 for the continuation of the cooperative topographic survey of the State, and the federal Survey allotted a like amount for the same purpose. The work on the Cooperstown quadrangle, in Otsego County, and the Stony Creek quadrangle, in Warren, Hamilton, and Saratoga counties, was completed; that on the Delhi quadrangle, in Otsego and Delaware counties; the Neversink quadrangle, in Sullivan and Ulster counties; and the Bath quadrangle, in Steuben County, was partly completed. This work was done by C. E. Cooke, W. H. S. Morey, Fred Graff, jr., W. M. Beaman, J. I. Gayetty, L. C. Fletcher, J. M. Whitman, and S. P. Floore, the area surveyed being 599 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjoining areas 231 miles of primary levels were run and 57 permanent bench marks were established by C. H. Semper.

*North Carolina.*—The survey of the Great Coharie quadrangle, in Sampson County, was completed by Albert Pike, the area mapped being 244 square miles.

*North Carolina-South Carolina.*—The survey of the Gaffney quadrangle, in Cleveland County, N. C., and Cherokee County, S. C., was completed by W. L. Miller and L. L. Lee. The area surveyed was 244 square miles, 100 of which are in North Carolina, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*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 Ottawa, McClure, Napoleon, Continental, and Defiance quadrangles, in Defiance, Williams, Lucas, Paulding, Putnam, Henry, Wood, and Fulton counties; the Newark, Thurston, Thornville, Logan, and Lancaster quadrangles, in Licking, Knox, Muskingum, Pickaway, Fairfield, Perry, and Hocking counties; and the Alliance, Lisbon, and Columbiana quadrangles, in Stark, Colum-

biana, and Mahoning counties, was completed, and that of the Frazeysburg, Conesville, Zanesville, New Lexington, and Granville quadrangles, in Coshocton, Morgan, Perry, Hocking, Athens, Muskingum, and Licking counties, was commenced. This work was done by J. H. Jennings, R. C. McKinney, W. H. S. Morey, R. D. Cummin, W. H. Monahan, J. S. B. Daingerfield, C. W. Goodlove, J. M. Whitman, I. M. Flocker, J. A. Duck, and W. H. Lovell, the area surveyed being 3,070 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 965 miles of primary levels were run and 298 permanent bench marks were established by C. H. Semper, R. C. Seitz, C. H. Burns, W. H. Monahan, I. M. Flocker, and E. C. Bibbee. The Coshocton, Brinkhaven, Caldwell, McConnellsville, New Lexington, Millersburg, and Plimpton quadrangles, in Holmes, Wayne, Ashland, Coshocton, Knox, Washington, Morgan, and Perry counties, were controlled by 299 miles of primary traverse run and 28 stations established by C. B. Kendall.

*Pennsylvania.*—The Geologic and Topographic Survey Commission of Pennsylvania allotted \$11,500 for the continuance of cooperative topographic surveys of the State, and the United States Geological Survey allotted a like sum for the same purpose. The survey of the Shenango quadrangle, in Mercer and Crawford counties; the Smicksburg quadrangle, in Jefferson, Armstrong, and Indiana counties; the Foxburg quadrangle, in Venango, Clarion, Butler, and Armstrong counties; the Gettysburg quadrangle, in Adams and York counties, and the Freeport quadrangle, in Armstrong, Butler, Allegheny, and Westmoreland counties, was completed; and that of the York quadrangle, in York County; the Zelionople quadrangle, in Butler and Lawrence counties; the Bedford quadrangle, in Bedford, Somerset, and Cambria counties; the Fairfield quadrangle, in Adams County, and the New Kensington quadrangle, in Butler and Allegheny counties, was commenced. This work was done by J. H. Jennings, C. W. Goodlove, Hersey Munroe, J. M. Whitman, W. O. Tufts, R. H. Reineck, L. C. Fletcher, J. H. Wheat, J. S. B. Daingerfield, A. O. Burkland, J. D. Forster, and R. W. Berry, the total area surveyed being 1,421 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition, the work on 58 square miles of the Sewickley quadrangle was revised. For the control of these and adjoining areas 456 miles of primary levels were run and 117 permanent bench marks were established by C. H. Semper, H. D. Hilton, and C. H. Burns. The Bellefonte and Philipsburg quadrangles, in Center and Clearfield counties; the McCall Ferry and Quarryville quadrangles, in Lancaster and York counties; and the Franklin, Hilliards, Mercer, and Stoneboro quadrangles, in Butler, Crawford, Mercer, Lawrence, and Venango counties, were controlled



by 411 miles of primary traverse run and 30 stations established by F. J. McMaugh and C. B. Kendall. The Berlin, Meyersdale, Confluence, Hyndman, and Somerset quadrangles, in Somerset, Fayette, Bedford, and Westmoreland counties, were partly controlled by triangulation by G. T. Hawkins, who occupied 9 stations.

*Tennessee.*—The survey of the Franklin quadrangle, comprising an area of 242 square miles in Williamson and Maury counties, was completed by Oscar Jones, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 19 miles of primary levels were run and four permanent bench marks were established. Mr. Jones also ran 93 miles of primary traverse and established 4 stations for the control of the Hollow Springs quadrangle, in Coffee, Rutherford, Cannon, and Bedford counties.

*Tennessee-North Carolina-Georgia.*—The mapping of the Ducktown special area was completed by Oscar Jones, the area covered being 88 square miles, 5 of which are in Cherokee County, N. C., 22 in Fanning County, Ga., and 61 in Polk County, Tenn., for publication on the scale of 1:36,000, with a contour interval of 20 feet. For the control of this area Mr. Jones located 4 new stations by means of triangulation, and J. G. Martin and W. H. Gray ran 53 miles of primary levels, in connection with which 10 permanent bench marks were established.

*Virginia.*—The survey of the Eagle Rock quadrangle, in Botetourt, Alleghany, and Craig counties, was commenced by Albert Pike and T. H. Moncure; and the resurvey of the Virginia portion of the Seneca quadrangle, in Fairfax and Loudoun counties, was completed by W. Carvel Hall and J. D. Forster. The new area mapped was 151 square miles and the area resurveyed was 72 square miles—all for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet. For the control of these and adjacent areas 42 miles of primary levels were run and 10 permanent bench marks were established by R. S. Deemer and W. B. Winstead.

*Virginia-West Virginia.*—A line of precise levels was extended by C. H. Semper from the vicinity of Covington, Va., to Charleston, W. Va., 11 miles being in Virginia and 153 miles in West Virginia. The line extended along the Chesapeake and Ohio and the Kanawha and Michigan railways, passing across the Lewisburg, Hinton, Raleigh, Kanawha Falls, and Charleston quadrangles, in Alleghany County, Va., and Greenbrier, Summers, Fayette, and Kanawha counties, W. Va. The work in West Virginia was done in cooperation with the State.

*West Virginia.*—For the continuation of cooperative topographic surveys in West Virginia the state geologist allotted \$12,000 and the federal Survey allotted an equal sum. The resurvey resulted in the completion of the work on the Elkins quadrangle, in Randolph

and Barbour counties, and the Wayne, Midkiff, St. Albans, Charleston, and Clendennin quadrangles, in Wayne, Lincoln, Kanawha, Putnam, Clay, and Logan counties, and the commencement of the work on the Clay quadrangle, in Clay and Nicholas counties. This work was done by E. I. Ireland, J. R. Eakin, S. P. Floore, T. F. Slaughter, J. I. Gayetty, and P. W. McMillen, the area surveyed being 1,504 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 quadrangles, 328 miles of primary levels were run and 86 permanent bench marks were established by C. H. Semper, O. N. Meredith, C. K. Alexander, and E. S. Dawson. The Clendennin and Clay quadrangles, in Clay, Kanawha, and Nicholas counties, and the Horton and Elkins quadrangles, in Randolph and Tucker counties, were controlled by D. H. Baldwin, who located 12 new stations by triangulation. The Montgomery, Winifrede, and Fayetteville quadrangles, in Boone, Fayette, Kanawha, Clay, and Nicholas counties, were partly controlled by R. H. Chapman, assisted by P. W. McMillen, who occupied 3 stations.

*Porto Rico.*—In compliance with a request from the Forest Service for an immediate survey of the boundary of the Luquillo National Forest, the work was commenced in March and completed early in June by E. M. Douglas, geographer, in charge of party, and C. L. Nelson, assistant topographer, 40.2 miles of line having been surveyed and marked by 98 concrete, stone, or wooden posts. In order to locate the corners of the reserve two United States Coast and Geodetic Survey triangulation stations were occupied and four new stations were selected, marked, and occupied. In addition to an accurate contour sketch of a narrow strip along the entire boundary, a reconnaissance sketch of 54 square miles of the reserve was made by Mr. Nelson.

#### OFFICE WORK.

The drafting of the following sheets was completed: Opelika, Ala.; Acworth and Columbus, Ga.; Providence, Hartford, Earlington, Madisonville, Central City, and Whitesville, Ky.; Eastport and Poland, Me.; Seneca, Ijamsville, and Mount Airy, Md.; Lake Winnebaukee, N. H.; Cooperstown, N. Y.; Great Coharie and Gold Hill, N. C.; Gaffney, N. C.-S. C.; Newark, Logan, Lancaster, Columbiana, Lisbon, Alliance, Thurston, Napoleon, Continental, McClure, Ottawa, Thornville, and Defiance, Ohio; Gettysburg, Shenango, Foxburg, Freeport, and Smicksburg, Pa.; Franklin and Ducktown special, Tennessee; Charleston, St. Albans, Clendennin, Elkins, Wayne, and Midkiff, W. Va.

Progress in the drafting of additional sheets was made as follows: Middletown, Md., 5 per cent; Stoney Creek, N. Y., 38 per cent; Eagle Rock, Va., 60 per cent.

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

For the control of the Seale (Ala.) quadrangle, 262 latitudes and departures and 35 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Madisonville, Earlington, Central City, and Hartford (Ky.) quadrangles, 1,622 latitudes and departures and 182 geographic positions were computed. For the control of the Princeton, Dawson Springs, Greenville, and White Plains (Ky.) quadrangles, 1,317 latitudes and departures and 159 geographic positions were computed. Level circuits were adjusted in the same area.

The geodetic positions of six triangulation points for the control of the Ellsworth (Me.) quadrangle were computed. Level circuits in the Eastport, Poland, Lewiston, and Cutler (Me.) quadrangles were adjusted.

For the control of the Emmitsburg, Taneytown, and Seneca quadrangles (Md.-Va.), 853 latitudes and departures and 123 geographic positions were computed. Level circuits in these areas and also in the Middletown (Md.) quadrangle were adjusted.

For the control of the Friars Point and Clarksdale (Miss.) quadrangles, 495 latitudes and departures and 84 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Iuka (Miss.-Ala.-Tenn.) quadrangle, 1,071 latitudes and departures and 77 geographic positions were computed.

