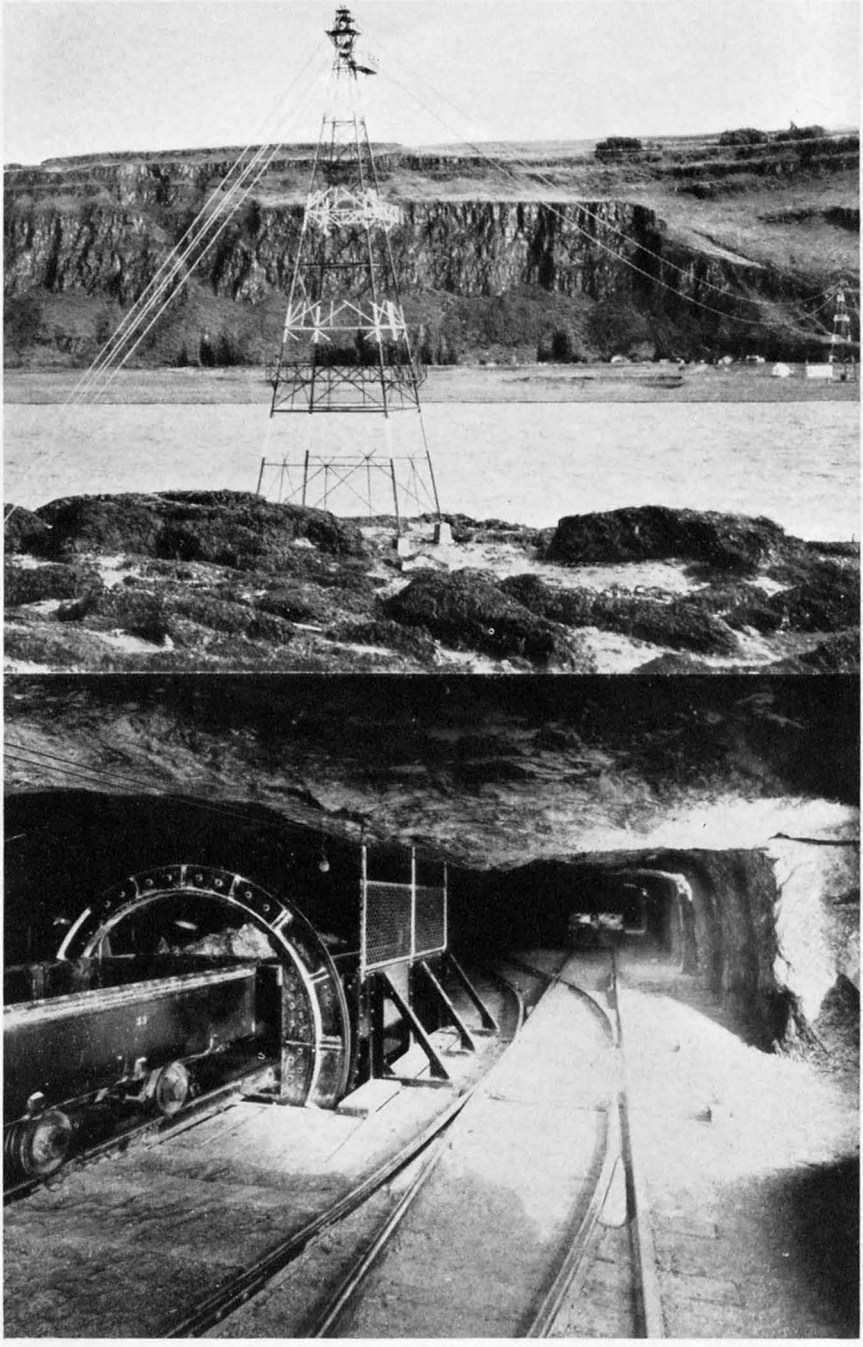

UPPER: MEASURING CABLE ON THE COLUMBIA RIVER.
LOWER: A POTASH MINE NEAR CARLSBAD, N. MEX.

GEOLOGICAL SURVEY

W. C. Mendenhall, *Director*

BASICALLY important in the general program of conservation and development were the results of the Geological Survey's work during the fiscal year 1938. Investigations of the Nation's mineral and water supplies were conducted with all possible vigor and dispatch, thousands of square miles were surveyed for topographic maps, and technical supervision was given to prospecting, mining, and producing operations on public and Indian lands. This work was accomplished through the use of the regularly appropriated funds, the cooperative funds from States, counties, and municipalities, the funds transferred from other departments of the Government for types of work within the Survey's field, and the emergency funds derived chiefly from the Public Works Administration and devoted largely to mapping of various types and to studies of floods. The aggregate expenditures amounted to $5,248,000, which was $265,000 less than the amount expended during the preceding year.

More than 3,600 analyses and tests of mineral and rock samples were made, including more than 1,100 for persons not officially connected with the Geological Survey.

New area to the extent of 13,500 square miles was surveyed in the field topographically. This work will yield contoured topographic maps of 198 areas in 35 States and in Puerto Rico. In addition, by the aid of aerial photography, 2,077 square miles was surveyed in four States for the production of planimetric maps without contours.

Fifty-six book publications of the Survey's regular series, and 23 pamphlets and circulars, aggregating more than 8,900 pages of printed matter, dealing with geology, mineral resources, and water supplies, were issued during the year, and about 822,000 copies of 312 topographic and other maps were printed. The geologic map of the Front Range, Colo., was prepared.

There were 63 geologic parties in the field in 35 States and Alaska. The field investigations on several continuing projects were completed, and work was begun on new projects, including geologic studies of areas in Idaho, Nevada, Colorado, and New Mexico. The

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geologic investigation of the platinum deposits at Goodnews Bay, Alaska, which now form the principal domestic source of platinum metals in the United States, was completed.

Measurements of stream flow were maintained at 3,831 stream-gaging stations. All the States, the District of Columbia, and Hawaii are affected by this work. Flood studies were continued during the year. Analyses were made of more than 2,400 samples of underground or surface waters to determine the suitability of the waters for industrial, agricultural, or domestic uses.

In the administration of the land-classification and mineral-leasing activities of the Survey more than 15,000 reports were made on cases requiring an expression of opinion and advice. Mineral production during the year from public and Indian lands and naval petroleum reserves under supervision of the Survey had an estimated value of $88,500,000, and revenue received by the Government as a result of this production amounted to about $9,750,000. This revenue and the conservation of the mineral resources involved were attributable, both directly and indirectly, to supervision by the Survey, which insures orderly and complete development of those resources.

An allocation of $2,690,000 from the Public Works Administration for scientific and engineering work, but chiefly for topographic mapping, will bring the total funds available for 1939 close to $7,500,000, and the Geological Survey looks with high hope to the work that can be accomplished for the public good.

GENERAL SUMMARY OF THE YEAR'S ACTIVITIES

Geologic work.—Sixty field parties were active during the year, and work was done in 35 States. Work continued throughout the year in metal mining districts of Colorado, Idaho, New Mexico, the oil and gas region of Kansas, and in the Carboniferous areas of Illinois, in cooperation with the States. Physiographic and geologic studies were continued in the Yosemite, Sequoia, and Zion National Parks in cooperation with the National Park Service. Cooperation was also continued with the American Petroleum Institute. Several major projects begun in 1937 or earlier were continued, and those on the Colorado Front Range, the Metaline mining district, Washington, the La Plata district, Colorado, and on the Pottsville flora of Illinois, were completed. New projects include the mineral resources of Kootenai County, Idaho, in cooperation with the State, a geologic and geophysical investigation of the ore deposits of the Austin district, Nevada, geology and mineral resources of the Duck Valley Indian Reservation, Nev., for the Office of Indian Affairs, the Chattanooga and Gold Hill mining districts, Colorado, and the Big Hatchet Mountains, N. Mex. Work for other Federal bureaus included examinations of dam sites for the Corps of Engineers, work in the Yosemite and Sequoia National Parks, Calif., and in the Zion and Bryce Canyon National Parks, Utah, the examination of mineral deposits for the Tennessee Valley Authority, and special geologic investigations for the Public Health Service and for the Department of Justice. More than 3,600 analyses and tests of mineral and rock samples were made, including 1,147 for persons not officially connected with the Survey. Tests of bleaching clays and temperature measure-

ments of deep wells were continued. Mathematical tables for calculating temperatures were prepared, contributory to a long study of geothermal methods for estimating the age of the earth which is nearing completing.

Explorations in Alaska.—During the field season of 1937 five field projects were carried on by the Alaskan branch of the Geological Survey. Of these three were concerned principally with geologic investigations relating to the mineral resources of the Territory and two were primarily topographic. For the field season of 1938 six field projects had been started before the end of the fiscal year 1937–38 and one additional field project was to be undertaken as soon as practicable. All of these field projects will be continued throughout the open season as late as conditions permit. Other work included the usual collection of statistics regarding the production of mineral commodities, the answering of many inquiries relating to the mineral resources of the Territory, and office and laboratory studies required to prepare the results of the field surveys for publication.

Topographic mapping.—The area covered by new topographic surveys, resurveys, and revision amounted to 13,583 square miles, which comprises the entire area or portions of 198 topographic maps with contours. Topographic mapping was done in 35 States and in Puerto Rico. Cooperation was had with 16 States, Puerto Rico, and the Tennessee Valley Authority. The area covered by planimetric maps without contours, resulting from aerial photography, covered 2,077 square miles in 4 States. By a cooperative agreement with the Tennessee Valley Authority, the Geologic Survey mapped from aerial photographs by stereophotogrammetric methods 1,168 square miles covering in whole or in part 29 quadrangles. Fifteen stereophotogrammetric instruments have now been installed at the Chattanooga office of the Geologic Survey. The aerial photographic method of mapping is gaining in favor. There are many areas in the United States in which this method could be applied most economically. In addition to the routine adjustment of primary control, there has been in progress a general adjustment of both horizontal and vertical control to agree with the standard datums of the United States. During the year eight bulletins reporting the results of control surveys have been prepared, and three that were previously prepared were published. The office work on river surveys that were made by the Conservation Branch is steadily progressing. The maps of 28 projects, comprising 114 sheets, were sent forward for reproduction during the year. The preparation of the transportation map of the United States, in sections, for the Bureau of Public Roads, was continued, and maps of 5 States, comprising 38 sheets, were published. Work on the United States portion of the map of the world on the scale of 1 : 1,000,000 was resumed. One hundred and sixty maps were prepared for photolithographs and 97 for engraving, and 212 maps were prepared for reprinting. An exhibit comprising 40 maps was prepared and sent to the International Geographic Congress at Amsterdam, Netherlands.

Investigation of water resources.—The water-resources branch collected and made available for publication stream-flow records at 3,831 river-measurement stations in the 48 States, the District of Columbia, and the Territory of Hawaii, obtaining this authentic information on the behavior of streams in drought, in flood, and in normal conditions—information that is invaluable for intelligent planning of projects for use or control of the surface water supply. It investigated underground water supplies in 34 States and in Guam, Hawaii, and the District of Columbia and obtained basic information on the occurrence, quantity, and quality of underground water supplies which is essential for the development, conservation, and use of ground water upon which a large part of the population of the country must depend. Investigations of stream-flow and silt movement of streams in seven projects of the Soil Conservation Service, and similar studies on the Colorado River, have also been continued. Analyses, partial or complete,

were made of 2,474 samples of water from surface and underground sources with reference to the suitability of the waters for industrial and agricultural uses and for domestic use (aside from questions of health), so far as such use is affected by the dissolved mineral matter. The annual report on the capacity of water wheels in water-power plants in the United States of 100 horsepower or more on January 1, 1938, was compiled. Engineers of the branch had field supervision of operation under permits and licenses of the Federal Power Commission in connection with 155 projects. Investigations of the water problems along the international boundary between the United States and Canada were continued for the State Department. The collection of information on recent outstanding floods was continued.

Classifying public land and supervising mineral leases.—The conservation branch made 15,509 formal findings of technical fact involving the mineral resources, water power, or storage possibilities of public land; added 97,583 acres to outstanding water-power reserves and eliminated 5,890 acres therefrom; defined the known geologic structure of 1 producing oil and gas field involving 1,391 acres; completed 32 miles of river-utilization surveys and surveyed in detail 4 dam sites in public-land States; prepared 3 reports based on geologic and geophysical studies of formation materials and conditions at dam sites; administered activities and operations under 155 power projects licensed by the Federal Power Commission and 172 permits and grants from the Department of the Interior; supervised on public land 8,605 oil and gas holdings involving 4,334 productive wells and 731 coal properties, 39 potash properties, 66 sodium properties, 27 sulphur properties, 11 phosphate properties, and 1 oil-shale property involving 526 productive mines; assisted hundreds of oil and gas permittees and operators in preparation of unit plans of development and operation; classified approximately 7,800 outstanding oil and gas prospecting permits under the extension provisions of the act of August 26, 1937 (50 Stat. 842); supervised on naval petroleum reserves 22 leaseholds involving 519 productive oil and gas wells; and on Indian land 5,382 leaseholds involving 4,407 oil and gas wells, 235 mining properties involving 44 lead and zinc properties, 142 coal properties, and 49 other mineral properties; issued the revised ooal operating regulations, effective December 23, 1937; changed territorial delineation of the three oil and gas supervisory districts and created a fourth supervisory district with headquarters at Roswell, N. Mex.

Publications.—The publications of the year consisted of 56 reports in the regular series and 23 pamphlets and circulars for administrative use, a total of 8,910 pages; 110 new or revised topographic and other maps and 202 reprinted maps. Among the book publications were reports on the geology of the Yukon-Tanana region, Alaska; the geology and mineral resources of areas in Colorado, Idaho, and Oregon; spirit leveling in Kansas, Missouri, and Vermont; records of water levels and artesian pressure in observation wells in the United States in 1936; ground water in south-central Nebraska and in areas in Arizona, Texas, and Utah; the thermal springs of the United States; the warm springs of Georgia; the floods of March 1936 in the eastern United States and floods in California and Texas; and several paleontologic papers. A revision of the operating regulations to govern coal-mining methods and the safety and welfare of miners on leased lands on the public domain was also issued. Besides these printed reports 24 brief papers were issued in mimeographed form as memoranda for the press or as informative circulars.

The engraving and printing division printed more than 822,000 copies of maps and did repay work amounting to about $195,000 for 72 other units of the Federal and State Governments.

NOTE.—Detailed tabular statements are given at the end of the report.

GEOLOGIC BRANCH

SUMMARY

Sixty field parties were active during the year, and work was done in 35 States. Work continued throughout the year in metal mining districts of Colorado, Idaho, New Mexico, the oil and gas region of Kansas, and in the Carboniferous areas of Illinois, in cooperation with the States. Cooperative investigations with the American Petroleum Institute were continued. Physiographic and geologic studies were also continued in the Yosemite, Sequoia, and Zion National Parks in cooperation with the National Park Service. Several major projects begun in 1937 or earlier were continued and those on the Colorado Front Range, the Metaline mining district, Washington, the La Plata district, Colorado, and on the Pottsville flora of Illinois, were completed. New projects include the mineral resources of Kootenai County, Idaho, in cooperation with the State, a geologic and geophysical investigation of the ore deposits of the Austin district, Nevada, geology and mineral resources of the Duck Valley Indian Reservation, Nev., for the Office of Indian Affairs, the Chattanooga and Gold Hill mining districts, Colorado, and the Big Hatchet Mountains, N. Mex. Work for other Federal bureaus included examinations of dam sites for the Corps of Engineers, work in the Yosemite and Sequoia National Parks, Calif., and in the Zion and Bryce Canyon National Parks, Utah, the examination of mineral deposits for the Tennessee Valley Authority, and special geologic investigations for the Public Health Service and for the Department of Justice. More than 3,600 analyses and tests of mineral and rock samples were made, including 1,147 for persons not officially connected with the Survey. Tests of bleaching clays were continued and aided further in placing an important paying industry on a firm foundation. Temperature measurements of deep wells were continued, and mathematical tables for calculating temperatures were prepared, contributory to a long study of geothermal methods for estimating the age of the earth, which is nearing completion.

WORK OF THE YEAR BY STATES

Alabama.—Additional field work was done in the Greasy Cove area, Etowah County, in connection with a study of iron ore in the Red Mountain formation in northeastern Alabama, and the investigation of the brown iron ore in the Russellville district was continued. Stratigraphic examinations were made of the Upper Cretaceous and Tertiary formations. An investigation for the Public Health Service was made of geologic and ground-water conditions in Coffee County, to determine their possible influence on the prevalence of tuberculosis.

Arizona.—Investigations were made of the geology and ore deposits of the Benson and Pearce quadrangles and of the manganese deposits in the Artillery Peak Mountains. A report on the ore deposits of the Tombstone district, prepared in cooperation with the Arizona Bureau of Mines, was transmitted to that

bureau for publication. Progress was made on reports on the geology and mineral resources of the Tucson quadrangle and on the geology and ore deposits of the Ajo quadrangle.

