

UNITED STATES DEPARTMENT OF THE INTERIOR

*ANNUAL REPORT OF THE
DIRECTOR OF
THE GEOLOGICAL SURVEY
TO THE SECRETARY OF THE INTERIOR
FOR FISCAL YEAR ENDED JUNE 30, 1931*

UNITED STATES DEPARTMENT OF THE INTERIOR

FIFTY-SECOND ANNUAL REPORT

OF THE

DIRECTOR OF
THE GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1931



UNITED STATES
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Directors of the Geological Survey

CLARENCE KING, 1879-1881

JOHN WESLEY POWELL, 1881-1894

CHARLES DOOLITTLE WALCOTT, 1894-1907

GEORGE OTIS SMITH, 1907-1930

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ANNUAL REPORT
OF THE
DIRECTOR OF THE GEOLOGICAL SURVEY

W. C. MENDENHALL, *Acting Director*

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
October 15, 1931.

SIR: The appropriations made directly for the work of the Geological Survey for the fiscal year 1931 included 17 items, amounting to \$2,869,990.85. In addition there was allotted \$13,013.75 for miscellaneous supplies from appropriations for the Interior Department.

A detailed statement of the amounts appropriated and expended is given at the end of the report. The balance on July 31 was \$171,300.31.

The total amount of funds made available for disbursement by the Geological Survey, together with State funds directly disbursed for work administered by the Federal officials, was \$4,842,151.02.

ORGANIZATION AND PROGRESS

The pages that follow set forth briefly the organization and the varied activities of the United States Geological Survey in the fifty-second year of its existence. Established in 1879, it was given by Congress a broad mandate for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." Specific provision was made for the publication of the results obtained in the execution of this mandate. Building upon this legislative foundation, the Geological Survey for more than half a century has endeavored to maintain high standards of professional work and conduct, to make steady contributions to the advance of knowledge within its assigned fields, and to apply this knowledge in the mineral industry, in cartography, and in hydrography. More than 2,000 volumes and many thousands of maps dealing with geology, mineral resources, water supplies, and other topics germane to the activities of the Geological Survey have been published.

The geologic branch is the senior of the Geological Survey's major units, the one from whose initial activities most of the other branches and several separate bureaus and institutions have sprung. Chief among these separate organizations are the Bureau of Ameri-

can Ethnology, the Bureau of Mines, and the Geophysical Laboratory of the Carnegie Institution.

The energies of the branch have necessarily been divided from the beginning between fundamental geology and applied geology. It has always recognized that sound work on the principles of any science must precede an attempt to apply the principles in everyday affairs. This essential idea has had gratifying recognition during the past year in the granting of a specific appropriation for geologic research. A summary of the branch's activities during the fiscal year 1931 appears elsewhere in this report.

Improving upon the beginnings made by its predecessors—the great exploratory surveys of the sixties and seventies of the nineteenth century—the Geological Survey early developed and applied in this country the art of topographic mapping, in order to have for its own use those base maps that are so essential to accurate studies of geology and mineral resources. These maps have proved so valuable in many engineering and other fields that the demands for them outside the Geological Survey have obscured and far outrun their original purpose. The topographic branch, devoted to the making of these maps, is now one of the most important units of the organization. Its activities for the fiscal year 1931 are briefly set forth in succeeding pages.

As settlement has extended across the continent in the last half century and invaded the arid and semiarid regions, and as cities in the East have grown and industrial development has become more intensive, the vital nature of the problem of adequate water supplies has penetrated the consciousness of our citizens.

In anticipation of this development and parallel with it, the Geological Survey has endeavored from an early date in its history to collect and to make public definite records of available water supplies. The value of these records increases with their length and their degree of completeness, and the uses to which they are put in planning irrigation enterprises and in municipal and industrial development are constantly multiplying. The water-resources branch is the unit upon which this work devolves. Out of the earlier activities of this branch grew the Bureau of Reclamation, at first a part of the Geological Survey, now a separate service in the Department of the Interior.

With the stimulus given to mining in Alaska by the discovery of the Klondike near the end of the last century, the activities of the Geological Survey in that Territory, previously desultory, were increased and systematized and eventually were recognized by the establishment of an Alaskan branch, which for more than a quarter of a century has been actively identified with the development of the Territory. Over 46 per cent of the area has now been mapped topographically and nearly 44 per cent geologically, the maps and the reports that accompany them serving as valuable guides in all mining and prospecting activities.

The latest of the Geological Survey's great field branches to be established is the conservation branch. Its function of land classification, first separated as the duty of an independent unit in 1912, had grown, like most of the other Geological Survey activities, out of the geologic branch, which began early in this century the classifi-

cation of lands into some of the categories recognized in the public land laws. This activity represents a delayed recognition of one of the functions delegated to the Geological Survey at the time of its establishment—a function impossible to exercise in the early years of small appropriations and small staffs. With the more definite statutory recognition, especially during the last 20 years, of different classes of public lands and the necessity of separating the lands into these classes in order that the statutes might be applied; with the enactment of mineral leasing laws; and, finally, with the transfer from the Bureau of Mines to the Geological Survey in 1925 of the technical administration of these laws under the department, this branch has grown in functions and importance into one of the major units of the organization.

With the encouragement of cordial and increased interest and support by the administration and the Congress, moderate expansion has been possible in the staff and in a number of the activities of the Geological Survey during the fifty-second year of its existence. Especially noteworthy has been the growth in geologic investigations and studies of water resources. Geologic work was strengthened by an increase in the appropriation "for geologic surveys" and by the granting of a new fund "for fundamental research in geologic science" which permitted the beginning of studies in some of the many problems that have long awaited attention. Broadened investigations of the surface and underground waters of the country were made possible by increased funds appropriated as a recognition by Congress of the national interest in this vital natural resource.

RESIGNATION OF THE DIRECTOR

December 22, 1930, George Otis Smith resigned as Director of the Geological Survey to accept the appointment as chairman of the reorganized Federal Power Commission.

A member of the Geological Survey since 1896, Doctor Smith became its fourth director on May 1, 1907, and served in that capacity continuously until 1930, except for about 10 months in 1922 and 1923 while a member of the United States Coal Commission. Thus he has been at the head of the Geological Survey for almost half of its existence, during a time of rapidly growing public and industrial recognition of the value of geology in the practical affairs of the Nation. To him the Geological Survey owes much for his example of unswerving official integrity and for his insistence upon loyalty to the ideals of public service. The practical application of science to the public welfare was his objective throughout his directorship—an objective to be attained only by a constant search for facts and by their accurate and fearless statement. Introduction of sound business methods and the encouragement of cordial relations with the public were factors in the smooth functioning of the organization during his incumbency.

Under Director Smith's administration the Geological Survey has grown greatly in the extent and scope of its activities. During the fiscal year 1931 the direct Federal appropriations were nearly twice and the total funds available from Federal and State sources for work by and under supervision of the Geological Survey were nearly

three times as large as the corresponding funds in 1907, the first year of his directorship.

The selection of Doctor Smith by the President to head the Federal Power Commission was a recognition of his success as an administrator and of the important position that the Geological Survey has taken for years under his direction in the conservation of water and power resources and their development in the public interest.

PUBLICATIONS OF THE YEAR

The following publications were issued during the fiscal year 1931:

ANNUAL REPORT

Fifty-first Annual Report of the Director of the Geological Survey.

PROFESSIONAL PAPERS

- 100. The coal fields of the United States, by M. R. Campbell and J. A. Bownocker.
- 159. The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the plant-bearing beds, by G. C. Martin.
- 160. Geologic history of the Yosemite Valley, by F. E. Matthes.
- 165-D. Geology of the Big Snowy Mountains, Mont., by Frank Reeves.
- 165-E. The kaolin minerals, by C. S. Ross and P. F. Kerr.

BULLETINS

- 812. Contributions to economic geology (short papers and preliminary reports), 1929, Part II, Mineral fuels.
- 813. Mineral resources of Alaska, report on progress of investigations in 1928, by P. S. Smith and others.
- 813-D. Notes on the geology of upper Nizina River, by F. H. Moffit.
- 814. Geology and ore deposits of the Wood River region, Idaho, by J. B. Umpleby, L. G. Westgate, and C. P. Ross, with a description of the Minnie Moore and near-by mines, by D. F. Hewett.
- 815. Geology and mineral resources of northwestern Alaska, by P. S. Smith and J. B. Mertie, jr.
- 817. Boundaries, areas, geographic centers, and altitudes of the United States and the several States, with a brief record of important changes in their territory and government (2d edition), by E. M. Douglas.
- 819. The Wasatch Plateau coal field, Utah, by E. M. Spieker.
- 820. Nitrate deposits in southeastern California, with notes on deposits in southeastern Arizona and southwestern New Mexico, by L. F. Noble.
- 821. Contributions to economic geology (short papers and preliminary reports), 1930, Part I, Metals and nonmetals except fuels.
- 821-A. A graphic history of metal mining in Idaho, by C. P. Ross.
- 821-B. A geologic study of the Madden Dam project, Alhajuela, Canal Zone, by Frank Reeves and C. P. Ross.
- 821-C. Iron ore on Canyon Creek, Fort Apache Indian Reservation, Ariz., by E. F. Burchard.
- 822. Contributions to economic geology (short papers and preliminary reports), 1930, Part II, Mineral fuels.
- 822-A. Geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater Counties, Mont., by R. S. Knappen and G. F. Moulton.
- 822-C. Bituminous sandstone near Vernal, Utah, by E. M. Spieker.
- 823. Bibliography of North American geology, 1919-1928, by J. M. Nickles.
- 824-A. Mineral industry of Alaska in 1929 and administrative report, by P. S. Smith.
- 825. Microscopic determination of the ore minerals, by M. N. Short.
- 826. Names and definitions of the geologic units of California, by M. G. Wilmarth.

WATER-SUPPLY PAPERS

620. Geology and ground-water resources of western Sandoval County, N. Mex., by B. C. Renick.
622. Surface-water supply of the United States, 1926, Part II, South Atlantic slope and eastern Gulf of Mexico basins.
623. Surface-water supply of the United States, 1926, Part III, Ohio River Basin.
628. Surface-water supply of the United States, 1926, Part VIII, Western Gulf of Mexico basins.
630. Surface-water supply of the United States, 1926, Part X, The Great Basin.
631. Surface-water supply of the United States, 1926, Part XI, Pacific slope basins in California.
633. Surface-water supply of the United States, 1926, Part XII, North Pacific slope drainage basins: B, Snake River Basin.
634. Surface-water supply of the United States, 1926, Part XII, North Pacific slope basins; C, Pacific slope basins in Oregon; and lower Columbia River Basin.
635. Surface-water supply of Hawaii, July 1, 1925, to June 30, 1926.
636. Contributions to the hydrology of the United States, 1929.
- 637-B. Preliminary report on the ground-water supply of Mimbres Valley, N. Mex., by W. N. White.
- 637-C. Water-power resources of the McKenzie River and its tributaries, Oreg., by B. E. Jones and H. T. Stearns.
641. Surface water supply of the United States, 1927, Part I, North Atlantic slope drainage basins.
643. Surface water supply of the United States, 1927, Part III, Ohio River Basin.
644. Surface water supply of the United States, 1927, Part IV, St. Lawrence River Basin.
645. Surface water supply of the United States, 1927, Part V, Hudson Bay and upper Mississippi River basins.
646. Surface water supply of the United States, 1927, Part VI, Missouri River Basin.
647. Surface water supply of the United States, 1927, Part VII, Lower Mississippi River Basin.
648. Surface water supply of the United States, 1927, Part VIII, Western Gulf of Mexico basins.
649. Surface water supply of the United States, 1927, Part IX, Colorado River Basin.
650. Surface water supply of the United States, 1927, Part X, The Great Basin.
655. Surface water supply of Hawaii, July 1, 1926, to June 30, 1927.

TOPOGRAPHIC AND OTHER MAPS

[The figures in parentheses indicate limiting parallels and meridians of the areas covered]

Alabama:

Montgomery (32° 15'-32° 30'; 86° 15'-86° 30').

Arizona:

Aguila Mountains (32° 30'-32° 45'; 113° 15'-113° 30').

Hyder (33°-33° 15'; 113° 15'-113° 30').

Kim (32° 30'-32° 45'; 113° 30'-113° 45').

Linskey (33° 45'-34°; 114°-114° 15').

Stoval (32° 45'-33°; 113° 30'-113° 45').

California:

Compton (33° 48'-33° 54'; 118° 12'-118° 18').

Hamlin School (35° 37' 30''-35° 45'; 119° 22' 30''-119° 30').

Leonards (35° 30'-35° 37' 30''; 119° 22' 30''-119° 30').

McFarland (35° 37' 30''-35° 45'; 119° 7' 30''-119° 15').

Miramonte Ranch (35° 37' 30''-35° 45''; 119° 30''-119° 37' 30'').

Naval Petroleum Reserve No. 1 (Elk Hills oil field) (35° 13' 30''-35° 20'; 119° 18'-119° 35').

Pond (35° 37' 30''-35° 45'; 119° 15'-119° 22' 30'').

Wasco (35° 30'-35° 37' 30''; 119° 15'-119° 22' 30'').

Colorado:

Glenwood Springs (39° 30'-40°; 107°-107° 30').

State, scale 1 inch=8 miles.

Delaware (see Delaware-Maryland; Delaware-New Jersey; New Jersey-Delaware).

Delaware-Maryland:

Wyoming (39°-39° 15'; 75° 30'-75° 45').

Delaware-New Jersey (see also New Jersey-Delaware):

Smyrna (39° 15'-39° 30'; 75° 30'-75° 45').

District of Columbia (see Maryland-Virginia-District of Columbia).

Hawaii:

Humuula (19° 30'-19° 45'; 155° 15'-155° 30').

Kaohē (19° 30'-19° 45'; 155° 30'-155° 45').

Idaho (see Wyoming-Montana-Idaho).

Illinois (see also Illinois-Missouri):

Danvers (40° 30'-40° 45'; 89°-89° 15').

Glasford (40° 30'-40° 45'; 89° 45'-90°).

Hardin (39°-39° 15'; 90° 30'-90° 45').

Nebo (39° 15'-39° 30'; 90° 45'-91°).

Normal (40° 30'-40° 45'; 88° 45'-89°).

Steger (41° 22' 30''-41° 30'; 87° 37' 30''-87° 45').

Illinois-Missouri:

Pearl (39° 15'-39° 30'; 90° 30'-90° 45').

Indiana (see Michigan-Indiana).

Iowa:

Mitchellville (41° 30'-41° 45'; 93° 15'-93° 30').

Maine (see also Maine-New Hampshire):

Rumford (44° 30'-44° 45'; 70° 30'-70° 45').

Sandy Bay (45° 45'-46°; 70° 15'-70° 30').

Square Lake (47°-47° 15'; 68° 15'-68° 30').

Stockholm (47°-47° 15'; 68°-68° 15').

Winterville (46° 45'-47°; 68° 30'-68° 45').

Maine-New Hampshire:

Moose Bog (45° 15'-45° 30'; 71°-71° 15').

Maryland (see Delaware-Maryland; Maryland-Virginia-District of Columbia).

Maryland-Virginia-District of Columbia:

Washington and vicinity (road map) (38° 30'-39° 30'; 76° 30'-77° 30'),
scale 1 inch=4 miles.

Michigan (see also Michigan-Indiana):

Benton Harbor (42°-42° 15'; 86° 15'-86° 30').

Fennville (42° 30'-42° 45'; 86°-86° 15').

Hartford (42°-42° 15'; 86°-86° 15').

South Haven (42° 15'-42° 30'; 86° 15'-86° 30').

Michigan-Indiana:

Niles (41° 45'-42°; 86° 15'-86° 30').

Minnesota (see Wisconsin-Minnesota).

Missouri (see also Illinois-Missouri):

Coldwater (37° 15'-37° 30'; 90° 15'-90° 30').

Montana (see Wyoming-Montana-Idaho).

New Hampshire (see also Maine-New Hampshire; Vermont-New Hampshire):

Cardigan (43° 30'-43° 45'; 71° 45'-72°).

New Jersey-Delaware (see also Delaware-New Jersey):

Bay Side (39° 15'-39° 30'; 75° 15'-75° 30').

New Mexico:

Tucumcari (35°-35° 30'; 103° 30'-104°).

North Dakota:

Devils Lake (48°-48° 15'; 98° 45'-99°).

Drake (47° 45'-48°; 100° 15'-100° 30').

Hamar (47° 45'-48°; 98° 30'-98° 45').

Pekin (47° 45'-48°; 98° 15'-98° 30').

Oklahoma:

McLoud (35° 15'-35° 30'; 97°-97° 15')

Oregon:

Mount Jefferson (44° 30'-45°; 121° 30'-122°).

Pennsylvania:

Tidioute (41° 30'-41° 45'; 79° 15'-79° 30').

Tennessee:

Erin (36° 15'-36° 30'; 87° 30'-87° 45').

Texas:

- Bassett (33° 15'–33° 30'; 94° 30'–94° 45').
 Belton (31°–31° 15'; 97° 15'–97° 30').
 Carrollton (32° 45'–33°; 96° 45'–97°).
 Grapevine (32° 45'–33°; 97°–97° 15').
 Ivan (32° 45'–33°; 98° 30'–98° 45').
 Killeen (31°–31° 15'; 97° 30'–97° 45').
 Lockhart (29° 45'–30°; 97° 30'–97° 45').
 Richland Springs (31° 15'–31° 30'; 98° 45'–99°).
 Santo (32° 30'–32° 45'; 98°–98° 15').
 Seguin (29° 30'–29° 45'; 97° 45'–98°).
 State, oil and gas fields, scale 1:750,000. 2 sheets.
 Tilden (28° 15'–28° 30'; 98° 30'–98° 45').
 Tolar (32° 15'–32° 30'; 97° 45'–98°).
 Tordia (28° 45'–29°; 98°–98° 15').
 Whitsett (28° 30'–28° 45'; 98° 15'–98° 30').

Vermont (see also Vermont-New Hampshire):

- Hyde Park (44° 30'–44° 45'; 72° 30'–72° 45').

Vermont-New Hampshire:

- Bellows Falls (43°–43° 15'; 72° 15'–72° 30')

Virginia (see also Maryland-Virginia-District of Columbia):

- Max Meadows (36° 45'–37°; 80° 45'–81°).
 Speedwell (36° 45'–37°; 81°–81° 15').
 University (38°–38° 15'; 78° 30'–78° 45').
 Warrenton (38° 30'–38° 45'; 77° 45'–78°).

Washington:

- Chewelah (48°–48° 30'; 117° 30'–118°).
 Steamboat Mountain (46°–46° 30'; 121° 30'–122°).

Wisconsin-Minnesota:

- La Crosse (43° 45'–44°; 91°–91° 15').

Wyoming (see also Wyoming-Montana-Idaho):

- State, oil and gas fields, scale 1 inch=8 miles.

Wyoming-Montana-Idaho:

- Yellowstone National Park (44° 10'–45°; 109° 50'–111° 5') scale 1 inch=2 miles.

THE YEAR'S OPERATIONS

Among the outstanding publications of the year are Professional Paper 160, on the geologic history of the Yosemite Valley, setting forth the results of years of study by a geologist who is expert at interpreting land forms; Bulletin 817, a revised edition of the fascinating story of the boundaries of the United States and the several States; Bulletin 823, a cumulated bibliography of North American geology for 1919–1928, supplementing the indispensable bibliography for 1785–1918 contained in Bulletins 746 and 747; and Bulletin 825, a detailed description of methods that have proved satisfactory in the microscopic determination of the ore minerals, with tables showing distinctive properties of the minerals and an account of short cuts that may be used in identifying them.

A summary of the year's operations is given below.

GEOLOGIC WORK

Research in geologic science, which has always formed an essential part of the Geological Survey's work but has been relatively overshadowed by the greatly increased demand for work in applied geology, has been expanded by means of the new item for that specific purpose included in the annual appropriation act, providing a fund of \$100,000.

The special 5-year potash exploration program authorized in 1926 was completed, four sites for core tests having been recommended by the Geological Survey to the Bureau of Mines during the year—two in New Mexico, one in

Texas, and one in Washington. The total number of sites thus recommended during the five years is 24, all but one in New Mexico and Texas. As a result of these explorations one company has sunk a shaft and begun commercial production in the New Mexico field. The geologic conditions of the areas investigated are similar to those of the German potash area, and substantial bodies of certain potash minerals that are apparently thick enough, rich enough, and shallow enough to justify extensive mining operations have been discovered.