Level circuits were adjusted in the Bath, Delhi, and Monticello (N. Y.) quadrangles.

For the control of the Millersburg, Plimpton, Coshocton, Brinkhaven, Caldwell, McLean, and New Lexington (Ohio) quadrangles, 2,565 latitudes and departures and 320 geographic positions were computed. Level circuits throughout Ohio were readjusted on the basis of the 1907 adjustment of the precise-level net as made by the Coast and Geodetic Survey.

For the control of the Bellefonte, McCall Ferry, and Quarryville (Pa.) quadrangles, 2,274 latitudes and departures and 242 geographic positions were computed. Level circuits in the Butler, Smicksburg, Bedford, Brookville, and York (Pa.) quadrangles were adjusted.

For the control of the Ducktown (Tenn.-N. C.-Ga.) special quadrangle the final geodetic positions of four triangulation points were computed and level circuits in the same vicinity were adjusted.

The office computation of the precise-level line extending from Covington, Va., to Charleston, W. Va., was made.

The geodetic positions of 12 triangulation stations, located for the control of the Clendennin, Clay, Horton, and Elkins (W. Va.) quadrangles, were computed. Level circuits on the Midkiff, Wayne, Clendennin, and Elkins (W. Va.) quadrangles were adjusted.

## CENTRAL DIVISION.

## FIELD WORK.

## SUMMARY.

During the season topographic surveying was carried on in Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Oklahoma, Texas, and Wisconsin. The survey of 14 quadrangles and the resurvey of 2 quadrangles were completed. In addition, 13 quadrangles were partly surveyed and the resurvey of one quadrangle and one special area was partly completed. The total new area mapped was 3,872 square miles—3,002 for publication on the scale of 1:62,500 and 870 for publication on the scale of 1:125,000. The area resurveyed was 843 square miles—625 for publication on the scale of 1:62,500 and 218 for publication on the scale of 1:24,000. In connection with this work, 2,049 miles of primary levels and 331 miles of precise levels were run and 564 permanent bench marks were established.

Primary traverse and precise leveling were carried on at various times by seven parties, the work being distributed over portions of Arkansas, Illinois, Indiana, Iowa, Michigan, Missouri, Oklahoma, Wisconsin, and Texas. The total area covered by primary traverse was 6,075 square miles, furnishing control in one 30-minute and thirty-one 15-minute quadrangles.

*Topographic surveys in central division from June 1, 1907, to July 1, 1908.*

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Levels.	
		1:125,000.	1:62,500.		Distance run.		Bench marks.	
		New.	New.	Resurvey.				
	<i>Feet.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles</i>		
Arkansas.....						63	16	
Illinois.....	20		771		771	694	141	
Indiana.....	20		160		160	65	21	
Iowa.....	20		197		197	99	20	
Kansas.....	20				<i>a</i> 89	3		
Michigan.....	20		491		491	258	77	
Minnesota.....	20		211		211	534	94	
Missouri.....	20		229	407	<i>a</i> 765	163	31	
Oklahoma.....	20-50	401	767		1,168	241	95	
Texas.....	20	469			469	217	61	
Wisconsin.....	20		176	218	394	43	8	
		870	3,002	625	4,715	2,380	564	

<sup>a</sup> 218 square miles of resurvey (89 in Kansas and 129 in Missouri) for publication on the scale of 1:24,000.

## DETAILS OF WORK BY STATES.

*Arkansas.*—For the control of the De Queen quadrangle, in Sevier, Polk, and Howard counties, W. A. Gelbach ran 63 miles of primary levels and established 16 permanent bench marks, and J. R. Ellis ran 119 miles of primary traverse and occupied 11 stations.

*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 Tallula quadrangle, in Morgan, Sangamon, Cass, and Menard counties; the Herrin quadrangle, in Jackson, Perry, Franklin, and Williamson counties; and the West Frankfort quadrangle, in Franklin and Williamson counties, was completed; and that of the Carlyle, New Athens, and Okawville quadrangles, in St. Clair, Washington, Clinton, and Bond counties; the Hardinville quadrangle, in Jasper, Crawford, Richland, and Lawrence counties; and the Vandalia quadrangle, in Fayette County, was commenced. This work was done by W. J. Lloyd, E. W. McCrary, J. F. McBeth, H. L. McDonald, Lee Morrison, and J. E. Tichenor, the total area surveyed being 771 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 662 miles of primary levels were run and 129 permanent bench marks were established by W. J. Lloyd, W. A. Gelbach, and Henry Bucher, and 236 miles of primary traverse were run and 22 stations established by J. R. Ellis. The Lasalle and Hennepin quadrangles, in Lasalle, Bureau, and Putnam counties, were controlled by 104 miles of primary traverse run and 5 stations established by C. B. Kendall. A line of precise levels 32 miles in length, extending from the vicinity of Terre Haute, Ind., to Oakland, Ill., through the Paris and Kansas quadrangles, in Edgar County, was run by C. H. Semper, and in connection with this work 12 permanent bench marks were established.

*Indiana.*—The survey of the Bloomington quadrangle, in Munroe, Owen, and Greene counties, was commenced by W. H. Griffin and C. L. Sadler, the area covered being 140 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. A line of precise levels 57 miles in length was extended by C. H. Semper through the Bloomfield, Jasonville, and Saline City quadrangles, in Clay and Vigo counties, and in connection with this work 19 permanent bench marks were established. Mr. Sadler also ran 8 miles of primary levels and established two permanent bench marks for the control of the same general area.

*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 Warren and Marion counties, was commenced by J. G. Staack and A. T. Fowler, the area covered being 197 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 76 miles of primary traverse were run and 7 stations established by J. R. Ellis, and 99 miles of primary levels were run and 20 permanent bench marks were established by W. A.



Gelbach. For the control of the Knoxville and Pella quadrangles, in Marion and Mahaska counties, Mr. Ellis ran 72 miles of primary traverse and established 7 stations.

*Kansas-Missouri.*—The resurvey of an area already covered by reconnaissance maps—the Fort Leavenworth special quadrangle, in Leavenworth County, Kans., and Platte County, Mo.—was commenced by Glenn S. Smith, Arthur Stiles, and J. G. Staack, the area completely surveyed being 218 square miles, 129 of which are in Missouri, for publication on the scale of 1:24,000, with a contour interval of 20 feet. In connection with this work 6 miles of primary levels, 3 being in Missouri, were run and 1 permanent bench mark was established by A. J. Ogle.

*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted \$3,000. The survey of the Howell and Milford quadrangles was completed and that of the Durand and Fowlerville quadrangles was commenced by A. M. Walker and C. D. S. Clarkson, the total area surveyed being 491 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This area lies in Livingston, Oakland, Shiawassee, Genesee, and Ingham counties. For the control of these quadrangles and adjacent areas 258 miles of primary levels were run and 77 permanent bench marks were established by C. B. Kendall and Frank H. West. The Calumet special quadrangle, in Houghton and Keweenaw counties, and the Fowlerville and Mason quadrangles, in Livingston and Ingham counties, were controlled by 191 miles of primary traverse run and 37 stations established by J. R. Ellis.

*Minnesota.*—The survey of the Rockford quadrangle, in Hennepin and Wright counties, was completed by J. G. Staack, the area surveyed being 211 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this quadrangle 74 miles of primary levels were run and 15 permanent bench marks were established by Edward Bandli.

*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, which resulted in the completion of the Weingarten quadrangle, in Ste. Genevieve and Perry counties, by C. G. Anderson, and the survey of the Higdon quadrangle, in the same region, was commenced. The survey of the Macon quadrangle, in Macon, Shelby, Monroe, and Randolph counties, was commenced by Merrill Hackett. The total area resurveyed was 407 square miles and the new area surveyed was 229 square miles, all for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 134 miles of primary levels were

run and 22 permanent bench marks were established by Edward Bandli; and 164 miles of primary traverse were run and 14 stations established by J. R. Ellis. The Sullivan quadrangle, in Franklin and Crawford counties, was controlled by 26 miles of precise levels by E. L. McNair, who set 8 permanent bench marks.

*Oklahoma.*—The governor of Oklahoma and the United States Geological Survey each allotted \$4,000 for the continuation of cooperative topographic surveys in that State. The work on the Luther, Merrick, Maud, and Shawnee quadrangles, in Lincoln, Logan, Oklahoma, Payne, Pottawatomie, and Seminole counties, was completed, and that on the Newalla and Burnett quadrangles, in Cleveland, Lincoln, Oklahoma, and Pottawatomie counties, was nearly completed. This work was done by C. L. Sadler, H. H. Hodgeson, and L. B. Roberts, the total area surveyed being 767 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 241 miles of primary levels were run and 95 permanent bench marks were established by F. M. Hutchinson, and 194 miles of primary traverse were run and 30 stations established by J. R. Ellis. In addition to the cooperative work, the survey of the Wyandotte quadrangle, in the Cherokee Nation, was completed by C. G. Anderson and J. A. Duck, the total area surveyed being 401 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

*Texas.*—The survey of the San Marcos quadrangle, in Caldwell, Hays, Comal, Gonzales, and Guadalupe counties, was completed by Fred McLaughlin, W. J. Forster, and D. B. Penick, the total area surveyed being 469 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet. For the control of the Mount Pleasant, Bassett, Boxelder, and Daingerfield quadrangles, in Bowie, Red River, Morris, Cass, and Titus counties, 217 miles of primary levels were run and 61 permanent bench marks were established by W. A. Gelbach, and 98 miles of primary traverse were run by F. J. McMaugh.

*Wisconsin.*—The survey of the Cross Plains quadrangle, in Dane County, was completed by A. T. Fowler; that of the Sparta quadrangle, in Monroe and La Crosse counties, was completed by Merrill Hackett; and that of the Fond du Lac quadrangle, in Fond du Lac and Winnebago counties, was commenced by H. L. McDonald, the total area mapped being 176 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The revision of the Oconomowoc quadrangle, covering 218 square miles in Waukesha, Dodge, and Washington counties, was completed by A. T. Fowler, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The Fond du Lac and Menasha quadrangles, in Fond du Lac, Winnebago, and Calumet counties, and the Stoughton and

Waterloo quadrangles, in Dodge, Jefferson, Dane, and Polk counties, were partly controlled by J. R. Ellis, who ran 184 miles of primary traverse, and by H. L. McDonald, who ran 15 miles of levels. The De Soto quadrangle, in Franklin County, was partly controlled by E. L. McNair, who ran 28 miles of precise levels and established 8 permanent bench marks.

#### DRAINAGE SURVEYS IN MINNESOTA.

A further appropriation of \$10,000 was made by Congress in the Indian act for the continuation 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 to the Geological Survey by the Secretary of the Interior. The work was prosecuted by A. P. Meade and E. L. McNair, and approximately 1,800 square miles were covered by a network of levels, 188 miles of precise levels and 272 miles of primary levels being run, in connection with which 79 permanent bench marks were established.