Arkansas.—A field study was made of quartz veins and some mineral deposits of Magnet Cove, Crystal Mountains, and other areas in western Arkansas. Papers on volcanic activity at Magnet Cove, taeniolite from Magnet Cove, unweathered manganese deposits of the Batesville district, and Pennsylvanian sedimentation in the Arkansas coal field were submitted for outside publication, and a paper on the influence of structure in localizing ore in the quicksilver deposits of southwestern Arkansas was submitted to the National Research Council. Bulletin 886–C on the geology and ore deposits of the southwestern Arkansas quicksilver district was issued. Reports on the fauna and stratigraphy of the Morrow group of Arkansas and Oklahoma, on recent developments in the Batesville district manganese deposits, and on the geology of the Fort Smith district are in preparation for official publication.

California.—A comprehensive report on the general geology, physiography, paleontology, and stratigraphy of the Kettleman Hills oil field and a report on the geology and ore deposits of the Grass Valley region are in process of publication. Studies of the Foraminifera of the Kreyenhagen shale of Garza Creek; stratigraphy, structure, and petrology of the siliceous rocks of the Monterey formation; the geology of the San Andreas Rift; the east front of the Sierra Nevada with regard to problems of the age of the fault escarpment; and the geology and mineral resources of the Death Valley region and of the Elsinore, San Luis Rey, and Corona quadrangles were in progress. Field investigations of the geologic structure, stratigraphy, and oil resources of the lower Tertiary strata in Reef Ridge in the Kettleman Plains and the Dudley No. 2 quadrangle in the Coalinga region, and of the geology and mineral resources of the Palos Verdes Hills, including a study of the Wilmington oil field, were completed. To obtain data for a study of source beds of petroleum, oil centers in California were visited. In cooperation with the National Park Service a geologic reconnaissance of the northwestern part of Yosemite National Park was continued. Papers were submitted for outside publication on the calcium carbonate content of some Mesozoic and Tertiary sediments, vein filling at Nevada City, arsenic from gold quartz veins of Grass Valley, and copper deposits in serpentine in southwestern Oregon and northwestern California as illustrated by the Cowboy mine.

Colorado.—The program for investigation of some mining regions in the State in cooperation with the State of Colorado and the Colorado metal mining fund was continued. Field studies of the Ouray district in the San Juan region, of the Cripple Creek district, and of districts in the La Plata Mountains were completed. Other studies were made in the Gold Hill mining district, in the Idaho Springs and Central City districts in the Front Range, and in the Chattanooga and Kokomo-Robinson districts. A paper on copper ores of the La Plata district and an explanatory text to accompany the geologic map of the Front Range mineral belt were submitted to the Colorado Scientific Society for publication. Other papers to be published outside were prepared on the Laramide igneous sequence and differentiation in the Front Range, stoping and assimilation in a granodiorite stock at Jamestown, and the Leadville district (National Research Council). A memorandum for the press was issued on platinum metals in a Colorado copper district. Progress was made on reports on the geology and ore deposits of the Ouray district, the Front Range, the La Plata district, the Jamestown mining district, the Kokomo-Robinson district, the Cripple Creek district, the Gold Hill mining district, and on the Nederland tungsten deposits, Paleozoic stratigraphy in the Sawatch Range, and the geology and mineral resources of the west slope of the Mosquito Range. Non-cooperative investigations

in the State consisted of completion of field studies in the Yampa coal field, in northwestern Colorado. A report on the alkaline rocks of Iron Hill was submitted for official publication, and papers on plagioclase and orthoclase feldspar from the Tertiary rocks of the San Juan region for outside publication. A report on the geology and mineral resources of the Snowmass Mountain area was published as Bulletin 884.

Florida.—A study of the physical geography of the State in cooperation with the Florida Geological Survey is in progress. A geophysical survey was made across the peninsula in north-central Florida, and stratigraphic and paleontologic studies were made of the Tertiary formations of the State and on the gastropods of the Alum Bluff group. A report on phosphate investigations in 1934–35 was completed for official publication. A paper on the molluscan fauna from the upper bed at the A. L. Parrish farm, Washington County, with notes on the Foraminifera from the upper and lower beds at the same locality, was submitted for outside publication.

Georgia.—The detailed areal mapping and study of ore deposits in the Cartersville district and the investigation of the geology of the Coastal Plain of Georgia, in cooperation with the Division of Mines, Mining, and Geology of Georgia, were continued. A reconnaissance study was made of the Upper Cretaceous formations of the State for the purpose of correlating these formations with those of Mississippi and Alabama. A report on the warm springs of Georgia and their geologic relations and origin was published as Water-Supply Paper 819. A paper on stratigraphy of the Coastal Plain of Georgia was published in the Bulletin of the American Association of Petroleum Geologists.

Hawaii.—A geophysical survey in the Hawaiian Islands was undertaken for the purpose of determining water supplies.

Idaho.—Cooperation with the Idaho Bureau of Mines was continued in studies of geology and ore deposits of the Dixie mining district, the placer deposits of central Idaho, the dry belt of the Coeur d'Alenes, the mining district in Kootenai County, the Atlanta-Rocky Bar mining district, the Florence mining district, and the Boise Basin. A report on geology and ore deposits near Murray was transmitted for publication by the Idaho Bureau of Mines, and papers on structural setting of veins in the Elk City and Warren districts and influence of structure in localizing ore in the Boise Basin were submitted to the National Research Council. Noncooperative projects consisted of a reconnaissance of physiography and glacial geology of eastern Idaho and detailed mapping of the geology and mineral resources in the Borah Peak, Irwin, Ammon, and Paradise Valley quadrangles. Bulletin 877 on the geology and ore deposits of the Bayhorse region, Custer County, was issued.

Illinois.—Cooperation with the Illinois Geological Survey in the study of the Pottsville flora of the Eastern Interior Basin was continued, and studies of the Fusulinidae of the Pennsylvanian series in Illinois were in progress. A paper on the origin of the bedding replacement deposits of the Illinois fluorspar field was prepared for outside publication.

Indiana.—A preliminary account of the flora of the New Albany shale of Indiana and Kentucky was submitted for outside publication. A paper on gastropods from the Spergen formation is in preparation. The report on the Pottsville flora of the Eastern Interior Basin is mentioned under Illinois. A study of Devonian fossils and stratigraphy is mentioned under Michigan.

Kansas.—In cooperation with the Geological Survey of Kansas, investigation of the subsurface Mississippian rocks was continued and a study of subsurface rocks of pre-Chattanooga age was begun. A temperature investigation of shallow shoestring sand pools in southeastern Kansas and northeastern Oklahoma and

geophysical observations in oil and gas districts of eastern Kansas were made. A paper on oil and gas resources of western Kansas was submitted to the American Association of Petroleum Geologists and one on Mississippian rocks of Labette County to the Kansas Geological Survey for inclusion in a State report on that county. Studies of source beds in Kansas and of the lead and zinc deposits of southeastern Kansas included in the Tri-State district are mentioned under Oklahoma.

Kentucky.—A report on additions to the Wilcox flora from Kentucky and Louisiana was completed for official publication. Work on the Pottsville flora of the Eastern Interior Basin is mentioned under Illinois. Preliminary account of the flora of the New Albany shale is mentioned under Indiana. A study of Devonian fossils and stratigraphy is mentioned under Michigan.

Louisiana.—A revised edition of the map of Louisiana, showing oil and gas fields, salt domes, and prospects, was prepared. A report on the Wilcox flora is mentioned under Kentucky.

Maine.—A study of the granites on Crotch and Deer Islands in the Stonington district was made in connection with a study of commercial granites and mapping granite quarries in New England.

Maryland.—In informal cooperation with the Maryland Geological Survey a geologic map with structure sections of Frederick County, including parts of Carroll and Washington Counties, was transmitted to the Maryland Geological Survey. Geophysical investigations in the Soldiers Delight and adjacent area were continued.

Massachusetts.—Study of commercial granites and mapping granite quarries in New England included granite areas in Massachusetts.

Michigan.—The resistivity survey of some oil districts near Lansing by members of the geophysical section in cooperation with the Department of Conservation of the State of Michigan was completed and the report transmitted to the State for publication. Studies of Devonian fossils and stratigraphy in Michigan, Indiana, Kentucky, and Ohio were continued.

Mississippi.—Studies of the stratigraphy of the Upper Cretaceous deposits and of the geology of the Jackson gas field were continued, and a paper on the State's deep test well in the Jackson gas field was sent to the Mississippi Geological Survey for publication.

Missouri.—A report on the stratigraphy and fauna of the Louisiana limestone of Missouri was transmitted for publication, and work on a paper on the Warsaw fauna of the Joplin district was continued.

Montana.—General reconnaissance studies of the physiography and glacial geology of portions of western Montana, northwestern Wyoming, and eastern Idaho, detailed studies of the geology and the coal, gas, and oil resources of the Little Rocky Mountains and adjacent areas, and an investigation of scarps and other evidences of Pleistocene and Recent faulting in southwestern Montana were continued. Field examinations of geologic structure and fuel resources of a part of Carbon County and of the geology and coal resources in the Otter Creek area, Powder River, Rosebud, and Big Horn Counties, were begun. An examination of the Willow Creek dam site in the Crow Indian Reservation near Billings was made for the Office of Indian Affairs. Reports for official publication on the geology and mineral resources of the Black Hills rim, in Montana and Wyoming, and of the Libby quadrangle, and on fossil plants from the Fort Union and associated formations in Montana, North Dakota, and Wyoming, were in progress. Papers were submitted for outside publication on amphibolization of sills and dikes in the Libby quadrangle, on the influence of structure on ore deposits in the Libby quadrangle, on structural features of the Flathead mine, and on Kinderhook conodonts from the Little Rocky Mountains.

Nevada.—Field and office work on the projects covering the general geology and ore deposits of the Hawthorne and Tonopah quadrangles, the Comstock lode at Virginia City, and the structure of the Basin Range, were continued. A study of the Austin or Reese River district was begun. Geophysical studies were made in the Austin and Spring Valley districts. An examination of ore deposits in the Duck Valley Indian Reservation was made for the Office of Indian Affairs. A paper on Mesozoic stratigraphy of the Hawthorne and Tonopah quadrangles, was submitted for outside publication.

New Hampshire.—In connection with an investigation of the granites of New England, studies were made of the granite districts in New Hampshire.

New Jersey.—A report on pre-Cambrian geology and mineral resources of the Delaware Water Gap and Easton quadrangles, New Jersey and Pennsylvania, was transmitted for official publication.

New Mexico.—The study of the geology and ore deposits of the Little Hatchet Mountains conducted in cooperation with the New Mexico Bureau of Mines was continued. A paper on the outlook for new ore discoveries in the Little Hatchet Mountains was submitted for outside publication. A field examination of the geology and the coal, oil, and gas resources of the eastern side of the San Juan Basin in Rio Arriba County was continued. Official reports covering this and earlier investigations, including a study of the Lumberton-Monero district, were in progress and also one on the Potash special quadrangle. A preliminary map showing geologic structure of part of Rio Arriba County was published. A correlation chart for the Permian of western Texas and southeastern New Mexico, and a short summary of the influence of structure in localizing ore in the Ground Hog mine, central district, were prepared for the National Research Council. A paper on a newly discovered section of Trinity age in southwestern New Mexico was prepared for the American Association of Petroleum Geologists.

New York.—A report on talc in the Gouverneur district, the field work for which was done several years ago on an allotment from Public Works Administration is nearing completion for official publication. A paper on some Psilophytales from the Hamilton group in western New York was prepared for outside publication. Bulletin 899–A on structure and gas possibilities of the Oriskany sandstone in Steuben, Yates, and parts of the adjacent counties, was issued.

North Dakota.—A report on the geology and coal resources of the Minot area is in course of publication. Work on the Fort Union and associated formations is mentioned under Montana.

North Carolina.—A report on gastropods from the Miocene and lower Pliocene of Virginia and North Carolina, with summary of stratigraphy, was completed for official publication.

Ohio.—A study of the stratigraphy and fossils of the Devonian of Michigan and Ohio was continued. A study of the stratigraphy and faunas from the Devonian and Carboniferous formations is mentioned under Pennsylvania.

Oklahoma.—The investigation of the geologic structure, stratigraphy, and petroleum possibilities in the Ouachita Mountains was extended. Preparation of reports on subsurface geology and oil and gas resources of Osage County was continued, and those covering Tps. 22 and 23 N., Rs. 8, 9, 10, and 11 E., and Tps. 24 and 25 N., Rs. 8 and 9 E., are in course of official publication. In the investigation of the lead and zinc deposits of the tri-State area, mapping the geologic structure and stratigraphy and study of the mines of the Oklahoma and Kansas portions of the district were continued. Reports on stratigraphy and fossils of the Moorefield formation and of the Morrow group of Arkansas and Oklahoma were in progress. A new edition of the map of the oil and gas fields of Oklahoma is in preparation. In connection with a comprehensive study of source beds of petroleum conducted in cooperation with the American Petroleum Institute,

localities in Oklahoma and Kansas were visited. A paper on some studies of source beds in Oklahoma and Kansas and a paper on the Verden sandstone of Oklahoma—an exposed shoestring sand of Permian age—were published by the American Association of Petroleum Geologists.

Oregon.—A report on the geology of a part of the Wallowa Mountains was transmitted to the Oregon State Department of Geology and Mineral Industries for publication, and a paper on the geology of the Salem Hills and the North Santiam River is in preparation for publication by the State. A preliminary geophysical investigation of the Sourdough chromite deposits in Oregon was made for the State Department of Geology and Mineral Industries. Bulletins 875 (Nonmetallic mineral resources of eastern Oregon), 879 (Geology and mineral resources of the Baker quadrangle), and 893 (Metalliferous mineral deposits of the Cascade Range in Oregon) were issued.

Pennsylvania.—Reports on the geology and mineral resources of the Honeybrook and Phoenixville quadrangles and of the Hanover and York quadrangles have been completed for official publication. Additional field work was done in York County in connection with a report on the geology and mineral deposits of York County in cooperation with the State of Pennsylvania. A report on a dam site on Codorus Creek, York County, was made for the War Department. Studies of the regional metamorphism in the Lower Kittanning coal beds of western Pennsylvania, and of the stratigraphy and flora of the Pocono formation of Pennsylvania, Virginia, and West Virginia, were continued. A report on some linguloid shells from the late Devonian and early Carboniferous rocks of Pennsylvania and Ohio was submitted for official publication, and a paper on garnet crystals in cavities in metamorphosed Triassic conglomerate in York County and a discussion of a paper by Ralph Miller on the Martinsville limestone in eastern Pennsylvania were submitted for outside publication. Work in the Delaware Water Gap and Easton quadrangles is mentioned under New Jersey.

Southern Appalachians.—The report on gold deposits of the southern Appalachians, including areas in Virginia, North Carolina, South Carolina, Georgia, and Alabama has been submitted for publication.

Tennessee.—Field work for revision of the mapping of the Knox dolomite of the Mascot-Jefferson City district in east Tennessee and for a study of the manganese deposits of Perry County was carried on in cooperation with the Division of Geology of the Tennessee Department of Conservation. Investigations of geologic and ground-water conditions in Giles County were made for the Public Health Service to determine their possible influence on the prevalence of tuberculosis.

Texas.—Reports were in preparation on the structure, stratigraphy, and fossils of the Navarro group, and on the stratigraphy, geomorphology, and structure of the southern Guadalupe Mountains. Field work was continued in a study of the geology of the Sierra Diablo region, west Texas, and in a study of the stratigraphy and fossils of the Eocene of southeastern Texas, and stratigraphic and paleontologic investigations of the Carboniferous and Permian formations of central Texas were made. A resistivity survey for the purpose of obtaining additional information as to the effects of faults and salt-water boundaries was made in the vicinity of El Paso. Professional Paper 187, on the geology of the Marathon region, was completed. A report on a new Upper Cretaceous rudistid from Texas and on fossils from the Eocene of the Gulf province and a revision of the map of the oil and gas fields of Texas are in process of publication. A correlation chart of the Permian of Texas and southern New Mexico was prepared for the National Research Council. Papers were prepared for outside publication on paleogeography and correlation of the west Texas Permian, a new taxodent genus from the Upper Cretaceous of Texas, and tectonics of the Guadalupe Mountain region.