Geologic work was done in 38 States and Hawaii, and in this work many State and Government agencies and nongovernmental scientific organizations continued to cooperate.

EXPLORATIONS IN ALASKA

The work of the Geological Survey in Alaska is in large part pioneer service under frontier conditions, though airplanes are being used for transportation to some of the remote camps. In the field season of 1930 an area of 944 square miles in southeastern Alaska was topographically mapped on a drainage base compiled from the Navy Department aerial photographs; the Taku district, east of Juneau, was examined in view of the recent discovery of ore deposits there; parts of the Kantishna and Bonfield districts and the Alaska Range were studied with the object of finding tonnage for the Alaska Railroad; an area of 2,400 square miles in southwestern Alaska north of Bristol Bay was surveyed topographically; and the drainage and geologic features of 500 square miles between the Yukon and Porcupine Rivers were mapped on a reconnaissance scale. The broad survey of recent mining developments, the collection of mining statistics, and the supervision of operations under coal and oil leases on Government lands were continued. Progress in compiling drainage maps from the Navy Department aerial photographs added about 1,000 square miles to the areas thus covered.

At the end of the fiscal year work had been started on eight field projects, including reconnaissance topographic mapping and mining studies in southeastern Alaska and the Copper River Valley; geologic investigations near Glacier Bay, in the Alaska Range, and in the Yukon-Tanana region; and geologic and topographic surveys in southwestern Alaska. In addition to these projects an extensive investigation has been begun under a special appropriation to the Alaska Railroad to discover resources that may contribute to railroad tonnage, funds being transferred to the Geological Survey for this purpose. Under this project examinations are being made in eight specific areas, besides a general study of nonmetallic mineral resources throughout the railroad belt.

TOPOGRAPHIC MAPPING

The topographic maps prepared as an essential base for detailed geologic mapping have proved to have hundreds of other uses, and the general realization of their value is shown in the increasing funds made available by States and other Federal units for cooperation in this work. The State cooperative funds during the year amounted to \$428,781.88, and were furnished by 21 States, 2 counties, and Hawaii. The area mapped during the year amounted to 18,283 square miles, and the total area now mapped is 1,356,988 square miles. Nine States, the District of Columbia, and Hawaii are completely mapped, and the percentages in the other States range from 8 in Florida to 98.6 in New Hampshire. Of the continental United States, exclusive of Alaska, 44.6 per cent has been mapped. Compilation of culture and drainage maps from aerial photographs was continued, the increasing use of these photographs attesting to the value of this new adjunct to topographic mapping. Surveys of the proposed Great Smoky Mountain National Park were continued, and surveys of the proposed Shenandoah and Mammoth Cave National Parks were completed. There was a large increase in the number of surveys requested by other departments and bureaus, including the Navy Department, War Department, Department of Justice, Forest Service, Corps of Engineers, National Park Service, Federal Power Commission, and Indian Service.

INVESTIGATIONS OF WATER RESOURCES

The work on water resources consists primarily of research and investigation—the collection of facts in regard to the quantity, quality, availability, and utilization of water. The widespread interest in the availability of water

for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. The work is done largely in cooperation with other Government organizations, with State, county, and municipal agencies, and with permittees and licensees of the Federal Power Commission. The amount expended by State, county, and municipal agencies for such work during the year, in part directly and in part through the Geological Survey, was \$461,649.72. This sum covered work in 40 States and Hawaii. Including the cooperative work, the study of surface waters, which consists primarily of the measurement of the flow of streams, was carried on in 47 States, the District of Columbia, and Hawaii, in which at the end of the year 2,663 gaging stations were being maintained. The work on ground-water resources has been planned to meet the more and more exacting public demand for precise information with increasing need for the water. Investigations relating to ground water or power and reservoir sites were made in 19 States and Hawaii. Research into the principles of hydrology has been continued in order to provide a more secure basis for ground-water investigations. Cooperation was continued with well drillers' associations with a view to developing higher standards and better results in water-well drilling. The work on quality of water involved the examination of 1,667 samples of water. Studies of the dissolved and suspended matter in the Colorado River and its tributaries were continued. The investigations of power resources included the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants.

WORK IN CLASSIFYING AND LEASING PUBLIC LANDS

The classification of public lands with respect to their mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands were continued in 20 States and Alaska. The number of cases involving land classification acted on during the year was 14,774, and the results accomplished include net decreases of 197,430 acres in the area of outstanding coal withdrawals and of 15,475 acres in outstanding petroleum withdrawals. At the end of the year the total area classified as mineral in character amounted to 36,433,446 acres in 14 States and Alaska, and the outstanding mineral withdrawals to 46,366,368 acres in 14 States. Definition of the "known geologic structure" of producing oil and gas fields was continued, and at the end of the year the net area so defined was 778,851 acres in seven States. Investigations to obtain information for classifying public land with respect to its value for the development of water power were made in two States. There was a net decrease of 51,392 acres in the area included in power reserves, making a total of 6,536,473 acres in 21 States and Alaska, on which about 15,000,000 continuous horsepower can be developed. The net decrease in enlarged-homestead designations was 234,644 acres, making a total outstanding of 317,484,532 acres in 14 States, and the net increase in stock-raising homestead designations was 1,232,728 acres, making a total outstanding of 122,778,718 acres in 19 States. There was a net increase of 8,530 acres in public water reserves, and the total outstanding is now 438,353 acres in 12 States. The supervisory work on public lands subject to the mineral leasing laws was increased by the issuance of 140 leases, 253 permits, and 33 licenses, covering 433,278 acres, and decreased by 1,721 cancellations and expirations of leases, permits, and licenses. The production of petroleum on such lands during the year was 23,821,111 barrels, of natural gas 41,962,184,000 cubic feet, and of gasoline 111,499,598 gallons, on which the royalty, rentals, and bonuses amounted to \$3,206,315. The production of coal on such lands was 3,053,189 tons, of phosphate rock 69,055 tons, of potash 4,727 tons, and of sodium salts 30,257 tons, on which the royalty, rentals, and bonuses amounted to \$401,081. Supervision over oil and gas operations on naval petroleum reserves was continued, and the total production was 5,590,418 barrels of petroleum, 5,123,456,000 cubic feet of natural gas, and 22,748,665 gallons of gasoline, on which the royalty value was \$1,255,656. Inspectional, regulatory, and advisory service was rendered in connection with the leasing of mineral deposits on Indian lands in eight States. In general the demands for engineering advice and assistance are increasing as the supervisory duties under the leasing laws are more clearly defined and enlarged and as the competence and impartiality of the supervisors become more widely known.

PUBLICATIONS

There were increases of 15 per cent in the number of manuscript pages edited and of 25 per cent in the number of drawings and photographs prepared for illustrations during the year but decreases of 10 per cent in the number of proofs received and read, of 39 per cent in number of publications issued, and of 36 per cent in number of pages in the new publications. The number of publications in press at the end of the year was 60, as compared with 31 at the end of the fiscal year 1930. There was a decrease of 14 per cent in new or revised maps issued but an increase of 32 per cent in reprinted maps. The publications of the year consisted of 47 books and pamphlets of the regular series, 78 new or revised maps, 192 reprinted maps, a seventh reprint of "Suggestions to authors," and numerous circulars, lists of publications, etc. The total number of pages in the new book publications was 8,047. In addition to the publications in the regular series, 62 brief reports, a few of them accompanied by maps, were issued in mimeographed form as memoranda for the press. The publications distributed numbered 897,431, of which 4,009 folios and 651,907 maps were sold for \$42,788.68.

GEOLOGIC BRANCH

T. W. STANTON, Acting Chief Geologist

ORGANIZATION AND PERSONNEL

The administration of the geologic branch continued during the year to be conducted through 11 sections, as follows:

Paleontology and stratigraphy, J. B. Reeside, jr., geologist, acting in charge.
 Geology of metalliferous deposits, G. F. Loughlin, geologist, in charge.
 Geology of areal and nonmetalliferous deposits, G. R. Mansfield, geologist, in charge.
 Geology of iron and steel metals, E. F. Burchard, geologist, in charge.
 Glacial geology, W. C. Alden, geologist, in charge.
 Coastal Plain investigations, L. W. Stephenson, geologist, in charge.
 Geology of fuels, H. D. Miser, geologist, in charge.
 Volcanology, T. A. Jaggar, jr., volcanologist, in charge.
 Petrology, C. S. Ross, geologist, in charge.
 Chemistry and physics, R. C. Wells, chemist, in charge.
 Geologic map editing, G. W. Stose, geologist, in charge.

On December 23, 1930, W. C. Mendenhall, chief geologist, became acting director, and from that date to the end of the fiscal year T. W. Stanton was acting chief geologist and J. B. Reeside, jr., succeeded Mr. Stanton in charge of the section of paleontology and stratigraphy.

The professional force at the end of the year included 134 geologists of various grades, many of whom are not employed continuously, 9 chemists, and 3 physicists. During the year there were 2 reinstatements (1 senior geologist and 1 geologist), 22 appointments (1 geologist, 11 assistant geologists, 7 junior geologists, 2 chemists, and 1 physicist), 1 resignation, and 2 transfers to other branches in the Geological Survey. On May 16 there were six transfers to temporary duty in the Alaskan branch. The subprofessional force comprises 7 draftsmen (2 temporary), 1 chief scientific aid, 12 scientific aids, 2 scientific helpers, and 1 skilled laborer, the changes being 8 appointments (2 draftsmen, 4 scientific aids, and 2 scientific helpers) and 1 resignation (scientific aid). In the clerical force there were 7 accessions and 4 separations, leaving a total of 30 clerks of various grades. 3 of whom are temporary.

ALLOTMENTS AND EXPENDITURES

The funds available for the work of the geologic branch for the fiscal year were as follows:

Geologic surveys.....	\$400, 000
Research in geologic science.....	100, 000
Volcanologic surveys.....	21, 000
Classification of lands.....	17, 000
Investigating potash deposits.....	12, 500
Repayments from other Federal departments.....	1, 460
Repayments from State and other cooperating organizations.....	48, 599
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	600, 559

The expenditures from these funds may be classified approximately as follows:

Geologic investigations (economic and scientific, including volcanologic).....	\$477, 741
Supervision, administration, services of clerical, technical, and skilled-labor forces, etc.....	115, 221
Unexpended balances.....	7, 597
	<hr/>
	600, 559

FUNDAMENTAL RESEARCH IN GEOLOGIC SCIENCE

In the Geological Survey appropriation for the fiscal year 1931 there was a new item, "For fundamental research in geologic science, \$100,000." This does not mean that research in geologic science had been neglected throughout the previous 51 years of the Geological Survey's existence. From the very beginning part of its energy has been devoted to the development of the general principles and the discovery of the fundamental facts on which the science of geology is based. The nature of the work and the character of the men engaged in it have made this necessary. The description of a mineral deposit of economic importance involves not only its present character and extent but also some discussion of how and why and when it was formed and what change it has since undergone. The mapping of the glacial deposits that are so widely distributed in the northern part of the country and at high altitudes farther south has naturally led to the working out of the very complex history of glaciation on this continent. The search for oil, gas, coal, and other needed materials associated with sedimentary rocks has called for very detailed studies of the stratigraphy and lithology of such rocks and of the structure developed in them by earth movements. The now well-known fact that throughout geologic time, so far as sedimentary history is concerned, there has been a regular succession of faunas and floras on the land and in the sea has justified detailed work in paleontology as a means of determining the succession and correlation of stratified rocks over wide areas and as an aid in dating other geologic events, such as mountain building, mineralization, and faulting. It has been necessary to study the chemical and mineral composition of igneous rocks and their alteration by weathering or metamorphism. Popular interest has called for the description and

explanation of great scenic features such as the Yosemite Valley and Yellowstone National Park. All these are research, and they with similar studies have all been carried on by the Geological Survey so far as its means would allow throughout its history, but as the population of the country has grown and the use of our mineral resources has very greatly increased, the demands on the Geological Survey for work in applied geology have increased far more rapidly than the funds and trained personnel. For these reasons the work in pure research has proportionally decreased rather than increased during the last quarter of a century.

The increased appropriation this year for geologic surveys and the added item for fundamental research have permitted the Geological Survey to make some expansion of its ordinary activities in geologic investigation and to begin work on a comparatively small number of research problems selected from a much larger number that have long awaited study but have been necessarily postponed because neither funds nor properly trained personnel were available. The research funds were allotted to six of the administrative sections approximately as follows:

Paleontology and stratigraphy.....	\$42,000
Geology of areal and nonmetalliferous deposits.....	13,000
Glacial geology.....	13,000
Coastal Plain investigations.....	14,000
Petrology.....	8,000
Chemistry and physics.....	10,000
	100,000

The principal research projects financed by this fund are as follows:

- Cenozoic, Mesozoic, and Paleozoic stratigraphic paleontology, including both animals and plants.
- Cretaceous and Tertiary micropaleontology.
- Stratigraphy and paleontology of the Atlantic and Gulf Coastal Plain.
- Geology of the Marathon Basin, Texas—a lower Paleozoic basin in a Cretaceous area.
- Southern California batholiths.
- The San Andreas rift zone.
- Geology and geography of Death Valley, Calif.
- Glacial geology of the northern Rocky Mountain region.
- Physiographic history and development of the Mississippi River.
- Mineralogy of the potash minerals and of the southern California pegmatites.
- Spectrographic study of minerals for the detection of rare elements.
- Petrography of sedimentary rocks.
- Development of methods of study of polished sections by reflected light.
- The microstructure of clays.
- Siliceous sediments of the Monterey group in California.

With the carefully selected additions already made to the professional and technical staff and their training in Geological Survey methods during the year and with a considerable number of competent specialists now available for additional appointments when increased funds are provided, the geologic branch is prepared for further effective and much needed expansion both in geologic surveys, most of which necessarily involve research, and in the fundamental research on which all geologic work must be based.

POTASH INVESTIGATIONS

The fifth and last year of the special potash exploration program authorized under the act approved June 25, 1926 (44 Stat. 768), and amended March 3, 1927 (44 Stat. 13888), was ended June 30, 1931. Under this program, which was carried out in cooperation with the Bureau of Mines, the Geological Survey selected and transmitted to the Bureau of Mines the locations for 24 core-test holes, to be drilled under the auspices of the Bureau of Mines. Thirteen of these sites were in New Mexico—1 in Chaves County, 7 in Eddy County, and 5 in Lea County; 10 in Texas—2 each in Crockett and Upton Counties, and 1 each in Crane, Ector, Glasscock, Loving, Reagan, and Winkler Counties; and 1 in Utah, in Grand County. As indicated by the location of the sites selected, areas in New Mexico and Texas were considered most promising for the discovery of commercial potash beds, and the explorations were accordingly confined chiefly to those States. The Permian salt basin of southeastern New Mexico and western Texas is geologically similar to the German potash area, and notable showings of potash had been obtained from numerous wells drilled for oil in that region. Showings of rich potash salts had also been disclosed, however, in several wells in Grand County, Utah, in a field in which the structural conditions are similar to those of the German potash field, and one site for core drilling was therefore selected in that area near the end of the drilling program.

During the year ended June 30, 1931, recommendations for 4 of the Government wells—2 in Eddy County, N. Mex., 1 in Lea County, N. Mex., and 1 in Grand County, Utah—were submitted to the Bureau of Mines. One of these wells, located in Eddy County, was completed during the year, as were 3 wells—1 in Loving County, Tex., and 2 in Lea County, N. Mex.—for which recommendations had been submitted to the Bureau of Mines during the preceding year. Two press notices giving the results of chemical and mineralogical tests of the cores from the fifteenth, sixteenth, seventeenth, and eighteenth Government tests, located, respectively, in Eddy, Chaves, and Lea Counties, N. Mex., and Loving County, Tex., were published.

An important development during the year was the completion of the shaft of the United States Potash Co. in sec. 12, T. 21 S., R. 29 E., Eddy County, N. Mex., and the beginning of commercial production by that company. Detailed analytical and mineralogical work on samples from this shaft has been done in the chemical laboratory of the Geological Survey.

The most abundant potash mineral found in all the tests made by the Government and by private companies in the salt basin in New Mexico and Texas is polyhalite. Substantial bodies of this mineral of a grade comparable with that of salts mined abroad, or better, have been found at several localities. Core tests in New Mexico also indicate that large bodies of the more acceptable chloride salt sylvite are present in that State and that some of them are apparently thick enough, rich enough, and shallow enough to justify mining operations. Other potash minerals recognized in the region are carnallite, kainite, langbeinite, and leonite.

INTERNATIONAL GEOLOGICAL CONGRESS

Guidebooks for the excursions of the International Geological Congress to be held in Washington in 1933 are being prepared by members of the Geological Survey and other geologists. Most of the guidebooks contain contributions by several authors.

GEOLOGIC MAP OF THE UNITED STATES

The compilation and preparation of a geologic map of the United States on a scale of 1:2,500,000, which was begun about two years ago, was pushed with more vigor during the year. By the end of the year maps of 36 States were finished, and considerable progress was made on the rest. The engraving of geologic boundaries was begun.

WORK IN GEOLOGY BY STATES

ALABAMA

Further field studies of deposits of red iron ore in Etowah and St. Clair Counties and of deposits of brown iron ore in Bibb, Chilton, Clay, Coosa, Shelby, Talladega, and Tallapoosa Counties were made by E. F. Burchard in connection with his studies of the iron ores of the State in cooperation with the Geological Survey of Alabama. A report on the red iron ores of north-eastern Alabama is nearing completion.

A paper on the economic geology of the Birmingham district has been prepared by E. F. Burchard for inclusion in one of the guidebooks for the International Geological Congress.

D. F. Hewett and E. F. Burchard examined deposits of manganese in Calhoun, Cherokee, and Etowah Counties.

Field investigations of a portion of the Paleozoic region of Alabama were made by Miss A. I. Jonas to gather data for the geologic map of the United States.

C. W. Cooke and Ralph W. Stewart examined type locations of Tertiary formations of Alabama.

ARIZONA

Manganese deposits near Alamo, Ariz., were examined by D. F. Hewett, and a report on them, with B. N. Webber as joint author, is in preparation.

Examinations of the geology between El Paso, Tex., and San Francisco, Calif., along the route of the Southern Pacific Railroad were made by N. H. Darton for the purpose of preparing a guidebook to the route.

A report on correlation of Jurassic sandstones of southeastern Utah, north-eastern Arizona, southwestern Colorado, and northwestern New Mexico is in preparation by J. B. Reeside, jr., A. A. Baker, and C. H. Dane.

The geology of the Tucson quadrangle is being studied by B. N. Moore for the purpose of revising and bringing up to date a report prepared some time ago by C. F. Tolman.

David White has in preparation a preliminary report on the evidence of plant life in the pre-Cambrian formations of Arizona and Montana. He made a brief visit to the Grand Canyon in September, 1930.

Publications: Bulletins 820, 821-C. (See p. 4.)

ARKANSAS

The report on the geology and lead and zinc deposits of northern Arkansas by E. T. McKnight, prepared under cooperative agreement with the Arkansas Geological Survey, is nearing completion. Further field studies of some stratigraphic problems were made in the area by Mr. McKnight in company with H. D. Miser, who conferred with him about problems of correlation.

A paper on the stratigraphy of the St. Peter sandstone and related formations in northern Arkansas is being written by E. T. McKnight.

The diamond mines near Murfreesboro, Pike County, were visited by H. D. Miser to note the new mining development. He also made a brief examination

of manganese deposits at Batesville, and he has in preparation a paper on compaction of the sediments at the Cason manganese mine, Batesville, for publication by the American Association of Petroleum Geologists.

David White, H. D. Miser, and L. G. Henbest spent several days in the Fayetteville region studying the formations of Carboniferous age with the object of making correlations between the Ozark and Ouachita regions, and C. B. Read collected coal samples and fossil plants from the Arkansas coal fields.

Studies of the Morrow formation of Arkansas and Oklahoma were made by G. H. Girty, who also continued work on the fauna of the Batesville sandstone.