#### OFFICE WORK.

The drafting of the following sheets was completed: West Frankfort and Tallula, Ill.; Howell, Mich.; Rockford, Minn.; Weingarten and Wyandotte, Mo.; Perkins, Maud, Shawnee, and Luther, Okla.; New Boston, Texarkana, and Linden, Tex.; Cross Plains, Sparta, and Oconomowoc, Wis. Progress was made on the drafting of sheets as follows: Carlyle and Hardinville, Ill., and Macon, Mo., 50 per cent each; Burnett, Okla., 85 per cent; Bloomington, Ind., 47 per cent; Fort Leavenworth special, Kans.-Mo., 45 per cent; Milo, Iowa, 35 per cent.

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

For the control of the DeQueen (Ark.) quadrangle, 1,055 latitudes and departures and 100 geographic positions were computed.

For the control of the Hardinville, Okawville, New Athens, and Carlyle (Ill.) quadrangles, 913 latitudes and departures and 209 geographic positions were computed. The final computation of the precise-level line in Edgar County, Ill., was made. Level circuits were adjusted in the Okawville, New Athens, Baldwin, Carlyle, Hardinville, Herrin, and Murphysboro quadrangles, all in Illinois.

The final computation of the precise level line extending through Clay and Vigo counties, Ind., was made and primary-level circuits in the Bloomington (Ind.) quadrangle were adjusted.

For the control of the Milo (Iowa) quadrangle, 292 latitudes and departures and 55 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Calumet (Mich.) special quadrangle, 554 latitudes and departures and 57 geodetic positions were computed.

Level circuits in the Howell and Milford (Mich.) quadrangles were adjusted.

Level circuits in the Rockford and Elk River (Minn.) quadrangles were adjusted.

For the control of the Edmond, Luther, Moore, Norman, Newalla, and Burnett (Okla.) quadrangles, 1,800 latitudes and departures and 212 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Bassett, Boxelder, Daingerfield, and Mount Pleasant (Tex.) quadrangles, 816 latitudes and departures and 82 geographic positions were computed.

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic surveying was carried on in Colorado, Montana, North Dakota, New Mexico, and Wyoming. The survey of 7 new quadrangles and of 2 special areas was completed; also the resurvey of 1 quadrangle and 1 special area. In addition 4 new quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 5,188 square miles—3,804 for publication on the scale of 1:125,000, 1,347 for publication on the scale of 1:250,000, 35 for publication on the scale of 1:24,000, and 2 for publication on the scale of 1:12,000. The area resurveyed was 759 square miles for publication on the scale of 1:125,000. In connection with this work 510 miles of primary levels and 80 miles of precise levels were run and 161 permanent bench marks were established.

Triangulation and precise leveling were carried on by four parties. This work was distributed over Montana, New Mexico, and Wyoming, covering an area of about 5,400 square miles and furnishing control for nine 30-minute quadrangles and one special quadrangle.

*Topographic surveys in Rocky Mountain division from June 1, 1907, to July 1, 1908.*

State.	Contour interval.	For publication on scale of—				Levels.	
		1:125,000.		1:250,000.	Total area surveyed.	Distance run.	Bench marks.
		New.	Resurvey.	New.			
	<i>Fect.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>	
Colorado .....	50-100	1,130	615	.....	<sup>a</sup> 1,817	213	70
Montana .....	50-100	585	20	1,203	1,808	110	31
New Mexico.....	100	1,218	.....	.....	<sup>b</sup> 1,255	252	55
North Dakota.....	50	.....	.....	144	144	.....	.....
Wyoming.....	100	871	124	.....	995	15	5
		3,804	759	1,347	6,019	590	161

<sup>a</sup> 72 square miles of resurvey in Colorado for publication on the scale of 1:48,000.

<sup>b</sup> In New Mexico 35 square miles for publication on the scale of 1:24,000 and 2 square miles for publication on the scale of 1:12,000.

## DETAILS OF WORK BY STATES.

*Colorado.*—The survey of the Livermore quadrangle, in Larimer County, was completed, and that of the Eaton quadrangle, in Larimer and Weld counties, was commenced by Frank Tweedy, Dave Winbray, H. S. Starr, and G. W. Lucas, the area covered being 267 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of areas in El Paso, Fremont, and Teller counties was continued by R. T. Evans, D. F. C. Moor, and H. R. Elliott, and resulted in the completion of the work on the Colorado Springs quadrangle and the Pikes Peak special area, the former including 575 square miles, surveyed for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the latter 72 square miles, for publication on the scale of 1:48,000, with a contour interval of 50 feet. A special line of levels was run from a bench mark at Manitou to the top of Pikes Peak for the purpose of accurately establishing the elevation of the peak, 20 miles of levels being run and 10 permanent bench marks established by Charles Hartmann, jr. The survey of the Ignacio quadrangle, in the San Juan National Forest, in La Plata County, was completed by Frank Tweedy, Gilbert Young, and Lee Morrison. This area includes the Durango quadrangle, the total new area mapped being 713 square miles. In connection with this work the mapping of 40 square miles of the Engineer Mountain quadrangle was revised by Mr. Tweedy. The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Pitkin and Eagle counties, was commenced by Fred McLaughlin and D. F. C. Moor, the area surveyed being 150 square miles. This work was done for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the partial control of the Eaton quadrangle 24 miles of primary levels were run and 7 permanent bench marks were established by W. R. Winstead. For the control of the Ignacio quadrangle and adjacent areas 70 miles of primary levels were run and 23 permanent bench marks were established by F. A. Nussle. For the partial control of the Cebolla quadrangle, in Gunnison and Hinsdale counties, 19 miles of primary levels were run and 5 permanent bench marks were established by R. T. Thompson. For the control of the Breckenridge special quadrangle, in Summit County, a line of precise levels was begun by C. H. Semper, 80 miles being run and 25 permanent bench marks established. D. F. C. Moor also occupied 8 stations by triangulation for the control of the same area.

*Montana.*—The survey of the Sapphire quadrangle, in the Hellgate National Forest, was completed, and that of the Missoula quadrangle, in the Lolo National Forest, was commenced by J. F. McBeth, J. E. Tichenor, W. J. Forster, and Arthur Stiles, the total area



surveyed being 492 square miles in Granite, Ravalli, and Missoula counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Mr. McBeth also revised 20 square miles of the Philipsburg quadrangle, in Granite County. For the control of the Missoula quadrangle 84 miles of primary levels and 27 permanent bench marks were established by N. W. Pilger. The survey of the Nyack quadrangle, in the Lewis and Clark National Forest, in Flat-head County, was commenced by Arthur Stiles, the area surveyed being 93 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area 26 miles of primary levels and 4 permanent bench marks were established by Charles Hartmann, jr.

*Montana-North Dakota.*—The survey of the Glendive quadrangle, in Dawson County, Mont., and Billings County, N. Dak., was completed by D. F. C. Moor, the total area surveyed being 1,347 square miles, for publication on the scale of 1:250,000, with a contour interval of 50 feet, 144 square miles being in North Dakota. Additional control for the Glendive quadrangle was obtained by Mr. Moor, who located 7 points by means of triangulation.

*New Mexico.*—The survey of the Gallina quadrangle, in the Jemez National Forest, in Rio Arriba County, was completed by Gilbert Young, Lee Morrison, and S. T. Penick, the total area surveyed being 250 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 11 miles of primary levels were run and 3 permanent bench marks were established by F. A. Nussle. The survey of the Silver City and Santa Rita special quadrangles, in the Gila and Big Burro national forests, in Grant County, was completed by A. B. Searle, J. H. Sinclair, Gilbert Young, S. T. Penick, Charles Hartmann, jr., Frank Tweedy, and D. F. C. Moor, the former consisting of 968 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the latter of 35 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this work 214 miles of primary levels were run and 45 permanent bench marks were established by Victor Mindeleff. The survey of the Fort Bayard special quadrangle, in Grant County, consisting of 2 square miles, was completed by C. E. Cooke, for publication on the scale of 1:12,000, with a contour interval of 10 feet. For the control of this area Mr. Cooke occupied 10 stations by triangulation and Stuart T. Penick ran 27 miles of primary levels and established 7 permanent bench marks. The Silver City quadrangle was controlled by Fred McLaughlin, who located 9 new points by triangulation.

*Wyoming.*—The survey of the Grosventre quadrangle, in the Yellowstone National Forest, in Uinta and Fremont counties, was completed by T. M. Bannon, W. M. Kent, and W. S. Sargent, the area

surveyed being 871 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Messrs. Bannon, Kent, and R. T. Evans also completed 124 square miles of revision on the Laramie quadrangle, in Albany County. The Hoback, Grays River, Cora, and Grosventre quadrangles, in Uinta County, were controlled by R. B. Robertson, who located 8 primary and 19 secondary triangulation points. For the control of the Rock Springs quadrangle, in Sweetwater County, J. D. Weems ran 15 miles of primary levels and established 5 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Livermore, Ignacio, Colorado Springs, and Pikes Peak special, Colorado; Glendive and Sapphire, Montana; Gallina, Silver City, and Santa Rita special, New Mexico; Grosventre and Medicine Bow, Wyoming. Progress amounting to 14 per cent was made in the drafting of the Laramie (Wyo.) sheet.

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

Level circuits in the Durango and Pagosa (Colo.) quadrangles were adjusted.

A least-square figure adjustment was made of the triangulation for the control of the Glendive (Mont.) quadrangle, and the final computation was made of the geodetic distances and positions of all stations within that area. The least-square adjustment and final computation of triangulation stations in the Blackfeet Indian Reservation were completed, and level circuits in the same area were adjusted.

The least-square adjustment of triangulation stations for the control of the Silver City (N. Mex.) quadrangle was made, and the final geodetic distances and positions of 9 stations were computed. Level circuits were adjusted in the Bloomfield, Dulce, Farmington, and Lumberton (N. Mex.) 30-minute quadrangles.

The least-square adjustment of the triangulation for the control of the Hoback, Grays River, Cora, and Grosventre (Wyo.) quadrangles, and the final computation of the geodetic positions of primary-traverse stations and of many of the secondary stations were made.

#### PACIFIC DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic surveying was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. The survey of 3 new quadrangles and 2 special areas and the resurvey of 15 quadrangles were completed. In addition 6 new quadrangles and

1 special area were partly surveyed and 10 quadrangles were partly resurveyed. The total new area mapped was 8,372 square miles—4,383 for publication on the scale of 1:125,000, 250 for publication on the scale of 1:62,500, and 3,739 for publication on the scale of 1:250,000. The area resurveyed was 2,331 square miles—1,441 for publication on the scale of 1:125,000, and 890 for publication on the scale of 1:62,500. In connection with this work 1,991 miles of primary levels and 128 miles of precise levels were run and 477 permanent bench marks were established. Primary control was carried on at various times by six parties. This work was distributed over portions of California, Idaho, Oregon, Utah, and Washington. The total area covered by this primary control is about 15,300 square miles, of which 450 square miles were controlled by primary traverse.