Utah.—Geologic studies of a part of the Strawberry Valley with special attention to oil shale, coal, oil, gas, and phosphate; of the coal resources and oil and gas possibilities of the Hanksville-Caineville district; and detailed studies of the structure, igneous rocks, mineral resources, and physiography of the Henry Mountains; of the Marysvale district, with special reference to alunite deposits; and of iron ores of Bull Valley were continued. An examination of a manganese deposit on Drum Mountain in Juab County was made and a report on these deposits transmitted for outside publication. Geologic investigations were continued of the geology and physiography of the plateau regions of Utah and in Zion and Bryce Canyon National Parks and Cedar Breaks National Monument in cooperation with the National Park Service. An examination of asphalt deposits of the Uinta Indian Reservation in northeastern Utah was made for the Office of Indian Affairs. The report on the geology and mineral resources of the Randolph quadrangle was transmitted for official publication. Outside publications included a paper on the origin of the Bull Valley iron ore deposits, comment on J. D. Forrester's paper on structure of the Uinta Mountains, and a paper on form of intrusion in the Henry Mountains.

Vermont.—The studies of commercial granites and mapping granite quarries of New England included granite areas in east-central Vermont.

Virginia.—Geologic work was conducted in the Galax, Independence, Rural Retreat, Mouth of Wilson, Mount Rogers, Max Meadows, and Speedwell quadrangles in connection with a study of the Gossan lead in cooperation with the Virginia Geological Survey. A paper on a southeastern facies of Lower Cambrian dolomite present in southwestern Virginia was sent to the Virginia Geological Survey for publication. Field investigations were made in the Appalachian Valley of Virginia in connection with a study of the Lower Paleozoic stratigraphy of the Appalachian Valley, and work on revision of a report on the titanium deposits was continued. A paper on relations between structure and ore deposition in the Titanium district near Roseland was completed for the National Research Council. Work on the Pocono flora is mentioned under Pennsylvania. Work on mollusca from the Miocene and Lower Pliocene is mentioned under North Carolina.

Washington.—Field investigation of the areal geology, mineral resources, and mines of the Metaline quadrangle, Pend Oreille County, was completed. A paper on dolomite and jasperoid in the Metaline district was transmitted for outside publication. In the later part of the fiscal year a study of the manganese deposits in the Olympic Peninsula was initiated.

West Virginia.—Work on the Pocono flora from Virginia, West Virginia, and Pennsylvania is mentioned under Pennsylvania.

Wyoming.—Areal and structural geologic mapping, with particular reference to coal and petroleum resources, of areas on the west and east sides of the Big Horn Basin was continued. Investigations of the Tertiary rocks of the Green River and Bridger Basins, and fossil syncline of southwestern Wyoming, with special reference to oil-shale beds, and of the geology and mineral resources of the Afton quadrangle were continued. A structural map of the Byron-Frannie area, Big Horn and Park Counties, was published. A report on geology and coal resources of the area south of Cody and one on the Shoshone area, Park County, are in preparation. Work in the Irwin quadrangle and on glacial geology and physiography is mentioned under Idaho. Work on the Black Hills rim and on the Fort Union and associated formations is mentioned under Montana.

General studies.—General investigations included Foraminifera of the Cretaceous formation of the Gulf Coast region, the genus *Ceratopea*, Tertiary echinoids of the eastern United States, Buliminidae, Globigerinidae, borderland problems of geology, physics, and chemistry, types and ranks of coal, source beds of petroleum, clay minerals, salt-dome cap rock, deep-sea cores from across the North Atlantic

Ocean, and a core sample from the deep-sea bottom southeast of New York City. A revision of a bulletin on microscopic determination of the ore minerals was completed for official publication. Geophysical abstracts covering the period from July 1936 to March 1938 were issued or are in course of publication.

WORK IN CHEMISTRY AND PHYSICS

Increasing attention during the past year has been given to chemical mineralogy, with special consideration of the internal structure of minerals. It is now possible to show that the physical properties of a mineral depend not only on the kinds of atoms composing it but also on their role and their arrangement in the crystal—features that can be determined by X-rays. The densities of strata, rocks, and minerals likewise, in the final analysis, are explained in the same way. It seems reasonable to expect that further study of the associations and conditions of formation of minerals will yield illuminating correlations with both their chemical composition and physical structure. Information on all the physical properties of rocks and minerals is being compiled in collaboration with the National Research Council.

During the year the stability relations of the different hydrates of sodium borate were studied further; also the optical properties of numerous minerals for many localities, including several manganese minerals, micas, sulphates from the Comstock lode, and many other minerals. Platinum and palladium were definitely identified in ore from the La Plata district, Colorado. A clay deposit in Iowa was shown to be mainly halloysite. Sodium sulphate is now being produced from a deposit in Texas, a sample of which was first identified as sodium sulphate among many samples sent in by the public for identification. Over 30 manuscripts were read critically by members of the section of chemistry and physics.

Altogether 3,636 examinations or tests of minerals and rock samples were made during the year. These included 1,147 specimens tested and identified for persons not officially connected with the Survey. There were 939 chemical analyses made for geologists and 493 similar analyses made in connection with research problems and geochemical investigations. The remaining 1,057 tests related to core samples, well cuttings, and similar materials.

Special investigations included a study of the base-exchange properties of river clays, a matter that will afford a correction of the previously calculated age of the ocean; the analysis and structural interpretation of several varieties of mica, especially taeniolite, lithiophyllite, and lepidolite, which have led to a better understanding of the relations between the different micas; elaborate mathematical studies relating to the flow of heat in the earth; the development of new methods of chemical analysis; and adjustment of estimates of the lengths of the geologic eras and periods in years, based both on geologic and radioactive evidence.

Spectrographic tests were made on many different minerals and ores, and minor constituents obtained in chemical work were more positively identified in this way. Crystallographic measurements were made of a number of minerals. Cuttings from a considerable number of wells were logged to determine the character of the strata at depth. Materials mined under royalties to the Government, such as potash, were checked as to quality and quantity. Assays were made for gold, silver, and platinum in a number of metalliferous samples.

Among minerals analyzed in the laboratory during the year were sodalite from Magnet Cove, Ark., pyrophyllite from Staley, N. C., many igneous rocks associated with ore deposits in the Western States, talc from Quebec, alunite from Nevada, potash brines from Utah and Wyoming, pumicite, oceanic clays, mica, mine waters, siderite from several mines, tetrahedrite, vermiculite, grahamite, dolomite, halloysite, trona, phosphate rock, vanadiferous sandstone, native gold and platinum, albite, rhodochrosite, alunogen, and other similar substances.

A monograph on bleaching clays was completed, covering their geographic and geologic distribution, their physical and chemical properties, and their processing, rating, and testing. This summarizes 8 years of intensive work and puts an important key industry on a firm foundation. All lubricating oils, most fats and waxes, many paint oils, all medicinal oils, and much sulphur are processed with bleaching clay. For this work over 4,000 samples of clays from the United States and many foreign countries were investigated. New classifications and new methods of testing and rating were developed. Extensions of chemical and physical methods of clay analysis were developed to add to the knowledge of their structure and properties, and new occurrences of bleaching clays have been discovered.

A paper was prepared on observed temperatures in the crust of the earth for publication by the National Research Council. A program was outlined for calculation of certain mathematical tables by the Works Progress Administration, and a temperature survey was made of a 7,000-foot well near Washington, Pa. Tables were prepared for calculating the temperatures in a radioactive and a nonradioactive earth and also for calculating the temperature changes resulting from the flow of solar heat into and out of the earth for depths not exceeding 100 feet. The last two sets of tables are to be included in a final report on earth temperatures. A paper on geothermal methods of estimating the age of the earth is nearly completed.

The temperature machine which has been developed during the past few years is practically complete and has given highly satisfactory service. One of these machines is being used by the National Park Service in making a depth (and possibly also a temperature) survey of Crater Lake, Oreg.

A number of involved mathematical equations were solved by elaborate calculations.

Several field trips were made and papers were presented at regular meetings of the American Geophysical Union, the American Chemical Society, and various geological and mineralogical societies.

ALASKAN BRANCH

The work of the Geological Survey in Alaska is comparable in its aims with that performed in the various States, the principal differences being in the placing of the emphasis and in the methods used. Thus, because of the unsettled, undeveloped, and unknown character of much of Alaska, there is less immediate need for intensive detailed studies but more pressing calls for exploratory and reconnaissance surveys; less need for delimiting the precise boundary of a particular mineral area and more for determining the areas of economic importance. The training and experience required for carrying on such pioneer surveys are markedly different from those effective in intensive research on detailed problems, and the technique involved in the two types of investigation differs as greatly as does the art of the painter of miniatures from that of the painter of cycloramas. This condition in Alaska but repeats, in a measure, the history of the development of the Government's surveys in the States, where exploration preceded reconnaissance, and reconnaissance in time gave place to more detailed surveys. The stages of exploration and reconnaissance in Alaska are still far from being ended. More than half of the Territory has not yet been surveyed on standards that are regarded as adequate for reconnaissance purposes, and less than 1 percent has been surveyed on standards acceptable for detailed investigations. At the rate at which the work is now being carried on in Alaska many generations will have come and gone before even reconnaissance maps of the whole Territory are available. That the results of these investigations are urgently needed and widely used is shown by the large number of reports and maps sold and by the many requests for information, much of which cannot be supplied because the investigations or surveys have not yet been made. The reports and maps are widely used, especially by those concerned with the mining industry, and as they are the only authoritative sources of information for much of the country, they are indispensable to legislative and executive officers of the Government and others in the effective planning and successful conduct of many undertakings, such as airplane communication, roads, forestry, and national defense.

Field work.—As the field projects in Alaska do not lend themselves well to description by fiscal years, because the field work is usually started in May and continues as late in the fall as practicable, they will be described by field seasons. Thus, the projects undertaken in the field season of 1937 were financed in part from

funds appropriated for the fiscal year 1937 and in part from funds for the fiscal year 1938, and the projects for the field season of 1938 were financed by funds for the fiscal years 1938 and 1939.

For the field season of 1937 five field projects were carried on by the Alaskan Branch of the Geological Survey. Three of these were concerned principally with geologic investigations relating to the mineral resources of the Territory, and two were primarily topographic surveys. The areas in which the principal new geologic projects were undertaken were on Admiralty Island and adjacent tracts in southeastern Alaska; in the Alaska Range near the head of the Copper River; and in the vicinity of Goodnews Bay, near the mouth of the Kuskokwim River, in western Alaska. The surveys on Admiralty Island were designed to afford information regarding the possibility of the area containing deposits of nickel that might be of national importance, as well as to obtain additional facts regarding the occurrence and mineralization of the gold lodes that have long yielded a small but constant output of gold from the island. The part of the Alaska Range that was surveyed is among the least known areas, and the principal object of the work was to determine the general features of the geology and whether the geologic conditions are favorable for the occurrence there of deposits of lode and placer gold and other minerals similar to the deposits already known in the outskirts of the area. The work near Goodnews Bay focused on a study of the platinum deposits that now form the principal domestic source of platinum metals in the United States. The topographic projects included reconnaissance surveys in parts of the Alaska Range near the head of the Copper River and detailed and reconnaissance surveys in the platinum fields and adjacent areas of the Goodnews Bay district.

For the field season of 1938 six field projects had been started before the end of the fiscal year 1938, of which three are primarily geologic and three are primarily topographic. An additional field project for this season will be started as soon as practicable. All these projects will be continued in the field throughout the open season as late as conditions permit and will then be completed in the office.

The three geologic projects for the season of 1938 include work on Chicagof Island in southeastern Alaska, in the Copper River region, and in the upper Yukon region. The survey of part of Chicagof Island will embrace one of the large lode-gold areas in the western part of southeastern Alaska, and the study will be directed toward determining the conditions attendant on mineralization there in the hope not only of understanding the immediate conditions but of gathering information that may be of service in searching for similar deposits in areas where commercial deposits have not yet been found. The work in the Copper River region will be a continuation of the studies that have been in progress for 4 years to determine the facts regarding the extensive tract that lies in and adjacent to the Alaska Range. The investigations in the upper Yukon region will cover a part of the old fossil gravel deposits that extend for 100 miles to the northwest of Eagle and that appear to have been the source from which was derived much of the gold that was later reconcentrated by the present streams to form the workable placers now being extensively mined. The three topographic projects include surveys on Chicagof Island, in the Copper River region, and in the Tanana Valley. The first two are needed for immediate use by the geologists working in these areas, and the maps, when completed, will also be available for general use and will thus reduce somewhat the blank areas in the Territory. The survey on Chicagof Island is being made on a relatively detailed scale, but that in the Copper River region will be mainly of the reconnaissance type, except for a small area near the principal mine, which will be in more detail. The topographic work in the Tanana Valley will consist of photographing from

the air by means of special cartographic cameras the lowland of the Tanana River from Fairbanks eastward to the international boundary, an area of some 7,000 to 10,000 square miles of country, most of which has not been surveyed at all or at best only on crude exploratory standards. Unfortunately, lack of funds will probably prevent the Geological Survey from promptly taking off the information afforded by these pictures and working it up into maps, but this will be done as rapidly as funds and personnel become available. The preparation of maps of this area is of great importance in the consideration of almost all matters affecting transportation and development throughout this part of Alaska. Similar surveys and maps should be prepared of the other great natural routes through the interior, such as the entire lowlands of the Yukon River and its larger tributaries and of the Kuskokwim River and its tributaries.

Office work.—After completion of field work each season much office and laboratory work is required in analyzing the specimens collected, identifying by microscopic and other means the rocks and minerals found, perfecting the field sketches and drawings, and interpreting the various geologic phenomena observed, so that the significant facts are revealed and can be intelligibly expressed by maps and reports that are published and become available to the public. It is usually reckoned that these office studies and work require about twice as long as the original field work, so that if the original field work was done in 100 days it requires about 200 days to prepare the results for publication. If the results are not thus made available the public loses much of the value of the investigation for which it has paid.

An office project not directly related to new field work but requiring familiarity with the mining industry of Alaska is the annual canvass of the production of minerals from the Territory. This work involves analysis and tabulation of returns from mine operators throughout the Territory as to their year's output of any kind of minerals of value and the checking of these results by information from any other sources that will make it possible to give complete and correct records of the amount of each kind of mineral produced, the districts from which it came, and the new developments that have taken place or are in prospect. This work has been completed for the year 1937 and the results prepared for publication; the canvass for 1938 is under way.

Reports and maps.—During the year six reports containing maps, seven separate maps (including two new editions and three reprints), and five press statements have been published. Ten reports including maps, one separate map, and new editions or revisions of three maps are in course of publication. In addition three reports, one map, and new editions of two maps were partly completed. Five papers prepared by personnel of the Alaskan Branch were approved for outside publication.

TOPOGRAPHIC BRANCH

GENERAL OFFICE WORK

Necessary office work incidental to the field work of the Topographic Branch consisted in the inking, inspection, and editing of the completed topographic field sheets prior to their submission for reproduction and the computation and adjustment of the results of control field work and photo-planimetric compilation.

Control Section.—In addition to the routine adjustment of primary control, there has been in progress a general adjustment of both horizontal and vertical control to agree with the standard datums of the United States.

During the year the manuscripts for eight bulletins reporting the results of control surveys were prepared. Three bulletins for which the manuscript had been prepared previously were published. Spirit leveling in Kansas, 1896–1935 (Bulletin 889); in southeastern Missouri, 1896–1937 (Bulletin 898–A); and in Vermont, 1896–1935 (Bulletin 888).

Section of Photo-mapping.—In the section of photo-mapping, aerial photographs were used for the compilation of planimetric bases of sixteen 7½′ quadrangles or parts of quadrangles in Louisiana and two 7½′ quadrangles in Michigan, a total of 977 square miles. After the customary field inspection, these maps are published as planimetric maps. Line bases to assist in topographic mapping were likewise compiled of nine 7½′ quadrangles in Massachusetts and fifteen 7½′ and 15′ quadrangles in Missouri, a total of 1,975 square miles, making a grand total of 2,952 square miles. Thirty-six square miles in Virginia and 49 square miles in Montana were mapped by the stereophotogrammetric method in the Washington office.

Cartographic Section.—Work on preparing additional sheets of the United States portion of the map of the world on the scale of 1:1,000,000 was resumed. Sheet J18, Chesapeake Bay, is in progress.

For the Bureau of Public Roads the work of preparing the transportation map of the United States was continued. Compilation and inking were in progress on 80 sheets. Proofreading and checking was done on 38 sheets. Maps of 5 States, comprising 38 sheets, were published.

Section of Inspection and Editing.—During the year 160 new maps were prepared for photolithographs as advance sheets. One hundred three new topographic maps were edited for publication, 6 of which were for three-color lithographs, and 97 for engraving. The preparation of quadrangle maps for reprinting is a large item in the work of the branch. Two hundred twelve quadrangle maps and 17 State and index maps were prepared and edited for reprint editions. Editing was also completed on 149 illustrations. Three hundred eighty-one proofs of maps in course of publication were read.

On June 30, 1938, in the Washington office, 126 topographic maps were prepared or partly prepared for lithography and 103 were in different stages of editing.

For the Conservation Branch the work of preparing river surveys for publication was continued. Work was done on 69 different projects. The maps of 28 projects, comprising 114 separate sheets, were transmitted for lithography during the year.