H. D. Miser, together with several midcontinent geologists, prepared a road log for the 1931 field trip of the Kansas Geological Survey through the Ouachita Mountains of Arkansas and Oklahoma, and with P. B. King and C. S. Ross he held a field conference in the Ouachita Mountains.

A paper on pre-Cretaceous rocks found in wells in the part of the Gulf Coastal Plain south of the Ouachita Mountains was submitted by H. D. Miser and E. H. Sellards for publication in the bulletin of the American Association of Petroleum Geologists.

CALIFORNIA

Further field studies in continuation of the investigations and report began some time ago by W. S. W. Kew in the San Pedro Hills area were conducted by W. P. Woodring, who completed field examinations of the area and made progress on the report. Mr. Woodring is also preparing a guidebook covering the hills for the International Geological Congress. A paper by Messrs. Woodring and Kew on Tertiary and Pleistocene deposits of the San Pedro Hills was submitted for publication in the proceedings of the Geological Society of Washington. Mr. Woodring also submitted a paper, "*Epitonium fallaciosum*," for publication in *Nautilus*.

A stratigraphic and structural study of the Kettleman Hills oil and gas fields is being made by W. P. Woodring and Ralph Stewart, who are studying the surface structure and stratigraphy, and Ralph Richards, who is studying the subsurface and economic phases of the field.

A revised map showing the oil and gas fields of California is in preparation by G. B. Richardson.

The southern California batholiths are being studied by E. S. Larsen. In this work he has completed the detailed mapping of the southeast corner of the San Luis Rey quadrangle.

Field and office studies of the San Andreas rift region were continued by L. F. Noble and C. L. Gazin.

A reconnaissance trip into Death Valley was made by L. F. Noble, W. C. Mendenhall, and H. G. Ferguson for the purpose of outlining future work in the valley.

A scientific study of the siliceous sediments and associated rocks of the Monterey group was started by M. N. Bramlette. In this connection he examined stratigraphic sections of Miocene deposits in the Los Angeles region, measured sections in the Topanga Canyon, in the Santa Monica Mountains, and made reconnaissance examinations in the Santa Maria region, San Joaquin Valley, and Puente Hills.

A report on the geomorphology of the upper San Joaquin Basin by F. E. Matthes is in preparation.

Mr. Matthes is also preparing a paper on the Yosemite region for a guidebook for the International Geological Congress. The guidebook for the Southern Pacific route is noted under Arizona.

A detailed field study of the Grass Valley mining district is in progress by W. D. Johnston, jr., and a report on the geology and ore deposits of the Ivanpah quadrangle, California and Nevada, is in preparation by D. F. Hewett.

Work in the Hawthorne and Tonopah quadrangles, parts of which are in California, is noted under Nevada.

Pumicite deposits near Bishop were examined by G. R. Mansfield to note their mode of occurrence.

The report on the copper deposits of Plumas County by Adolph Knopf is in preparation. In this work he has been assisted on the study of ores in the Engels district by M. N. Short.

A geologic map of the State is being compiled in cooperation with the California Division of Mines.

S. W. Muller made a field study of the Brock shale, Pit shale, and Hosselkus limestone in the Redding quadrangle.

Work in the Lassen Volcano Observatory at Mineral, in charge of R. H. Finch, consisted of continuous operation of seismographs, observations of temperature of the hot springs, measurements of movements in landslip areas, and studies of certain flows in the Lassen Volcano National Park. Mr. Finch submitted a paper for outside publication on the last lava flow on the mainland of the United States.

Publications: Professional Paper 160; Bulletins 820, 826. (See p. 4.)

COLORADO

Cooperation with the Geological Survey Board of the State of Colorado and the Metal Mining Board in the study of the mining districts of the State was continued under the general supervision of B. S. Butler, and a progress report on cooperative geologic surveys in Colorado for the year 1930 by Mr. Butler has been published by the Colorado Scientific Society.

The study of the mineralized belt of the Front Range was extended by T. S. Lovering northeastward from Breckenridge to Jamestown and included reexamination of features in the Silver Plume, Georgetown, Idaho Springs, and Central City areas and completion of a detailed study of the Nederland tungsten district begun in 1930. The report on the Nederland district is in preparation by Mr. Lovering. E. N. Goddard continued a detailed field study of the Jamestown district.

In the San Juan region work has been continued in the Ouray-Telluride area by W. S. Burbank and E. B. Eckel, and a preliminary report on the structure of the Ouray area by Mr. Burbank has been published. The detailed report on this area has not yet been prepared, as field studies covering the entire region have not yet been completed. Messrs. Burbank and Eckel also made some examinations in the Lake City area, and Messrs. Butler, Burbank, and Eckel did preliminary work in the Silverton district and made examinations in the La Plata and Plume districts with a view to possible future work there. In the Rico district geologic work was started by E. T. McKnight and Mr. Butler. The field work in this district will require another season for completion.

Geologic mapping in the Galena Mountain area was begun by J. W. Vanderwilt early in the year, and a preliminary report on the area was completed for publication by the Colorado Scientific Society. The geology of the Snowmass area as a whole is little known, and geologic mapping must be carried further before it will be possible to judge of the commercial importance of the mineral deposits of the area.

Field work in the Cripple Creek district has been carried on by A. H. Koschmann, bringing to a conclusion the work which G. F. Loughlin has been doing there for several years past. A report on the investigations is under way.

Further field work in an area south of Leadville was done by C. H. Behre, in the Alma region by B. S. Butler and J. D. Singewald, and in the North Platte Gulch area by J. W. Vanderwilt. Detailed reports on the Leadville district by Mr. Behre, the Alma district by Messrs. Singewald and Butler, the Climax district by Messrs. Butler and Vanderwilt, and the North Platte Gulch area, Alma district, by Mr. Vanderwilt, are in preparation for Geological Survey publication. A preliminary geologic map of the Alma mining district, accompanied by a short text, and a paper on the Climax molybdenum deposits by Messrs. Butler and Vanderwilt have been submitted for publication by the Colorado Scientific Society.

Carnotite deposits of southwestern Colorado and southeastern Utah were examined by G. F. Loughlin to obtain information wanted by Congress.

A paper on the molybdenum-quartz veins in Colorado, by J. W. Vanderwilt, was presented at the annual meeting of the Geological Society of America.

A paper on deposition features of the Parting quartzite near Alma, by Q. D. Singewald, was submitted to the American Journal of Science, and another paper, entitled "Alteration as an end phase of igneous intrusion in sills on Loveland Mountain, Park County," by Mr. Singewald, was sent to Economic Geology.

A revision of the general geologic map of western Colorado was started during the year, and Mr. Lovering has made good progress for the northern part of the Front Range. In the preparation of such a map correlation problems of the sedimentary rocks in the different parts of the State have been studied. J. Harlan Johnson has been engaged on a study of the Carboniferous rocks, and J. B. Reeside, jr., and J. S. Williams have made preliminary correlations of the

Mesozoic rocks. A report by Mr. Johnson on the Carboniferous formations of central Colorado is well advanced. David White spent several weeks in a study of special problems in cooperation with several geologists.

A guidebook of the mineralized area of western Colorado for the International Geological Congress is being prepared by Messrs. Burbank and Lovering with the assistance of Messrs. Eckel, Goddard, Johnson, Lang, Singewald, and Vanderwilt.

Further field work was done by E. S. Larsen in the San Juan region to collect additional data for his comprehensive report on the geology of this region.

E. T. McKnight prepared a discussion of a paper by G. E. Collins, entitled "Localization of ore bodies in the San Juan region," for publication by the Colorado Scientific Society.

A report on correlation of the Jurassic sandstones of southeastern Colorado is noted under Arizona.

M. R. Campbell continued preparation of a report on the Mount Harris area, in the Yampa coal field, and of a detailed report covering the whole field. Mr. Campbell spent a little time in the field gathering additional data for the report.

A semidetailed structural reconnaissance examination of the southern part of the Julesburg Basin was begun in June, 1931, by C. H. Dane and W. G. Pierce.

In connection with coal classification work, M. R. Campbell examined coals in the Denver district.

Edwin Kirk completed and submitted for publication in the American Journal of Science papers on early Paleozoic formations of Colorado.

G. H. Girty has in preparation a paper on new species of Carboniferous fossils from Colorado.

J. B. Reeside completed a report on the supposed marine Jurassic Sundance in the foothills of the Front Range for publication by the American Association of Petroleum Geologists.

A chart, in three sheets, giving a correlation of the named geologic units in Colorado, by M. Grace Wilmarth, was issued.

CONNECTICUT

Field and office studies of the geology of portions of eastern Connecticut were made by Mrs. E. B. Knopf in connection with the preparation of material for the revised geologic map of the United States and of material which she is contributing to the guidebook of this section of the country for the International Geological Congress. Mrs. Knopf has also continued her study of metamorphism of crystalline schists in the Clove and Millbrook quadrangles.

DISTRICT OF COLUMBIA

A guidebook for Washington and vicinity for the International Geological Congress is being prepared by M. R. Campbell.

FLORIDA

A second paper on the gastropods of the Alum Bluff group of Florida by Julia Gardner was completed and submitted for publication as Professional Paper 142-G.

A study of Tertiary mollusks from southern Florida was made by W. C. Mansfield, and the results have been embodied in a report that has been submitted for publication in the Proceedings of the United States National Museum. Mr. Mansfield also submitted a paper on Pliocene fossils from limestone in southern Florida for Geological Survey publication.

Field work in collecting fossils and geologic data on the Tampa limestone in western and north-central Florida was done by W. C. Mansfield in cooperation with the Florida Geological Survey.

GEORGIA

C. W. Cooke and W. H. Monroe continued field mapping of the Cretaceous, Tertiary, and Quaternary formations of the Coastal Plain of Georgia, in cooperation with the Georgia State Geological Survey, and office work on the compilation of material for a geologic map of Georgia. L. W. Stephenson did field work on the Cretaceous of Georgia for this map.

Miss Anna I. Jonas made a study of the crystalline areas of the State to collect data for the revised geologic map of Georgia and the geologic map of the United States.

D. F. Hewett examined manganese deposits at Cartersville.

HAWAII

In the Hawaiian Islands, the headquarters of the volcanologic work of the Survey, T. A. Jaggard, jr., and his assistants continued the study of the volcanic activity in the islands. Constant observations and reports were made of the Halemaumau pit of Kilauea Volcano, where the rim cracks and changes were measured from time to time, and of the activities of Mauna Loa. Seismographs were maintained at three places near Kilauea Volcano and others at Hilo and at Kealahou in the Kona district. Howard Powers continued mapping in the Kona area, and carried on petrographic studies at the observatory. The Hawaiian Volcano Research Association continued cooperation in these studies and in the publication of the "Volcano Letter," issued weekly at the observatory. Seismograph observations, directed by Mr. Jaggard, are maintained also in Alaska, at Kodiak and Dutch Harbor.

IDAHO

Investigations of the geology and ore deposits of south-central Idaho, partly in cooperation with the Idaho Bureau of Mines and Geology, were continued by C. P. Ross. Field examinations were made in the Germania Basin, Warren area, and Marshall Lake district, and mapping of the Bayhorse quadrangle was continued. T. H. Hite, of the Idaho Bureau of Mines, continued work in the Bayhorse quadrangle under Mr. Ross's direction. Edwin Kirk made stratigraphic studies in the Bayhorse quadrangle with Mr. Ross, and reports on the Ordovician, Silurian, and Devonian fossils were prepared by Mr. Kirk and on fossil plants by David White. R. W. Brown reported on fossil plants from the Challis area. Preliminary reports on the Bayhorse quadrangle and on the geology of the Eastern Division, Idaho National Forest, were transmitted to the Idaho Bureau of Mines and Geology for publication, and a paper on classification of lode deposits of south-central Idaho by Mr. Ross was transmitted for publication in Economic Geology. Reports on the Dome district, the Marshall Lake and Warren districts, the Boulder Creek district, and some ore deposits in Boise Basin have been prepared by Mr. Ross. A report on the geology and ore deposits of the Casto quadrangle was completed and transmitted for Geological Survey publication. Progress has been made by Mr. Ross on his comprehensive report on the mining districts of south-central Idaho and a report on the geology and ore deposits of the Bayhorse quadrangle. Mr. Ross also compiled material on central Idaho for use in the preparation of the revised geologic map of the United States.

G. R. Mansfield spent a few days on field investigations of the geology and mineral resources of the Ammon and Paradise Valley quadrangles for the purpose of revising previous work and filling in a few gaps in areal and economic geology. Reports on these quadrangles are in preparation. R. W. Brown reported on Cretaceous plants from the Lanes Creek quadrangle for Mr. Mansfield.

Mr. Mansfield has in preparation a guidebook covering southeastern Idaho and northwestern Utah for the International Geological Congress.

An examination of manganese deposits at Lava Hot Springs was made by G. R. Mansfield, who also examined a so-called gold prospect in Montpelier Canyon. Supposed dinosaur remains near Gray's Lake, in the Lanes Creek quadrangle, which proved to be fossil tree trunks, were investigated by Mr. Mansfield.

W. C. Alden, assisted by C. L. Gazin, extended his study of the glacial geology and physiography of Idaho to parts of Boundary, Bonner, Fremont, Madison, and Jefferson Counties. Progress was also made by Mr. Alden on his report on the glacial geology and physiography of northern Idaho, western Montana, and eastern Washington.

Edward Sampson resumed the preparation of a report on geology and ore deposits of the Pend Oreille district, northern Idaho, and completed a report on correlation of later pre-Cambrian sediments in the Cordillera near the forty-ninth parallel.

Publications: Bulletins 814, 821-A. (See p. 4.)

ILLINOIS

Preparation of a report on the geology of the Hardin and Brussels quadrangles, in cooperation with the Illinois Geological Survey, was continued by W. W. Rubey. Mr. Rubey prepared an abstract on the Illinois River a problem

in channel equilibrium for publication in the journal of the Washington Academy of Sciences. Edwin Kirk reported on Ordovician invertebrate fossils for Mr. Rubey.

Cooperative investigations of the Pottsville floras of Illinois were continued by David White.

Stratigraphic studies were made by Edwin Kirk in the vicinity of Galena, Scales Mount, Apple River, and Stockton.

INDIANA

A report on two new crinoid genera from the Devonian and Silurian of Indiana is in preparation by Edwin Kirk.

David White's studies of the fossil plants from the Pottsville of Illinois were extended into western Indiana.

IOWA

David White's studies of the fossil plants from the Pottsville of Illinois were extended into eastern Iowa.

Rocks of Cambrian to Silurian age were studied in the field by E. O. Ulrich, Edwin Kirk, and E. F. Bean, and those of Ordovician age in the vicinity of Elkader, Guttenberg, and Dubuque were examined by Mr. Kirk, who also studied specimens at the University of Iowa.

G. H. Girty and J. S. Williams revised a manuscript on the Kinderhook fauna.

KANSAS

Studies of the geology of eastern Kansas are being carried on by R. C. Moore for the purpose of furnishing material for the geologic map of the United States and also for a revised geologic map of the State.

J. B. Reeside, jr., joined members of the Kansas Geological Survey for a field conference on the Cretaceous stratigraphy in the western part of the State.

A field and office study of the geology of the Cheyenne Bottoms and adjacent regions, Barton County, was made by N. W. Bass for the Biological Survey, and a report thereon was submitted to that bureau for administrative purposes.

G. R. Mansfield examined pumicite deposits near Fowler and Mead.

KENTUCKY

David White's studies of the fossil plants from the Pottsville of Illinois were extended into western Kentucky.

E. W. Berry prepared a report on fossil plants from the Wilcox group and Jackson formation, and Edwin Kirk has in preparation a paper on crinoids from the Devonian of Kentucky.

LOUISIANA

M. I. Goldman continued studies of salt dome cap rock in preparation of his report on that subject. He prepared for publication in the Bulletin of the American Association of Petroleum Geologists a paper entitled "Bearing of cap rocks on subsidence on the Clay Creek salt dome, Washington County, Tex., and the Chestnut dome, Natchitoches Parish, La.," and a discussion of a paper on the petrography of cap rocks.

Lower Cretaceous invertebrate fossils from deep wells in Louisiana were reported on by T. W. Stanton.

A chart giving a tentative correlation of the named geologic units for Louisiana, by Miss M. Grace Wilmarth, was issued.

MAINE

D. F. Hewett examined manganese deposits at Blue Hill.

MASSACHUSETTS

In connection with the collection of data for the geologic map of the United States Mrs. E. B. Knopf did field work in western Massachusetts.

Additional field work was done by L. M. Prindle in the Greylock quadrangle in connection with geologic studies of the geology of the Taconic area, and progress was made on his report on the region.

A paper on the structural geology of central Massachusetts was prepared by Eugene Callaghan for publication in the Bulletin of the Geological Society of America.

D. F. Hewett examined manganese deposits at West Cummington.

MICHIGAN

E. O. Ulrich with W. O. Hotchkiss made stratigraphic studies of the Lake Superior sandstones between Houghton and a point about 10 miles east of Munising, including Grand Island. Rocks of Cambrian to Silurian age were studied by Mr. Ulrich and Edwin Kirk in cooperation with E. F. Bean, State geologist of Wisconsin.

MINNESOTA

Stratigraphic studies of Paleozoic sections were made by Edwin Kirk in the vicinity of Mantorville, Stewartville, Spring Valley, and Wykoff.

MISSISSIPPI

Field work in the Jackson area has been carried on by W. H. Monroe, partly for the purpose of gathering data regarding the oil and gas possibilities of the area. A preliminary report including a structure contour map and a geologic map have been prepared by Mr. Monroe for publication.

David White examined a portion of the core from a well near Jackson to determine the age of beds from a depth of 4,000 feet.

Well cuttings of Carboniferous age were studied by P. V. Roundy.

An investigation of the Homochitto area was made by C. W. Cooke for the Forest Service.

MISSOURI

G. H. Girty continued revision of a paper on the Warsaw fauna of the Joplin region begun sometime ago in connection with the stratigraphic work of the late C. E. Siebenthal.

A chapter on systematic paleontology, by Josiah Bridge, E. O. Ulrich, and A. F. Foerste, was contributed to the report on the geology of the Eminence and Cardareva quadrangles published by the Missouri Bureau of Geology and Mines.

Messrs. Ulrich and Bridge, accompanied by members of the Bureau of Geology and Mines, made a brief field study of formations of the Upper "Canadian" and Buffalo River group in southeastern Missouri.

Carboniferous microfossils were studied by P. V. Roundy, who also examined Carboniferous well cuttings.

MONTANA

Further field work was done by W. C. Alden in parts of Missoula, Lake, Beaverhead, Flathead, Lincoln, Sanders, Madison, and Gallatin Counties in the course of his investigations of the glacial geology and physiography of western Montana. A report embodying the results of these investigations for several years is in preparation by Mr. Alden.

The field study of the geology and mineral resources of the Libby quadrangle was continued by Russell Gibson, who prepared a preliminary report on the work done, which was issued as a memorandum for the press entitled "Metalliferous deposits near Libby and Troy, Montana." The detailed report of this investigation is in preparation, but further field work is required before it can be completed.

Areal and structural mapping, largely for the purpose of classifying coal lands, was carried on in portions of Rosebud and Custer Counties by W. G. Pierce and party. Mr. Pierce has in preparation a report on the Rosebud coal field for Geological Survey publication, and also a paper on Pleistocene terraces in eastern Montana. A continuation of the investigation of these coal beds eastward to the Powder River in Custer and Powder River Counties was begun in the spring of 1931 by a party in charge of F. S. Parker.

The coal fields in Richland and Dawson Counties were investigated during the summer of 1930 by F. S. Parker, completing the work begun in the spring of 1930, and a report on this work is being prepared by Mr. Parker for Geological Survey publication.

Progress was made by A. J. Collier on his report on the geology of the Little Rocky Mountains and adjacent plains. He also gave some time to the

compilation of data for the Montana State geologic map and the geologic map of the United States.

The report on the Helena mining district by J. T. Pardee and F. C. Schrader is nearing completion.

Stratigraphic studies of Upper Devonian rocks near Logan were made by Edwin Kirk.

Manganese and phosphate deposits near Phillipsburg were examined by J. T. Pardee.

Work by David White on plant life in the pre-Cambrian of Montana is noted under Arizona.

Publications: Professional Paper 165-D, Bulletin 822-A. (See p. 4.)