*Topographic surveys in Pacific division from June 1, 1907, to July 1, 1908.*

State.	Contour interval.	For publication on scale of—					Total area surveyed.	Levels.	
		1:125,000.		1:62,500.	1:250,000.	1:31,680.		Distance run.	Bench marks.
		New.	Resurvey.	New.	New.	Resurvey.			
Arizona .....	<i>Feet.</i> 50-100	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Miles.</i>	
California .....	{ 5-10-100 100	2,998	579	250			829	155	54
Idaho .....	100	162					162	287	62
Nevada .....	100				3,739		3,739	268	51
Oregon .....	50-100	1,053					1,053	224	53
Utah .....	100		862				862	40	8
Washington ..	50-100	170					170	69	16
		4,383	1,441	250	3,739	890	10,703	2,119	477

#### DETAILS OF WORK BY STATES.

*Arizona.*—A resurvey of the area covered by the San Francisco Mountains reconnaissance map, consisting of the Flagstaff quadrangle, in the San Francisco Mountains National Forest, in Coconino County, was commenced by Pearson Chapman, the area surveyed being 579 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area 155 miles of primary levels were run and 54 permanent bench marks were established by T. A. Green. The survey of the Troy quadrangle, in Pinal and Gila counties, was completed by Pearson Chapman and C. F. Eberly, the area surveyed being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

*California.*—The Department of Engineering of California allotted \$12,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey

of the areas covered by the Lodi and Sacramento reconnaissance maps was undertaken and resulted in the completion of the work in 14 quadrangles, the Carbondale, Goose Creek, Clements, Cosumnes, Clay, Lockeford, Waterloo, Castile, Headreach, Galt, Elkgrove, Franklin, Bruceville, and Linden, in Sacramento, San Joaquin, Solano, and Amador counties; and the partial completion of work in the New Hope, Woodbridge, Mills, Antelope, Arcade, Folsom, Pleasant Grove, and Roseville quadrangles. This work was done by W. R. McKean, B. A. Jenkins, E. R. Bartlett, R. M. LaFollette, Bayard Knock, and M. A. Knock, the total area resurveyed being 890 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 10 feet. For the control of these quadrangles 373 miles of primary levels were run and 61 permanent bench marks were established by L. F. Biggs and B. A. Jenkins. In addition to the cooperative surveys a map was made of the Coalinga and the McKittrick-Sunset oil districts, which occupy an irregular strip in Fresno, Kings, San Luis Obispo, and Kern counties, consisting of 2,324 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This work was done by E. P. Davis, G. R. Davis, J. W. Muller, J. E. Blackburn, and R. M. LaFollette. The survey of the Big Bar quadrangle, in the Trinity National Forest, in Trinity County, was commenced by J. P. Harrison; and that of the Mount Goddard and Bishop quadrangles, in the Sierra National Forest, in Fresno and Inyo counties, was commenced by G. R. Davis, the area surveyed by both being 674 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the noncooperative work in California 602 miles of primary spirit levels were run and 155 permanent bench marks were established by L. F. Biggs. Triangulation control for the Weaverville, Big Bar, Sawyers Bar, and Seiad Valley quadrangles, in Trinity and Siskiyou counties, was completed by C. F. Urquhart, who occupied 21 triangulation stations, 7 of which are Coast and Geodetic Survey points. Control for ten 15-minute quadrangles in the Sacramento Valley, in Sacramento, San Joaquin, Amador, Eldorado, Placer, Sutter, Yuba, and Butte counties, was completed by Mr. Urquhart and C. L. Nelson, 76 new triangulation stations being established. For the control of the Woodbridge and Galt quadrangles, in Sacramento and San Joaquin counties, Mr. Urquhart ran 44 miles of primary traverse. For the additional control of the Davisville, Clarksburg, and Rio Vista quadrangles, in Sacramento and San Joaquin counties, 101 miles of precise levels were run and 17 permanent bench marks were established by L. F. Biggs.

*Idaho.*—The survey of the Meadows quadrangle, in the Weiser National Forest, in Washington and Boise counties, was commenced by C. F. Eberly and J. G. Hefty, the area surveyed being 162 square



miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this and adjacent areas 287 miles of spirit levels were run and 62 permanent bench marks were established by Mr. Hefty and D. A. Maxwell.

*Idaho-Oregon.*—The Cambridge and Meadows 30-minute quadrangles, in Washington and Boise counties, Idaho, and Union County, Oreg., were controlled by G. T. Hawkins, who located 9 triangulation points.

*Idaho-Wyoming-Utah.*—The Montpelier, Cokeville, Evanston, and Kemmerer quadrangles, in Bear Lake County, Idaho, Uinta County, Wyo., and Rich County, Utah, were controlled by G. T. Hawkins, who located 13 triangulation points.

*Nevada.*—The survey of the Tonopah quadrangle, covering an area of 3,739 square miles in Esmeralda and Nye counties, was completed by J. E. Blackburn, for publication on the scale of 1:250,000, with a contour interval of 100 feet. For the control of this area 268 miles of primary levels were run and 51 permanent bench marks were established by T. A. Green.

*Oregon-Washington.*—For the continuation of cooperative topographic surveys in Oregon the state engineer allotted \$2,500 and the United States Geological Survey allotted a like sum. The survey of the Umatilla quadrangle, in Morrow and Umatilla counties, Oreg., and Klickitat County, Wash., was completed by C. H. Birdseye, C. F. Eberly, C. E. Giffin, and Robert Muldrow, and that of the Eugene quadrangle, in Lane County, Oreg., was begun by J. P. Harrison and C. E. Giffin. The area surveyed was 837 square miles, 113 of which are in Washington, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area 135 miles of primary levels were run and 32 permanent bench marks were established, 30 miles of levels and 9 bench marks being in Washington. In addition to the cooperative mapping, the survey of the Mount Hood special area, in the Bull Run National Forest, in Clackamas and Multnomah counties, was continued by A. H. Sylvester and Ralph Cowgill, the area completely covered being 329 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this and adjacent areas 92 miles of primary levels were run and 24 permanent bench marks were established by John R. Evans. A line of precise levels was begun by L. F. Biggs, 27 miles being completed, and 6 permanent bench marks were established.

The Umatilla quadrangle, in Morrow and Umatilla counties, Oreg., and Klickitat County, Wash., and the Pasco, Wallawalla, Wallula, and Dayton quadrangles, in Benton, Columbia, Garfield, and Wallawalla counties, Wash., were controlled by A. H. Sylvester and G. T. Hawkins, 19 triangulation points being located.

*Utah.*—The resurvey of a portion of the area covered by the Salt Lake reconnaissance map, in the Uinta National Forest, in Wasatch, Summit, and Utah counties, was begun by A. E. Murlin, who completed the work on the Strawberry Valley quadrangle and commenced that on the Soldier Summit quadrangle, the total area resurveyed being 862 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Callee quadrangle, in Millard County, T. A. Green ran 40 miles of primary levels and established 8 permanent bench marks.

*Washington.*—The survey of the Mount Baker quadrangle, in the Washington National Forest, in Whatcom and Skagit counties, was commenced by Robert Muldrow, the area surveyed being 57 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle 39 miles of primary levels were run and 7 permanent bench marks were established by Homer M. Hadley.

#### OFFICE WORK.

The drafting of the following sheets was completed: Carbondale, Goose Creek, Clements, Cosumnes, Clay, Lockeford, Waterloo, Castile, Woodbridge, Galt, Elkgrove, Franklin, Bruceville, Linden, Antioch (first named Montezuma), and Coalinga and McKittrick-Sunset oil districts, California; Tonopah, Nev.; Umatilla, Oreg.; and Strawberry Valley, Utah. Progress was made in the drafting of sheets as follows: Flagstaff, Ariz., 43 per cent; New Hope, Cal., and Mount Hood special, Oregon, each 50 per cent.

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

Level circuits in the Bowie, Chiricahua, Pearce, Wilcox, Flagstaff, Grandview, and Williams quadrangles, in Cochise and Coconino counties, Ariz., were adjusted.

Office computation was made of the precise line of levels from Sacramento, Cal., down the river. Primary-level circuits in the Folsom, Galt, Hatchville, Ione, Lockeford, Stockton, and Woodbridge (Cal.) quadrangles were adjusted. The least-square adjustment of the triangulation done in California in 1907 was made in the Sacramento office.

For the control of the Cambridge and Meadows 30-minute quadrangles (Idaho-Oregon) the least-square figure adjustment and final computation of geodetic distances and positions were made. Level circuits in the same area were adjusted. For the control of the Montpelier, Cokeville, Evanston, and Kemmerer quadrangles, in Bear Lake County, Idaho, Uinta County, Wyo., and Rich County, Utah, the least-square figure adjustment of the triangulation was made and the geodetic positions of 13 triangulation stations were computed.

For the completion of the control of the Furnace Creek and Las Vegas (Nev.) quadrangles computation was made of the approximate positions of certain points located during the preceding season. Level circuits in the Tonopah (Nev.) quadrangle were adjusted.

The least-square figure adjustment and final computations of geodetic distances and positions of triangulation stations for the control of the Umatilla, Benton, Pasco, Wallawalla, Wallula, and Dayton quadrangles (Wash.-Oreg.) were made. Level circuits in the Blalock Island and Umatilla quadrangles, in the same States, were adjusted.

#### COMPILATION OF SPECIAL NATIONAL-FOREST MAPS.

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

The maps were made on the scale of 1 mile to the inch and published with 6 townships to the page. All the work of the United States Geological Survey, the General Land Office, and the Hayden, Transcontinental, and Wheeler surveys, as well as 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 1907-8 for the following forests: Gallatin, Chiricahua, Lewis and Clark, Manti, Payson, Beaver, Wichita, Trinity, Olympic, Sawtooth, Klamath, Madison, Blue Mountain, Mount Graham, Big Belt, Wasatch, Bitterroot, Priest River, Sierra Madre, Bear River, Siskiyou, Prescott, San Gabriel, and Holy Cross.

The maps were nearly completed for the Hell Gate, Stanislaus, Battlement Mesa, and San Bernardino forests. The Gunnison, Cochetopa, and Tahoe forest maps were about one-half completed, and work was started on the maps of the Lolo, Arkansas, Grand Canyon, Huachuca, La Sal, Santa Catalina, Santa Rita, and Monticello forests.

The work was greatly retarded during the latter part of the year owing to changes in boundaries and redistricting of national forests.

#### INSTRUMENTS AND TOPOGRAPHIC RECORDS.

During the year all the topographic instruments in the office were examined, and all those found to be worn out, useless, or of obsolete 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. There were purchased ten 15-inch Y levels, nine telescopic alidades, twenty 20-foot leveling rods, two

6-inch transits, three aneroid barometers, and sixteen steel tapes; also an air pump connected with a mercurial barometer for testing aneroids and an apparatus for engraving numbers on instruments, both of which have already proved their usefulness. All minor repairs to instruments were made in the Survey shop, the extensive repairs or remodeling being done by outside contractors as heretofore.