For the Tennessee Valley Authority the work of final preparation and transmitting of 12 maps for reproduction and the reading of 8 proofs was done.

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During the year an exhibit of 40 maps was prepared for the International Geographic Congress to be held in Amsterdam, Netherlands, during July 1938.

MAP INFORMATION OFFICE

In January 1920 the Map Information Office, authorized by Executive order of December 30, 1919, was organized in the Geological Survey as part of the Topographic Branch. Since that time it has been conducted entirely by Geological Survey personnel.

The files of the office contain samples of practically all types of maps published by the Federal mapping agencies, many maps of foreign governments and commercial map publishers, catalogs and index maps, and a card index for reference, which is much used by Government agencies and the general public. In addition to its functions as a clearing house for map information, the office has also been given the task of collecting, classifying, and disseminating information concerning all aerial photography throughout the United States, both of a Federal and non-Federal character.

The office is used as a clearing house for all aerial topographic data similar to that for maps. One of the accomplishments of the year was the compilation and publishing, for the Board of Surveys and Maps, of an index map of the United States on which were shown all areas photographed up to March 1937.

Also, all of the minutes of the meetings of the Federal Board of Surveys and Maps have been taken, and all correspondence relating to the Board is done, by Geological Survey personnel.

FIELD SURVEYS

Work was done in 35 States and in Puerto Rico. Cooperative projects were conducted in 16 of these States and in Puerto Rico and with the Tennessee Valley Authority.

The art of making topographic maps from aerial photographs by the use of stereophotogrammetric methods is well established in the United States. By a cooperative agreement with the Tennessee Valley Authority, the Geological Survey is mapping areas within the Tennessee River Basin. On June 30, 18 Geological Survey employees were detailed on this project. Fifteen stereophotogrammetric plotting instruments are installed at Chattanooga, where the work is being done.

Of the area of the United States 45 percent has been covered by topographic maps, the year's increment amounting to 0.2 percent. The reduced percentage, as compared with 47.4 reported in 1937, is due to the fact that during the year maps of 79,668 square miles, based on reconnaissance surveys prior to 1896 and considered inadequate, have been withdrawn from distribution and the areas classified as unmapped.

WORK OF THE YEAR BY STATES

Abbreviations for projects listed below: Federal Emergency Administration of Public Works, "P. W."; Tennessee Valley Authority (by stereophotogrammetric methods) "T. V. A."

Arizona.—In preparation for geologic mapping, Klondyke 15′ quadrangle completed and Galiuro Mountains 15′ quadrangle begun. For the Forest Service, San Vincente 15′ quadrangle completed. At the request of the National Park Service, Canyon de Chelly National Monument begun. Diamond Butte 15′ quadrangle (P. W.) completed.

Arkansas.—In cooperation with the Geological Survey of Arkansas, Blakemore 15′ quadrangle completed and Lonoke 15′ quadrangle begun. Benton 15′ quadrangle (P. W.) begun.

California.—In cooperation with the State engineer of California, Colton and Jurupa Mountains 7½′ quadrangles completed. In preparation for geologic mapping, Grizzly Ridge 15′ quadrangle completed. For the National Park Service, the revision of Sequoia and General Grant National Parks completed.

Colorado.—In cooperation with the Metal Mining Fund of Colorado, Dunton mining area and Ward Sunset mining area completed. In cooperation with the city of Denver, Arvada, Brighton, Fort Logan, and Long Branch 7½′ quadrangles completed; Diamond K Ranch, East Lake, Fitzsimons, Golden, Littleton, Lafayette, Marshall, and Morrison 7½′ quadrangles and the cultural revision for areas within the city limits of Denver begun. In preparation for geologic mapping, Climax 15′ quadrangle begun and Gold Hill mining area completed. At the request of the National Park Service, Great Sand Dunes National Monument completed. Mount Gunnison 15′ quadrangle continued for the Forest Service.

Connecticut.—Uncasville 7½′ quadrangle (P. W.) completed.

Georgia.—For the Forest Service, Chatsworth (Ga.-Tenn.) 15′ quadrangle completed and Tamassee (S. C.-Ga.) 15′ quadrangle begun. Coosa Bald, Cowrock, Jacks Gap, Mulky Gap, Neels Gap, Suches, and Tray Mountain 7½′ quadrangles (T. V. A.) completed, and Noontootla and Wilscot 7½′ quadrangles (T. V. A.) begun.

Idaho.—At the request of the Office of Indian Affairs, Pocatello, 15′ quadrangle completed and Pauline 15′ quadrangle begun. In preparation for geologic mapping, Big Creek and Yellow Pine 15′ quadrangles and Wallace special area, sheets Nos. 2, 3, and 4 completed and sheet No. 1 begun. For the Forest Service, Headquarters 15′ quadrangle begun. Landmark Rock 15′ quadrangle (P. W.) begun.

Illinois.—Alto Pass, Casey, Lena, Monticello, and New Douglas 15′ quadrangles completed; Ina and Mulberry Grove 15′ quadrangles continued and Freeport 15′ quadrangle begun in cooperation with the Department of Registration and Education of Illinois, Geological Survey.

Indiana.—In cooperation with the Department of Conservation of Indiana, Charlestown, Jeffersonville, New Albany, Owen, and Speed 7½′ quadrangles completed and Bethlehem, Borden, Clear Lake, Coal City, Georgetown, Linton, and Switz City 7½′ quadrangles begun.

Kansas.—In cooperation with the Geological Survey of Kansas, Altoona 15′ quadrangle begun and Fredonia 15′ quadrangle completed.

Louisiana.—In cooperation with the United States Army Engineer of the first New Orleans district, mapping with contours completed for Belle Chasse and Delacroix 7½′ quadrangles and Hahnville, New Orleans, and Thibodaux 15′ quadrangles. In cooperation with the Louisiana Board of State Engineers, mapping without contours from aerial photographs completed for Aloha, Bellwood, Bermuda, Clear Lake, Cloutierville, Coldwater, Coochie Brake, Creston, Cypress,

Flatwoods, Gorum, Grappes Bluff, Hagewood, Montgomery, Natchitoches, Powhatan, St. Maurice, and Verda 7½′ quadrangles, and Hemphill Creek and Temple 7½′ quadrangles begun.

Massachusetts.—In cooperation with the Department of Public Works, Division of Waterways, Assawompset Pond, Colrain, Leicester, Mount Grace, Orange, Paxton, Plympton, Sandwich, Shelburne Falls, Snipatuit Pond, Southwick, and Woronoco 7½′ quadrangles completed; Hampden, Ludlow, Medfield, Sterling, and Wrentham 7½′ quadrangles begun. Pawtucket (R. I.-Mass.) 7½′ quadrangle (P. W.) begun.

Michigan.—In cooperation with the State Highway Department of Michigan, mapping with contours completed for Adair, Algonac, Goodells, Marine City, New Baltimore, Port Huron, St. Clair, St. Clair Flats, and Smiths Creek 7½′ quadrangles; Rattle Run 7½′ quadrangle begun; mapping without contours from aerial photographs completed for Dearborn, Detroit, Highland Park, and Royal Oak 7½′ quadrangles. In cooperation with the Department of Conservation of Michigan, mapping without contours from aerial photographs begun for Ballentine 15′ quadrangle.

Missouri.—In cooperation with the Geological Survey and Water Resources of Missouri, mapping with contours completed for Exeter, Fristoe, Knoblick, Middlebrook, Ozark, Silex, and Vienna 15′ quadrangles and Butler, Fletcher, Galloway, Horton, New Home, Pacific, Tiff, Weldon Springs, and West Plains No. 1 7½′ quadrangles; Cabool, Fordland, Gatewood, Long Lane, Noel, and Topaz 15′ quadrangles continued; Linneus, Lupus, Rothville, and Vera 15′ quadrangles and Eureka, Metz, Monegaw Springs, Moundville, Osceola, Roscoe, and Worland 7½′ quadrangles begun; mapping without contours from aerial photographs completed for Green Ridge, Nelson, Smithton, and Sweet Springs 15′ quadrangles and Sedalia and Sedalia West 7½′ quadrangles.

Montana.—For the National Park Service, revision of Glacier National Park begun. In preparation for geologic mapping, Little Rocky Mountains area begun. At the request of the Forest Service, Mount Cowen and Mount Wallace 15′ quadrangles begun. Gallup City 15′ quadrangle (P. W.) completed.

Nebraska.—In preparation for geologic mapping, Republican River, sheet No. 1, Hardy to Beaver Creek and sheet No. 4, Vining Creek to Alma completed and sheets Nos. 2, 3, and 5 begun.

Nevada.—In preparation for geologic mapping, Austin mining area and Mineral Hill 15′ quadrangle completed and Cortez 15′ quadrangle begun. For the Forest Service, Owyhee 15′ quadrangle begun.

New Jersey.—Patterson 7½′ quadrangle (P. W.) completed.

New Mexico.—For the Forest Service, Jemez Springs 15′ quadrangle completed. In preparation for geologic mapping, Oil City 15′ quadrangle completed and Hackberry Lake 15′ quadrangle begun. Carrizozo 15′ quadrangle (P. W.) completed.

New York.—In cooperation with the Department of Public Works of New York, Nyack 7½′ quadrangle completed and East Syracuse and Haverstraw 7½′ quadrangles begun.

North Carolina.—Andrews, Marble, and Peachtree 7½′ quadrangles (T. V. A.) completed.

North Dakota.—Heart Butte 15′ quadrangle (P. W.) completed and Aylmer 15′ quadrangle (P. W.) begun.

Oregon.—At the request of the Forest Service, Mapleton 15′ quadrangle completed and Earl 15′ quadrangle resumed.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, Allentown West, Millheim, and Waterville 15′ quadrangles completed and Mifflinburg 15′ quadrangle begun.

Puerto Rico.—In cooperation with the Commissioner of the Department of the Interior of Puerto Rico, Aguadilla, Isabela, Moca, and Quebradillas 7½′ quadrangles completed; Alto Sano, Camuy, and San Sebastian 7½′ quadrangles begun.

Rhode Island.—Pawtucket (R. I.-Mass.) 7½′ quadrangle (P. W.) begun.

South Carolina.—For the Forest Service, Tamassee (S. C.-Ga.) 7½′ quadrangle begun.

Tennessee.—For the Forest Service, Chatsworth (Ga.-Tenn.) 15′ quadrangle completed. Bean Station, Caney Creek, Joppa, Luttrell, Mascot, Talbott, and Bristol and Holston Valley (Tenn.-Va.) 7½′ quadrangles (T. V. A.) completed; Avondale, Benton, Clevenger, New Market, and Parkville 7½′ quadrangles (T. V. A.) begun.

Texas.—Winona 15′ quadrangle (P. W.) completed. In preparation for geologic mapping, Turkey Mountain 15′ quadrangle begun.

Utah.—For the Forest Service, Delano Peak 15′ quadrangle and Marysvale and vicinity completed and Beaver 15′ quadrangle begun. In preparation for geologic mapping, Bull Valley area begun.

Vermont.—In cooperation with the State geologist of Vermont, Barnet 15′ quadrangle continued.

Virginia.—Curles Neck and Richmond South 7½′ quadrangles and Middletown and Winchester 15′ quadrangles completed; Front Royal, Hightown, and Rustburg 15′ quadrangles and Hopewell 7½′ quadrangle begun in cooperation with the Conservation and Development Commission of Virginia, Geological Survey. Wallace, Wyndale, and Bristol and Holston Valley (Tenn.-Va.) 7½′ quadrangles (T. V. A.) completed and Hilton and Mendota 7½′ quadrangles (T. V. A.) begun.

Washington.—For the Forest Service, Dayton 30′ quadrangle completed.

Wisconsin.—In cooperation with the State Highway Commission of Wisconsin, mapping with contours of Maiden Rock 15′ quadrangle begun and mapping without contours from aerial photographs begun for Bessemer, Lac Du Flambeau, Minocqua, and Winchester 15′ quadrangles.

Wyoming.—At the request of the Forest Service, Moccasin Lake 15′ quadrangle completed and Mount Bonneville 15′ quadrangle begun.

WATER-RESOURCES BRANCH

The importance of water and of systematic records related to the quantity, chemical quality, and availability of both surface and ground waters becomes increasingly greater each year. The growth of the country in population and industry, with consequent increases in demands for water, and especially the continued series of dry years that included the disastrous and widespread droughts of 1934 and 1936, and the many recent disastrous floods in different parts of the country, have impressed on the people the controlling importance of water in surface streams and in underground basins in relation to many of man's activities. The information collected by the Geological Survey is used extensively by many Federal, State, and private agencies. The Public Works Administration, the National Resources Committee, and related activities have found the Survey records and information with respect to water to be invaluable in studies of projects of all classes and in all sections of the country.

Reliable information with respect to supplies of water, both on the surface and in the ground, and to their fluctuations with variations in rainfall is essential to orderly, sound, and economic development along many lines, as in domestic water supplies, irrigation, flood protection, control of pollution, recreational uses, water-power development. The work of the water-resources branch thus occupies a position of great importance in the economic affairs of the Nation.

The investigations by the branch are conducted largely in cooperation with Federal bureaus; State, county, municipal, and other governmental agencies; and permittees and licensees of the Federal Power Commission. A major part of this cooperation is set forth below.

Federal bureaus.—Water resources investigations were conducted for the following Federal bureaus: The Bureau of Biological Survey, the Soil Conservation Service, and the Weather Bureau of the Department of Agriculture; the Office of Indian Affairs, the Bureau of Reclamation, and the National Park Service of the Department of the Interior; the Bureau of Prisons of the Department of Justice; the Department of State; the Federal Power Commission; the National Resources Committee; the Tennessee Valley Authority; the Office of Chief of Engineers, the Mississippi River Commission, and the Schofield Barracks of the War Department; and the Bureau of Naval Ordnance of the Navy Department.

States.—Amounts aggregating approximately $806,000 were made available by States and municipalities for cooperative water-resources investigations. In addition to the data obtained as a result of this cooperation, other data having an estimated value of over $133,000 were furnished by individuals and other organizations.

Permittees and licensees of the Federal Power Commission.—At the request of the Federal Power Commission, 30 engineers of the branch have been designated as representatives of the Commission to perform such field work as may be assigned to them by the Commission. The operation of about 295 gaging stations was conducted by the branch or was performed by permittees and licensees under the supervision of the branch in connection with 115 projects of the Federal Power Commission. Engineers of the branch have had field supervision of operation under permits and licenses of the Federal Power Commission in connection with 155 projects.

Division of Surface Water.—The division of surface water conducts investigations of surface water, which consist of the measurement of the flow of rivers in all the States, the District of Columbia, and Hawaii at selected gaging stations where the volume of water is measured and records of stage and other data are collected. In this work 46 States, the Territory of Hawaii, several Federal bureaus, and several individuals cooperated in the maintenance of the 3,831 gaging stations (of

which 2,616 are equipped with water-stage recorders) that were in operation at the end of the year. Records for about 113 additional gaging stations were received from Federal bureaus and from individuals. There were 46,832 regular and 5,024 miscellaneous discharge measurements made during the year.

Division of Ground Water.—The division of ground water investigates the waters that lie below the surface, in the zone of saturation, from which wells and springs are supplied; the source, occurrence, quantity, and head of these waters; their conservation; their availability and adequacy for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers; and the methods of constructing wells and recovering water from them and of improving springs. The constantly increasing use of water supplies from wells is causing a greater demand each year for intensive studies of the quantities of ground water that are perennially available. Work was done in 34 States and in Guam, Hawaii, and the District of Columbia, nearly all in cooperation with Federal, State, Territorial, or local governmental agencies.

During the year about 100 technical reports or papers relating to ground water or reservoir sites were released to the public in printed, mimeographed, or typewritten form. Of special interest are the comprehensive report on more than 1,000 thermal springs in the United States (Water-Supply Paper 679–B), and the paper entitled "Some problems relating to legal control of use of ground waters," which was presented at the annual meeting of the American Water Works Association and published in the journal of that association. The report on water levels and artesian pressures in observation wells in different sections of the country in the calendar year 1937 is in press as Water-Supply Paper 840. A comprehensive paper on methods for determining the permeability of water-bearing material is in preparation.

Division of Quality of Water.—The division of quality of water analyzes water from surface and underground sources with reference to the suitability of the waters for industrial and agricultural uses and for domestic use (not related to questions of health) so far as such use is affected by the dissolved mineral matter. Analyses (partial or complete) of 2,474 samples of water from surface and underground sources were made in the laboratory in Washington, D. C., during the year. The analyses included some for many of the studies of ground water in the different States and for most of the special investigations on water supplies for specific projects. Close cooperation was continued with the division of ground water in the study of problems relating to quality of ground water and the preparation of the parts of ground-water reports that involve consideration of the chemical

character of the waters. During the year the sections in five ground-water reports concerning quality of water were reviewed.