NEVADA

In the continuation of the cooperative program carried on last year with the Nevada Bureau of Mines in a study of some of the mining regions of the State, additional field mapping and examination of mines was done by H. G. Ferguson and S. W. Muller in the Hawthorne and Tonopah quadrangles and in the Tybo district by W. M. Ferguson. A detailed report covering the work of several years in the Hawthorne and Tonopah quadrangles will be published by the Geological Survey. A preliminary report on the Tybo district is in preparation for publication by the State.

T. B. Nolan, assisted by Ian Campbell, completed field work on a resurvey of the Tonopah district begun last year, and is preparing a detailed report on this district for Geological Survey publication. A preliminary report was issued by the Nevada Bureau of Mines.

Reconnaissance examinations of some mining districts in eastern Nevada were made by F. C. Schrader, and preliminary reports by him covering the Patterson, Cherry Creek, and Spruce Mountain districts were completed and transmitted to the Nevada Bureau of Mines for publication. Mr. Schrader also continued work on a report on the geology and ore deposits at Carson Sink.

A report on "bedded" deposits of manganese oxides near Las Vegas, by D. F. Hewett and B. N. Webber, was transmitted to the Nevada Bureau of Mines for publication.

Office work on a report on the geology and ore deposits of the Ivanpah quadrangle by D. F. Hewett has progressed.

Edwin Kirk prepared a scientific article for outside publication on the Eureka quartzite of Nevada. S. W. Muller has in preparation a paper on the Mesozoic stratigraphy of New York Canyon, Gabbs Valley Range, Mineral County, in connection with which several months' field work was done.

The sodium-sulphate plant at Rhodes Marsh and a deposit of kaolinite near Sodaville were visited by G. R. Mansfield.

David White collected mud samples from the playas near Gerlach.

NEW HAMPSHIRE

Work in the Taconic quadrangle, which lies partly in New Hampshire, is noted under Massachusetts.

NEW JERSEY

A paper by W. T. Schaller on the crystal cavities of the New Jersey zeolite region was transmitted for publication as an Bulletin 832.

M. R. Campbell made a study of the gravel deposits of a portion of New Jersey under a grant from the National Research Council.

NEW MEXICO

Progress was made by A. C. Spencer on his report on the geology and mineral resources of the Santa Rita district and by G. F. Loughlin and A. H. Koschmann on a report on the ore deposits of the Magdalena district.

The Central mining district, Grant County, is being studied by S. G. Lasky in cooperation with the New Mexico Bureau of Mines.

A paper on the Valles Mountain region is in preparation by C. S. Ross.

Field mapping of the coals of the Mesaverde formation of the southern edge of the San Juan Basin in McKinley, Sandoval, and Valencia Counties was continued by a party under the direction of J. D. Sears early in the year and later by C. B. Hunt. A report by Mr. Sears on an area in the southwestern part of the San Juan Basin, mapped in 1929, is in preparation. Mr. Hunt

completed the first draft of a report on the coal and petroleum possibilities in the area mapped in 1930 and has in preparation a paper on the igneous geology of Mount Taylor and vicinity. In the spring of 1931 Mr. Hunt and party extended the field investigation of the coal beds, stratigraphy, and structure of the San Juan Basin to an area adjacent to the south and east sides of Mount Taylor.

G. H. Girty is studying the Abo fauna of La Luz Canyon.

Work in the potash field is reported on page 13.

Investigations for the Southern Pacific guidebook and the correlation of Jurassic sandstones are noted under Arizona.

Publication: Bulletin 820. (See p. 4.)

NEW YORK

Work in the Taconic quadrangle, which lies partly in New York, is noted under Massachusetts, and work in the Clove, Millbrook, Sheffield, and Sandisfield quadrangles is noted under Connecticut.

Mrs. E. B. Knopf continued field and office work in eastern New York in connection with the preparation of material for the geologic map of the United States.

NORTH CAROLINA

Field and office work in the southern Appalachian region was done by Miss A. I. Jonas for the purpose of collecting data for the geologic map of the United States.

NORTH DAKOTA

A study of the Fort Union and associated formations was begun by R. W. Brown and K. J. Murata.

OKLAHOMA

Mapping of the coal deposits, stratigraphy, and structure of the portion of the McAlester quadrangle lying north of the Choctaw fault was carried on by T. A. Hendricks and party in 1930. This investigation was extended in 1931 by Mr. Hendricks, assisted by C. B. Read, to the portion of the Oklahoma coal field lying between the McAlester quadrangle and the Arkansas line.

A report covering the coal-bearing portion of the McAlester quadrangle is in preparation by T. A. Hendricks.

Fossil plants from the Pennsylvanian section in the McAlester quadrangle were studied by C. B. Read in connection with the preparation of a report on the Carboniferous floras of Oklahoma, Texas, and Arkansas.

David White, H. D. Miser, and L. G. Henbest examined the McAlester shale and associated formations in the McAlester and Atoka quadrangles and in the region between Ada and the Arbuckle Mountains. Mr. Miser attended the field conference of the Society of Economic Paleontologists and Mineralogists at Ardmore and joined Dr. C. N. Gould and Dr. E. H. Sellards for a short trip in the Ouachita Mountains.

A paper on pre-Cretaceous rocks found in wells in the part of the Gulf Coastal Plain south of the Ouachita Mountains, by H. D. Miser and E. H. Sellards, was submitted for publication by the American Association of Petroleum Geologists.

E. O. Ulrich and Josiah Bridge, accompanied by members of the Oklahoma Geological Survey, did field work in the Arbuckle Mountains to review the disputed classification and correlation of formations including Taff's Simpson and Viola formations, and Mr. Bridge reported on Cambrian invertebrates from the Arbuckle Mountains.

G. H. Girty continued work on a report on the fauna of the Sycamore limestone, which he is preparing in cooperation with C. L. Cooper, of the Oklahoma Geological Survey, and Edwin Kirk prepared descriptions of Mississippian crinoids for incorporation in this paper.

Preparation of a report on the ostracodes and conodonts of the Sycamore limestone was continued by P. V. Roundy, who also continued his study of other microfossil material.

The study of the Moorefield formation and preparation of a report were continued by G. H. Girty.

Work on the Morrow formation is noted under Arkansas.

A brief examination of forest lands in the Ouachita Mountains, southeast of Oklahoma City, was made by H. D. Miser for the Forest Service.

A chart in four sheets showing the tentative correlation of the named geologic units of Oklahoma, by Miss M. Grace Wilmarth, was issued.

OREGON

Cooperation with the Oregon State Mining Board was continued throughout the year, and a progress report on the cooperative work was issued as a press notice of the Geological Survey. Investigations of the gold, copper, and quicksilver resources in the western part of the State were continued in charge of J. T. Pardee and included completion of studies in the Takilma-Waldo district by P. J. Shenon and party and examinations in the Albright-Turner, Squaw Creek, and Robertson districts. Mr. Shenon has completed drafts of his reports on the geology and ore deposits of the Takilma district and on the geology and ore deposits of the area including the Robertson, Humdinger, and Robert E. gold mines, southwestern Oregon, and has in preparation a third report on the metalliferous deposits in southwestern Oregon, covering other mining districts examined.

The mapping of the Black Butte-Bonanza quicksilver areas was completed by F. G. Wells and party, who also did areal mapping and examined mines in the Meadows district and examined several mines and prospects in an area extending from the vicinity of Tiller to the Rogue River Trail and in small areas containing the Chieftain and Continental gold mines on South Myrtle Creek. The draft of a report on the quicksilver deposits of southwestern Oregon has been completed by Messrs. Wells and Waters.

Examinations of the Bohemia, North Santiam, and Blue River districts by A. F. Buddington and Eugene Callaghan were concluded, and reports on these districts have been prepared.

In the spring and summer of 1931 Epgene Callaghan began a study of the gold lodes of the Cascade Mountains, and J. T. Pardee made an examination of placer deposits along the coast near Bandon.

In eastern Oregon James Gilluly continued his detailed areal mapping and examination of mines of the Baker quadrangle with special reference to the Keating copper district and examined other mining districts in eastern Oregon in which active work was being done. A report on the copper deposits near Keating by Mr. Gilluly has been completed for publication as Bulletin 830-A. A report covering the Baker quadrangle and another on some mining districts of eastern Oregon are in preparation by Messrs. Gilluly and J. C. Reed. A paper on zonal relations of the veins of the Sumpter quadrangle was presented by D. F. Hewett for publication in the Proceedings of the American Institute of Mining and Metallurgical Engineers, and a paper on the replacement origin of the albite granite near Sparta, by James Gilluly, has been prepared for Geological Survey publication.

Investigations of the nonmetallic resources of eastern and central Oregon were carried on by Ralph Richards and B. N. Moore. They included studies of diatomaceous earth in the vicinity of Harper, Malheur County, and Drewsey, Harney County, of limestone in Baker and Wallowa Counties, and of granite, tuff, rhyolite, road metal, volcanic ash, pumice, and potash. The diatomaceous earth and limestone deposits will be the subject of separate reports. Reconnaissance geologic mapping in central and eastern Oregon was also continued by Messrs. Richards and Moore to gather data for use in the compilation of the geologic map of the State and in the preparation of the revised geologic map of the United States.

A paper on the mineral resources of northern California and southern Oregon, by J. T. Pardee, was presented at a meeting of the Northern California-Southern Oregon Development Association at Grants Pass.

PENNSYLVANIA

The report on the geology and mineral resources of the Middletown quadrangle, by G. W. Stose and Anna I. Jonas, was completed and transmitted for publication as a bulletin of the Geological Survey, and progress was made on the detailed geologic reports covering the Tyrone quadrangle, by Charles Butts, and the Butler and Zelienople quadrangles, by G. B. Richardson.

Field and office work for a report on the geology and mineral resources of the Hanover and York quadrangles, a cooperative project with the Pennsylvania Geological Survey, was continued by Mr. Stose and Miss Jonas.

SOUTH CAROLINA

A report by C. W. Cooke on the geology of the Coastal Plain of South Carolina is in preparation.

Work on the geologic map of the State is noted under North Carolina.

SOUTH DAKOTA

Charles B. Read completed a paper on *Pinoxylon dakotense* Knowlton, from the Cretaceous of the Black Hills, for publication in the Botanical Gazette.

E. W. Berry completed a study of fossil plants from the Fuson, New Castle, and lower Lance formations.

TENNESSEE

E. F. Burchard prepared new material on the brown iron ore of the western Highland Rim for inclusion in his manuscript on the subject transmitted some time ago for publication by the Tennessee State Geological Survey.

A brief field study of iron ore in Cass and Marion Counties was made by E. F. Burchard, and deposits of manganese ore near Elizabethtown and Cleveland were examined by Mr. Burchard and D. F. Hewett.

Work on the geologic map of the State is noted under North Carolina.

D. F. Hewett and L. W. Currier examined zinc mines at Mascot and Jefferson City in connection with the study of the New River in southern Virginia.

TEXAS

L. W. Stephenson continued field work in some Upper Cretaceous areas of Texas, particularly on the Navarro formation, and continued compilation of the geology of the Coastal Plain of Texas for the geologic map of the State. Progress was made by Mr. Stephenson on his monograph of the Navarro formation, which is being prepared in cooperation with the Texas Bureau of Economic Geology.

N. H. Darton continued field and office work on the geology of western and central Texas for the geologic map.

Miss Julia Gardner continued field and office studies of the Eocene formations of northeastern and southwestern Texas in connection with a general study of the stratigraphy of the Eocene of Texas and to gather material for use in the preparation of the new geologic map of the State.

A paper on the Midway formation of Texas by Miss Gardner, including a chapter on the coral fauna by T. W. Vaughan and Willis P. Popenoe, is in preparation in cooperation with the Texas Geological Survey for publication as a bulletin of the University of Texas. Articles on the relationships of certain faunas to the Midway fauna of Texas by Miss Julia Gardner, on the Yeager clay by Miss Gardner and A. C. Trowbridge, and on the Taylor age of the San Miguel formation of Maverick County by L. W. Stephenson have been published by the American Association of Petroleum Geologists.

Philip King completed his field study of the geology of the Marathon Basin and made progress in the preparation of a report on it. In company with Mr. King, David White made a study of the Pennsylvanian and Permian of western Texas, especially in the Marathon and Glass Mountain area, and Edwin Kirk made stratigraphic and paleontologic studies with Mr. King in the Marathon area. Mr. King presented a paper on the pre-Carboniferous stratigraphy of the Marathon uplift for publication by the American Association of Petroleum Geologists and, together with C. L. Baker and E. H. Sellards, gave a paper on erratic boulders of large size in the western Texas Carboniferous before the meeting of the Geological Society of America at Toronto, in December, 1930. Mr. King began early in the summer of 1931 a detailed study of the geology of the Diablo Plateau area, in which he was assisted by J. Brookes Knight.

Fossil plants from western Texas were reported on by David White for E. H. Sellards, and Cambrian and Ordovician fossils were reported on by Edwin Kirk for Doctor Sellards.

E. O. Ulrich and Josiah Bridge studied the early Paleozoic formations of the central mineral region in cooperation with E. H. Sellards and party, of the Bureau of Economic Geology.

In cooperation with local geologists many localities of the Cretaceous of central Texas were visited by J. A. Cushman, and collections were made in connection with the report on Foraminifera of the Coastal Plain.

M. I. Goldman continued his study of salt dome cap rock and prepared a paper entitled "Bearing of the cap rock on subsidence on the Clay Creek salt dome, Washington County, Texas, and the Chestnut dome, Natchitoches Parish, Louisiana," for publication in the Bulletin of the American Association of Petroleum Geologists.

P. V. Roundy continued his study of Carboniferous microfossils from Texas. A revised oil and gas map of Texas was completed and published.

A chart in three sheets by Miss M. G. Wilmarth, showing the tentative correlation of the named geologic units in Texas, was issued.

Work on the Southern Pacific guidebook is noted under Arizona.

The work in the Texas potash field is described on page 13.

UTAH

The detailed structural and stratigraphic studies in the Green River Desert and adjoining portions of the San Rafael Swell begun last year were continued until October, 1930, by A. A. Baker, and progress was made on a report covering this investigation. Further field studies are being carried on by a party in charge of Mr. Baker.

Mr. Baker continued preparation of his geologic report of the Monument Valley-Navajo region, San Juan County. A preliminary map showing the geologic structure of the region was issued.

A report on the geology of the Salt Valley anticline and the northwestern flank of the Uncompahgre Plateau, Grand County, was prepared by C. H. Dane. A preliminary map showing the geologic structure of parts of Grand and San Juan Counties by A. A. Baker, C. H. Dane, and E. T. McKnight was issued.

A structure contour map of southeastern Utah is being compiled by A. A. Baker.

Field mapping of the coal, stratigraphy, and structure of a portion of the Wasatch Plateau was continued by E. M. Spieker and party in the summer of 1930 and resumed in the early summer of 1931. The compilation of the map showing the area covered and preparation of the report are in progress but await further field work before completion.

T. B. Nolan continued office work on his report on the geology and mineral resources of the Gold Hill quadrangle. A paper on an occurrence of spadaite at Gold Hill, Utah, by W. T. Schaller and T. B. Nolan, was submitted for publication in the American Mineralogist. Carnotite deposits of southwestern Colorado and southeastern Utah were investigated by G. F. Loughlin at the request of the Committee on Mines and Mining of Congress.

H. E. Gregory continued his geologic studies of the Colorado Plateau region, southwestern Utah.

A guidebook covering the Colorado Plateau region of Utah for the International Geological Congress was prepared by H. E. Gregory, and a guide to northwestern Utah is being prepared by G. R. Mansfield.

A paper on a new *Pterophyllum* from the Shinarump conglomerate in Utah by E. W. Berry was submitted for publication in the Journal of the Washington Academy of Sciences.

Work in the Bridger Basin is noted under Wyoming, and work on the correlation of the Jurassic sandstones is noted under Arizona.

Publications: Bulletins 819, 822-C. (See p. 4.)

VERMONT

Work in the Taconic quadrangle, which lies partly in Vermont, is noted under Massachusetts.

VIRGINIA

A study of the New River zinc district in cooperation with the Virginia Geological Survey was begun in the fall of 1930 by L. W. Currier, who with the assistance of H. E. Thomas is continuing detailed mapping and studying the areal geology and mines and prospects of the district.

Manganese deposits at Galax and Scottsville were examined by D. F. Hewett.

L. W. Stephenson, W. C. Mansfield, and C. W. Cooke visited fossil localities and places of geologic interest in the Chesapeake Bay region in connection with the plans for an excursion to this region and the preparation of a guidebook for the International Geological Congress.

Charles Butts has continued areal mapping and study of the Paleozoic formations of the Appalachian Valley of Virginia, in cooperation with the Geo-

logical Survey of Virginia. A guidebook of the Appalachian Valley region of Virginia is being prepared for the International Geological Congress by Mr. Butts.

E. O. Ulrich and Josiah Bridge visited the Porterfield quarries near Saltville and quarries near Marion.

WASHINGTON

Work on the glacial geology and physiography of Washington is noted under Montana.

WISCONSIN

E. O. Ulrich continued descriptions of Wisconsin Upper Cambrian trilobites for inclusion in the monograph by him and C. E. Resser in course of publication by the Milwaukee Public Museum. Part 1 of this monograph has been issued, and Part 2 has been prepared.

WYOMING

Edwin Kirk studied the fossil fauna of the lower Big Horn formation.

In continuation of his studies on the origin and geologic history of Tertiary rocks of the Green River Basin, Wyoming and Utah, a report on which is in progress, W. H. Bradley did further field work on the Bridger, Wasatch, and Green River formations in the southern part of the Bridger Basin of Wyoming and Utah. Some results of this investigation will be embodied in a report on the physiography of the north flank of the Uinta Mountains in Wyoming and Utah.

A detailed study of the geology of the Afton quadrangle was begun by W. H. Rubey, assisted by J. S. Williams, partly for the purpose of classifying the lands as to phosphate.

A new edition of the map of the oil and gas fields of the State was issued.

G. R. Mansfield studied dam sites in the canyon of the Snake River in cooperation with the Forest Service.

A report on the upper Sunshine and lower Sunshine reservoir sites, Park County, was made by T. S. Lovering for the Bureau of Reclamation.

MISSISSIPPI VALLEY

Investigation of the physiographic history of the head of the Mississippi embayment was continued by F. E. Matthes and included studies of the areas about the lower Ohio, Tennessee, and Wabash Rivers.

CANADA

E. O. Ulrich made field studies of the stratigraphy of Paleozoic sections in the vicinity of Philipsburg, Quebec, and prepared a paper on the Naylor ledge, near Philipsburg, for presentation at the meeting of the Paleontological Society of America at Toronto.

Cretaceous ammonites from Alberta were studied by J. B. Reeside, jr.

GUATEMALA

A paper on reasons why the Mayan cities of the Peten district, Guatemala, were abandoned was prepared by C. W. Cooke.

MEXICO

Lower Cretaceous invertebrate fossils from Mexico were studied by T. W. Stanton.

GENERAL INVESTIGATIONS

Considerable work has been done on stratigraphic, paleontologic, and other subjects that do not relate to individual States. The studies belonging to this class of investigations have related to fossil plants from the Green River formation, by R. W. Brown; the Jackson group, by C. W. Cooke; upper Eocene Foraminifera of the southeastern United States, by J. A. Cushman; Miocene Foraminifera of the Atlantic Coastal Plain, by J. A. Cushman and E. D. Cahill; Upper Cretaceous Foraminifera of the Gulf Coastal Plain, by J. A. Cushman and L. G. Henbest; the genus *Productus*, by G. H. Girty; ammonites of the Greenhorn limestone, by J. B. Reeside, jr.; the Ostracoda and Carboniferous microfossils, by P. V. Roundy; the early Paleozoic gastropods of

North America, by E. O. Ulrich and Josiah Bridge; early Paleozoic cephalopods, by E. O. Ulrich, Josiah Bridge, and A. F. Foerste; lower Paleozoic stratigraphy of the upper Mississippi Valley, by E. O. Ulrich; occurrence and major features of the supposed fossil plants from the pre-Cambrian formations of western America, by David White; geologic map of the United States, by G. W. Stose in cooperation with other members of the Geological Survey and with various State organizations; copper deposits of the southern Appalachian region, by C. S. Ross and M. N. Short; and geology of the Great Basin, by D. F. Hewett. Work was also done on an exhibit showing the rank of coals, by David White and M. R. Campbell, for the meeting of the committee on classification of coals.