A change in the system of filing topographic records was adopted whereby the work of cataloguing is materially reduced. There were 2,225 new records catalogued and filed. The triangulation and leveling 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.

#### INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the field season inspection of topographic mapping, completed or in progress, was carried on by J. H. Renshaw in the northeastern and central portions of the United States, by W. M. Beaman in the southeastern and central parts, and by François E. Matthes in the western part. All States in which work was in progress were visited during the season, and the parties were instructed for the purpose of maintaining uniformity of style and system in the expression of topographic features.

During the office season careful attention was given by the inspectors to the final drawing of topographic sheets, for the purpose of eliminating personal characteristics and errors of expression.

#### WATER-RESOURCES BRANCH.

##### ORGANIZATION.

During the last year an effort has been made to maintain as much as possible of the investigations of the water resources of the country—work formerly carried on under larger but still insufficient appropriations. The work performed may be divided, as formerly, into three parts: First, the investigation of stream flow and allied problems; second, the investigation of the occurrence, sources, and amounts of underground waters in various portions of the country; and third, the investigation of the quality of water, both surface and underground. A combination of these three investigations is necessary to afford the data for the determination of water resources required in the appropriation act.

The work was carried on under the direction of M. O. Leighton, chief hydrographer, assisted by John C. Hoyt, assistant chief hydrographer. The chief hydrographer was designated as advisory hydrographer to the Inland Waterways Commission, and in that capacity



presented a report on the possibility of preventing floods and assisting navigation in the Ohio Valley by the construction of upland reservoirs, which has been widely discussed in engineering and popular journals.

#### STREAM-FLOW INVESTIGATIONS.

The total number of river-measurement stations maintained by the water-resources branch during the fiscal year 1907-8 was 630, of which 367 stations were carried on independently by the Geological Survey and 263 stations were maintained in cooperation with other organizations.

*New York and New England district.*—The great reduction in the appropriation for the past fiscal year rendered it necessary to discontinue a large amount of work in this as in other districts.

Stream measurements were made in this district at 53 stations, and, in addition, river profiles and lake surveys were made in cooperation with the Survey Commission of the State of Maine. These surveys covered Chamberlain, Allegash, and Telos lakes, in the Allegash River drainage; Webster, Second, and Grand lakes, in the East Branch of Penobscot River drainage; Baskahegan and Mattawamkeag lakes, in the Mattawamkeag River drainage; Mattawamkeag River from mouth to mouth of Baskahegan Stream; Schoodie, Seboois, and Endless lakes, and Pleasant Pond, in the Piscataquis River drainage. The amount appropriated by the State of Maine was \$3,200.

The State of New York also cooperated in stream-measurement work, the state legislature having granted authority to the state engineer to expend \$1,500 for this purpose. This sum was applied to the maintenance of 13 stations. The New York state water supply commission, charged with the duty of making a report on water powers within the State, availed itself of the organization of the Geological Survey for the maintenance of 6 stations in connection with its work. The total amount appropriated by the state water supply commission for this purpose was \$1,950.

A report on the hydrography of the Penobscot River basin, dealing with stream flow, quality of water, floods, navigation, water power, and water storage, was in preparation during the year and is nearly completed.

Work in this district was under the charge of H. K. Barrows, district engineer.

*Middle Atlantic States district.*—In this district, which covers the States of Pennsylvania, New Jersey, Maryland, Virginia, and West Virginia, a large part of the work was discontinued for lack of funds. Thirteen stations were, however, maintained by the Geological Survey, in addition to the Pennsylvania stations, the expenses

of which were borne by the state water supply commission of Pennsylvania. The stations maintained in the State of Maryland were supported through the cooperation of W. B. Clark, state geologist.

Work in this district was under the charge of J. C. Hoyt, assistant chief hydrographer.

*Southern Atlantic States district.*—The act of Congress authorizing the Secretary of Agriculture to investigate and report on the watersheds of the southern Appalachian and White Mountain regions, with reference to the advisability of the Government purchasing and setting apart these regions as national forest reserves, made it possible to increase the work in this district. The Secretary of Agriculture requested the Director of the Geological Survey to take up the stream investigations involved in this work and made an allotment therefor of \$6,000. Reports on the relation of the southern Appalachian Mountains to water power and to inland navigation were presented to the Department of Agriculture and printed as two circulars of the United States Forest Service, and a third report, on floods, is now being prepared.

Stream measurements were made in this district during the year at 106 stations, 43 of which were maintained from the appropriation above referred to. The work in the district was under the charge of M. R. Hall, district engineer.

*Central States district.*—The important investigations in this district that were temporarily discontinued during the fiscal year 1907 on account of the great reduction in appropriation were resumed during the latter part of the fiscal year 1908. These investigations, relating to the seasonal distribution of stream flow and its relation to floods, to navigation, and to water power, are being vigorously pushed.

There were 39 stations maintained in this district, and the work was under the charge of A. H. Horton, district engineer.

*Missouri River district.*—In this district, which includes the States of North Dakota, South Dakota, Montana, and northern Wyoming, 82 stream-measurement stations were maintained, and the work was confined chiefly to those streams available for irrigation. In the maintenance of stations connected with irrigation projects under construction the United States Reclamation Service cooperated.

Work in this district was directed by Robert Follansbee and, later, by J. E. Stewart, district engineer.

*Denver district.*—This district includes the States of Colorado, southern Wyoming, Nebraska, Kansas, Oklahoma, and Texas and the Territory of New Mexico. Of the 72 river-measurement stations maintained in the district during the year, 13 were located on irrigation projects, and the expenses of these were paid by the United States Reclamation Service.

As this district holds the sources of some of the most important streams of the country, the work here is of especial importance. The memorable suit between the State of Kansas and the State of Colorado concerning the diversion of the waters of Arkansas River has emphasized the necessity of procuring more accurate data concerning all matters relating to the utilization of water. The results of suits of this kind not only have local interest but are highly important from a national standpoint, as, with the growth of the country, interstate suits growing out of stream diversion will doubtless become more frequent.

The work in this district was under the charge of W. B. Freeman, district engineer.

*Great Basin district.*—In this district, which comprises the States of Idaho, Utah, and Nevada, stream measurements were made at 50 stations. The United States Reclamation Service cooperated in the maintenance of project stations in all three of these States, while additional cooperation was rendered by the state engineer of Nevada.

Work in this district was under the direction of E. C. LaRue, district engineer.

*Columbia River district.*—The district including the States of Washington and Oregon contains water resources of notable interest and value. The region is drained by the Columbia, one of the largest rivers on the continent, a stream of interstate and national importance. Although enormous developments have taken place in this district, it can hardly be said that more than a beginning has been made, and the necessity for thorough knowledge of the water resources in advance of settlement is fully realized. The United States Government owns vast areas in this region, and a further postponement of extensive investigations can not be justified under any proper standard of governmental administration.

Forty-five stations were maintained in Washington and 67 stations in Oregon. The work in Oregon was conducted in cooperation with the state engineer.

The work in this district was directed by J. C. Stevens, district engineer.

*California district.*—The work in California was carried on in cooperation with the State, a liberal appropriation having been made by the state legislature in response to the demand of citizens who realize that industrial development is almost absolutely dependent on a systematic investigation of water resources.

River measurements were made at 73 stations, and observations and surveys looking to the diffusion of information concerning the conservation of water supplies were also made.

The stream-measurement work in this district was under the direction of W. B. Clapp, district engineer.

In addition to the direct investigation of stream flow throughout the State, an investigation of the laws of transportation of suspended material in rivers was carried on in the hydraulic laboratory maintained at Berkeley. This investigation is one of the most important ever undertaken by the United States Government, for it affects questions of navigation and irrigation throughout the country. The Government has expended many millions of dollars in removing from river channels the *débris* brought down by floods, and this annual expenditure for dredging may be expected to continue until a scientific study of the whole question of *débris* transportation shall have found a solution to the problem. This investigation is an integral part of the whole purpose of the Survey's water investigations, namely, the ascertainment of the basic facts upon which future corrective development of river channels must depend.

The *débris* investigation was under the charge of G. K. Gilbert, geologist, the work being conducted in cooperation with the geologic branch.

#### GROUND-WATER INVESTIGATIONS.

Investigations of the underground waters of the United States were continued during the fiscal year 1907-8 as during previous years, except that as the appropriations were less the work was necessarily continued on a reduced scale.

The most comprehensive general investigation under way during the year in this division was that of the ground waters of the Atlantic Coastal Plain. This work was undertaken as a result of a cooperative agreement entered into between the United States Geological Survey and the state geologists of the Coastal Plain States. The geologic and water-resources branches of the Survey shared the federal portion of the expense, and the work was placed under the general direction of M. L. Fuller, continuing under his charge until his resignation from the Survey in the autumn of 1907. T. Wayland Vaughan was then named as federal representative, and the work was continued under his supervision.

Toward the close of the year work in the Coastal Plain of Texas, which had been pursued as an independent investigation, was placed under Mr. Vaughan's charge, for the reason that the Texas Coastal Plain is, in all essential particulars, a part of the general Coastal Plain province.

Prof. C. H. Gordon completed during the summer of 1907 the field work involved in two investigations in northern Texas, one covering the north-central portion of the State and the other the northeastern portion. Professor Gordon resigned from the Survey to accept a position as professor of geology in the University of Tennessee, entering upon his duties with the beginning of the school year. His

university duties interfered with the preparation of his federal reports, but these were taken up at the end of May, and by July 1 substantial progress had been made on the report on north-central Texas. That on northeastern Texas will be delayed.

A report in preparation by Prof. H. E. Gregory, of Yale University, on the ground waters of Connecticut was submitted during the year and at its close was undergoing revision.

A report by Prof. A. F. Crider on the ground waters of eastern Arkansas was likewise submitted toward the close of the year and is undergoing revision.

A report by George C. Matson on the ground waters of the blue-grass region of Kentucky, prepared as a result of field work carried out during the previous fiscal year, was submitted for publication toward the close of the year.

A report by F. G. Clapp on the ground waters of southern Maine, prepared as a result of field work carried out during previous years, was forwarded for publication toward the close of the fiscal year.

Substantial progress has been made in the preparation of a report on the ground waters of the State of Iowa, in which Prof. W. H. Norton, of Cornell College, Mount Vernon, Iowa; Prof. W. S. Hendrixson, of Iowa College, Grinnell, Iowa; and H. E. Simpson, of the United States Geological Survey, cooperated.

The preparation of a report on the ground waters of southern Minnesota has been continued during the year by O. E. Meinzer, acting in cooperation with Prof. C. W. Hall, of Minneapolis. Mr. Meinzer's share of the work was completed at the end of the year, and it is expected that Professor Hall's portion will soon be finished.