Studies of suspended and dissolved matter of the Colorado River and its tributaries were continued. The unpublished analyses for the different gaging stations through September 30, 1937, were tabulated and the tables made available for public inspection in Washington, D. C., and in five of the Survey district offices in or near the Colorado River Basin.

Studies of silt movement on seven demonstration projects of the Soil Conservation Service of the Department of Agriculture, which were started as Federal Project 180 under an allocation of Public Works funds to the Survey, were continued. Summary reports of the results obtained from the beginning of the work through September 30, 1936, were prepared and transmitted to the Soil Conservation Service. The reports contain analyses of the records and recommendations for modifications of the work.

During the year water analyses were made for the Conservation Branch and the Geologic Branch of the Survey, for the Office of Indian Affairs and the National Park Service of the Department of the Interior, for the Department of Agriculture, for the Bureaus of Construction and Repair and of Yards and Docks of the Navy Department, for the Public Health Service of the Treasury Department, for the Architect of the Capitol, and for the government of the District of Columbia.

During the year five papers were presented by members of the division before educational, industrial, and scientific organizations.

Division of Power Resources.—The work of the division of power resources consisted of the compilation by States of information as to the capacity of water wheels in water-power plants of 100 horsepower or more as of January 1, 1938, on the basis of reports prepared by the Geological Survey's district engineers, thus providing a readily accessible file of information of developed water-power plants in the United States.

Assistance was furnished the Federal Power Commission in the preparation of a preliminary report on the use of power and its relation to water-power and fuel reserves requested by the President.

Copies of published reports and references to published articles and reports on water power and allied subjects were compiled and furnished to the chairman of the committee preparing a report on the Nation's energy resources, their prudent utilization and conservation, and their competitive relation to each other and to the economic structure, requested by the President.

A study is in progress and will be concluded in the fiscal year 1939 of the changes in the number, average capacity, average annual out-

put, and average use factor of privately and publicly owned electric public-utility power plants, based on records from 1920 to 1936.

Division of Water Utilization.—The division of water utilization investigates problems of the utilization and control of the waters of streams and under the administration of the Conservation Branch performs work relating to supervision and investigation of these problems and to activities pertaining to power projects of the Federal Power Commission and of the Department of the Interior as conducted by the field organization of this branch.

During the year the division has continued the investigations of water problems along the international boundary between the United States and Canada for the State Department and International Joint Commission. It has also continued the supervision and coordination of the collection by the district offices of the division of surface water of special stage and discharge information relative to recent outstanding floods. Water-supply papers, including these special flood data with reference to the floods of January–February 1937 in the Ohio and Mississippi Basins, the flood of May–June 1937 in New Mexico, and the floods of the winter of 1937–38 in California, have been submitted for printing or are in process of preparation.

The division is conducting studies of the relations of rainfall, runoff, and other hydrologic factors to develop fundamental information concerning the runoff characteristics of drainage areas and river systems. Such studies may be useful in appraising the practicability of flood control and water conservation by construction of reservoirs, by the proper use of land, and by other means, and in promoting better knowledge of the adequacy of available water supplies for various kinds of use.

The Water-Resources Branch is the authoritative collector of basic information regarding the stages and discharges of the rivers of the country. The interpretations by this division of data accumulated incidentally in the course of the peculiarly wide yet close study of the behavior of rivers and of such hydrologic phenomena as floods and droughts are a notable contribution to a body of scientific knowledge that will have wide practical applications.

WORK OF THE YEAR BY STATES

The stream-gaging stations listed under the different States are operated in part with funds appropriated to the Geological Survey, in part with funds furnished by States and municipalities in cooperation with the Geological Survey, and in part with funds furnished by other Federal bureaus.

Alabama.—Surface-water investigations were continued in cooperation with the State Geologist, and 43 gaging stations were operated. Funds were also contributed by the Mobile Army Engineer office and licensees of the Federal Power

Commission. Preliminary tests were made of 143 samples of well water from Coffee County in connection with a study of tuberculosis by the Public Health Service of the Treasury Department.

Alaska.—Analyses were made of two water samples from Mount McKinley National Park, and suggestions were made to the National Park Service in regard to treatment of the waters for hotel use.

Arizona.—Surface-water investigations were continued in cooperation with the State Water Commission, the State Water Conservation District, and the Salt River Valley Water Users' Association, and 50 gaging stations were operated. Funds were also contributed by the Federal Court Water Commissioner on the Gila River, the Bureau of Reclamation, and the Office of Indian Affairs. Reports on ground water in the Avra-Altar Valley and parts of the Gila and San Simon valleys were published as Water-Supply Papers 796–E and 796–F, and a report on ground water in the Holbrook region is in press as Water-Supply Paper 836–B. Analyses were made of 10-day composites of daily samples collected throughout the year from the Colorado River at Grand Canyon and at Willow Beach. The silt load was measured daily at gaging stations at both places. Samples from three springs near Tonto National Bridge, 5 miles south of Pine, were analyzed for the National Park Service.

Arkansas.—Surface-water investigations were continued in cooperation with the State Geologist and the State Highway Commission, and 32 gaging stations were operated. Funds were also contributed by the Little Rock Army Engineer office, the Weather Bureau, and licensees of the Federal Power Commission. Through cooperation with the State Agricultural Experiment Station the study of the annual pumpage and resultant fluctuations in ground-water levels was continued.

California.—Surface-water investigations were continued in cooperation with the State Department of Public Works, the Metropolitan Water District of Southern California, the East Bay Municipal Utility District, the Santa Clara Valley Conservation District, Stanford University, the cities of San Diego, San Luis Obispo, Santa Barbara, and Santa Cruz, and the counties of Los Angeles, Riverside, San Bernardino, Ventura, and Orange, and 284 gaging stations were operated. Funds were also contributed by the Bureau of Reclamation, and licensees of the Federal Power Commission. Water levels were measured in observation wells in different areas. The record for some wells now covers a period of 34 years. Tests were made for the Office of Indian Affairs of three samples from Agua Caliente Hot Springs near Palm Springs.

Colorado.—Surface-water investigations were continued in cooperation with the State Engineer, and 187 gaging stations were operated. A report on the artesian basin of the San Luis Valley was published as a part of the report on the Rio Grande Joint Investigation. Partial analyses were made of daily samples and composites of daily samples collected from the Colorado River at Grand Junction and from the Gunnison River at Grand Junction.

Connecticut.—Surface-water investigations were continued in cooperation with the State Water Commission, the cities of Hartford and New Britain, and 35 gaging stations were operated. In cooperation with the State Water Commission, and through the aid of a W. P. A. project, extensive records were obtained of water levels in observation wells and of the salt content of the water in wells near the coast. Field, laboratory, and office work were supervised for a W. P. A. project on the salinity of the Connecticut River, including the direction of the preparation of a report (nearly completed) based on about 150,000 determinations of chloride in samples collected since the initiation of the project in 1934.

Cuba.—Three samples of surface water from near Guantanamo were analyzed for the Bureau of Yards and Docks of the Navy Department with reference to the treatment of the water for a supply for the Naval Station.

District of Columbia.—Ground-water investigations were continued with special reference to pumpage and water levels. Analyses were made of a sample from a new well of the Department of Agriculture and of a sample from the Anacostia River at the intake entrance to the United States Capitol power pump house. Three samples for analyses were collected from wells at the District Training School at Laurel, Md., and recommendations made as to the treatment of the water.

Florida.—Surface-water investigations were continued in cooperation with the State Road Department, Okeechobee Flood Control District, and the cities of Jacksonville and Tampa, and 47 gaging stations were operated. Funds were also contributed by the Jacksonville Army Engineer office, and permittees of the Federal Power Commission. Ground-water investigations were continued in cooperation with the State Geological Survey. Progress was made on the report on the area west of the Suwannee River, and studies were begun in the Jacksonville area, where the rate of pumping for industrial purposes has recently been greatly increased.

Georgia.—Surface-water investigations were continued in cooperation with the State Department of Natural Resources, and 53 gaging stations were operated. Funds were also contributed by the Mobile Army Engineer office and permittees of the Federal Power Commission. A report on the warm springs of the State was published as Water-Supply Paper 819. Analyses were made of 10-day composites of daily samples collected at six gaging stations. Single samples from rivers at other gaging stations were analyzed, and samples were collected from 60 public water supplies, most of which were analyzed before the end of the year. Daily samples were collected at seven points on the Savannah River for the study of salinity.

Guam.—A report on the ground-water resources of the Island of Guam was transmitted to the Secretary of the Navy.

Hawaii.—Surface-water and ground-water investigations were continued in cooperation with the Territory of Hawaii, and a total of 118 gaging stations were operated on the islands of Kauai, Oahu, Molakai, Maui, and Hawaii. Several ground-water reports were released during the year. A study of the availability of geophysical methods in the ground-water work of the islands was undertaken in cooperation with the geophysical section of the geologic branch of the Survey. A report containing a detailed geologic map of Oahu is in press as Bulletin 2 of the Territorial Division of Hydrography, and a report giving the records of the wells on Oahu is in press as Bulletin 4. Reports on the ground water in Maui and and Molakai are in preparation.

Idaho.—Surface-water investigations were continued in cooperation with the State Department of Reclamation and the State Water Conservation Board, and 293 gaging stations in Idaho and 2 in British Columbia were operated. Funds were also contributed by the Department of State. Comprehensive reports on the ground water in the Snake River Plain and in the Mud Lake region are in press as Water-Supply Papers 774 and 818. Water-level measurements were made in cooperation with the Soil Conservation Service.

Illinois.—Surface-water investigations were continued in cooperation with the State Department of Registration and Education, and 45 gaging stations were operated. Funds were also contributed by the Rock Island Army Engineer office.

Indiana.—Surface-water investigations were continued in cooperation with the State Department of Public Works and the city of Indianapolis, and 34 gaging stations were operated. Ground-water investigations were continued in cooperation with the State Division of Geology in the State-wide observation-well program, and special attention was given to the Indianapolis area.

Iowa.—Surface-water investigations were continued in cooperation with the State Geological Survey and the State Institute of Hydraulic Research, and 51 gaging stations were operated. Funds were also contributed by the Rock Island Army Engineer office. Investigations were continued in cooperation with the Soil Conservation Service in a study of the effects of soil conservation measures on the ground-water levels.

Kansas.—Surface-water investigations were continued in cooperation with the State Board of Agriculture, and 52 gaging stations were operated. Funds were also contributed by the Kansas City and Little Rock Army Engineer offices and the Soil Conservation Service. A State-wide study of ground-water resources was started in cooperation with the State Geological Survey. Most of the work was done in the area occupied by the *Equus* beds, with special reference to an improved water supply for Wichita. A preliminary report on the ground-water supplies available for irrigation in Ford County was published by the University of Kansas. The program of water-level measurements in the vicinity of Mankato was continued in cooperation with the Soil Conservation Service. During the year 666 samples for determination of the silt load were collected from four streams at points near Ionia and Jewell. The work on silt movement on the Soil Conservation Service project at Mankato was discontinued on June 30.

Kentucky.—Surface-water investigations were inaugurated on April 1 in cooperation with the State Department of Highways, and 32 gaging stations were being operated at the end of the year.

Louisiana.—Surface-water investigations were continued in cooperation with the State University, and 3 gaging stations were operated. Funds were also contributed by the Mississippi River Commission. Cooperation was started with the State Geological Survey in a systematic State-wide investigation of the ground-water resources, the first work being done in Rapides Parish.

Maine.—Surface-water investigations were continued in cooperation with the State Public Utilities Commission, and 33 gaging stations were operated.

Maryland.—Surface-water investigations were continued in cooperation with the State Geologist, the Washington Suburban Sanitary District, and the cities of Baltimore and Salisbury, and 26 gaging stations were operated. An intensive study was made for the Navy Department as to the quantity of ground water available in the vicinity of Indian Head.

Massachusetts.—Surface-water investigations were continued in cooperation with the State Department of Public Works, the State Metropolitan District Commission, the State Metropolitan District Water Supply Commission, and the State Department of Public Health, and 35 gaging stations in Massachusetts and 1 in Rhode Island were operated.

Michigan.—Surface-water investigations were continued in cooperation with the State Stream Control Commission, and 48 gaging stations were operated. Ground-water investigations were continued in cooperation with the State Geological Survey. All records obtained for observation wells since the beginning of the project in 1932 were prepared for publication.

Minnesota.—Surface-water investigations were continued in cooperation with the State Division of Drainage and Waters, and 212 gaging stations were operated. Funds were also contributed by the Department of State, the St. Paul Army Engineer office, and the Biological Survey.

Mississippi.—Surface-water investigations were continued in cooperation with the State Geological Survey, and 9 gaging stations were operated. Funds were also contributed by the Mississippi River Commission.

Missouri.—Surface-water investigations were continued in cooperation with the State Geological Survey, the State Highway Department, the State Park Department, and the cities of Joplin and Springfield, and 94 gaging stations were

operated. Funds were also contributed by the Kansas City and St. Louis Army Engineer offices and the Soil Conservation Service. The observation-well program in the Tarkio area was continued in cooperation with the Soil Conservation Service. During the year 3,590 samples from streams in and near the Tarkio and Bethany projects of the Soil Conservation Service were examined for silt content.

Montana.—Surface-water investigations were continued in cooperation with the State Engineer, and 147 gaging stations were operated. Funds were also contributed by the Department of State, the Kansas City Army Engineer office, and permittees of the Federal Power Commission. A report based on a 10-year record was released concerning the effects of the proposed storage in Flathead Lake on the ground-water levels at the head of the lake.

Nebraska.—Surface-water investigations were continued in cooperation with the State Engineer, and 59 gaging stations were operated. Ground-water investigations were continued in cooperation with the State Water Survey Department. The State-wide observation-well program was continued. The report on the geology and ground-water resources of south-central Nebraska, with special reference to the Platte River Valley between Chapman and Gothenburg, was published as Water-Supply Paper 779. Reports on the ground-water conditions in Keith County and in the Grand Island area were prepared, and work was started in Box Butte County.

Nevada.—Surface-water investigations were continued in cooperation with the State Engineer, and 11 gaging stations were operated.

New Hampshire.—Surface-water investigations were continued in cooperation with the State Water Resources Board, and 29 gaging stations were operated.

New Jersey.—Surface-water investigations were continued in cooperation with the State Water Policy Commission, the North Jersey District Water Supply Commission, and the Delaware River Joint Toll Bridge Commission, and 80 gaging stations were operated. Funds were also contributed by the New York Army Engineer office. Ground-water investigations were continued in cooperation with the State Water Policy Commission. The program of observation wells begun in 1923 was continued. A report on the water supplies from the No. 1 sand in the vicinity of Parlin was published by the State as Special Report No. 7.

New Mexico.—Surface-water investigations were continued in cooperation with the State Engineer, the Interstate Stream Commission, and the Middle Rio Grande Conservancy District, and 251 gaging stations were operated. Funds were also contributed by the Office of Indian Affairs. Ground-water investigations were continued in cooperation with the State Engineer and the Middle Rio Grande Conservancy District. Investigations were in progress in regard to the salt-water conditions in the Carlsbad area, the shallow ground waters in the Roswell Basin, and the ground-water conditions in the Middle Rio Grande area in relation to the surface water. A report on the ground-water conditions in the San Jose-Bluewater Valley was made for the Office of Indian Affairs. Reports on the origin of water in the Major Johnson Springs, near Carlsbad, and on the recharge of the shallow ground water in the Roswell Basin were released in typewritten form. Reports on geology and ground water were published as parts of the report on the Rio Grande Joint Investigation. Analyses were made of 186 samples from the Rio Grande and tributaries and of 426 samples from the Pecos River. In Roswell analyses were made of 10-day composites of daily samples from seven gaging stations.

New York.—Surface-water investigations were continued in cooperation with the State Department of Conservation, the State Water Power and Control Commission, the State Department of Public Works, the Black River Regulating District, the Hudson River Regulating District, the Oswegatchie River Improve-

ment Commission, the cities of Albany and Jamestown, the New York City Board of Water Supply, the Village of Ossining, and Nassau County, and 149 gaging stations were operated. Funds were also contributed by the Binghamton-Pittsburgh, and New York Army Engineer offices. Ground-water investigations were continued in cooperation with the State Water Power and Control Commission and with Nassau and Suffolk Counties. Records of wells in Kings, Suffolk, Nassau, and Queens Counties were published by the State as Bulletins GW–3, GW–4, GW–5, and GW–6. A report on the water supply of Shelter Island was released, and a study was made of the underflow of the Croton Valley below the dam. Papers on the methods used in the Croton investigation and on the return of ground water used in air conditioning and resultant temperature effects were presented for publication by the American Geophysical Union.