The following papers giving results of general studies were completed or published during the year by the Geological Survey or in technical journals:

Alden, W. C., The great ice sheets of the Middle West. Prepared for presentation before the Chicago conference of the National Research Council.

Alden, W. C., Guidebook of Middle West glacial excursion of the Sixteenth International Geological Congress.

Matthes, F. E., Glacier measurements in the United States. Transactions of the Geophysical Union.

Bradley, W. H., Nonglacial marine varves. American Journal of Science.

Butts, Charles, The Appalachian Plateau and Mississippi Valley. *Geologie der Erde*.

Campbell, M. R., The alluvial fan of the Potomac River. Geological Society of America.

Knopf, E. B., Retrogressive metamorphism and phyllonitization. American Journal of Science.

Rubey, W. W., A plea for closer cooperation among students of stream work. Transactions of the Geophysical Union.

Rubey, W. W., Shortening of folded strata and scale structure sections. Science or American Journal of Science.

Mansfield, G. R., Some problems of the Rocky Mountain phosphate field. Economic Geology.

Hewett, D. F., Manganese reserves of the United States. Prepared for Committee on Industrial Preparedness of the American Institute of Mining and Metallurgical Engineers, to be submitted to the War Department.

Johnston, W. D., jr., Chromium. Mineral Industry.

Richardson, G. B., New edition of map showing oil and gas fields and pipe lines in the United States.

Ross, C. S., and Kerr, P. F., The kaolin minerals. Professional Paper 165-E.

Ross, C. S., and Kerr, P. F., The clay minerals and their identity. Journal of Sedimentary Petrology.

Ross, C. S., Henderson, E. P., and Posnjak, E., Clarkeite; a new uranium mineral. American Mineralogist.

Short, M. N., Microscopic determination of the ore minerals. Bulletin 825.

WORK IN CHEMISTRY AND PHYSICS

The work in chemistry and physics includes tests and analyses of specimens and samples (other than waters) and researches on geochemical and geophysical problems.

During the year 8,412 examinations were made, of which 279 were complete quantitative analyses and 392 were qualitative analyses dealing with research problems other than potash, 1,265 were identifications of specimens sent in by persons not officially connected with the Geological Survey, 1,902 were qualitative tests for potash, 424 were quantitative determinations of potash, and 4,150 were petrographic or microscopic determinations of potash and associated minerals in cores and cuttings related to the search for potash.

W. T. Schaller identified many of the more difficult minerals collected by geologists in the field, attended meetings of the American Mineralogical Society, where he read papers on the chrysocolla group and ammonioborite, a new mineral, and studied in the field

the mineralogy of the mine of the United States Potash Co., near Carlsbad, N. Mex., on which a report is being prepared. Among the unusual minerals studied during the year were a manganese-calcium silicate from Oregon; the rare vanadium copper sulphide, sulvanite, from Utah; a manganoan cuprodescloizite from Arizona; the hydrated ferric sulphate, kornelite; and bavenite from California, a beryllium mineral. A cesium mica from the Black Hills was studied by J. J. Fahey, in collaboration with F. L. Hess.

Spectroscopic work occupied a large part of George Steiger's time. Spectra of known elements were prepared for reference, and a technique was developed by which about 50 tests for beryllium were made. Several unusual metallic associations in gold concentrates were also identified by the spectrograph.

Rock analyses were made principally by J. G. Fairchild, George Steiger, J. J. Fahey, L. T. Richardson, and E. T. Erickson. The substances analyzed ranged from diatomite to spinel, including gas from springs, gold and silver ores, beryl, mica, mine water, grahamite, niter, shale, clay, travertine, and volcanic ash.

R. C. Wells continued determinations of the age of minerals by the lead-uranium ratio and with L. T. Richardson studied the heat of solution of some potash minerals. He made a brief field trip to Colorado and New Mexico and another to Pennsylvania to examine an occurrence of uraninite in serpentine.

Investigations relating to the genesis of ores were carried on by R. E. Stevens, who measured the diffusion of gases through Swedish kolm and experimented on the behavior of certain silicates and metallic sulphides, especially pyrite, in various solutions in a bomb at 300° C. Chemical studies involving the geochemistry of organic substances were made by E. T. Erickson.

Potash investigations were continued mainly as described in the last few reports, with more emphasis on the field in Eddy County, N. Mex., where sylvite and carnallite have been found in sufficient richness to warrant sinking a shaft and mining in commercial quantities.

On account of the small force of chemists available analytical work was necessarily limited almost entirely to determinations of the potassium content of the richer portions of the cores and cuttings shipped from the field. The minerals were identified by petrographic methods, and their percentage also estimated approximately by this method when possible. The petrographic examinations were made principally by F. C. Calkins, with supplemental assistance by J. J. Fahey, L. T. Richardson, and W. T. Schaller. The chemical work on potash was done mainly by E. T. Erickson. R. K. Bailey continued at Roswell, N. Mex., preparing potash cores and well cuttings for shipment to Washington and making logs of wells. (See p. 13.)

Field measurements of deep earth temperatures were made by C. E. Van Orstrand during June, July, August, and September, 1930, in Alabama, Texas, Oklahoma, California, Oregon, Wyoming, and Michigan. Some of the observations were made in cooperation with the American Petroleum Institute. The results were computed with the assistance of H. C. Spicer, computer, who also began the

preparation of some mathematical tables of certain exponential functions.

P. G. Nutting continued his study of the activity of sands and clays in adsorbing oil, or certain components of oil, with particular reference to the seat of activity, its origin, its relation to the composition and structure of the material, and the nature of the adsorbed substance. He made many comparative tests of characteristic oil sands and filtering clays from both foreign and domestic sources

During the winter a conference was held every two weeks at which members of the staff reviewed their work or summarized recent progress in geochemistry and geophysics.

The following papers were completed during the year:

- Schaller, W. T., Psittacinite from Arizona: *Am. Mineralogist*.
 ——— The ending of modifiers of mineral names: *Am. Mineralogist*.
 ——— Ammonioborite, a new mineral: *Am. Mineralogist*.
 ——— Chemical composition of cuprotungstite: *Am. Mineralogist*.
 ——— Ptilolite from Utah: *Am. Mineralogist*.
 ——— Mordenite-ptilolite group: *Am. Mineralogist*.
 ——— Tephroite crystal from New Jersey: *Am. Mineralogist*.
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ALASKAN BRANCH

PHILIP S. SMITH, Chief Alaskan Geologist

ORGANIZATION AND PERSONNEL

The Alaskan branch consisted at the end of the year of the chief Alaskan geologist, 4 geologists, 1 mining engineer, 1 coal-mining assistant, 4 topographic engineers, 1 draftsman, 4 clerks, and 1 minor apprentice lithographer. In addition, 9 geologists and 4 topographic engineers were employed for special service on the Alaska Railroad project, and numerous camp hands and other assistants were employed for temporary service.

SCOPE OF THE WORK

The task of obtaining information regarding the mineral resources of Alaska and assisting the industry in every practicable way has

for many years devolved upon the Alaskan branch. During the third of a century that this work has been in progress the Geological Survey has published many hundreds of reports on various phases of the mineral industry of Alaska, and these have been accompanied by several hundred maps of different parts of the territory. Practically every known mineral-producing camp has been visited by the geologists, engineers, and topographers of the Geological Survey, and reports regarding these camps have been issued.

The fiscal year has little significance in reporting on the Geological Survey's work in Alaska, especially because most of the appropriations for the Alaska work are made immediately available on the passage of the act through which the money is appropriated.

Two rather distinctly different kinds of technical work are performed by the Alaskan branch—one of a general investigational type and the other of a semiadministrative type in connection with the supervision of the leases granted by the Government covering coal, oil, and other mineral lands. Each is not only distinct in character but is supported by different funds. For convenience the two types of work will be referred to as the work on mineral resources and the leasing work.

FUNDS

The funds used by the Geological Survey in its Alaska work are provided in two items in the general act making appropriations for the Interior Department. One of these is "for continuation of the investigation of the mineral resources of Alaska." In the act for the fiscal year 1931 the amount appropriated was \$75,000. In the similar act for 1932 the amount appropriated was \$84,500. Each of these appropriations was made available immediately on the passage of the act in which it was contained. The other item is an allotment made from the appropriation "for the enforcement of the provisions of the acts of October 30, 1914, October 2, 1917, February 25, 1920, and March 4, 1921, and other acts relating to the mining and recovery of minerals on Indian and public lands and naval petroleum reserves." Allotments under this item are available only during the fiscal year specified. In the fiscal year 1931 an allotment of \$10,000 was made for work of this kind in Alaska.

WORK ON MINERAL RESOURCES

MANUSCRIPTS AND PUBLICATIONS

The principal products of the Alaska work of the Geological Survey are reports and maps based on original surveys or investigations. During the year six such official reports have been issued:

Notes on the geology of upper Nizina River, by F. H. Moffit (Bulletin 813-D).
Mineral resources of Alaska: Report on progress of investigations in 1928, by Philip S. Smith and others (Bulletin 813).

Geography and geology of northwestern Alaska, by Philip S. Smith and J. B. Mertie, jr. (Bulletin 815).

Mineral industry of Alaska in 1929, by Philip S. Smith (Bulletin 824-A).

Administrative report, 1929-30, by Philip S. Smith (Bulletin 824-A).

The Upper Cretaceous floras of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by G. C. Martin (Professional Paper 159).

The following reports are in course of editing or printing:

The Slana district, upper Copper River region, by F. H. Moffit (Bulletin 824-B).

The Lake Clark-Mulchatna region, by S. R. Capps (Bulletin 824-C).

Mining in the Circle district, by J. B. Mertie, jr. (Bulletin 824-D).

The occurrence of gypsum at Iyoukeen Cove, Chichagof Island, by B. D. Stewart (Bulletin 824-E).

Glaciation in Alaska, by S. R. Capps (Professional Paper 170-A).

A geologic reconnaissance of the Dennison Fork district, by J. B. Mertie, jr. (Bulletin 827).

Eight reports have been completed by their authors and approved for publication:

Mineral industry of Alaska in 1930, by Philip S. Smith.

Administrative report, 1930-31, by Philip S. Smith.

The Kantishna district, by F. H. Moffit.

Mining developments in the Tatlanika and Totatlanika Basins, by F. H. Moffit.

The eastern portion of the Mount McKinley National Park, by S. R. Capps.

Geography and geology of Lituya Bay, by J. B. Mertie, jr.

The Tatonduk-Nation district, by J. B. Mertie, jr.

Surface water supply of southeastern Alaska, by F. F. Henshaw.

Seven short papers on the mineral production of Alaska and various phases of the work of the Alaskan branch were published as press memoranda.

Two maps were issued during the year, as follows:

Topographic map of Goodnews Bay district, by R. H. Sargent and W. S. Post; scale, 1:250,000. Issued in a preliminary photolithographic edition.

Topographic map of Valdez and vicinity, by J. W. Bagley, C. E. Giffin, and R. H. Sargent; scale, 1:62,500. Published for sale.

The following maps have been prepared and transmitted for publication during the year:

Topographic map of Revillagigedo Island, by R. H. Sargent; scale, 1:250,000. Compiled principally from aerial photographs taken by the Alaska Aerial Survey Expedition of the Navy Department, 1926 and 1929. To be issued in a preliminary photolithographic edition.

Topographic map of Mount Spurr region, by R. H. Sargent and Gerald FitzGerald; scale, 1:250,000. To be published for sale.

Topographic map of Lake Clark-Mulchatna region, by Gerald FitzGerald and R. H. Sargent; scale, 1:250,000. To be published for sale.

Alaska map E (reprint, extensively revised); scale, 1:2,500,000. To be published for sale.

Alaska map A (reprint, revised); scale, 1:5,000,000. To be published for sale.

Topographic map of lower Matanuska Valley (reprint, revised), by R. H. Sargent; scale, 1:62,500. To be published for sale.

In addition, practically all the published reports are accompanied by maps, the bases of which have been made principally from surveys conducted by the topographers of the Alaskan branch.

Progress was also made in the preparation of a map of the Nushagak region, scale 1:250,000, compiled from surveys made in 1930, and maps of portions of the Taku and Wrangell districts, compiled principally from aerial photographs taken by the Navy Department, for use as bases for topographic maps and for field studies.

Besides the official reports, several articles were prepared by the scientific and technical members of the Alaskan branch for publication in outside journals, and 41 public lectures were given regarding

the general work of the branch or some of its special features. Most of these were prepared unofficially but represent by-products of the regular work and serve to reach special audiences not readily reached by the official publications. Among the articles may be mentioned the following:

- Some popular misconceptions concerning Alaska, by Philip S. Smith.
- Geographic and geologic evidence relating to the connection of Siberia and northwestern Alaska, by Philip S. Smith.
- Random notes on recent ice as a geologic agent, by Philip S. Smith.
- Alaska and the Geological Survey, by Philip S. Smith.
- Photographing Alaska from 2 miles in the air, by R. H. Sargent.
- Paleozoic stratigraphy of the Upper Yukon, by J. B. Mertie, jr.
- Safety work in mines, by B. D. Stewart.

PROJECTS IN PROGRESS DURING THE SUMMER OF 1930

In addition to the routine duties of supplying information in answer to hundreds of inquiries received from the public and from other branches of the Government, 10 principal projects were carried on during the season of 1930, 7 involving field work and 3 only work in the office. The seven field projects are described below.

Topographic mapping in southeastern Alaska included the mapping of parts of Revillagigedo Island, on which Ketchikan is situated, and of the adjacent mainland, a project that was started during the field season of 1928. Much of this region contains indications of mineralization, and the maps will also serve as bases for other Government institutions and persons having to do with the development of the other resources of the region; for example, the Forest Service and others who are vitally interested in the power and pulp-wood resources.

In 1929 a rush of prospectors followed the announcement of the discovery of sulphide ores containing copper, zinc, lead, and gold in the Taku district, east of Juneau. Verification of the report that considerable tracts hitherto regarded as composed mainly of deep-seated igneous rocks and therefore unpromising as prospective mineral areas were really occupied by other rocks and might therefore repay prospecting, made it desirable that an authoritative statement based on a thorough field examination of the area should be prepared by the Geological Survey. B. D. Stewart, of the Juneau office, was assigned to the task and spent altogether about five weeks in the field, visiting as many of the prospects and as much of the area as time and other conditions permitted.

For many years it has been realized that the success of the Government-owned railroad in Alaska would depend in no small measure on the development of the mineral resources along its route. The general manager, Col. O. F. Ohlson, asked for some assistance by the Geological Survey in aiding this development, and in 1930 two geologic parties were assigned to the railroad zone. These parties were in charge of F. H. Moffit and S. R. Capps. The special areas studied by Mr. Moffit were the Kantishna district and near-by country west of the railroad and part of the Bonfield district east of the railroad. The party in charge of Mr. Capps examined the geology and mineral resources of a tract on the south side of the Alaska Range extending eastward from the head of the West Fork of the Chulitna River to the Nenana River. Parts of this area were known to be mineralized, and in addition its survey was undertaken to permit the construction of a complete section across the range and thus contribute to the interpretation of the geologic events that have occurred and throw light on their relation to the occurrence of ore deposits. An area of about 300 square miles was surveyed geologically on reconnaissance standards and about 180 square miles that had been surveyed in earlier years was more intensively studied and its geology thoroughly revised, so as to bring it into adjustment with the latest information on the region as a whole.

One of the largest unsurveyed tracts still remaining in Alaska lies in southwestern Alaska north of Bristol Bay. Reports received from prospectors and indications that were seen in the nearest areas that had been examined

by the Geological Survey gave reason to believe that in parts of this tract there might be valuable mineral deposits, and in order that more authoritative information might be available a start was made on the work of surveying the tract by a party in charge of Gerald FitzGerald. Field work began June 5 and ended September 8. During that period an area of 2,400 square miles was surveyed topographically for publication on a scale of 4 miles to 1 inch, with a contour interval of 200 feet. In the course of the work about 125 miles of river traverse was made on a field scale of 1:96,000 (1½ miles to 1 inch), using micrometer and rod readings, with a contour interval of 100 feet.

Another large area in Alaska that has long remained unsurveyed and little visited even by casual trappers is the triangular tract lying between the Yukon and Porcupine Rivers west of the international boundary. Reconnaissance geologic surveys of this tract were made in 1930 by a party in charge of J. B. Mertie, jr. No topographic map was available to show even the major features of the country or to serve as a base on which to plat the geologic observations, but a drainage map of the southeastern part of the area was prepared as one of the results of the traverses and plane-table sketches of the geologist. Field work began on the Yukon at the mouth of the Tatonduk River June 5 and ended September 2. The drainage and geologic features of an area of 500 square miles were mapped adequately for publication on the usual reconnaissance scale.

The customary broad survey of recent developments in the mining industry as a whole, with special visits to some of the more active mining camps or those that had not been recently visited by members of the Geological Survey, was made by Phillip S. Smith, chief Alaskan geologist. Leaving Washington late in June, he spent some time with the topographic party of Mr. Sargent in southeastern Alaska. In Juneau he held brief consultations with B. D. Stewart, of the Geological Survey office, and with officials of other bureaus whose work bears close relations to that of the Geological Survey. Mr. Smith then went to Anchorage for consultation with Colonel Ohlson regarding the mineral investigations for the Alaska Railroad and made personal studies in all the productive mining camps adjacent to the railroad between Seward and the Willow Creek gold lode district. In August, under instructions from Washington, Mr. Smith joined the special senatorial investigating committee under the chairmanship of Senator Howell and remained with that committee throughout its study in the railroad belt, in order to make available any information regarding mineral resources it might call for.

The areas reported in the following table are based on the field season and not on the fiscal year, and therefore no account is taken of the work that was started during the field season of 1931 but remained uncompleted at the end of the fiscal year 1931.

Areas surveyed by Geological Survey in Alaska, 1898-1930, in square miles

Field season	Geologic surveys			Topographic surveys		
	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)	Exploratory (scale 1:500,000 or smaller)	Reconnaissance (scale 1:250,000)	Detailed (scale 1:62,500 or larger)
1898-1929.....	75,150	176,330	4,277	55,630	209,905	4,066
1930.....	500	480	-----	-----	3,344	-----
	75,650	176,630	4,277	55,630	213,249	4,066
Percentage surveyed of total area of Alaska.....	43.7			46.5		

* Includes 180 square miles revised extensively in 1930, included also under 1930, and therefore counted only once in the total.

In this table only the net areas surveyed are listed in the appropriate column, though of course most of the areas that have been surveyed geologically have also been surveyed topographically. It

is by no means unusual that areas surveyed hastily at first are later resurveyed with more precision on the same or larger scale, and if the areas thus revised were not excluded from the totals the same areas would be counted twice.

The scale most commonly adopted for Alaska surveys, either geologic or topographic, is the reconnaissance scale (1:250,000), about 4 miles to the inch, with a contour interval of 200 feet. This scale is adequate for most general purposes, and the maps can be made expeditiously and cheaply. For work requiring less detailed mapping the exploratory scale of 8 to 10 miles to the inch has been adopted. For detailed work the usual scale is 1 mile to the inch, but larger scales are used if required. Thus, the surveys of the region near the mines at Juneau were on a scale of about one-third mile to the inch.

The office project of compiling for map use the aerial photographs made by the Navy Department in southeastern Alaska was continued throughout the fiscal year. At the present rate of progress it will be more than a decade before even the material that is now on hand can be worked up. During 1930 drainage maps were compiled for areas of about 400 square miles in the Taku district near Juneau and of between 500 and 600 square miles in the region between Wrangell and the earlier mapped area north of Ketchikan. This work was in charge of R. H. Sargent, who devoted much of his own time to it and was assisted by V. S. Seward, topographic engineer, and J. I. Davidson, draftsman.

The collection of information regarding the output of minerals from Alaska each year is carried on mainly from the Washington office, but the wide acquaintance of the field men and their surveys in different parts of the Territory make them a source of much definite information. In addition, many of the other Government organizations collect data within their respective fields which contribute to the general result. Banks, express companies, and other organizations conducting business in Alaska also assist.