Work in the three Pacific Coast States has been continued under the general direction of W. C. Mendenhall. As a result of this work a report on the ground waters of south-central Oregon, by G. A. Waring, was submitted and sent to the Public Printer toward the close of the year. Field work was completed by Mr. Waring as a basis for reports on the ground waters of the Harney basin, in southern Oregon, and on the ground waters of the lower Yakima Valley, in Washington. The Harney basin report was submitted for publication, and that on the Yakima Valley is well advanced toward completion. Reports were submitted during the year and have been sent forward for publication on the ground waters of the Indio region, California, by W. C. Mendenhall, and on the foothill belt of southern California by the same author.

At the close of the year Mr. Mendenhall had under way a preliminary report on the ground waters of the San Joaquin Valley, and a bulletin which will embody the geologic results attained as an incident to the ground-water investigations in this field.



In January Mr. Mendenhall, whose headquarters had theretofore been in Los Angeles, Cal., was recalled to the Washington office, and at the close of the year he was given general charge of the underground-water work in the United States.

#### INVESTIGATIONS OF QUALITY OF WATER.

Investigations of quality of water have been made under the general supervision of R. B. Dole, assisted by Herman Stabler, H. N. Parker, W. D. Collins, E. B. Phelps, Chase Palmer, and others.

*Surface waters of the United States.*—The most important investigation of quality of water conducted during the year has been the continuation of a study of surface waters commenced in 1906, as detailed in the report of last year. In connection with this work more than 50,000 samples of water have been collected from the principal lakes and streams of the United States, and about 4,800 analyses have been made. The analytical work of this study has been completed and the water-testing laboratories that were established for its performance have been discontinued. Reports are now being prepared discussing the analytical results in relation to industrial and municipal uses of water, chemical denudation, and other features.

*Analyses of underground waters.*—Besides the tests of surface waters, about 300 mineral analyses of well and spring waters have been made in connection with underground-water investigations in Florida, Indiana, Kentucky, Virginia, and Texas. It has been demonstrated that much more economical and satisfactory results are obtained by making water analyses in laboratories established and maintained by the Survey than by paying private laboratories for such work or depending on miscellaneous analyses that may have been made on waters from the regions under study. Several reports involving results of work of the water-testing laboratories on underground waters have been prepared for publication.

*California.*—In cooperation with the state board of examiners of California, the investigation of the quality of surface waters in that State has been continued. A chemical laboratory under the direction of Walton Van Winkle, assistant chemist, has been established at Berkeley, where samples of water from stations on the principal California streams are analyzed. Considerable information in regard to the quality of underground waters has also been obtained.

*Kansas.*—In cooperation with the state board of health of Kansas, H. N. Parker, assistant hydrographer, has continued the investigation of the quality of waters of the State. The field work, which involved the complete analysis of about 800 samples of water, 300 field assays of water, and the collection of detailed information regarding the waterworks and sewerage systems of practically every municipality—

in the State, was completed, and the last half of the year was spent in preparation of a report for publication.

*Pollution investigations.*—A study of the pollution of streams by certain industrial wastes and of methods of preventing the same has been conducted in cooperation with the sanitary research laboratory of the Massachusetts Institute of Technology. E. B. Phelps, assistant hydrographer, has made extensive original research into the character of sulphite-pulp waste liquor and methods of utilizing it, and has submitted his report on that subject.

*Industrial uses of water.*—A manuscript on the industrial uses of water has been partly prepared by Herman Stabler, assistant engineer. The report considers in detail the different industrial processes in which water is used, the effect of impurities, and various methods of preparing water for industrial consumption.

## TECHNOLOGIC BRANCH.

### ORGANIZATION.

The organization of this branch in Washington remained the same as at the close of the preceding year, embracing the expert in charge, Joseph A. Holmes; the chief engineer, Herbert M. Wilson, who in the absence of the expert in charge assumes his duties; the editorial assistants; and the general clerical force engaged on the correspondence, records, supplies, shipments, accounts, and bibliography. From the Washington office directions are issued to officers and employees in different parts of the country.

### FUELS DIVISION.

The analyzing and testing of the coals, lignites, and other mineral fuels belonging to and required for the use of the United States, in order to determine their fuel value, were continued during the year. The work of the fuels division by sections is summarized as follows:

### CHEMICAL SECTION.

The work of the chemical section covered in general all analyses and calorimeter determinations of fuels, including coals used by the Government; the chemistry and physics of the combustion of fuels; the heating value of the various fuels and methods of determining it; and the by-products obtainable in the coking of coals, mainly from public lands. Physical and chemical investigations of the composition of fuels and of the gases evolved at different temperatures and high-temperature measurements of the products of combustion were made by J. K. Clement. A small laboratory was maintained at Washington under the direction of G. O. Spitler for sampling the coals purchased by the government departments in that city.

During the year 1,624 samples of coal were analyzed under the direction of F. M. Stanton, the work involving 24,360 determinations. Calorimeter tests were made on Illinois and Pennsylvania coals to determine their yields in by-products. A laboratory investigation of the losses of moisture and gases by lignites and subbituminous coals in drying was completed. Tests were made by H. C. Porter on the "volatility" or ease of volatilization of different coals, to determine the smoke-producing constituents given off at various temperatures. An investigation of California petroleum was started by Irving C. Allen, 480 samples, covering all the oil fields in the State, being collected. Research work was conducted by J. C. W. Frazer on the composition of coal, involving the use of various solvents for the hydrocarbons, with the object of isolating definite compounds.

A laboratory study of the deterioration of coal in storage was begun, samples of seven representative coals being stored under different conditions. From time to time the amount and composition of gases given off by coal in closed vessels were determined and changes in the character of the coal noted.

The experimental work done at the former chemical laboratories in St. Louis was described in a bulletin (No. 323) that appeared during the year.

#### STEAM-ENGINEERING SECTION.

Tests were made at Norfolk, on behalf of the Government, to determine the most efficient method of burning certain Virginia and West Virginia coals under boilers. In addition 28 steaming tests with briquets were made on a locomotive and 20 on the U. S. torpedo boat *Biddle*. In cooperation with the Navy Department a test of briquets under service conditions was made on the battle ship *Connecticut*.

During the year the results of a study of 400 steaming tests made at St. Louis were published in a bulletin (No. 325) and the results of a special investigation of drafts were prepared for publication. A report dealing with experiments in heat transmission is in preparation.

The work of the steam-engineering section was under the general direction of D. T. Randall. W. T. Ray conducted investigations on the combustion of fuels in different types of furnaces.

#### PRODUCER-GAS SECTION.

About 1,251 tests were made in the liquid-fuel investigations, including the effect of various adjustments of the engines on their efficiency, the comparison of gasoline as a power producer with denatured alcohol, and the results of diluting the fuels.

Producer-gas tests, numbering 7, involving 55,965 observations, were made by the close of November, when the gas producer and engines were dismantled and work was concentrated at Washington on computing and tabulating the results.

The results of the gasoline-engine tests at Norfolk have been compiled for publication as a bulletin, and a report dealing with producer-gas tests is in preparation.

Under D. T. Randall, in charge of fuel efficiency tests, C. D. Smith continued in charge of the producer-gas section, and R. M. Strong was engaged on investigations of liquid fuels.

#### INSPECTION AND SAMPLING SECTION.

The inspection and sampling section has been under the supervision of J. S. Burrows. Its work comprised the collection of mine and car samples of fuels shipped to the testing plants, and also the sampling of coals purchased by various departments of the Government, 966 samples being collected from deliveries to different government buildings in Washington, D. C., and 553 samples being received from various branches of the government service in different parts of the country.

A report on the mine sampling and analysis of the coals tested at Norfolk has been submitted for publication. A bulletin (No. 339) on the purchase of coal under government and commercial specifications on the basis of its heating value was published during the year.

#### SMOKE-ABATEMENT SECTION.

Supplementing the work of the steam-engineering section, H. W. Weeks, of the smoke-abatement section, under the direction of D. T. Randall, compiled data on the methods and appliances used at more than 500 power plants, in nine States, where bituminous coals were burned under boilers without smoke, the main purpose of the inquiry being to procure a basis for better practice at government plants. The information gathered has been tabulated for publication. A preliminary statement (Bulletin 334) dealing with the smoke problem and the essentials of smokeless combustion was published during the year.

#### COKING AND WASHERY SECTIONS.

The coking section at Denver continued under the direction of A. W. Belden, and the washery section, also at Denver, under that of G. R. Delamater. During the fiscal year 57 coking tests and 67 washery tests were completed, the samples being taken from coal seams on or adjacent to public lands of the United States. The tests were made with a view to determining the improvement in quality

to be obtained by washing and the possibility of making satisfactory coke from particular coals, or from mixtures of different coals.

During the year the results of washing and coking tests of coal and cupola tests of coke made by the fuel-testing plant at St. Louis were published in a bulletin (No. 336).

#### BRIQUET SECTION.

The work of the briquet section, under the charge of C. T. Malcolmson, was conducted at the Norfolk fuel-testing plant. About 850 tons of briquets were made, of which 460 tons were for tests on naval vessels, 320 tons for tests on locomotives, and 70 tons for the steam-engineering section. Absorption, specific gravity, tumbler, and weathering tests of the briquets have been made; also flowing tests on binders and tests of oils by distillation.

A discussion of the comparative merits of various substances used as binders was published in Bulletin 343. Another bulletin giving details of manufacture and the results of chemical and physical tests of the briquets made at Norfolk is in preparation. The results of steaming tests with briquets will be published separately.

#### COAL WASTE AND MINE EXPLOSIVES SECTION.

Investigations designed to prevent waste in the development of the nation's fuel supplies and to lessen danger to the miner from explosions of gas or dust were made under the direction of Clarence Hall. During the year Mr. Hall visited the Darr and Naomi mines in Pennsylvania, the Monongah mine in West Virginia, and the Yolande mine in Alabama, where there had been serious explosions, to get at first hand all available data on the conditions existing before the disasters, the exact manner in which the explosions were propagated, and the results of the explosions. He also visited the Shoneberger mine near Pittsburg while it was on fire.

As part of its work this section analyzed samples of black powder and dynamite for the United States Reclamation Service; it also analyzed dynamite and exploders and tested blasting machines and electric fuse wires for the Isthmian Canal Commission, besides inspecting at frequent intervals the plants at which the explosives used by the commission are manufactured. Various other analyses of explosives were made.

A preliminary statistical report on coal-mine accidents was issued as a bulletin (No. 333).

#### STRUCTURAL-MATERIALS DIVISION.

Investigations of structural materials belonging to and used by the United States, such as stones, clays, cements, etc., were continued dur-



ing the year at the structural-materials testing laboratories in Forest Park, St. Louis, Mo. The work was directly under the care of Richard L. Humphrey, engineer in charge of the division, who had the assistance of a corps of engineers, chemists, geologists, and others.