North Carolina.—Surface-water investigations were continued in cooperation with the State Department of Conservation and Development, and 96 gaging stations were operated. Funds were also contributed by the Tennessee Valley Authority, the Soil Conservation Service, and permittees of the Federal Power Commission. Ground-water investigations were continued in cooperation with Elizabeth City in a study of methods for overcoming the clogging of well screens. The collection of water-level measurements in wells has been continued. During the year 2,644 samples were collected for determination of silt in four streams near High Point, in connection with the operation of the Soil Conservation Service demonstration project.

North Dakota.—Surface-water investigations were continued in cooperation with the State Engineer, and 29 gaging stations were operated. Ground-water investigations were continued in cooperation with the State Geological Survey in a study of the Dakota artesian basin and the establishment of a State-wide observation-well program.

Ohio.—Surface-water investigations were continued in cooperation with the Miami Conservancy District, the Muskingum Watershed Conservancy District, and the city of Columbus, and 62 gaging stations were operated. Funds were also contributed by the Cincinnati, Huntington, and Pittsburgh Army Engineer offices. An investigation of ground-water supplies of Butler and Hamilton Counties, in the Cincinnati area, was continued in cooperation with those counties. A study was also made of pumpage from wells in the vicinity of Canton.

Oklahoma.—Surface-water investigations were continued in cooperation with the State Planning and Resources Board and Oklahoma City, and 27 gaging stations were operated. Funds were also contributed by the Soil Conservation Service, and the Little Rock Army Engineer office. Ground-water investigations in cooperation with the State Geological Survey were started, the first unit project being an investigation of Texas County with special reference to ground-water supplies available for irrigation. Water-level measurements were made in the Stillwater area of the Soil Conservation Service. During the year 228 samples were collected for determination of silt in three streams near Stillwater, Okla., in connection with the Soil Conservation Service demonstration project at Stillwater. The silt measurements were discontinued December 31, 1937. Partial analyses were made of 64 samples from wells near Ponca City in connection with a study of the pollution of ground water by waste from oil refinery operations. Analyses were made of six samples of ground and pond water used at zinc mines and mills.

Oregon.—Surface-water investigations were continued in cooperation with the State Engineer and the cities of McMinnville and Portland, and 200 gaging stations were operated. Funds were also contributed by the Portland Army Engineer office, the Biological Survey, and permittees of the Federal Power Commission. Ground-water investigations were continued on several projects in coopera-

tion with the State Agricultural Experiment Station and the State Water Resources Department. A report was released on water for domestic use in Columbia County. Reports were completed on the geologic features of the dam sites in the basins of the Nehaken, Rogue, and Willamette Rivers. Analyses were made for the National Park Service of two samples of water from Oregon caves.

Pennsylvania.—Surface-water investigations were continued in cooperation with the State Department of Forests and Waters and the city of Harrisburg, and 107 gaging stations were operated. Funds were also contributed by the Pittsburgh Army Engineer office, and permittees of the Federal Power Commission. Ground-water investigations were continued in cooperation with the State Topographic and Geologic Survey. The report on northeastern Pennsylvania was published by the State as Bulletin W–4, the report on south-central Pennsylvania is in press as Bulletin W–5, and the report on north-central Pennsylvania was completed and released in typewritten form. The collection of water-level data was continued.

South Carolina.—Surface-water investigations were continued in cooperation with the State Highway Department, the city of Spartanburg, and the town of Duncan, and 23 gaging stations were operated. Funds were also contributed by the Soil Conservation Service. The study of ground-water levels in the Tyger River area of the Soil Conservation Service was continued. During the year 8,532 samples were examined for silt content, and three gaging stations were maintained on North and South Tyger Rivers, in connection with the operation of the Soil Conservation Service demonstration project at Spartanburg. This work on the project was discontinued June 30.

South Dakota.—Surface-water investigations were continued in cooperation with the Kansas City Army Engineer office and the Biological Survey, and 21 gaging stations were operated. A report on the ground-water levels near Huron in 1937 was included in Water-Supply Paper 840.

Tennessee.—Surface-water investigations were continued in cooperation with the State Division of Geology, and 101 gaging stations were operated. Funds were also contributed by the Tennessee Valley Authority and the Nashville Army Engineer office. Records were obtained as to the pumpage and water levels in wells in Memphis. Preliminary tests were made of 216 samples of well waters from Giles County in connection with a study, by the Public Health Service of the Treasury Department, of tuberculosis in that county.

Texas.—Surface-water investigations were continued in cooperation with the State Board of Water Engineers, and 93 gaging stations were operated. Funds were also contributed by the Little Rock Army Engineer office. An extensive program of ground-water investigations was continued in cooperation with the State Board of Water Engineers and the cities of Big Spring, El Paso, Houston, and Lufkin. Intensive investigations were continued in the High Plains. A report on methods of locating salt-water leaks in water wells was published as Water-Supply Paper 796–A, and a report on ground water in Webb County was published as Water-Supply Paper 778. Mimeographed or typewritten reports were released on the ground-water resources of the Balmorhea, Lufkin, and Bryan areas and on the effects of pumping on water levels in the Houston area. Mimeographed reports were issued, giving the results of the W. P. A. water-well and spring inventories in the counties of Wilson, Ector, Dallam, Comal, Burleson, Brazoria (west of the Brazos River), Smith, Rusk, Lubbock, Leon, Karnes, Guadalupe, Lee, Knox, Glasscock, Andrews (south half), Eastland, Lamb, Potter, Midland, Randall, Austin, Coleman, Shelby, Colorado, Hale, Swisher, Parner, Panola, Refugio and part of Goliad, Brown, De Witt, and Floyd. A study was begun of the ground waters in the coastal sand-dune region. A substantial contribution in regard to the water levels in observation wells throughout Texas

was included in Water-Supply Paper 840. During the year 181 samples of water were analyzed.

Utah.—Surface and ground-water investigations were continued in cooperation with the State Engineer, and 71 gaging stations were operated. Special attention was given to the fluctuations of water levels with precipitation and pumpage or artesian flow and to the effects of the conservation program administered by the State Engineer. A report on the geology and ground-water resources of Ogden Valley was published as Water-Supply Paper 796–D. A report on the artesian water levels and interference between artesian wells in the vicinity of Lehi is ready to be published. Analyses were made of 36 composites of daily samples from the San Juan River near Bluff. The silt load was measured daily. Partial analyses were made of daily samples and of composites of daily samples collected throughout the year from the Colorado River at Cisco and the Green River at Green River.

Vermont.—Surface-water investigations were continued in cooperation with the State, and 27 gaging stations were operated.

Virginia.—Surface-water and ground-water investigations were continued in cooperation with the State Commission on Conservation and Development, and 89 gaging stations were operated. Funds were also contributed by the Huntington Army Engineer office. Work was done and a report released on artesian water in Southampton, Sussex, and Isle of Wight Counties. The observation-well program near Washington, D. C., which was begun in 1928, was continued.

Washington.—Surface-water investigations were continued in cooperation with the State Department of Conservation and Development, the Inter County River Improvement Commission, the cities of Aberdeen, Everett, Seattle, and Tacoma, and Skagit and Whatcom Counties, and 104 gaging stations in Washington and 5 in British Columbia were operated. Funds were also contributed by the Department of State, the Bureau of Reclamation, the Office of Indian Affairs, the Soil Conservation Service, and permittees of the Federal Power Commission. Ground-water investigations were begun in cooperation with the State Department of Conservation and Development and the city of Tacoma. A progress report on the Tacoma area was released and work was started in the Spokane Valley. Records were obtained on observation wells in the State-wide program and in the Pullman area of the Soil Conservation Service. During the year 4,946 samples were examined for silt content from six points on streams in and near the Pullman demonstration area.

West Virginia.—Surface-water investigations were continued in cooperation with the State Geological Survey, the State Public Service Commission, and the State Water Commission, and 46 gaging stations were operated. Funds were also contributed by the Huntington and Pittsburgh Army Engineer offices and permittees of the Federal Power Commission.

Wisconsin.—Surface-water investigations were continued in cooperation with the State Public Service Commission and the State Statutory Commission on Water Pollution, and 84 gaging stations were operated. Funds were also contributed by the Biological Survey, the Soil Conservation Service, the St. Paul Army Engineer office, and permittees of the Federal Power Commission. Records of water levels in observation wells were obtained in cooperation with the State Conservation Department and with the assistance of the Soil Conservation Service. During the year 2,434 samples from streams near LaCrosse were examined for silt content in connection with the operation of the LaCrosse demonstration project of the Soil Conservation Service.

Wyoming.—Surface-water investigations were continued in cooperation with the State Engineer, and 101 gaging stations were operated. Funds were also contributed by permittees of the Federal Power Commission.

CONSERVATION BRANCH

The work of the Conservation Branch involves surveys and investigations precedent to an inventory of the water and mineral resources of the public domain, supervision of private operations for development of power and production of minerals from public and Indian lands and naval petroleum reserves, and supplying information and advice to numerous land-administrative agencies of the Government.

These activities were maintained throughout the year, but not on the comprehensive and detailed basis that the work warranted, because of the lack of adequate funds. Mineral production during the year from public and Indian lands and naval petroleum reserves under supervision had an estimated value of $88,500,000, and the revenue accrued therefrom amounted to about $9,750,000. This substantial revenue is attributable both directly and indirectly to the supervision provided, the cost of which is meager compared with the income involved.

Cases pending in the branch at the end of the year decreased 16 percent, though the annual volume of work increased 72 percent, largely as the result of classification of the status of 7,697 oil and gas prospecting permits under the act of August 26, 1937, as required by Departmental Order No. 1240 of December 23, 1937. This work was accomplished by the assignment of a number of field engineers to Washington, with a consequent loss to field supervisory activities. Progress made on unit plans placed the work on a current basis at the end of the year. A total of 1,637 plans of development and operation were received during the year and at its close only eight of these were awaiting original technical consideration in the branch.

No expenditures were made from Public Works funds allotted for projects on which the several divisions of the branch had been engaged during the preceding year, and the unexpended balance of such funds was transferred back to the National Industrial Recovery fund on March 28, 1938.

MINERAL CLASSIFICATION DIVISION

The office activities of the mineral classification division were directed in considerable part to determining the areas subject to inclusion in plans for unit or cooperative development submitted by holders of Government oil and gas prospecting permits and leases and to consideration and submission of reports on initial applications for oil and gas leases.

In the aid of mineral classification pertinent information relating to the occurrence of carbon dioxide gas in Colorado; of coal in Montana, New Mexico, Oregon, Utah, and Wyoming; of oil and gas in Alabama, Colorado, Florida, Kansas, Louisiana, Mississippi, Montana, New Mexico, Oklahoma, South Dakota, Utah, and Wyoming; and of

phosphate in Florida, Idaho, and Wyoming was obtained either by the personnel of the mineral classification division or through the geologic branch.

In the routine work of the division 7,621 cases requiring technical consideration were disposed of during the fiscal year.

In addition to the preceding work, revision of the definition of the known geologic structure of one producing oil and gas field and the initial definition of another similar field were prepared and promulgated as follows:

Definitions of Known Geologic Structure, Fiscal Year 1938

State	Field	Date promulgated	Acres
Colorado	Moffat [1]	Dec. 17, 1937	4,357
Wyoming	Muskrat	Dec. 29, 1937	1,391

[1] Change in name.

The aggregate area of the outstanding definitions of the known geologic structure of oil and gas fields on June 30, 1938, amounted to 1,156,644 acres in California, Colorado, Montana, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming.

WATER AND POWER DIVISION

The work of obtaining basic information as to the water-power resources and storage possibilities of public land and of making it available for use in the administration of public-land laws and by Federal and other agencies engaged in planning, constructing, and operating water-power projects was continued in the field, but on a small scale because of lack of funds. River utilization surveys covering 32 miles of streams and tributaries and detailed surveys at four dam sites were made. Surveys of mineral leaseholds embracing an area of 12.5 square miles were also completed. Work was continued in the office on the preparation of reports on geologic conditions at 61 dam sites examined in the field during the next preceding year.

Office activities included action resulting in the addition of 97,583 acres to outstanding water-power reserves in 9 public-land States and Alaska and the elimination of 5,890 acres from such reserves in 6 States, with a net increase of the total reserved area in 22 States and Alaska to 6,675,132 acres. The elimination of 1,995 acres from reservoir-site reserves left a net total of 131,499 acres withdrawn. Field supervision, with the Water Resources Branch, of power projects for the Federal Power Commission involved investigations and reports on 5 projects, supervision of construction and operation on 155 projects, and continuation of studies of cost accounting on 9 projects. Field supervision of power projects holding permits and grants from

the Department of the Interior involved 172 projects, making a total of 327 projects for the Department of the Interior and the Federal Power Commission.

Statistics compiled by the division show that the holders and users of rights-of-way granted by the Secretary of the Interior for power purposes had, for the calendar year 1937, an aggregate installed capacity of 5,278,764 horsepower, including 3,644,006 horsepower at hydraulic plants and 1,634,758 horsepower at fuel plants, and an aggregate energy generation of 14,040,649,490 kilowatt-hours, which is an increase of 22 percent over the production in the next preceding year. The energy generated by water power increased 2,124,816,095 kilowatt-hours, or about 21 percent, and that generated by fuel increased 447,452,772 kilowatt-hours, or about 32 percent. Revenues accruing to the Government from these grants aggregated $249,025 from 1912 to 1937, and $15,325 additional has been assessed for the calendar year 1938. Payments for unauthorized occupancy of public lands by power projects prior to the issuance of license therefor by the Federal Power Commission amount to $104,667 additional.

MINING AND OIL- AND GAS-LEASING DIVISIONS

The work of the mining and oil- and gas-leasing divisions consists of inspectional and regulatory supervision of mineral prospecting and development on public land, Indian land, and naval petroleum reserves.

The mining division is charged with supervision of all operations for the discovery and development on public land of deposits of coal, potassium, sodium, phosphate, and oil shale; in New Mexico and Louisiana of sulphur; on certain land grants of gold, silver, and mercury; and on restricted allotted and tribal Indian lands of all minerals except oil and gas. This supervisory and regulatory work during the fiscal year was accomplished through six field offices at Denver, Colo.; Billings, Mont.; Carlsbad, N. Mex.; McAlester and Miami, Okla.; and Salt Lake City, Utah; and through a cooperative agreement approved May 4, 1935, with the Department of Mines, Territory of Alaska.

The work of the oil- and gas-leasing division includes inspectional and regulatory supervision of all operations for the discovery, development, and production of petroleum and natural gas on public land of the United States, on naval petroleum reserves, and on all Indian land subject to departmental jurisdiction, both tribal and allotted, except the Osage Reservation, Okla. The work was accomplished in the fiscal year 1938 through the agency of the 15 field offices and suboffices at Taft, Calif.; Roswell and Farmington, N. Mex.; Tulsa, Oklahoma City, Holdenville, and Drumright, Okla.; Wichita Falls, Tex.; Denver, Colo.; Casper, Midwest, and Thermopolis, Wyo.;

Billings and Great Falls, Mont.; and Salt Lake City, Utah. During the year the territorial delineation of the three supervisory districts was changed and a fourth supervisory district created with headquarters at Roswell, N. Mex.

Public land.—The number of public-land properties under supervision of the mining division at the end of the fiscal year 1938 was 743, a decrease of 27 from June 30, 1937. Coal properties in 14 States and Alaska decreased 31, to 626; potash properties in 3 States decreased 5, to 34 in 2 States; sodium properties in 9 States increased 5, to 49 in 8 States; phosphate properties in 4 States decreased 4, to 7 in 3 States; sulphur properties in 1 State increased 9, to 27; and the 1 oil-shale lease was canceled. The reduction in coal properties resulted indirectly from the Secretary's instructions of January 24, 1934, and that in potash properties from the Secretary's order 914 of April 5, 1935. Senate Resolution 298, approved June 16, 1938, restricted further issuance of phosphate leases. In prospecting for the above-named minerals nine bore holes were drilled during the year.

Accidents to employees working in mines under departmental lease are generally fewer than in competitive mines not on Government land, and it is gratifying to note that of the 28 awards to coal mines by the Joseph A. Holmes Safety Association for the calendar year 1937, four were made to departmental lessees. The use of safety appliances and safety clothing is increasing generally throughout mines on Government land.

The number of public-land properties under supervision of the oil- and gas-leasing division decreased 4.9 percent to a total of 8,605, involving 11,749,396.98 acres in 18 States and Alaska.

A substantial part of the time of the personnel of the division was devoted to assisting oil and gas permittees in fulfilling departmental requirements for the submission of unit or cooperative plans of operation and development and to reviewing and revising the engineering and royalty features of such plans after their submission. Approximately 7,800 outstanding oil and gas prospecting permits were classified under the various extension provisions of the act of August 26, 1937 (50 Stat. 842). At the end of the fiscal year 1938 a total of 1,637 plans of unit or cooperative development for oil or gas pools, fields, or areas involving public land had been filed with the Geological Survey, of which 91 had been given final approval by the Secretary of the Interior, 1,492 had been rejected, withdrawn, or suspended, and 54 were pending final action, including 8 which were awaiting technical consideration in the Conservation Branch.