The Geological Survey maintains in Alaska two district offices, one at Juneau and one at Anchorage. The main duties of the personnel attached to these offices relate to mineral leasing, but a part of their service relates to general investigations of mineral resources. Under this arrangement approximately two-fifths of the time of B. D. Stewart, who supervises the local offices, is allotted to general investigations of mineral resources. The Alaska offices also act as local distributing points for publications of the Geological Survey and assist in furnishing the main office at Washington with information on many phases of the mineral industry of the Territory.

PROJECTS FOR THE SEASON OF 1931

Eleven projects, funds for which were appropriated directly to the Geological Survey, have been approved for the season of 1931. These projects had been under way for only a short time at the end of the fiscal year, and no specific details are available regarding the work accomplished. Eight of these projects that involve field work are reconnaissance topographic mapping in the Wrangell-Ketchikan district, southeastern Alaska; mining studies principally in the Taku district near Juneau and at other points in southeastern

Alaska; geologic investigations in the vicinity of Glacier Bay; reconnaissance topographic mapping in the Klutina Lake district, in the Copper River Valley; reconnaissance geologic studies in the Alaska Range at the head of the Copper River; geologic and topographic reconnaissance surveys in the Tikchik Lakes district of southwestern Alaska; geologic reconnaissance of parts of the Yukon-Tanana Region, central Alaska; and general studies of the mining developments throughout Alaska.

The topographic mapping in the Wrangell-Ketchikan district is a continuation of the work that was started in the Ketchikan district in 1928 and continued in 1930, whereby an area of about 1,900 square miles was mapped. The work done in 1931 will tie to this earlier work and carry it northward as far as time and other conditions permit.

The Taku project is a continuation of the investigations that were started in 1930. B. D. Stewart will again be in charge of this work.

Several years ago field investigations of the region adjacent to Glacier Bay, west of Juneau, were carried on by F. E. and C. W. Wright, but the results were not completed in form for publication. Through cooperation with the Bureau of Mines the services of C. W. Wright, who is now a member of that bureau, have been made available for the completion of this project.

Lying west of the Richardson Highway in that part of its course between Tonsina and Copper Center, in the Copper River Valley, and including Klutina and Tonsina Lakes, is a tract of country that was not surveyed during the time that the country near it to the north and to the east was mapped. As a preliminary to geologic studies in this area a topographic party in charge of C. F. Fuechsel was sent into the region early in June.

A start on the geologic examination of that part of the Alaska Range which lies between the head of the Copper River and Tanana Valley, east of the Delta River and extending as far as the international boundary, was made in 1929 by a small exploratory party in charge of F. H. Moffit. In 1931 Mr. Moffit has resumed his general studies in this region, though without aid of a suitable topographic map. Work started early in June and will continue into September.

In southwestern Alaska a combined topographic and geologic party in charge of Gerald FitzGerald, topographer, with P. A. Davison, geologist, will carry forward the work started by Mr. FitzGerald in 1930, of mapping as much as practicable of the unsurveyed area lying between Bristol Bay and the headwaters of the Holitna and other streams near it that are tributary to the Kuskokwim River.

Ever since the earliest investigations of Alaska's mineral resources by the Geological Survey its parties have traversed parts of the great belt of country lying between the Yukon and Tanana Rivers. Work in this area has reached an advanced stage, but before it can be completed certain problems require further field examination. To do this work J. B. Mertie, jr., with a small party, landed at Rampart early in June. During the summer he will visit parts of the Rampart and Hot Springs districts and, if time and other conditions permit, will swing eastward into the Livengood or Tolovana district, perhaps ending his season at Fairbanks about the middle of September.

The general survey of Alaska mining conditions to be conducted by the chief Alaskan geologist during the season of 1931 will resemble similar work in the past, but owing to duties in Washington the actual field work will not be started until after the first of July.

The office compilation of drainage maps from the thousands of photographs taken by the Navy aviators in southeastern Alaska is being continued. It is essential that drainage maps of this sort covering at least 2,000 square miles should be compiled before the field season of 1932 begins, as otherwise the topographic mapping will have to be delayed. Even without topography these maps are in much demand by the Forest Service and other Government organizations and private individuals who are active in developing southeastern Alaska.

RAILROAD PROJECT

The most extensive project undertaken by the Geological Survey in Alaska in 1931 is not supported by funds appropriated to it directly, but by funds that have been transferred for its use by the Alaska Railroad. The item for the Alaska Railroad in the Interior Department appropriation act for 1931 includes a provision "that not to exceed \$250,000 of this fund shall be available for continuation of the investigation of mineral and other resources of Alaska to ascertain the potential resources available which will affect railroad tonnage." Arrangements have been made whereby the Geological Survey is to conduct such of these investigations as pertain to mineral resources in the interests of the railroad and in such manner and at such places as are approved by the responsible railroad officials. Plans were drawn up by the Geological Survey and approved by the manager of the railroad, and the funds necessary to start the work were supplied for examinations in the Anthracite Ridge, Copper Mountain, Kantishna, Valdez Creek-Chulitna, Fairbanks, Willow Creek, Girdwood, and Moose Pass areas. The plans also include an examination of the nonmetallic mineral resources throughout the railroad belt and the maintenance of a geologist throughout the year to serve as general representative to advise the manager on mining and geologic matters, to work with prospectors and make available the results of the surveys, and to serve as a medium of coordination between the railroad and other agencies engaged in this program.

Work on all these projects is in general charge of S. R. Capps, who started the field work early in June and will keep it going as late in the fall as practicable. From the later part of July to the end of the work Mr. Capps will be assisted in his general supervision by D. F. Hewett, geologist. Through the courtesy of the Bureau of Mines the samples collected in the course of the work will be analyzed at the laboratories of the bureau in Alaska—the coal samples in the coal-testing laboratory at Anchorage and the metallic and nonmetallic minerals other than coal in the laboratory at Fairbanks conducted in cooperation with the Alaska Agricultural College and School of Mines.

In the Anthracite Ridge region are deposits of coal, some of which are of anthracite quality. The region is intersected by many faults, and the beds are cut by or interlaminated with many igneous intrusives. Only by very detailed work can the amount of coal be determined. It is therefore proposed that mapping, both geologic and topographic, on a scale of 5 inches to the mile will be undertaken. This project is in charge of Ralph W. Richards, geologist, and the topographic work will be done by L. O. Newsome. About 20 men will be needed for various phases of the work on this project.

In the Kantishna and Copper Mountain districts, which lie 60 miles or more west of the Alaska Railroad and north of the Alaska Range, silver-lead, zinc, copper, antimony, and gold lodes have long been known and ore has been shipped from some of the lodes, though, because of the remoteness of the region, it has not well repaid the operators in spite of the fact that some of it had a value of over \$100 a ton. No detailed maps of either of these tracts are available, so a separate topographic party has been assigned to each to make a map of the mineralized area on a scale of 1 mile to the inch. S. N. Stoner, topographer, is in charge of the party at Copper Mountain and S. C. Kain of the topographic work in the Kantishna district. Investigations of the geology and ore deposits will also be made—in the Kantishna district by F. G. Wells, who will act as chief of the combined geologic and topographic party, and at Copper Mountain by J. C. Reed, who will conduct the geologic work.

The Valdez Creek district lies about 50 miles due east of Cantwell, a station on the Alaska Railroad not far from Broad Pass. Gold lodes occur in this district but have been only slightly developed. To assist in the determination of the extent and character of the mineralization a small geologic party in charge of C. P. Ross will carry on reconnaissance surveys.

In the Willow Creek and Fairbanks districts gold lodes are being productively mined, and in the past the ores from each have yielded gold worth more than a million dollars. The mines are all small, and the efforts of the operators are necessarily directed toward finding and developing small, rich veins which do not afford tonnage of significance to the railroad. The Geological Survey's studies in these districts will, therefore, be directed largely toward determining the volume of low-grade ores that might be profitably developed if worked on a large scale. This work in the Fairbanks district will be carried on by J. M. Hill and in the Willow Creek district by J. C. Ray.

North of Turnagain Arm and about 40 miles east of Anchorage, in the neighborhood of Girdwood, gold placers have been worked for many years, and in the hills at the head of the valleys in which they occur, notably at the head of Crow Creek, rich gold ores have been found and some underground development work done. This region has not been surveyed in detail, and only the larger aspects of its geology have been determined. In this area a combined topographic and geologic party in charge of W. G. Carson, topographer, with C. F. Park, geologist, will map on a scale of 1 mile to the inch as much of the country as time and other conditions permit.

Extending for nearly the whole length of Kenai Peninsula southward from Turnagain Arm is a series of black slates and shales which in many places are cut by intrusive igneous rocks and intersected by quartz veins and stringers, the whole more or less mineralized. Many small prospects and small productive mines have been opened within this belt, and more detailed study of it than heretofore will be made by the party in charge of Ralph Tuck.

EXPENDITURES

The funds directly appropriated for the work of the Geological Survey on Alaska's mineral resources during the field season of 1930 were made available through the Interior Department appropriation acts for 1930 and 1931. Each act made the funds appropriated available immediately. The act for 1930 was approved March 4, 1929, and the act for 1931 was approved May 14, 1930. The amount appropriated by the act for 1930 was \$67,500; for 1931, \$75,000. During the field season of 1931 the funds used were made available through the act for 1931, already noted, and the act for 1932, which appropriated \$84,500.

In April, 1931, in order to finance the work which the Geological Survey was requested to perform in the interests of the Alaska Railroad, transfers of \$30,000 for direct expenditures by the Geological Survey were made by the railroad. These funds were considered available for expenditure by the Geological Survey only up to the end of the fiscal year, but a supplementary transfer of \$50,500 to continue the work until about the end of the calendar year 1931 was made, and further transfers will be requested as additional funds are required.

Expenditures from funds appropriated for investigation of mineral resources of Alaska for the fiscal year 1930-31

Projects for the season of 1930.....	\$12, 939
Projects for the season of 1931.....	17, 690
Administrative salaries, July 1, 1930, to June 30, 1931.....	3, 173
All other technical and professional salaries, July 1, 1930, to June 30, 1931.....	29, 766
All other clerical and drafting salaries, July 1, 1930, to June 30, 1931..	8, 307
Office maintenance and expenses.....	3, 125

75, 000

Of the \$30,629 allotted to field projects for both seasons, about 53 per cent was allotted to geologic or related general work and 47 per cent to topographic work.

The item for administrative salaries includes only those salaries that are directly related to general administration and does not include charges for administration such as each party chief is called on to perform with regard to the party in his charge. The low cost of administration is due principally to the fact that the administrative officers are engaged also in technical projects, to which is therefore charged a proportional part of their salaries.

LEASING WORK

Part of the activities of the Alaskan branch are related to the proper conduct of mining work on the public mineral lands that have been or may be leased to private individuals or corporations under certain laws. Funds for this work throughout the United States are provided in a general item contained in the Interior Department appropriation act. The amount allotted to Alaska for the fiscal year 1931 was \$10,000.

In order that the policies and practices that have been developed by the leasing unit of the conservation branch of the Geological Survey for handling the much larger volume of similar work in the States should be maintained in Alaska and at the same time the specialized knowledge of Alaskan affairs possessed by the Alaskan branch should be utilized, the general conduct of the leasing work in Alaska is in a measure shared between the two branches, the office work in Washington being done principally by the conservation branch and the field work by the Alaskan branch. B. D. Stewart, supervising engineer, who has headquarters at Juneau, is in immediate charge of the field work, assisted by J. J. Corey, coal-mining engineer, at Anchorage.

The primary purpose of the leasing work is to supervise the operations under the coal and oil leases or permits that have been granted by the Government and to advise and consult with the proper authorities, both Federal officers and private applicants, regarding lands that may be under consideration for a lease or permit. Practically all the coal mining and much of the oil prospecting in Alaska is done on public lands by private individuals or companies under leases or permits issued by the Secretary of the Interior. The interest of the Government in these lands requires not only that these grants shall be a source of revenue to the Nation but that proper methods of extracting the minerals shall be employed, thus preventing waste or damage to the property, and that the lives, health, and welfare of those engaged in the work shall be properly safeguarded. Practically all the producing coal mines that have been opened in the Territory are in the region adjacent to the Alaska Railroad. The Government has therefore an especial interest in their successful operation. For this reason the Federal engineers have given intensive study to the problems confronting these mines and have been especially active in supervising their operations, not only to see that the terms of the leases are observed but also to be of as much assistance as possible to the small operators who are opening them, by giving them competent technical advice and aiding them in making their ventures successful.

TOPOGRAPHIC BRANCH

J. G. STAACK, Chief Topographic Engineer

ORGANIZATION AND PERSONNEL

At the end of the year the organization of the topographic branch was as follows:

- Atlantic division, Albert Pike, division engineer, in charge.
- Central division, Glenn S. Smith, division engineer, in charge.
- Pacific division, H. H. Hodgeson, division engineer, in charge.
- Section of inspection and editing, W. M. Beaman, topographic engineer, in charge.
- Section of computing, S. S. Gannett, topographic engineer, in charge.
- Section of photographic mapping, J. H. Wheat, topographic engineer, in charge.
- Section of cartography, A. F. Hassan, cartographic engineer, in charge.
- Map information office, J. H. Wheat, topographic engineer, in charge.

Including the above-named engineers, the technical force comprises 173 topographic, geodetic, or cartographic engineers of various grades and 68 engineering field aides and draftsmen of various grades—a total of 241. The clerical force comprises 16 clerks.

EXPENDITURES

As shown in the table which follows, the Geological Survey supplements to a notable extent its own appropriations for topographic mapping with State and other Federal funds for similar purposes. Under this policy of cooperation the topographic work is standardized and its cost reduced. The total expenditures for topographic mapping were \$1,342,181.14.

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1931

	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Topographic surveys, 1931.....	\$744,000.00	\$256,559.98	\$1,000,559.98	\$428,781.88	\$1,429,341.86
Great Smoky National Park, 1929-30.....	7,020.10	-----	7,020.10	-----	7,020.10
Great Smoky National Park, 1930-31.....	50,000.00	-----	50,000.00	-----	50,000.00
Shenandoah National Park, 1930-31.....	25,000.00	-----	25,000.00	-----	25,000.00
Mammoth Cave National Park, 1930-31.....	25,000.00	-----	25,000.00	-----	25,000.00
Mammoth Cave National Park (second deficiency, 1931).....	4,600.00	-----	4,600.00	-----	4,600.00
Total appropriations.....	855,620.10	256,559.98	1,112,180.08	428,781.88	1,540,961.96
Second deficiency bill, 1931, reappropriations from topographic survey funds.....	84,600.00	-----	84,600.00	-----	84,600.00
Total funds available.....	771,020.10	256,559.98	1,027,580.08	428,781.88	1,456,361.96
Expenditures:					
Alabama.....	13,004.60	-----	13,004.60	10,000.00	23,004.60
Arizona.....	16,803.84	-----	16,803.84	-----	16,803.84
Arkansas.....	10,295.47	-----	10,295.47	-----	10,295.47
California.....	61,718.27	2,865.49	64,583.76	60,658.51	125,242.27
Colorado.....	18,843.67	-----	18,843.67	11,237.23	30,080.90
Florida.....	-----	13,304.72	13,304.72	-----	13,304.72
Georgia.....	-----	34,945.05	34,945.05	-----	34,945.05
Hawaii.....	10,350.02	-----	10,350.02	4,995.32	15,345.34
Idaho.....	19,451.19	-----	19,451.19	2,528.87	22,010.06
Illinois.....	17,877.28	-----	17,877.28	47,786.27	65,663.55
Iowa.....	1,361.59	-----	1,361.59	2,028.82	3,390.41

Appropriations and expenditures for topographic surveys for the fiscal year ended June 30, 1931—Continued

	Appropriation for topographic surveys	Transfers and repayments for work performed for other Federal units	Total Federal funds	State cooperative funds	Total funds
Expenditures—Continued.					
Kentucky.....	\$29,168.87		\$29,168.87		\$29,168.87
Louisiana.....		\$10,943.81	10,943.81		10,943.81
Maine.....	48,543.50	21,680.51	70,224.01	\$56,119.00	126,343.01
Michigan.....	23,031.50		23,031.50	37,014.11	60,045.61
Mississippi.....	232.35	63,322.04	63,554.39		63,554.39
Missouri.....	21,295.94	46,906.21	68,202.15	22,164.35	90,366.50
Montana.....	15,675.86		15,675.86	2,100.18	17,776.04
Nevada.....	7,285.58		7,285.58		7,285.58
New Hampshire.....	19,505.67		19,505.67	13,026.75	32,532.42
New Mexico.....	6,779.35		6,779.35	3,292.52	10,071.87
New York.....	8,637.96		8,637.96	20,251.22	28,889.18
North Carolina.....	29,758.66		29,758.66		29,758.66
North Dakota.....	705.36	2,136.86	2,842.22		2,842.22
Oklahoma.....		1,552.21	1,552.21	1,569.17	3,121.38
Oregon.....	28,041.77	7,312.18	35,353.95	7,947.46	43,301.41
Pennsylvania.....	25,408.17	2,174.34	27,582.51	25,107.50	52,690.01
South Dakota.....		2,539.59	2,539.59		2,539.59
Tennessee.....	42,468.27		42,468.27	13,000.00	55,468.27
Texas.....	13,931.02		13,931.02	27,667.59	41,598.61
Utah.....	10,483.29		10,483.29		10,483.29
Vermont.....	1,591.83		1,591.83	4,999.91	6,591.74
Virginia.....	64,805.15	15,910.32	80,715.47	34,000.00	114,715.47
Washington.....	22,628.40	18,388.43	41,016.83	3,479.04	44,495.87
West Virginia.....	1,985.20		1,985.20	2,997.16	4,982.36
Wisconsin.....	13,608.08	5,560.20	19,168.28	14,810.90	33,979.18
Wyoming.....	7,178.66		7,178.66		7,178.66
Division contingents.....	6,535.28		6,535.28		6,535.28
Field distribution offices.....	1,100.00		1,100.00		1,100.00
Books for library.....	215.92		215.92		215.92
Map information.....	3,565.54		3,565.54		3,565.54
One-millionth maps.....	10,010.82		10,010.82		10,010.82
Stationery (field).....	850.00		850.00		850.00
Computing.....	3,056.93		3,056.93		3,056.93
Inspection and editing.....	6,462.93		6,462.93		6,462.93
Office salaries.....	4,529.35		4,529.35		4,529.35
Photographic mapping.....	1,653.10		1,653.10		1,653.10
Instruments (field).....	5,053.09		5,053.09		5,053.09
Chief topographic engineer contingent.....	1,319.95		1,319.95		1,319.95
Miscellaneous repay.....		2,924.66	2,924.66		2,924.66
Refunds and adjustments.....		4,093.36	4,093.36		4,093.36
Total expenditures.....	656,839.28	256,559.98	913,399.26	428,781.88	1,342,181.14
Unexpended balance.....	114,180.82		114,180.82		114,180.82
Grand total.....	771,020.10	256,559.98	1,027,580.08	428,781.88	1,456,361.96

^a Represents 29.06 per cent of total cost; balance included in charges for State cooperation and Federal field projects.

^b \$350,672.08 expended on State cooperation.

^c Includes \$674.27 Mammoth Cave National Park and \$2,768.17 Shenandoah National Park balances.

GENERAL OFFICE WORK

Necessary office work incidental to the field work consisted in the inking, inspection, and editing of the topographic field sheets prior to their submission for reproduction, the computation and adjustment of the results of control field work, and the preparation of partial culture and drainage bases from aerial photographs. Base maps of Georgia and Michigan were begun, and a contour map of Colorado was completed. Railroad maps were prepared for the Congressional Record, world maps for the Department of State, and an eclipse map for the Nautical Almanac. Office mapping from aerial photographs was completed for the upper Columbia River,

Washington, and was begun for the Zion National Park, Utah. Stereophotogrammetry, or the measurement of horizontal distances and elevations from photographic plates by means of an optical measuring and drafting apparatus, was employed on both projects. Aerial photographs for use in topographic mapping were furnished by the Air Corps, United States Army, under a continued cooperative agreement which had been found satisfactory and economical. Contracts for aerial photographic work were also awarded to commercial firms when the exigencies of the mapping warranted it. The increasing use of aerial photographs attests to the value of this new adjunct to topographic mapping. (See also p. 84, Inspection and editing of topographic maps.)