#### LABORATORY WORK.

The following is a résumé of the operations of the division:

*Summary of operations of the structural-materials division.*

Section.	Test pieces.	
	Made.	Tested.
Constituent materials.....	3,915	8,031
Beam.....	1,104	2,764
Block.....	419	716
Permeability.....	1,964	1,866
Shear.....	97	32

In addition to the above-enumerated tests the following analyses were made in the chemical section:

Steel.....	2,011
Cement.....	1,113
Rock.....	38
Wire screen.....	31
Miscellaneous.....	355

Also analyses of water, cement, sand, etc., and 631 determinations of mortars, cinders, steel, cements, lime, and rocks were made for the United States Reclamation Service.

In all 3,548 analyses and about 25,000 determinations were made.

All the laboratory work undertaken was done on a basis of cooperation with the ordnance-testing laboratory at Watertown, Mass., so that duplication might be avoided. No important changes in the equipment of the laboratories were made during the year.

#### FIELD WORK.

A preliminary examination of materials about Denver, St. Louis, and San Francisco, as well as a detailed study of the structural materials about Portland, Oreg., and Tacoma and Seattle, Wash., was made by N. H. Darton, geologist, who was assigned to the technologic branch. Several tons of sand, gravel, and broken rock were obtained at Portland and Seattle and shipped to St. Louis to be tested for their value in concrete.

Other field work was done in Illinois, Iowa, and Missouri, and samples of stone and sand were shipped to St. Louis from several localities.

## PUBLICATIONS.

A bulletin (No. 324) on the San Francisco earthquake and fire; another (No. 329) describing the organization, equipment, and operation of the structural-materials laboratories; a third (No. 331) on Portland cement mortars and their constituent materials; and a fourth (No. 344) treating of the strength of concrete beams have been published during the year. A report describing fire-resisting tests of various building materials has been submitted for publication.

## SPECIAL INVESTIGATIONS.

The following special problems were studied: The occurrence and distribution of workable peat deposits, by C. A. Davis, peat expert; the origin of coal, by C. D. White, geologist; microscopic investigations of coal, by R. Thiessen, assistant chemist; and the occurrence of gases in coal, by R. T. Chamberlin, assistant geologist.

Mr. Davis visited a number of peat bogs in the Atlantic States.

Mr. White completed a study of the relative importance of oxygen and ash in coal as affecting its heating value, based on the large number of ultimate analyses of coal and lignite made by the fuels division, and prepared a report on his findings. Mr. White also took up the experimental treatment of the lignites of North Dakota and eastern Montana, in order to develop methods of handling that will give quantitative as well as microstructural data. Several related coals and some living woods were included in these studies for the sake of comparison.

Mr. Chamberlin, in connection with his work, visited the Monongah mine, in West Virginia, and the Naomi and Darr mines, in Pennsylvania, after disastrous explosions, and collected samples of mine air, after damp, gas, dust, and coal, which he analyzed. Comparative studies on the mine-dust samples, charred and uncharred, old dust from the main entries, and fresh dust obtained near the coal face have been in progress.

## PUBLICATION BRANCH.

## BOOK-PUBLICATION DIVISION.

## SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 1 monograph, 2 professional papers, 30 bulletins (1 of which was also published in 7 separate chapters) and 13 advance chapters from one other bulletin, 22 water-supply papers, 1 annual report on mineral resources for 1906 (also published in 45 separate chapters), 5 advance chapters from the annual report on mineral resources for 1907, and 9 geologic folios. These publications were the Twenty-eighth Annual

Report; Monograph XLIX; Professional Papers 53 and 56; Bulletins 304, 309, 311, 313, 316 (volume and 7 separates), 317 to 337, 339, 13 separates from 340, and 342 to 344; Water-Supply Papers 195, 197, 198, 199, and 201 to 218; Mineral Resources for 1906 (volume and 45 separate pamphlets) and 5 separate chapters from Mineral Resources for 1907; geologic folios 151 to 159, inclusive. Summaries of these publications are given on pages 11–20 of this report. They comprise 10,149 pages, those of the last fiscal year covering 14,875 pages. In addition to the publications of the regular classes many circulars and pamphlets, most of them relating to administration, were published.

During the year 20,691 pages of manuscript were prepared for printing, and proof sheets for 10,827 final printed pages were read and corrected, this work involving the handling of 4,479 galley and 16,140 page proofs. The corresponding figures for last year were 26,912 manuscript pages, 16,833 final printed pages, 7,112 galley proofs, and 28,018 page proofs.

The make-up was prepared for 369 plates, the proofs of which were also read, as against 661 plates so prepared last year.

Indexes were prepared for 39 publications, covering 7,538 pages, the corresponding figures for last year being 67 publications and 12,167 pages.

Six persons have been employed in this section for most of the year. The amount of work recorded is considerably less than that reported last year, but material assistance was rendered at different times in reorganizing the work of the section of distribution.

#### SECTION OF ILLUSTRATIONS.

Illustrations were prepared for 1 annual report, 3 professional papers, 25 bulletins, 7 water-supply papers, 2 volumes of mineral resources, and 1 handbook for geologists. These illustrations consisted of 175 maps, 713 sections and drawings, 3,325 paleontologic drawings, 586 photographs (retouched), and 144 miscellaneous illustrations.

At the close of the year material for the illustration of 28 reports was in hand, part of which has already been prepared. The committee on illustrations has rejected during the year 433 illustrations, or 8 per cent of the number submitted to the publication division.

Proofs to the number of 1,858 were received and compared critically. Not only have many proofs been carried up to the fourth revise, but considerable preliminary proof reading of lithographic map work has been done to expedite the completion of the lithographs by the contractors. The examination of the printed editions of 403 plate inserts delivered by the various contractors at the Government

Printing Office resulted in the rejection of 2,007 copies, and their reprinting was ordered by the Public Printer.

During the year 182 electrotypes were furnished to outside applicants not connected with this Survey, and 45 cuts were reused in various reports.

#### SECTION OF GEOLOGIC MAPS.

The number of folios published and prepared for publication by this section was less than usual this year, and the drafting force was employed part of the time in compiling data for the geologic map of North America and preparing maps for other geologic reports. At the beginning of the year 15 folios were on file or in course of publication, and 4 were transmitted to the section for publication during the year. Of these 9 have been issued. (See pp. 19-20.)

On June 30, 1908, but one folio, Mercersburg-Chambersburg, Pa., was on file and 9 were in course of engraving and publication: Aberdeen-Redfield, S. Dak.; Accident-Grantsville, Md.-Pa.; Bellefourche, S. Dak.; El Paso, Tex.; Franklin Furnace, N. J.; Philadelphia, Pa.-N. J.; Santa Cruz, Cal.; Trenton, N. J.-Pa.; Watkins Glen-Catatonk, N. Y.

#### SECTION OF TOPOGRAPHIC MAPS.

A year ago the editor of topographic maps reported 69 new topographic atlas sheets and special maps which had not yet been put into the hands of the engravers and 34 in process of engraving. The corresponding figures on June 30, 1908, were 54 and 37. The accessions during the year numbered 81 maps, and the withdrawals 3 maps; 90 maps were published.

Manuscripts edited, including verification or correction of all geographic names: Atlas sheets and special maps, 77; corrections, 158 maps. Proof read: New topographic atlas sheets and special maps, 90; corrections, 158. During the year the manuscripts of 179 map illustrations to be included in 33 volumes, including 2 Senate documents, were examined and edited. Five persons were engaged in the work of this section during the entire year.

#### SECTION OF DISTRIBUTION.

There were delivered to the section of distribution during the year 127 new books, 9 folios, 87 new maps, 127 reprints of maps, and 15 special maps, a total of 365; the totals of all editions being 332,523 books, 42,231 folios, and 534,477 maps; grand total, 909,231.

During the year 333,705 volumes, 39,389 folios, and 474,868 maps (including 369,521 sold), a total of 847,962, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was \$17,013.56, a decrease of \$1,619.75 from the amount received during the year 1906-7.

During the year 76,670 letters were received, answered, and filed, being 7,210 fewer than for the preceding year.

## DIVISION OF ENGRAVING AND PRINTING.

## MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 103 atlas sheets and special maps were on hand for publication, 34 of which were partly engraved. Of these, 3 were afterward withdrawn, leaving 100. The accessions during the year (comprising new maps, reductions, and combinations) numbered 81 maps. The status of these 181 maps on June 30, 1908, was as follows:

Published during the year or in press at its close (double sheets counted one)-----	90
In process of engraving-----	37
Not taken up-----	54

Besides the engraving of new maps, corrections were made on the copperplates of 158 maps hitherto published. Editions of 214 maps were printed and delivered to the map room. Of these, 87 were new and 127 were reprints or new editions.

Nine geologic folios were published and 42,231 copies printed and delivered. Nine other geologic folios were partly completed at the close of the year.

Under contracts with the Government Printing Office, illustrations were printed for the following publications: Professional Papers United States Geological Survey, Nos. 55, 60, 62, 63; Bulletins United States Geological Survey, Nos. 318, 320, 321, 324, 335, 338; congressional documents, Sixtieth Congress, first session—Senate Documents Nos. 151 and 325, Senate Report No. 580, and House Document No. 719. For the Government Printing Office, also, maps of 9 bird reservations, 2 national monuments, and 1 national park were reproduced and printed. For the Forest Service maps of 27 national forests were reproduced, printed, and delivered. This work for other branches of the Government amounted to \$46,800.90, and 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 over two million and required over seven million printings. The total number of copies printed of maps, folios, and miscellaneous matter was 2,824,796, requiring over eleven million impressions. There were also 299 transfer impressions made and sent 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 1,700 repairs were made to instruments, and 273 new copperplates and 35 electrotypes were finished.

#### PHOTOGRAPHIC LABORATORY,

The output of the laboratory included 14,194 negatives, of which 13,087 were glass and 1,107 were paper; 42,763 prints, of which 11,650 were map prints and 31,113 were mat prints; and 1,411 lantern slides.

#### ADMINISTRATIVE BRANCH.

##### EXECUTIVE DIVISION.

*Correspondence, records, appointments, supplies, and shipments.*—The total amount of work performed in this section was considerably greater than that for the fiscal year ending June 30, 1907. The scope of the work of the section has been enlarged (1) by the appointment of a purchasing clerk, whose duty it is to make arrangements for purchases of all material procured at Washington in the open market, and to issue the orders therefor; (2) by the establishment of a "follow-up" system on all correspondence recorded in the section; (3) by the recording of a greater proportion of the letters received; (4) by the establishment in the section of the sales offices for local cash sales of Survey publications; (5) by the establishment of a system of cost keeping; and (6) by the increased number of letters filed. Moreover, the general growth of the Survey manifests itself at every desk in this section.

*Mails, files, and records.*—During the year 107,283 pieces of mail were received, an increase of 2 per cent over the number for the previous fiscal year. Of this mail, 20,218 pieces, an increase of more than 10 per cent over the number for 1907, contained remittances for sale publications of the Survey.