Drilling activity on public land during the fiscal year 1938 included the commencement of 362 new wells and the completion of 408 wells, of which 316 were rated as productive of oil and gas and 92 as barren.

The total number of wells under supervision on June 30, 1938, was 8,339, including 4,334 capable of oil or gas production. Production of petroleum from public land in 1938 was substantially greater than in other recent years; production of gas was approximately the same as in 1937; production of natural gasoline was substantially less than in other recent years.

Indian land.—The number of Indian-land properties under supervision of the mining division during the fiscal year was 235 in 9 States. These properties involved 44 lead and zinc leaseholds in the Quapaw Reservation, Okla., with aggregate royalty accruals of $487,339.50, a decrease of 14.25 percent from the preceding year; 54 coal leaseholds on segregated Choctaw and Chickasaw land and restricted allotted land in Oklahoma, with an aggregate production, decreased from 527,579.75 tons in 1937 to 289,089.10 tons in 1938, and revenue accruals from royalties, bonuses, and sale of coal lands amounting to $73,080.30; 1 asphalt lease on segregated land in Oklahoma; and 136 properties in 9 western States, of which 13 were agency coal mines, 12 coal lessees, 63 individual Indian coal mines, and 48 metalliferous leases and nonmetalliferous leases other than coal leases.

Oil and gas supervision involved 5,382 leaseholds, 4,407 wells, and aggregate bonus, royalty, and rental accruals estimated at $2,500,000 for Indian beneficiaries in 11 States and 31 different tribes. The cooperative duties involved royalty accounting, appraisals of bonuses, royalty offers, and pollution damages, assistance to lessees of Indian land on operating problems and in the preparation of unit plans of development, and assistance to agency officials and tribal councils on technical phases of leasehold development and administration.

Naval petroleum reserves.—On behalf of the Navy Department supervision was continued during the fiscal year over operations for the production of oil and gas within Naval Petroleum Reserves Nos. 1 and 2, in California, and for the conservation of shut-in production within Naval Petroleum Reserve No. 3, in Wyoming. Production from 519 wells on the reserves aggregated 4,238,533.36 barrels of petroleum, 2,395,996,000 cubic feet of natural gas, and 10,581,504 gallons of natural gasoline and had an aggregate royalty value of $1,020,444.84.

SUMMARY OF FIELD ACTIVITIES, BY STATES

Alabama.—Investigated oil and gas prospecting operations throughout the State in aid of mineral classification. Supervised one coal lease on public land.

Alaska.—Supervised 1 power project, 2 leases, 10 prospecting permits, and 4 licenses for coal, and 147 prospecting permits for oil and gas on public land..

Arizona.—Supervised 24 power projects, 3 prospecting permits for coal and 7 for sodium, 3 leases and 66 prospecting permits for oil and gas on public land, 7 Indian agency coal mines, and 11 asbestos leases and 1 gold lease on Indian land. Examined 3 vanadium lease applications on Indian land.

Arkansas.—Supervised 1 power project and 9 prospecting permits for oil and gas on public land.

California.—Supervised 92 power projects, 3 prospecting permits for coal and 27 for sodium, 1 sodium lease, 2 potash leases, and 240 leases and 1,037 prospecting permits for oil and gas on public land, 1 coal lease and 3 gold leases on Indian land, and 22 oil and gas leases on naval petroleum reserves.

Colorado.—Investigated occurrence of carbon dioxide gas in the Black Canyon area, Delta County. Supervised 16 power projects, 96 leases, 32 prospecting permits, 11 licenses, and 4 awarded lease applications for coal, 1 sodium lease, and 35 leases and 638 prospecting permits for oil and gas on public land, and 1 coal lease, 1 vermiculite lease, and 5 oil and gas leases on Indian land.

Florida.—Investigated phosphate and oil and gas prospecting operations throughout the State in aid of mineral classification. Examined one tract in Suwannee County, one tract in Glades County for purposes of mineral classification, and an area in Monroe County involving reported oil and gas occurrences.

Idaho.—In cooperation with the Geologic Branch initiated investigations of phosphate deposits in eastern Bonneville County. Supervised 40 power projects, 1 lease and 17 prospecting permits for coal, 2 phosphate leases, and 69 prospecting permits for oil and gas on public land.

Kansas.—Investigated oil and gas prospecting operations in western Kansas in aid of mineral classification. Supervised 5 leases and 18 prospecting permits for oil and gas on public land.

Louisiana.—Investigated oil and gas prospecting operations throughout the State in aid of mineral classification. Supervised 22 leases and 3 prospecting permits for oil and gas on public land.

Mississippi.—Investigated oil and gas prospecting operations throughout the State in aid of mineral classification. Supervised 1 power project and 1 lease for oil and gas on public land.

Montana.—For the Office of Indian Affairs examined a location in Flathead River, near Polson, Mont., for rock foundation for irrigation pump site. Examined two tracts of land in Cascade County for purposes of mineral classification. In cooperation with the Geologic Branch continued structural and stratigraphic investigations in the Little Rocky Mountains area, Phillips and Fergus Counties. Initiated an investigation of the coal resources of the Otter Creek district and Big Horn, Powder River, and Rosebud Counties. Made field investigation and prepared report on foundation for a pipe line. Supervised 39 power projects; 91 leases, 21 prospecting permits, and 42 licenses for coal; 7 phosphate leases; 127 leases and 827 prospecting permits for oil and gas on public land; and 2 Indian agency coal mines, 7 coal and 3 silver-lead-gold leases, 1 bentonite lease, and 50 oil and gas leases on Indian land.

Nevada.—Supervised 26 power projects, 5 coal prospecting permits, 1 phosphate lease, 6 sodium permits, 1 potash permit, and 68 prospecting permits for oil and gas on public land, and 11 marl leases on Indian land.

New Mexico.—Continued an areal, stratigraphic, and subsurface structural investigation in Lea and Eddy Counties for purposes of mineral classification. In cooperation with the Geologic Branch continued investigations of the coal resources and oil possibilities of the east side of the San Juan Basin, including the Lumbarton and Monero districts, Rio Arriba County. Made additional studies of Dead Man's Wash erosion area. Supervised 3 power projects, 24 leases, and 20 prospecting permits for coal, 10 permits for sodium, 9 leases and 27 permits for potash, 27 sulphur permits, and 286 leases and 1,689 prospecting permits for oil and gas on public land, and 6 agency coal mines, 2 coal leases, 63 individual Indian coal mines, and 5 oil and gas leases on Indian land.

North Dakota.—Supervised 66 leases, 1 prospecting permit, and 21 licenses for coal, 4 permits for sodium, and 4 leases and 23 prospecting permits for oil and gas on public land.

Oklahoma.—Investigated oil and gas prospecting operations in western Oklahoma in aid of mineral classification. Supervised 3 power projects, 15 leases, and 87 prospecting permits for oil and gas on public land, and 30 leases, 23 mining permit leases, 1 leased purchased tract, 7 unleased purchased tracts, and 1 temporary mining permit for coal, 1 asphalt lease, and 1 right-of-way lease on segregated tribal and restricted allotted Indian lands, 44 zinc-lead leases on Quapaw Indian land, and 5,265 oil and gas leases on Indian land.

Oregon.—Examined 1 tract of land in Clatsop County for purposes of coal classification. Supervised 37 power projects, 1 lease and 2 prospecting permits for coal, 1 oil-shale lease, and 1 lease and 69 prospecting permits for oil and gas on public land.

South Dakota.—Completed a structural and stratigraphic investigation of the Gustave district in Butte and Harding Counties. Supervised 5 leases and 3 prospecting permits for coal and 46 prospecting permits for oil and gas on public land, and 6 oil and gas leases on Indian land.

Utah.—In cooperation with the Geologic Branch continued structural and stratigraphic investigations of the Henry Mountains area, in Wayne and Garfield Counties, and the Strawberry Valley quadrangle, in Utah and Wasatch Counties. Surveyed 6 square miles of mineral leaseholds. Supervised 16 power projects, 52 leases, 43 prospecting permits, and 3 licenses for coal, 4 sodium permits, 1 phosphate lease, and 39 leases and 887 prospecting permits for oil and gas on public land.

Washington.—Completed 32 miles of river-utilization surveys and surveyed in detail 4 dam sites on Tolt River. Supervised 21 power projects, 1 lease and 12 prospecting permits for coal, 1 sodium permit, and 8 prospecting permits for oil and gas on public land, and 5 silver-gold leases, 6 tungsten leases, and 1 oil and gas lease on Indian land.

Wisconsin.—Supervised 1 power project.

Wyoming.—Initiated topographic, structural, and stratigraphic investigations of the Lance Creek oil and gas field, in Niobrara County. Completed a structural and stratigraphic investigation of the Muskrat gas field, in Fremont County, and continued structural investigations of the Dewey and Mule Creek areas, in Weston County, for purposes of mineral classification. Examined two tracts of land in Lincoln County for purposes of coal classification. In cooperation with the Geologic Branch, continued investigations of phosphate deposits in northern Lincoln County. Completed structural and stratigraphic investigations of the Cody-Pitchfork district, in Park County, continued similar investigations of the east side of the Big Horn Basin, in Big Horn County, and initiated similar investigations of the Shoshone district, in Park County. Surveyed 6.5 square miles of mineral leaseholds. Supervised 6 power projects, 61 leases, 53 prospecting permits, and 22 licenses for coal, 2 permits for sodium, and 520 leases and 1,626 prospecting permits for oil and gas on public land, and 41 oil and gas leases on Indian land. Performed technical supervision at Emergency Conservation Camp 858, established for conserving coal deposits.

WORK ON PUBLICATIONS

Texts.—The book publications of the year numbered 56 in the regular series and 23 pamphlets and circulars for administrative use. The total number of pages was 8,910. Besides these printed publications 24 brief papers were issued in mimeographed form as memoranda

for the press or as informative circulars. During the year, 19,857 pages of manuscript were edited and prepared for printing, 2,537 galley proofs were read, and 9,714 page proofs were revised. Indexes were prepared for 47 publications, covering 7,386 pages. Copy and proof or stencils for 252 pages of multigraph or mimeograph matter were read. During the year, 75 foreign letters, in German, French, Spanish, Italian, and Portuguese, were translated.

Illustrations.—The section of illustrations prepared 1,657 drawings and photographs, transmitted 722 illustrations to accompany 32 reports, received and examined 1,009 proofs, and examined 60 edition prints.

Geologic map editing and drafting.—The geologic map of the Front Range, Colo., accompanied by a geologic legend, was prepared for engraving, and proof of the map and legend were read. The map is ready for transfer to printing plates. Color scheme for the map was prepared. A total of 182 illustrations, comprising geologic maps, sections, and diagrams, were drawn in the section to illustrate scientific papers of geologists. The drawings for 22 papers were edited, and proofs of 24 geologic maps and sections were read and corrected.

Distribution.—A total of 559 publications, comprising 56 new books and pamphlets, 106 new or revised topographic and other maps, 205 reprinted topographic and other maps, and 192 advance sheets were received during the year. A number of special pamphlets and forms for administrative use were also delivered and distributed. The total units of all publications received numbered 126,832 books and pamphlets and 943,340 topographic and other maps, a grand total of 1,070,172. The division distributed 112,010 books and pamphlets, 2,943 geologic folios, and 770,234 maps, a grand total of 885,187, of which 2,871 folios and 617,803 maps were sold. The net proceeds (gross collections less copying fees and amounts refunded) from the sales of publications were $38,832.79, including $38,307 for topographic and geologic maps, and $525.79 for geologic folios. In addition to this $9,877.92 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were $48,710.71.

Engraving and printing.—During the year 86 newly engraved topographic maps, including 3 revised maps, were printed, and also 24 special maps, making a total of 110 new maps printed and delivered. Of the newly engraved maps 59 were completed under the Public Works allotment. Corrections were engraved on the plates of 256 maps. Reprint editions of 190 engraved topographic maps and 12 photolithographed State and other maps were printed and delivered. In addition, 73 new topographic maps had been engraved and were in press June 30, including 53 under Public Works allotment, and the engraving of 111 other new topographic maps was in hand, including

54 under Public Works allotment. Of new and reprinted maps, 312 different editions, amounting to 822,475 copies, were delivered.

A large amount of work was done for 72 other units of the Government and State governments, and the charges for it amounted to about $195,000, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 445 were made during the year, and the amount turned over to miscellaneous receipts was $548.20.

Of topographic maps and contract and miscellaneous work of all kinds, a grand total of 4,331,170 copies were printed and delivered.

The photographic laboratory made 8,772 negatives (including 3,901 wet plates for photolithographs, 653 wet plates for photographic prints, 54 paper negatives, 1,426 dry plates, 521 lantern slides, 230 half-tone negatives, and 1,987 field negatives), 14,848 prints (including 1,302 maps and diagrams, 148 celluloid positives, 12,949 photographs for illustrations and records, and 449 bromide enlargements), 3,500 zinc plates, 309 intaglio etchings, and 10 celluloid prints, and mounted 2,052 prints.

LIBRARY

The total number of books and separate items circulated by the library amounted to 46,000. Books borrowed from other libraries for the use of the Geological Survey numbered 827, and books loaned to other libraries numbered 1,469. More than 21,000 new books, periodicals, maps, and other items were received, and more than 8,000 new cards were filed in the catalog.

About 1,400 books were bound at the Government Printing Office at a cost of more than $7,000, which just about covered the binding of the new acquisitions of the year.

The bibliography of North American geology for 1935–36 was published as Bulletin 892.

APPROPRIATIONS AND EXPENDITURES

The appropriation made directly for the work of the Geological Survey for the fiscal year 1938 included 10 items, amounting to $2,927,000, of which $67,822.69 remained unobligated on June 30, 1938. In addition, $6,500 was allotted from the appropriation for contingent expenses of the Department of the Interior for miscellaneous supplies.