SUMMARY OF RESULTS

The status of topographic surveys is set forth by States in the following table, which shows that the country as a whole is now 44.6 per cent mapped, the year's increment amounting to four-tenths of 1 per cent. There was a large increase in the number of surveys requested by other departments and bureaus, as compared with former years. The resurveys in large part covered areas previously surveyed on a smaller scale.

New topographic surveys of the United States, July 1, 1930, to June 30, 1931, and total area surveyed in each State

State	Publication contour interval (feet)	Mapped in fiscal year (square miles) for publication on scale of 1 to —							Total area mapped in fiscal year (square miles)			Total area mapped to June 30, 1931 (square miles)	Percentage of total area of State mapped to June 30, 1931	Spirit levels (miles)	Transit traverse (miles)	Triangulation stations occupied
		12,000 or larger	20,000	24,000	31,680	48,000	62,500	125,000	Revision	Resurvey	New survey					
Alabama	20						186		186		21,491	41.3		288		
Arizona	5, 25, 100	a 14					172	132	100	132	72	58,968	51.7	415		15
Arkansas											21,730	40.7	349	362		
California	5, 10, 25, 50, 100	b, 7		606	604		172	455		1,261	583	129,458	81.8	169		74
Colorado	25, 50	42				75	230			80	267	56,092	54.0	248		5
Connecticut												4,965	100.0			
Delaware												2,370	100.0			
District of Columbia												70	100.0			
Florida	1	c 2									2	4,718	8.0	24	30	
Georgia	5, 20			197						95	102	24,937	42.1	405		
Idaho	10, 50, 100				25	47					762	31,795	37.9	118		
Illinois	5, 10, 20			76				792	50	162	656	33,839	59.7	667		
Indiana												3,668	10.1			
Iowa	10, 20							46		46		13,167	23.5	63	10	
Kansas												64,159	78.1			
Kentucky	10				111					111		26,620	65.6	83	120	
Louisiana												8,823	18.2	435	422	
Maine	20							1,860			1,860	17,674	53.5	569	517	11
Maryland												12,327	100.0			
Massachusetts												8,266	100.0			
Michigan	5, 10, 20			a 343			206				206	14,069	24.3	55	961	
Minnesota												8,013	9.5			
Mississippi	5, 20						1,006				1,006	4,991	10.6	1,115	799	
Missouri	2, 5, 10, 20	b 2					1,277			194	1,085	44,168	63.6	1,420	1,158	
Montana	100							486	60		426	42,728	29.1			3
Nebraska												27,117	35.0			
Nevada	100							400			400	46,866	42.3	134		
New Hampshire	20						790			63	727	9,212	98.6	202		24
New Jersey												8,224	100.0			
New Mexico	10, 20, 25	7		12					1	7	11	41,926	34.2	182		25
New York	5, 20			92			43			135		49,204	100.0	525	415	7
North Carolina	20						143			143		19,040	36.3			
North Dakota	1, 5	f 4, 2										13,148	18.6	15	15	
Ohio												41,040	100.0			
Oklahoma	2	g 2, g										41,927	59.8	117	30	
Oregon	5, 10, 25, 50, 100			33				2,132		18	2,147	34,716	35.9	123	108	
Pennsylvania	2, 5, 20	h 2, h					661		33	36	592	37,225	82.5	1,011	624	
Rhode Island												1,248	100.0			
South Carolina												13,737	44.3			

South Dakota.....	1, 5	^c 2, ⁱ 2									19, 243	24. 8	10	9			
Tennessee.....	20					385			319	66	23, 622	56. 2		410			
Texas.....	2, 10, 20		108			218			218	108	88, 284	33. 2	305				
Utah.....	50			171						171	19, 343	22. 8					
Vermont.....	20					95				95	7, 870	82. 3					
Virginia.....	5, 10, 20	^k , ⁱ 10	25	68		836			879	60	37, 809	88. 7	509	723			
Washington.....	5, 10, 20, 25, 100		104	376			424		153	751	36, 407	52. 7	139	19			
West Virginia.....	50					938		938			24, 170	100. 0					
Wisconsin.....	20		33			431			33	431	19, 155	34. 2	300	64			
Wyoming.....	100						244			244	30, 914	31. 6					
Total continental United States (exclusive of Alaska).....			98	33	1, 253	1, 698	330	10, 487	4, 963	1, 182	4, 271	12, 830	1, 350, 553	44. 6	9, 707	7, 065	183
Hawaii.....											6, 435	100. 0					

^a Advance-sheet edition in 5-foot contours; final publication in 25-foot contours and on a scale of 1:62,500.

^b 0.4 square mile mapped on scale of 1:2,400.

^c Mapped on scale of 1:1,200.

^d Culture and drainage compiled from aerial photographs.

^e Mapped on scale of 1:4,800.

^f Mapped on scale of 1:3,600.

^g 60 acres mapped of 1:1,200.

^h 25 acres mapped on scale of 1:1,200.

ⁱ Mapped on scale of 1:2,400.

^j 0.3 square mile mapped on scale of 1:4,800.

^k 0.3 square mile mapped on scale of 1:1,200.

^l Publication scale 1:9,600.

FIELD SURVEYS

Alabama.—The State geologist of Alabama cooperating, the survey of the Cottondale quadrangle was completed and that of the Blocton quadrangle was continued.

Arizona.—At the request of the geologic branch the survey of the Ajo quadrangle was begun. The survey of the Camp Verde quadrangle for the Forest Service was begun. The cultural revision for the west half of the Moon Mountain quadrangle was completed.

California.—In cooperation with the State engineer of California the survey of the Stevens, Lokern, Discovery Well, Canoas Creek, Kettleman Plain, Middle Dome, Avenal Gap, County Mill, Coal Oil Canyon, Pentland Junction, No. 71, No. 72, and No. 73 quadrangles was completed, and that of the Tejon Hills and No. 39 quadrangles was begun. In cooperation with the county surveyor of Los Angeles County, the survey of the Wilsona, Lovejoy Springs, Little Rock, Casa Desierta, Joshua, Del Sur, Moody Springs, Llano, Ravenna, Esperanza School, Little Buttes, No. 1, No. 2, No. 3, and No. 6 quadrangles was completed, that of the Del Valle quadrangle was continued, and that of the Red Rover, Red Mountain, Redrock Mountain, Warm Spring Canyon, Whitaker Peak, Oak Flat, and Beartrap Canyon quadrangles was begun. At the request of the Forest Service the survey of the Hoaglin quadrangle was continued. In preparation for geologic mapping the survey of the White River No. 3 quadrangle was begun. At the request of the Federal Power Commission the survey of the Tehipite Valley, Kellers Ranch, Oat Mountain, and Cedar Grove reservoir and dam sites on Kings River was completed.

Colorado.—In cooperation with the Colorado Metal Mining Fund and the Colorado Geological Survey Board, the survey of the Lost Creek drainage basin, Rico district, Kokomo-Robinson area, Nederland and vicinity, and Ironton and vicinity was completed, and that of the Ouray mining district was continued. For the Forest Service the survey of the Mount Powell No. 3 quadrangle was completed.

Florida.—The survey of the Pensacola Naval Air Station was completed for the Navy Department.

Georgia.—The survey of the upper Altamaha River Basin, covering parts of the Oconee, Apalachee, Ocmulgee, Alcovy, South, and Yellow Rivers, with tributaries, was completed in cooperation with the United States Army district engineer at Savannah.

Hawaii.—In cooperation with the commissioner of public lands of the Territory of Hawaii the cultural revision was completed for the Hilo quadrangle.

Idaho.—The Bureau of Mines and Geology cooperating, the survey of the Little Eightmile mining district was completed. The survey of the Newsome quadrangle was continued at the request of the Forest Service. For the National Park Service the survey of an addition to the Craters of the Moon National Monument was completed. In preparation for geologic mapping, the survey of the Irwin quadrangle was begun. The survey of the Calispell quadrangle was begun.

Illinois.—The survey of the Jerseyville, Fithian, Granite City, and Monks Mound quadrangles and highway projects Nos. 91 (Maquon and Galva quadrangles), 93 (Toulon quadrangle), 104 (Jacksonville quadrangle), and 119 (Arrowsmith, LeRoy, McLean, and Minier quadrangles), was completed, that of the Metamora and Dunlap quadrangles was continued, and that of the Orion, Pecatonica, and Potomac quadrangles and highway project No. 82 (Prophetstown quadrangle) was begun. This work was done in cooperation with the Department of Registration and Education of Illinois, Geological Survey.

Iowa.—The State geologist of Iowa cooperating, the survey of the Iowa City quadrangle was begun.

Kentucky.—The survey of the proposed Mammoth Cave National Park was completed.

Maine.—In cooperation with the Public Utilities Commission of Maine the survey of the Pittsfield, Forks of Machias, Tunk Lake, Allagash, Strong, Milan, and Errol quadrangles was completed, that of the Saponac and Ashland quadrangles was continued, and that of the Fish River Lake, Boyd Lake, Sysladobsis Lake, Stetson, Nicatous Lake, Presque Isle, Bridgewater Center, and Mooseleuk Mountain quadrangles was begun. In cooperation with the War Department the survey of the Fort Fairfield, St. Francis, and Vanceboro

quadrangles was completed and that of the Forest, Van Buren, and Johns Pond quadrangles was begun.

Michigan.—In cooperation with the Department of Conservation of Michigan, Geological Survey, the survey of the Muskegon, Shepherd, and Lake Harbor quadrangles was completed and that of the Cement City quadrangle was begun, and the compilation from aerial photographs of the culture and drainage of Isle Royal, Mackinac, and Bois Blanc Islands was completed and that of the Groscap, St. Ignace, Hart, Walkerville, Fern, Cooks, Baldwin, Ludington, Manistee, Freesoil, and Hiawatha quadrangles was begun.

Mississippi.—In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Horn Lake, Strayhorn, and Rich quadrangles was begun, and in cooperation with the United States Army district engineer at Vicksburg the survey of the Whaley, Cypress Brake, Sumner, Doddsville, Tippto, and Mound Bayou quadrangles was begun.

Missouri.—The survey of the De Soto No. 1, De Soto No. 4, and Jefferson City No. 4 quadrangles was begun in cooperation with the State geologist of Missouri. In cooperation with the United States Army district engineer at Memphis, Tenn., the survey of the Sikeston, Bloomfield, Thebes, and Cairo quadrangles was completed and that of the Hendrickson, Morley, Advance, Puxico, and Greenbrier quadrangles was begun. In cooperation with the Department of Justice the survey of a proposed site for a hospital near Springfield was completed.

Montana.—The survey of the Libby quadrangle was completed for geologic mapping. For the Forest Service the survey of the Trout Creek quadrangle was begun.

Nevada.—The survey of the Halleck quadrangle for the Forest Service was begun.

New Hampshire.—In cooperation with the Highway Department of New Hampshire the survey of the Dixville, Percy, Milan, Errol, and Barnet quadrangles was completed and that of the Woodsville, Groton, and Lowell quadrangles was begun.

New Mexico.—The survey of the Central District area and Virginia mining district was completed in cooperation with the Bureau of Mines and Mineral Resources of New Mexico.

New York.—The survey of the Kinderhook and Schunemunk quadrangles was completed, that of the Ramapo quadrangle was continued, and that of the Rochester No. 1, Catskill, and Rhinebeck quadrangles was begun in cooperation with the Department of Public Works of New York. In cooperation with Monroe County and the Department of Public Works of New York the survey of the Braddock Point No. 3 quadrangle was completed and that of the Rochester No. 2, Rochester No. 3, and Rochester No. 4 quadrangles was begun.

North Carolina.—The survey of the North Carolina portion of the Great Smoky Mountains National Park was continued.

North Dakota.—The survey of the Fort Totten Indian Agency in North Dakota was completed for the Indian Service.

Oklahoma.—In cooperation with the Department of Justice the survey of the proposed location of the Southwestern Reformatory, near El Reno, was completed.

Oregon.—The survey of The Dalles and Dufur quadrangles was completed and that of the Pendleton quadrangle was continued in cooperation with the State engineer of Oregon. For the Forest Service the survey of the Maiden Peak quadrangle was completed. In preparation for geologic mapping the survey of the Dayville quadrangle was begun.

Oregon-Washington.—The survey of the lower Columbia River between Vancouver, Wash., and Mayger, Oreg., was completed in cooperation with the United States Army district engineer at Portland, Oreg.

Pennsylvania.—In cooperation with the Department of Internal Affairs of Pennsylvania, Topographic and Geologic Survey, the survey of the Loysville, Warrensville, and Starrucca quadrangles was completed, that of the Millville and Laporte quadrangles was begun, and the cultural revision of the Connellsville quadrangle was begun. In cooperation with the Department of Justice the survey of a prison site near Lewisburg was completed. The revision of the Eagles Mere quadrangle was completed.

South Dakota.—The survey of the Rosebud Indian Agency and the Pine Ridge Indian Agency in South Dakota was completed for the Indian Service.

Tennessee.—With the cooperation of the State geologist of Tennessee the survey of the Pegram and Ridgetop quadrangles was completed. The survey

of the Tennessee portion of the Great Smoky Mountains National Park was continued.

Texas.—With the cooperation of the Board of Water Engineers of Texas the survey of the Burnet No. 4, Blanco No. 1, Austin No. 2, and Marble Falls quadrangles was completed. In cooperation with the Reclamation Department of Texas the survey of the Harlem-Imperial Farms and Darrington-Ramsey Farms projects was completed.

Utah.—The survey of the Zion National Park for the National Park Service was continued.

Vermont.—In cooperation with the State geologist of Vermont the survey of the Saxtons River quadrangle was completed and that of the Mount Cube quadrangle was begun.

Virginia.—The survey of the Independence, Old Town, Wakefield, Stanardsville, and Warm Springs Run quadrangles was completed, that of the Healing Springs quadrangle was continued, and that of the Elkton, Timber Ridge, Accomac, Rural Retreat, Mount Rogers, Marion, Pearisburg, Blacksburg, Macks Mountain, and Mouth of Wilson quadrangle, was begun, all in cooperation with the Conservation and Development Commission of Virginia, Geological Survey. The survey of the proposed Shenandoah National Park was completed. The survey of the Colonial National Monument, Yorktown Battlefield area, was completed in cooperation with the National Park Service, the Conservation and Development Commission of Virginia, and the United States Yorktown Sesquicentennial Commission, and the survey of the Williamsburg area was completed in cooperation with the National Park Service. In cooperation with the War Department and the Fredericksburg and Spotsylvania County Battlefields Memorial Commission, the survey of Fredericksburg and vicinity was completed.

Washington.—In cooperation with the Department of Conservation and Development the survey of the Kalispell quadrangle was begun. For the Forest Service the survey of the Eatonville and Mount Constance quadrangles was begun. The survey of the upper Columbia River from Rock Island Rapids to the mouth of the Snake River was completed in cooperation with the United States Army district engineer at Seattle.

West Virginia.—In cooperation with the State geologist of West Virginia the cultural revision was completed for the Charleston, St. Albans, Guyandot, Louisa, Wayne, and Milton quadrangles and was begun for the Midkiff and Ceredo quadrangles.

Wisconsin.—In cooperation with the Geological and Natural History Survey of Wisconsin the survey of the Boscobel, Boaz, Mondovi, Wabasha, and Lake City quadrangles was completed, and the culture and drainage of the Robbins quadrangle were compiled from aerial photographs. In cooperation with the War Department the survey of Camp McCoy was completed.

Wyoming.—The survey of the Jackson quadrangle was continued and that of the Irwin quadrangle was begun in preparation for geologic mapping.

WATER-RESOURCES BRANCH

N. C. GROVER, Chief Hydraulic Engineer

ORGANIZATION AND PERSONNEL

The water-resources branch, like other branches of the Geological Survey, is primarily an agency of research and investigation. It collects systematically for general public information and use facts in regard to the quantity, quality, and utilization of water. The widespread interest in the availability of water for many uses has led to a persistent and increasing demand for reliable data that would serve as a basis for safe and sane developments. During the year the varied work of the branch has been administered under the following units:

- Division of surface waters, Carl G. Paulsen, hydraulic engineer, in charge.
- Division of ground water, O. E. Meinzer, geologist, in charge.
- Division of quality of water, W. D. Collins, chemist, in charge.
- Division of power resources, A. H. Horton, hydraulic engineer, in charge.
- Division of water utilization, R. W. Davenport, hydraulic engineer, in charge.

The technical force at the end of the year comprised the chief hydraulic engineer, 29 senior hydraulic engineers, 21 hydraulic engineers, 155 associate, assistant, and junior engineers, 2 engineering field aides, 4 senior geologists, 9 associate, assistant, and junior geologists, 1 senior chemist, 6 associate, assistant, and junior chemists, 3 laboratory assistants and apprentices, 1 illustrator, and 1 computer—a total of 233. The clerical force comprised 45 clerks. The changes in personnel during the year show a net increase of 31.

FUNDS

The funds available for Geological Survey work on water resources were as follows:

Gaging streams	\$552, 405. 49
Transfers from Federal agencies.....	356, 534. 02
Repayments by Federal agencies.....	6, 091. 69
Cooperative funds furnished by States and municipalities.....	461, 649. 72
Noncooperative funds furnished by States and municipalities.....	7, 224. 54
Funds furnished by permittees and licensees of the Federal Power Commission.....	47, 934. 68
	1, 431, 840. 14

COOPERATION

Work in the branch is largely conducted 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.

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

Alabama.....		\$140. 14
Arizona.....		16, 075. 00
Arkansas.....		3, 888. 84
California:		
State.....	\$47, 166. 48	
Municipal.....	24, 975. 87	
		72, 142. 35
Connecticut.....		7, 000. 00
Florida:		
State.....	7, 500. 00	
Municipal.....	1, 643. 67	
		9, 143. 67
Hawaii:		
Territory.....	34, 514. 65	
Municipal.....	11, 789. 24	
		46, 303. 89
Idaho.....		18, 178. 28
Illinois.....		5, 994. 63
Indiana.....		2, 781. 54
Kansas.....		3, 988. 09
Kentucky.....		1, 095. 88
Maine.....		6, 525. 09
Maryland:		
State.....	1, 100. 00	
Municipal.....	1, 950. 00	
		3, 050. 00

Massachusetts :			
State -----	\$3, 844. 42		
Municipal -----	2, 343. 95		
			\$6, 188. 34
Michigan :			
State -----	5, 499. 76		
Municipal -----	572. 69		
			6, 072. 45
Minnesota -----			1, 980. 56
Mississippi -----			287. 21
Missouri -----			12, 375. 52
Montana -----			7, 598. 59
Nebraska -----			5, 222. 61
Nevada -----			1, 391. 81
New Hampshire -----			3, 009. 78
New Jersey -----			13, 877. 44
New York :			
State -----	20, 010. 00		
Municipal -----	271. 95		
			20, 281. 95
New Mexico -----			1, 363. 08
North Carolina -----			9, 835. 89
North Dakota -----			494. 32
Ohio -----			24, 291. 75
Oregon :			
State -----	10, 375. 27		
Municipal -----	702. 65		
			11, 077. 92
Pennsylvania -----			4, 297. 63
South Carolina :			
State -----	2, 500. 00		
Municipal -----	196. 97		
			2, 696. 97
Tennessee -----			21, 062. 73
Texas -----			49, 039. 25
Utah -----			6, 900. 00
Vermont -----			7, 608. 74
Virginia -----			24, 921. 89
Washington :			
State -----	1, 084. 96		
Municipal -----	4, 835. 93		
			5, 920. 89
West Virginia -----			4, 300. 00
Wisconsin -----			7, 043. 34
Wyoming -----			6, 201. 67
			<hr/>
			461, 649. 72

Bureau of Reclamation.—The measurement of streams that are to furnish water to reclamation projects was continued in cooperation with the Bureau of Reclamation on the Black Canyon project and on the lower Colorado River.

Indian Service.—Stream gaging was continued for the Indian Service on the Gila and San Carlos Rivers.

National Park Service.—Streams in the Yellowstone National Park were measured during the year at stations maintained in cooperation with the National Park Service.

Department of the Navy.—A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was continued in cooperation with the Bureau of Yards and Docks.

Forest Service.—A study of stream flow in the Angeles National Forest, in southern California, was continued in cooperation with the Forest Service.