The recording and filing of correspondence required the services of three clerks throughout the greater part of the year. The number of letters mailed through the section was 66,860, of which 17,509 were registered.

*Personnel.*—In the roster of secretarial appointments 916 changes were made and recorded during the year, as compared with 1,002 in the previous year. Of these changes 335 were new appointments, 147 separations (4 by death), 247 promotions, and 9 reductions. The remaining 178 changes were such as not to affect the total number of employees or the pay rolls, and included extensions of limited appointments, changes of title, changes from annual to per diem rating or the reverse, the designation of disbursing agents, etc. The decrease in the number of changes recorded is accounted for by the change in the department method of making probationary appointments absolute. There are now on the rolls of the Survey 840 names, an increase of 188, or 28.8 per cent.

An average of 1,250 applications for leave were handled per month, or 15,000 for the year. These covered 11,331 days of annual leave and 2,428½ days of sick leave, being 55 per cent of the amount of annual leave and 12 per cent of the amount of sick leave which it is permissible to grant under the law; also 8,508½ days of leave without pay. The above figures of leave without pay do not cover the transfers to state pay rolls, nor do they include 64 indefinite furloughs, which were made in December for employees of the technologic branch.

*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 nearly completed at the end of the year.

The amount derived from the sale at public auction of property examined by inspectors and found unserviceable was \$1,418.77. During the preceding fiscal year it was \$2,946.29.

*Express and freight.*—During the year 4,750 pieces of express and freight, of which 1,092 pieces were outgoing and 3,658 pieces were received, were handled by the shipping clerk, who also checked 641 freight and express accounts.

*Purchase and distribution of supplies.*—The present system concentrates in this section all operations connected with purchases in Washington, such as procuring bids, issuing orders, and preparing vouchers, and requires the services of three persons during most of the time. During the year 2,220 requisitions were handled, which involved the drawing of 2,360 orders. Under the system of drawing the order and preparing the voucher at one operation, the number of vouchers passed was the same as that of orders drawn.

*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 8,913 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand and 447 requisitions were drawn on the department for supplies. In addition to this work, 613 requisitions for printing were made on the department, and 397 requisitions for furniture and supplies.

*Administrative bookkeeper.*—All transactions of the Survey requiring administrative examination and check are handled by the administrative bookkeeper, who acts in the dual capacity of audit clerk and bookkeeper. A satisfactory system of accounts and double-entry bookkeeping was adopted at the beginning of the year, the net results of which are given in the following table of classification of disbursements, the repayments shown in the table on page 91 having been deducted.

## Classification of expenditures by the United States Geological Survey for the fiscal year ended June 30, 1908.

Appropriation.	Salaries and wages.	Traveling expenses.	Office furniture and fixtures.	Telegrams and telephones.	Instruments.	Camp outfit.	Subsistence.	Forage.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory	\$64,503.45									
Skilled laborers, etc.	19,964.45									
Gaging streams, etc.	76,335.05	\$5,829.01	\$565.39	\$271.05	\$1,330.43	\$571.10	\$8,277.17	\$548.68		
Paleontologic researches	8,883.75	484.86	3.73	1.20	.60	16.05	303.00	221.42		
Chemical and physical researches	17,103.59	23.24	73.40	.50		67.47	13.35			
Preparation of illustrations	16,862.32	2.25	73.83	24.91	8.41		.50			
Report on mineral resources	57,332.76	5,182.41	1,969.94	447.52	185.28	43.94	2,375.90	13.20		
Topographic surveys	176,752.91	24,494.92	719.40	360.47	5,717.13	13,145.73	46,990.02	17,002.40		
Geologic surveys	145,881.87	14,345.72	1,764.36	232.16	2,923.60	7,414.11	11,619.77	4,113.05		
Mineral resources of Alaska	41,181.84	14,920.62	1,142.96	91.57	262.39	6,271.37	7,523.12	2,329.14		
Geologic maps of United States	65,871.17	50.55	693.44	19.23	45.90		105.60			
Surveying forest reserves	60,628.10	3,895.43	244.20	56.78	1,653.38	2,101.80	11,331.70	8,252.62		
Testing fuel	176,196.91	10,306.40	1,106.53	352.45	1,065.62	389.80	11,031.57	1,366.75	\$20,825.29	\$12,357.27
Testing structural materials	64,016.22	3,567.36	241.08	579.87	962.68	72.85	2,402.94	3.10	15,127.16	3,034.35
	991,514.39	83,102.77	8,598.26	2,437.51	14,155.42	30,094.22	101,976.64	33,850.36	35,952.45	15,391.62

Appropriation.	Stationery supplies.	Library.	Rent.	Transportation of property.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Total.
Salaries, statutory										\$64,503.45
Skilled laborers, etc.										19,964.45
Gaging streams, etc.										99,136.23
Paleontologic researches	\$1,206.02		\$1,120.00	\$1,092.71	\$601.60		\$1,339.34	\$48.68		9,967.36
Chemical and physical researches	14.00			16.00	20.40		.35			19,485.09
Preparation of illustrations	35.02			30.13	9.96		2,126.13	2.50		17,793.17
Report on mineral resources	115.03			4.00		\$626.27	65.65			71,148.22
Books for library	1,892.68		512.43	315.08	68.95		796.78	11.35		1,774.73
Rent of basement	12.76	\$1,734.98		26.99						1,500.00
Rent of office rooms			1,500.00							3,000.00
Topographic surveys	3,891.95		3,000.00							299,871.28
Geologic surveys	1,553.81		264.07	5,201.03	1,892.31		15.40	524.43	\$2,899.11	196,505.23
Mineral resources of Alaska	507.67		6.00	1,950.23	3,884.86		471.55	344.14		79,707.08
Geologic maps of United States	208.56		68.00	4,378.55	662.81		303.10			98,868.76
Surveying forest reserves	7,062.70		8.00	730.75	1,075.23	31,791.16	9.26	418.40	49.70	97,534.85
Testing fuel	813.50		24.80	2,708.30	1,093.78		7,998.13	71.50		247,781.34
Testing structural materials	537.06		97.54	3,437.10	517.72		4,147.43	113.08		99,017.20
	17,850.76	1,734.98	6,858.04	19,966.02	9,827.62	32,427.43	17,207.47	1,663.67	2,948.81	1,427,558.44

## 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, 1908.*

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director.....	\$35,340.00	.....	\$35,340.00	\$34,003.46	\$736.54
Salaries, scientific assistants.....	29,900.00	.....	29,900.00	29,899.99	.01
Skilled laborers, etc.....	20,000.00	.....	20,000.00	19,964.45	35.55
Gaging streams, etc.....	100,000.00	\$28,270.73	128,270.73	127,406.96	863.77
Paleontologic researches.....	10,000.00	3.42	10,003.42	9,970.78	32.64
Chemical and physical researches.....	20,000.00	4.35	20,004.35	19,489.44	514.91
Preparation of illustrations.....	18,280.00	10,655.00	28,935.00	28,448.17	486.83
Report on mineral resources.....	75,000.00	1,147.42	76,147.42	72,295.64	3,851.78
Books for library.....	2,000.00	.....	2,000.00	1,774.73	225.27
Rent of basement.....	1,500.00	.....	1,500.00	1,500.00	.....
Rent of office rooms.....	3,000.00	.....	3,000.00	3,000.00	.....
Topographic surveys.....	300,000.00	16,418.19	316,418.19	316,289.47	128.72
Geologic surveys.....	200,000.00	9,022.46	209,022.46	205,527.69	3,494.77
Mineral resources of Alaska.....	80,000.00	107.34	80,107.34	79,814.42	292.92
Geologic maps of United States.....	100,000.00	46,802.74	146,802.74	145,671.50	1,131.24
Surveying forest reserves.....	100,000.00	167.40	100,167.40	97,702.25	2,465.15
Testing fuel.....	250,000.00	2,806.95	252,806.95	250,588.29	2,218.66
Testing structural materials.....	100,000.00	945.84	100,945.84	99,963.04	982.80
	1,445,020.00	116,351.84	1,561,371.84	1,543,910.28	17,461.56

## LIBRARY.

*Accessions.*—Inadequate room in the library has forced the continuance of the policy of discarding books to make room for accessions. During the twenty-six years of its existence the library has acquired, by exchange and otherwise, many valuable works that are not wholly of geologic interest. Although these would not be out of place here if shelf room were ample, they have been removed to make room for works more frequently consulted. More to be regretted was the necessity of discarding, on account of their large size, a number of periodicals, including some mining journals; but the discarded books are transferred to the Library of Congress, where they are cared for and made available for reference.

In the Library of Congress the section of geology is unimportant, this subject being left for the Geological Survey's library to cover. The Survey library is therefore coming to be used more and more by geologic students and writers, both resident in Washington and visiting. The readers in the library this year numbered 8,580, and the books loaned, not including those consulted in the library, 9,279.

Owing to the more rigid scrutiny of accessions the increase during the year was less than usual. About 10,000 items, including books, pamphlets, periodicals, and maps, were added. Notable among these are:

Journal of the Royal Microscopical Society of London, 1878-1898. 21 volumes.  
 Abhandlungen der Naturforschenden Gesellschaft, Halle, 1853-1906. 22 volumes.  
 Mitteilungen der Ungarischen Geologischen Gesellschaft, 1872-1882.

During the year 1,990 complete volumes were added to the accessions record, which on June 30, 1908, shows the library to contain 62,174 volumes. This number is exclusive of the 3,894 numbered volumes that have been transferred to the Library of Congress.

As in past years, the exchange list has been supervised in the library. All publications of the Survey so far as issued have been distributed to its correspondents, from whom a large proportion of the most valuable additions to the library are received, including the transactions of all the known geologic societies of the world, most of the geologic reports issued by governments, many important private monographs, and other publications.

The appropriation of \$2,000 for purchase of books enables the library to acquire about 70 periodicals, the principal new publications of geologic interest, and occasionally to add, through purchase from second-hand dealers, some rare out-of-print works long needed.

*Catalogue.*—About one-sixth of the contents of the library have now been completely catalogued, and printed entries therefor have been incorporated in the card catalogue. All the rest are briefly entered in the library records, and, being classified on the shelves, are available when called for. The complete cataloguing is continued as rapidly as possible, 6,960 volumes having been catalogued and shelf-listed this year.

Practically all the catalogue entries of geologic books (except those of copyrighted books) that are printed on cards for sale by the Library of Congress are supplied by the Survey library, 1,106 of these entries having been furnished during the last year.

A card catalogue of the geologic books in the Library of Congress is also maintained in the library of the Survey, as an adjunct to the catalogue of its own books.

The map catalogue includes about 700 entries, principally of maps published in the United States by the various state surveys, by the Government of Great Britain, and by the geological surveys of Norway and Sweden. It includes also folios of the Geologic Atlas of the United States.



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