Financial Statement of the Geological Survey for the Fiscal Year 1938

	Funds available				Obligations			
	Amounts appropriated or transferred	Repayments and adjustments		Total	Disbursements	Outstanding liabilities	Total	Balance
		Made	To be made					
Salaries	$140,000.00	$227.67		$140,227.67	$140,224.69		$140,224.69	$2.98
Topographic surveys	650,000.00	325,730.16	$51,603.71	1,027,333.87	973,636.03	$41,693.88	1,015,329.91	12,003.96
Geologic surveys	500,000.00	19,814.95	8,517.74	528,332.69	511,684.36	7,723.36	519,407.72	8,924.97
Alaskan mineral resources	60,000.00	159.44		60,159.44	47,748.21	10,417.95	58,166.16	1,993.28
Gaging streams	900,000.00	387,501.82	150,783.91	1,438,285.73	1,382,412.31	28,190.34	1,410,602.65	27,683.08
Classification of lands	100,000.00	1,348.36	534.34	101,882.70	98,237.79	956.84	99,194.63	2,688.07
Printing and binding	120,000.00			120,000.00	18,335.64	95,664.36	114,000.00	6,000.00
Preparation of illustrations	22,000.00			22,000.00	21,979.42	1.50	21,980.92	19.08
Geologic and topographic maps	120,000.00	160,349.20	41,170.71	321,519.91	287,092.05	26,309.65	313,401.70	8,118.21
Mineral leasing	315,000.00	20,242.77	1,698.24	336,941.01	330,949.80	5,602.15	336,551.95	389.06
Total	[a]2,927,000.00	915,374.37	254,308.65	4,096,683.02	3,812,300.30	216,560.03	4,028,860.33	67,822.69
Central Valley reclamation project, California (reimbursable) (transfer to Geological Survey), 1938	20,000.00			20,000.00		754.99	754.99	19,245.01
Flood control, general (transfer to Interior, Geological Survey, Act Aug. 9, 1937)	4,000.00			4,000.00	1,707.05	25.00	1,732.05	2,267.95
Flood control, Mississippi River and tributaries (transfer to Interior, Geological Survey, Act Aug. 9, 1937)	4,000.00			4,000.00	2,847.13	1,046.38	3,893.51	106.49
Irrigation, Indian reservations (reimbursable), (transfer to Geological Survey, Act Aug. 9, 1937), 1938	15,750.00			15,750.00	9,447.19	5,948.42	15,395.61	354.39
Maintenance and improvement of existing river and harbor works (transfer to Interior, Geological Survey, Act June 22, 1936)	[b]8,106.98	3.73		8,110.71	7,414.39	602.48	8,016.87	93.84
Maintenance and improvement of existing river and harbor works (transfer to Interior, Geological Survey, Act Aug. 9, 1937)	62,670.00	36.23		62,706.23	38,357.50	14,521.99	52,879.49	9,826.74
Maintenance, Wapato irrigation and drainage system, etc., Yakima Reservation, Wash. (receipt limitation) (transfer to Geological Survey, Act Aug. 9, 1937), 1938	500.00			500.00	147.36	352.64	500.00	
National Industrial Recovery, Interior, Indians (transfer to Geological Survey, Act June 22, 1936), 1933–39	[b]357.82		29.88	387.70	275.41	30.00	305.41	82.29
National Industrial Recovery, Interior, Geological Survey, 1933–39	[c]93,524.89	1,504.90	18.58	95,048.37	79,442.05	4,494.72	83,936.77	11,111.60
National Industrial Recovery, National Resources Committee, Interior, Geological Survey, 1933–39	[b]1,393.22			1,393.22	1,146.91	.91	1,147.82	245.40
Operation and conservation of naval petroleum reserves (Navy transfer to Interior, Geological Survey, Act Aug. 9, 1937), 1938	40,000.00	3.91		40,003.91	39,934.53	3.40	39,937.93	65.98
Public Works Administration, allotment to Interior, Geological Survey, 1935–39	[d]300,892.72	5,212.92	1,410.12	307,515.76	195,480.91	6,555.76	202,036.67	105,479.09
Supervising mining operations on leased Indian lands (transfer to Geological Survey, Act Aug. 9, 1937), 1938	80,000.00	230.68	176.34	80,407.02	80,219.81	179.80	80,399.61	7.41
Tennessee Valley Authority fund (transfer to Interior, Geological Survey, Act Aug. 9, 1937), 1938	119,889.49	913.68	31.66	120,834.83	101,647.12	12,483.66	114,130.78	6,704.05
Tennessee Valley Authority fund (transfer to Interior, Geological Survey, Act June 22, 1936)	[b]3,155.39	2,082.60		5,237.99	5,233.24		5,233.24	4.75
Waterways Treaty, United States and Great Britain (transfer to Interior, Geological Survey, Act June 16, 1937), 1938	48,500.00			48,500.00	33,529.83	13,170.08	46,699.91	1,800.09
Working fund, Department of the Interior (transfer from Army Engineers to Geological Survey, for topographic mapping, fiscal year 1935)	[b]10,702.40		24.16	10,726.56	4,571.71	219.16	4,790.87	5,935.69
Working fund, Interior, Geological Survey (Agriculture, cooperative construction of rural post roads)	[e]38,456.72	778.58	1,066.63	40,301.93	21,168.04		21,168.04	19,133.89
Working fund, Interior, Geological Survey (Agriculture, highway funds, Act of June 16, 1933, National Industrial Recovery)	[f]34,402.91	2,683.32		37,086.23	13,692.13		13,692.13	23,394.10
Working fund, Interior, Geological Survey (War, rivers and harbors)	[b]168.15	9.45		177.60	177.60		177.60	
Transfer total	886,470.69	13,460.00	2,757.37	902,688.06	636,439.91	60,389.39	696,829.30	205,858.76
Grand total	3,813,470.69	928,834.37	257,066.02	4,999,371.08	4,448,740.21	276,949.42	4,725,689.63	273,681.45

[a] In addition to these appropriations there was an allotment of $6,500 for miscellaneous supplies from the appropriation for contingent expenses of the Department of the Interior.

[b] Balance unobligated on June 30, 1937, and continued available for expenditure during the fiscal year 1938.

[c] Of the balance of $161,524.89 remaining on June 30, 1937, $68,000 has been rescinded.

[d] Includes $892.72 unobligated on June 30, 1937, and continued available for expenditure during the fiscal year 1938.

[e] Includes $18,456.72 unobligated on June 30, 1937, and continued available for expenditure during the fiscal year 1938.

[f] Includes $14,402.91 unobligated on June 30, 1937, and continued available for expenditure during the fiscal year 1938.

Classification of Obligations Incurred by the Geological Survey During the Fiscal Year Ended June 30, 1938

	Salaries	Topographic surveys	Geologic surveys	Alaskan mineral resources	Gaging streams
Salaries of permanent employees	$140,224.69	$681,451.21	$432,904.03	$33,928.76	$927,348.88
Wages of temporary employees		282,414.73	17,071.84	3,133.32	163,524.40
Supplies and materials		10,296.23	6,688.72	2,495.23	24,790.27
Dead storage of passenger-carrying vehicles		3.10	5.00		12.00
Other storage and pasturage of animals		708.23	173.69		318.52
Communication services		781.11	401.06	34.45	5,445.72
Travel expenses		95,812.20	25,350.63	11,652.12	96,912.32
Hire, maintenance, repair, and operation of passenger-carrying vehicles		1,375.05	3,534.81	19.87	37,561.14
Transportation of things		2,737.52	1,575.44	1,439.91	10,631.31
Hire, maintenance, repair, and operation of freight-carrying vehicles		38,428.98	5,685.12	74.44	34,216.34
Printing and binding		89,700.35	7,190.52	2,318.72	5,277.96
Furnishing of heat, light, power, water, and electricity					183.50
Rents		15.00	202.50	150.00	2,597.99
Repairs and alterations		5,868.48	3,559.87	545.26	38,908.30
Special and miscellaneous current expenses		7.20	8.84	29.67	42.08
Purchase of passenger-carrying vehicles		1,303.21	1,677.28		18,066.18
Purchase of freight-carrying vehicles		4,979.57	2,841.18		23,111.03
Purchase of scientific instruments and parts		3,590.88	2,690.18	55.11	59,005.91
Other equipment		8,667.70	7,850.41	2,289.30	25,190.52
Structures and parts					24,912.93
Miscellaneous refunds, adjustments, and transfers		100,006.90			176,215.97
Total	140,224.69	1,328,147.65	519,411.12	58,166.16	1,674,273.27

	Classification of lands	Printing and binding	Preparation of illustrations	Geologic and topographic maps	Mineral leasing	Total
Salaries of permanent employees	$82,219.58		$21,558.16	$235,975.11	$375,733.99	$2,931,344.41
Wages of temporary employees	4,170.82			233.32	1,681.89	472,230.32
Supplies and materials	522.47		56.01	41,060.28	1,140.44	87,049.65
Dead storage of passenger-carrying vehicles					22.02	42.12
Other storage and pasturage of animals	57.89				41.61	1,299.94
Communication services	227.20			2.69	2,382.66	9,274.89
Travel expenses	6,940.57		3.90	506.70	17,533.03	254,711.47
Hire, maintenance, repair, and operation of passenger-carrying vehicles	1,494.69			39.64	13,729.31	57,754.51
Transportation of things	217.45			161.89	2,638.78	19,402.30
Hire, maintenance, repair, and operation of freight-carrying vehicles	1,398.77				154.18	79,957.83
Printing and binding	285.60	$114,000.00	331.49		409.53	219,514.17
Furnishing of heat, light, power, water, and electricity					4,471.11	4,654.61
Rents					507.10	3,472.59
Repairs and alterations	143.45		4.19	10,227.84	3,304.15	62,561.54
Special and miscellaneous current expenses					68.83	156.62
Purchase of passenger-carrying vehicles	853.00				4,192.50	26,092.17
Purchase of freight-carrying vehicles						30,931.78
Purchase of scientific instruments and parts	112.22		22.72	19.50	25.38	65,521.90
Other equipment	550.92		4.45	19,310.84	9,321.81	73,185.95
Structures and parts						24,912.93
Miscellaneous refunds, adjustments, and transfers				5,863.89	19,531.17	301,617.93
Total	99,194.63	114,000.00	21,980.92	313,401.70	456,889.49	4,725,689.63

In addition to the above amounts, there was expended directly by cooperating agencies $41,243.55 for topographic surveys, $966.92 for geologic surveys, and $480,481.61 for stream gaging.

APPENDIX

Summary of Outstanding Mineral Withdrawals and Classifications

[June 30, 1938, in acres]

State	Coal		Oil		Oil shale		Phosphate		Potash
	Withdrawn	Classified as coal land	Withdrawn	Classified as oil land	Withdrawn	Classified as oil-shale land	Withdrawn	Classified as phosphate land	Withdrawn
Alaska		56,993							
Arizona	139,415								
Arkansas		61,160							
California	17,603	8,720	1,178,392						90,324
Colorado	4,142,233	3,082,272	215,370		1,172,778	952,239			
Florida							66,796	120	
Idaho	11,520	4,603					276,239	270,036	
Louisiana			466,990	4,233					
Montana	6,259,193	[1] 9,373,884	1,336,697	67,651			280,089	3,833	
Nevada	83,673								39,422
New Mexico	4,119,616	984,829							9,282,160
North Dakota	5,954,364	11,178,286	84,894						
Oregon	4,361	18,887							
South Dakota		250,093							
Utah	3,404,043	1,267,697	[2] 1,344,473		2,737,274	2,703,755	277,344	2,937	
Washington	691,801	141,444							
Wyoming	2,143,991	[3] 6,847,235	541,777		2,079,897	425,214	989,133	25,293	
Total	26,971,813	33,276,103	5,168,593	71,884	5,989,949	4,081,208	1,889,601	302,219	9,411,906

[1] Includes 3,151 acres of coal land reserved for use of the United States (coal reserve No. 1.)
[2] Includes 13,578 acres withdrawn as helium reserve.
[3] Includes 2,078 acres of coal land reserved for use of the United States (coal reserve No. 2).

General Summary of Cases Involving Land Classification

Class of cases	Record for fiscal year 1937–38						Record since receipt of first case	
	Pending prior to July 1, 1937	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1938	Gain or loss during fiscal year	Received	Acted on
Mineral leasing laws:								
Permit applications	17	162	179	169	10	+7	62,515	62,505
Lease applications	411	2,773	3,184	2,351	833	−422	7,091	6,258
Committee cases	12	64	76	76		+12	13,221	13,221
Concurrence	64	979	1,043	1,011	32	+32		
Interference (surface rights)	10	210	220	217	3	+7		
Unit operation plans	161	284	445	391	54	+107	1,637	1,583
Cases involved in unit plans	966	1,350	2,316	1,907	409	+557	5,392	4,983
Development (drilling operations, etc.)	2	53	55	51	4	−2	17,632	17,628
Miscellaneous		[1] 7,919	7,919	7,697	222	−222	7,919	7,697
Mineral classification:								
Oil and gas (including "349")	264	1,014	1,278	1,218	60	+204	30,957	30,897
Water and power:								
Federal Power Commission:								
Preliminary permits	12	69	81	75	6	+6	515	509
Licenses							28	28
Determinations under Sec. 24	3	63	66	58	8	−5	691	683
Classification	3	5	8	7	1	+2	562	561
Rights-of-way	30	128	158	143	15	+15	7,454	7,439
Irrigation project reports		1	1		1	−1	945	944
General information:								
General Land Office (cooperatives, etc.)	27	124	151	138	13	+14		
Indian Office							9,549	9,549
Total	1,982	15,198	17,180	15,509	1,671	+311		

[1] Classification of the status of oil and gas prospecting permits under the act of August 26, 1937 (50 Stat. 842), as required by Departmental Order No. 1240 of December 23, 1937.

Mineral Production From Public Land and Revenues Accrued Therefrom, Fiscal Year 1938

State	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)	Coal (short tons)	Potassium (short tons)	Sodium (short tons)	Phosphate (short tons)	Accrued revenues
Alaska				124,272				$7,233.73
Alabama				57,290				5,729.00
California	19,892,830	39,527,576	4,426,154	59		61,787		3,919,171.96
Colorado	1,006,257	1,413,857	49,427	491,228		1,325		132,542.42
Idaho				1,474				438.38
Louisiana	249,081	1,515,747	11,639					240,837.14
Montana	474,054	2,707,391		274,451			20,291	87,993.06
New Mexico	8,195,801	20,394,774	8,617,429	42,509	572,307	6,193		941,851.42
North Dakota		25,745		432,115				28,596.58
Oklahoma	146,095		197,699					21,110.01
South Dakota				3,178				530.29
Utah	180	2,266,048	453,431	1,080,352				134,226.62
Washington				20,690				2,069.53
Wyoming	11,666,070	12,081,292	25,754,114	1,267,023				1,706,161.98
Total	41,630,368	79,932,430	39,509,893	3,794,641	572,307	69,305	20,291	7,228,492.12
Total, 1937	37,556,776	80,186,340	97,838,813	4,221,203	449,584	75,870	26,104	6,338,007.08

State	Total area mapped during fiscal year 1938 (square miles)										Types of standard surveys, with contours, fiscal year 1938 (square miles)			Total area mapped to June 30, 1938 (square miles)	Percentage of total area of State mapped to June 30, 1938	Control, fiscal year 1938		
	[a] Planimetric on scale of 1 to—		For publication with contour intervals from 5 to 100 feet on scale of 1 to—													Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
	48,000	31,680	12,000	15,840	24,000	30,000	31,680	48,000	62,500	125,000	New survey	Resurvey	Revision					
Alabama														21,983	42.3			
Arizona									761		761			29,000	25.4			
Arkansas									415		286	129		24,046	45.1		76	1
California							87		120	305		207	305	129,143	81.6	155		21
Colorado			6		21		513		239		162	586	31	57,282	55.1	652	628	18
Connecticut							56					56		4,965	100.0	18		
Delaware														2,370	100.0			
District of Columbia														70	100.0			
Florida														6,373	10.9			
Georgia					[b] 297				13			310		25,202	42.5			
Idaho					150				329		350	129		35,993	42.9	34		8
Illinois							31		532		524	31	8	40,889	72.2	199		
Indiana					353						353			4,640	12.8	829	633	
Iowa														13,710	24.4			
Kansas								383				383		64,446	78.4	272	231	
Kentucky														27,358	67.4			
Louisiana		1,014					582					582		11,330	23.4	95	434	
Maine														21,876	66.2			
Maryland														12,327	100.0			
Massachusetts							513					513		8,266	100.0	23		
Michigan		131			287						287			15,181	26.2		596	1
Minnesota														8,890	10.5			
Mississippi														7,511	16.0			
Missouri	932		11		664			962			725	912		53,304	76.8	726	417	
Montana				[b] 49					200	137	249		137	37,078	25.2	413		36
Nebraska					198							198		27,931	36.0			
Nevada			[c] 3						247		250			43,180	39.0	6		21
New Hampshire														9,302	100.0	40		
New Jersey							56					56		8,224	100.0	22		
New Mexico									695		501	194		32,778	26.7	160		16
New York							90					90		49,204	100.0	180		
North Carolina					[b] 117							117		19,040	36.3			
North Dakota									223		223			14,757	20.8	151	132	

See footnotes at end of table.

Topographic Mapping by the Geological Survey in the United States, Puerto Rico, and Hawaii, to June 30, 1938—Continued

State	Total area mapped during fiscal year 1938 (square miles)										Types of standard surveys, with contours, fiscal year 1938 (square miles)			Total area mapped to June 30, 1938 (square miles)	Percentage of total area of State mapped to June 30, 1938	Control, fiscal year 1938		
	[a] Planimetric on scale of 1 to—		For publication with contour intervals from 5 to 100 feet on scale of 1 to—													Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
	48,000	31,680	12,000	15,840	24,000	30,000	31,680	48,000	62,500	125,000	New survey	Resurvey	Revision					
Ohio														41,040	100.0			
Oklahoma														42,172	60.2			
Oregon									270		171		99	33,560	34.7	303		
Pennsylvania									504		423	81		40,585	89.9			
Rhode Island							46					46		1,248	100.0	35		
South Carolina									38			38		15,278	49.3	42		
South Dakota														19,887	25.6	10		
Tennessee					[b] 547				6			553		23,633	56.2			
Texas									358		133	225		90,428	34.0	207	290	
Utah								56	233		289			19,322	22.7	335		26
Vermont									112		112			8,864	92.7			
Virginia					[b] 208		121		[d] 337			622	44	37,897	88.9	98	150	29
Washington										660	660			42,192	61.0	132	32	2
West Virginia														24,170	100.0			
Wisconsin									9		9			19,817	35.3		754	7
Wyoming									163		163			34,244	35.0	13		
Total	932	1,145	20	49	2,842		2,095	1,401	5,804	1,102	6,631	6,058	624	[e] 1,361,986	45.0	5,150	4,373	186
Hawaii														6,435	100.0			
Puerto Rico						[f] 270					244		26	515	15.0	260		28

[a] Compiled from aerial photographs with field examination. Show culture, drainage, and woodland, but no contours.
[b] Mapped from aerial photographs by steriophotogrammetric methods.
[c] Mapped on a scale of 1:4,800.
[d] Includes 36 square miles mapped from aerial photographs by stereophotogrammetric methods.
[e] Areas in Arizona, California, Montana, Nevada, New Mexico, Oregon, and Utah, which were surveyed by the Geological Survey prior to 1896 by reconnaissance methods and included in previous reports, have been eliminated from this table as areas unmapped and the maps withdrawn from distribution.
[f] Contour interval 5 meters.