Weather Bureau.—Stream gaging has been continued on the Colorado River in Arizona in cooperation with the Weather Bureau. A study of stream flow was made of the Republican River near Guide Rock, Nebr., of the Tennessee River at Gunter'sville and Riverton, Ala., and Savannah, Ga., and of the Cumberland River at Celina, Carthage, and Clarksville, Tenn.

Office of Public Buildings and Public Parks of the National Capital.—A study of the flow of Rock Creek was continued in cooperation with the Office of Public Buildings and Public Parks. This study will be of special value in determining the effect of development in the District of Columbia and surrounding suburbs on the flow of the creek. The information collected will be of value in plans for preserving the flow in the creek.

Department of State.—Stream gaging was continued on the Rio Grande on the Mexican boundary and on numerous streams on the Canadian boundary from the Lake of the Woods westward. On the Rio Grande 17 gaging stations were operated. On the Canadian boundary 112 gaging stations were operated and maintained in connection with international problems; 48 of them were international gaging stations operated jointly with the Dominion Water Power and Hydrometric Bureau because of the common interest of the two countries in them.

On the Canadian boundary studies were made of flood-control problems on the Roseau River in Minnesota, the waters of the St. Mary and Milk Rivers in Montana were divided between the two countries pursuant to an order of the International Joint Commission, extensive surface and ground water investigations were made on the Kootenai River in Idaho, and other investigations pertinent to international matters affecting the utilization of streams were conducted. The cost of the work was met by funds transferred to the Geological Survey by the Department of State.

Department of Justice.—Investigations of ground-water supplies were made for the Department of Justice for the proposed Federal reformatory at El Reno, Okla.; at the new Federal detention prison, El Paso, Tex.; at McNeil Island Penitentiary, McNeil Island, Wash.; and at Camp Lee prison farm, Va. An investigation was also made relative to underground water in Hawaii for use in a proceeding to condemn certain land at Lualualei, Oahu.

Corps of Engineers, United States Army.—Stream gaging has been continued in cooperation with the Corps of Engineers in connection with flood control and with studies and reports to be made under House Document 308 of the Sixty-ninth Congress, first session. This work has been carried on in the Boston, Providence, New York, Philadelphia, Baltimore, Washington, Norfolk, Huntington, Wilmington, Charleston, Chattanooga, Nashville, Montgomery, Mobile, Galveston, Savannah, Jacksonville, Vicksburg, Louisville, Cincinnati, St. Paul, Kansas City, Seattle, and Portland Army engineer districts and includes about 655 gaging stations. The cost of this work is met by transfers from the funds of the Corps of Engineers. Dam-site investigations were made on the upper Missouri River and the Rappahannock River, and reports were transmitted to the Chief of Engineers.

Federal Power Commission.—The stream gaging required by the Federal Power Commission in connection with permits and licenses issued for the development of water power under the Federal water power act has been performed or supervised by engineers of the Geological Survey in Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Iowa, Indiana, Kentucky, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, New Mexico, New York, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Utah, Virginia, Washington, West Virginia, Wisconsin, and Wyoming. The operation of constructed projects or projects under construction has been supervised in Arizona, Arkansas, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wisconsin, and Wyoming.

PUBLICATIONS

The publications of the year prepared by the water-resources branch comprised 20 reports and 2 separate chapters. (See p. 5.) At the end of the year 37 other reports were in press.

CHARACTER AND METHOD OF WORK

The study of surface waters, which consists primarily of the measurement of the flow of streams, has been conducted in 47 States, the District of Columbia, and Hawaii at selected gaging stations at which the volume of water carried by the streams is measured and records of stage and other data, from which the daily flow of the stream is computed, are collected. At the end of the year 2,663 gaging stations were being maintained; 247 stations were discontinued and 483 new stations established during the year. Records for about 126 additional stations were received, ready for publication, from Government bureaus and private persons, and several Government and State organizations and individuals cooperated in the maintenance of the regular gaging stations.

The division of ground water investigates the waters that lie below the surface; their occurrence, quantity, quality, and head; their recovery through wells and springs; and their utilization for domestic, industrial, irrigation, and public supplies and as watering places for livestock and desert travelers. Each year surveys are made of selected areas where problems of water supply are urgent, and the results are generally published in water-supply papers that include maps showing the ground-water conditions. The investigations relating to the chemical composition of the water are made in cooperation with the division of quality of water. Projects involving large expenditures for drilling wells to develop water supplies are considered each year by the several departments of the United States Government, and the ground-water division is called upon to furnish information and advice on many of these projects. During the fiscal year about 63 investigations relating to ground-water and reservoir sites were in progress, and work was conducted in 19 States and Hawaii. The demands of the public for precise information in regard to ground-water resources are becoming more and more exacting with increasing need for the water. In recent years considerable re-

search into the principles of ground-water hydrology has been undertaken in the division in order to provide a more secure basis for ground-water investigations.

Cooperation was continued with the eight State associations of water well drillers and with the American Association of Water Well Drillers.

The division cooperated in the establishment of a section of hydrology of the American Geophysical Union, and Mr. Meinzer was chosen chairman of the section. Papers were presented at the first annual meeting in Washington by Mr. Meinzer, A. M. Piper, C. V. Theis, and G. H. Taylor.

Mr. Meinzer presented a paper entitled "The source and disposal of ground water in the Mokelumne area, California—an application of the inventory method," before the American Society of Economic Geologists at the annual meeting in Toronto. D. G. Thompson gave a paper on "Some ground-water problems in the southeastern section States," at Columbia, S. C., before the southeastern section of the American Waterworks Association. Abstracts of papers relating to ground-water hydrology were prepared for the "Annotated bibliography of Economic Geology" and for foreign abstract journals.

Work was continued in the hydrologic laboratory by V. C. Fishel, working under the direction of A. M. Piper.

The work on quality of water included the analysis of the mineral content of 1,667 samples of water from surface and underground sources. These included some analyses for nearly all the studies of ground water in the different States as noted below. Samples of water were collected from various cities for a report on industrial water supplies which is to supersede Water-Supply Paper 496. Studies of the dissolved and suspended matter in the Colorado River and its tributaries were continued. A paper on the composition of mineral waters was prepared by Mr. Collins for publication in a "Cyclopedia of medicine" now in press.

The work of the division of power resources comprised the preparation of monthly and annual reports on the production of electricity and consumption of fuel by public-utility power plants, a report on the developed water power of the United States, a report containing the monthly and annual figures of output by States for 1930, and compilations of the stocks of coal held by electric public-utility power plants for inclusion in reports of commercial stocks of coal undertaken quarterly by the Bureau of Mines of the Department of Commerce.

The monthly and annual figures of output of electricity and fuel consumption are based on reports submitted by concerns producing electricity for public use. On January 1, 1931, 1,609 companies, operating 3,904 power plants with a total capacity of generators of 34,263,944 kilowatts, were on the list of companies requested to submit reports. Plants whose output is less than 10,000 kilowatt-hours a month are generally not included. Reports are received from plants representing over 95 per cent of the capacity of all plants listed. The output of plants not reporting is estimated.

Annual production of electricity for public use in the United States, 1919-1930

Year	Total		Water power			Fuel power		
	Kilowatt-hours	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)	Kilowatt-hours	Per cent of total	Change from previous year (per cent)
1919	38,921,000,000	-----	14,606,000,000	37.5	-----	24,315,000,000	62.5	-----
1920	43,555,000,000	+11.9	16,150,000,000	37.1	+10.6	27,405,000,000	62.9	+17.7
1921	40,975,000,000	-5.9	14,970,000,000	36.5	-7.3	26,005,000,000	63.5	-5.1
1922	47,654,000,000	+16.3	17,207,000,000	36.1	+14.9	30,447,000,000	63.9	+17.1
1923	55,665,000,000	+16.8	19,343,000,000	34.8	+12.4	36,322,000,000	65.2	+19.3
1924	59,014,000,000	+6.0	19,969,000,000	33.8	+3.2	39,044,000,000	66.2	+7.5
1925	65,870,000,000	+11.6	22,356,000,000	33.9	+11.9	43,514,000,000	66.1	+11.4
1926	73,791,000,000	+12.0	26,189,000,000	35.5	+17.1	47,602,000,000	64.5	+9.4
1927	80,205,000,000	+8.7	29,875,000,000	37.2	+14.1	50,330,000,000	62.8	+5.7
1928	87,850,000,000	+9.5	34,696,000,000	39.5	+16.1	53,154,000,000	60.5	+5.6
1929	97,352,000,000	+10.8	34,629,000,000	35.6	-2	62,723,000,000	64.4	+18.0
1930	95,936,000,000	-1.5	33,021,000,000	34.4	-4.6	62,915,000,000	65.6	+3

Annual consumption of fuel in the production of electricity for public use in the United States, 1919-1930

Year	Coal		Fuel oil		Gas	
	Short tons	Change from previous year (per cent)	Barrels	Change from previous year (per cent)	M cubic feet	Change from previous year (per cent)
1919	35,100,000	-----	11,050,000	-----	21,406,000	-----
1920	37,124,000	+5.8	13,123,000	+18.8	24,702,000	+15.4
1921	31,585,000	-14.9	12,045,000	-8.2	23,722,000	-4.0
1922	34,179,000	+8.2	13,197,000	+9.6	27,172,000	+14.5
1923	38,966,000	+14.0	14,684,000	+11.3	31,433,000	+15.7
1924	37,556,000	-3.6	16,630,000	+13.3	48,443,000	+54.1
1925	40,222,000	+7.1	10,246,000	-38.4	46,521,000	-4.0
1926	41,511,000	+2.7	9,399,000	-8.3	53,207,000	+14.4
1927	41,888,000	+1.4	6,782,000	-27.8	62,919,000	+18.3
1928	41,350,000	-1.3	7,155,000	+5.5	77,326,000	+22.9
1929	44,937,000	+8.7	10,124,000	+41.4	112,707,000	+45.8
1930	42,898,000	-4.5	9,260,000	-8.5	120,290,000	+6.7

The improvement each year in the utilization of fuel in the generation of electricity by public-utility companies continued, as indicated in the following table:

Average consumption of coal^a per kilowatt-hour by public-utility power plants in the United States, 1919-1930

Year	Pounds	Per cent of rate in 1919	Year	Pounds	Per cent of rate in 1919
1919	3.2	100	1925	2.1	66
1920	3.0	94	1926	1.95	61
1921	2.7	84	1927	1.84	57
1922	2.5	78	1928	1.76	55
1923	2.4	75	1929	1.69	53
1924	2.2	69	1930	1.62	51

^a Oil and gas included as equivalent coal.

Owing to the continuation of the drought, which started in 1929, through the year 1930, the production of electricity by the use of water power was again less than during the previous year.

The regular annual report of the capacity of water wheels in water-power plants in the United States was released February 10, 1931, and the final report of the monthly and annual production of electricity for public use in 1930 was released April 30, 1931.

WORK OF THE YEAR BY STATES

The following table shows by States the number of gaging stations maintained for the collection of stream-flow records and the interest in those stations of the agencies cooperating with the Geological Survey:

Gaging stations and cooperating parties for the year ending June 30, 1931

State or Territory	Geological Survey alone	Bureau of Reclamation	Forest Service	Indian Service	Army engineers	Weather Bureau	Other Federal bureaus	State cooperation	Municipal cooperation	Private persons	Counted more than once	Maintained at end of year	Established during year	Discontinued during year	Regular gagings during year	Miscellaneous gagings during year
Alabama	1				28					5	1	33	1		324	2
Arizona	1	1		5				61			6	62	7		2,001	25
Arkansas					1	4		13		7	7	18	2	3	89	3
California			20	1				277	35	81	136	281	35	11	6,044	525
Colorado		2			10			17	9	2	10	30		5	271	
Connecticut					3			15	2	4	4	20	6		156	6
Delaware																
Florida					10			23		6	13	26	10		206	69
Georgia					15			10	1	10	2	26	2	2	256	16
Idaho		6	6		14	2	33	108	4	200	93	280	118	126	2,157	64
Illinois					6	2		29	3	2	7	35	1	1	177	1
Indiana					14	4		33	2	4	24	33	19		188	
Iowa					5				1			6	1	1	81	3
Kansas					22	4		25		1	5	47			336	1
Kentucky					31	1		5		11	12	36	9		238	3
Louisiana					1						1	1	1		10	
Maine					14			21		9	15	29	1		305	24
Maryland and District of Columbia	1				6		1	6	8	1	1	22	2	3	147	71
Massachusetts								24	3	1	4	24	3	1	216	
Michigan									1	2	1	2	24	24	150	15
Minnesota					14		21	17		4		56	27	6	403	21
Mississippi	1				9			10		1	10	11	5	2	135	2
Missouri					14	3		77		19	22	91	6	8	933	4
Montana					31		36	39		13		119	6		516	4
Nebraska					15					1	1	15	1	1	246	
Nevada				1				11		5	6	11		1	11	
New Hampshire					12			16		11	16	23	1		178	
New Jersey						1		45		9	7	17	4	1	298	27
New Mexico							1					1			152	
New York					13			103	2	37	52	103	5	1	814	6
North Carolina					30			78		1	31	78	4		523	41
North Dakota					8		9	2				19	7		106	
Ohio					9	1		106		9	4	23	106	11	697	8
Oklahoma					9							9	1	1	57	
Oregon					39	6		93	11	42	98	93	6	6	752	57
Pennsylvania					11		2	94	1	12	18	102	94		71	3
Rhode Island					1							1			6	
South Carolina					10			17		3	5	17	1		82	1
South Dakota					19			1				20	2		261	2

Tennessee					59	3		77		10	72	77	9	4	599	89
Texas					16	11	16	95	6	5	38	111	8	4	2,074	144
Utah	4	3					1	53	1	20	25	57	4	3	434	15
Vermont					3			21		6	4	26	4	1	185	
Virginia					33			83	1	12	46	83	7	4	483	11
Washington			1		66		10	101	19	28	109	116	3	16	827	87
West Virginia					30			29	1	10	11	59			358	69
Wisconsin					8			42		10	13	47	10	4	284	6
Wyoming		4		4	16	1	7	39		3	6	68	4	1	435	7
Hawaii								88	13	56	69	88	9	1	547	25
	8	16	27	11	655	43	140	1,994	145	668	1,044	2,663	483	247	25,816	1,457

Alabama.—The systematic survey of the ground waters of Alabama was temporarily discontinued, but the water-stage recorder was continued in operation on the springs at Huntsville. A report on ground water resources of northeastern Alabama was completed by W. D. Johnston, jr., and transmitted to the State geologist.

Arkansas.—The investigation of the source and quantity of ground-water supplies available for rice irrigation in the Grand Prairie region, Ark., was continued by D. G. Thompson, who prepared a report entitled "A quantitative study of the ground water supply of the Grand Prairie region, Ark." This was issued as a 20-page press notice. The work in Arkansas is conducted in cooperation with the State geological survey and the State agricultural experiment station.

California.—Water levels were measured in selected wells in southern California under the direction of F. C. Ebert. The record now covers a period of 27 years. Work was continued with the financial support of the East Bay Municipal Utility District on the investigation of the ground water in the alluvial fan of the Mokelumne River by H. T. Stearns, G. H. Taylor, C. A. McClelland, G. M. Sherwood, R. B. Colby, and R. C. Cady. A progress report on the investigation supplemental to Water-Supply Paper 619 was released. W. N. White spent a month in the area, working in an advisory capacity. Measurement of wells in the Calaveras River area was continued in cooperation with the city of Stockton. Tests of samples of water-bearing materials were made at the laboratories of the State university at Davis. A report on the water table in the Calaveras River area was prepared by T. W. Robinson and G. H. Taylor and released in manuscript form. G. H. Taylor presented a paper on investigations relating to the absorption of precipitation and its penetration to the zone of saturation, at a meeting of the section of hydrology of the Geophysical Union at Washington. This paper was chiefly concerned with experiments now in progress in the Mokelumne area. In a preliminary survey of the quality of surface waters of the State, 105 partial analyses were made. The samples analyzed were representative of different stages for nearly all the gaging stations in the State. A report of this survey was submitted to the State engineer as a basis for planning a comprehensive study of the quality of the surface waters of California.

Florida.—A district office was established at Ocala, Fla., August 4, 1930, with D. S. Wallace, engineer, in charge. A survey of the ground-water resources of Florida was begun in cooperation with the State Geological Survey by V. T. Stringfield, under the direction of D. G. Thompson. Mr. Thompson presented a paper entitled "Problems of water supply in Florida" before the Florida section of the American Waterworks Association. A brief report entitled "Ground-water resources of Florida," by Messrs. Thompson and Stringfield, was published by the State geological survey.

Hawaii.—The comprehensive investigation of the ground waters on the island of Oahu was continued in cooperation with the Territorial Commissioner of Public Lands. Early in July H. T. Stearns was assigned as geologist in charge of the work. K. N. Vaksvik continued his artesian-well studies, and Mr. Stearns spent half of November in an investigation of the high-level water supply available in Lualualei Valley for condemnation proceedings for the Department of Justice. A study of a water supply for the proposed naval ammunition depot at Lualualei, Oahu, was continued for the Bureau of Yards and Docks.

Idaho.—A report on ground water in the Snake River area by H. T. Stearns, Lynn Crandall, and W. G. Steward was completed.

Illinois.—A. G. Fiedler attended the annual meetings of the State well drillers' association and the American Association of Water Well Drillers in Urbana, Ill., and also a joint meeting of the specifications committees of the American Association of Water Well Drillers and the American Specifications Institute in Chicago.

Indiana.—A district office was established at Indianapolis, Ind., August 18, 1930, with H. E. Grosbach, engineer in charge. A. G. Fiedler attended the convention of the Indiana Well Drillers' Association at Des Moines.

Kansas.—A. G. Fiedler presented a paper entitled "Proper well construction" before the annual meeting of the Kansas Waterworks School in Lawrence.

Michigan.—A district office was established at Lansing, Mich., August 25, 1930, with Berkeley Johnson, engineer in charge.

Minnesota.—A. G. Fiedler attended the convention of the Minnesota Well Drillers' Association. A branch office maintained at Minneapolis, in charge of Mr. Fiedler, who is investigating well-drilling methods and cooperating with the State well drillers' associations, was closed June 30.

Montana.—Work was continued by G. M. Hall in the preparation of reports on Big Horn and Fergus Counties.

Nebraska.—L. K. Wenzel was assigned to study ground waters of the Platte River region under the supervision of A. L. Lugn and R. M. Leggette. The work is being done in cooperation with the State conservation and survey division.

New Jersey.—Informal cooperation was continued with the State department of conservation and development and the State water policy commission. The chloride content was determined for 51 samples of well water collected in the vicinity of Atlantic City for observations on the possibility of salt-water contamination.

New Mexico.—Field work was continued by W. N. White in the Mimbres Valley and by S. S. Nye in Lea County. The following cooperative reports were published in the ninth annual report of the State engineer: Preliminary report on the ground-water supply of the Mimbres Valley, by W. N. White; Shallow ground-water supplies in northern Lea County, by S. S. Nye; Recommendations for a more efficient utilization of the Roswell artesian basin, by A. G. Fiedler and S. S. Nye.

North Dakota.—R. M. Leggette investigated dam sites on the Missouri River in North Dakota and prepared and transmitted a report thereon to the Chief of Engineers, United States Army.

Oklahoma.—S. F. Turner made an investigation and prepared a report for the Department of Justice on the water supply available for the proposed reformatory at El Reno, Okla.

Oregon.—Investigations of the ground-water resources of Oregon were continued in cooperation with the State agricultural experiment station. The investigation of the ground water available for irrigation in The Dalles region was continued by A. M. Piper, and T. W. Robinson was assigned to the investigation of the ground-water supply of the Harney Basin. A report on the geology and ground-water resources of The Dalles region was prepared by Mr. Piper and released in manuscript form. He also prepared a summary of the ground-water resources of Yamhill County, which was issued as a press bulletin, and a report on dam sites in eastern Oregon, which was submitted to the conservation branch of the Geological Survey.

Pennsylvania.—A district office was established at Harrisburg, Pa., June 1, 1931, with J. W. Mangan as engineer in charge. The systematic survey of the ground-water resources of the State was continued in cooperation with the State topographic and geologic survey by R. M. Leggette in the north-western part of the State and by S. W. Lohman in the northeastern part.

South Carolina.—A district office was established at Columbia, S. C., November 1, 1930, with A. E. Johnson as engineer in charge.

South Dakota.—R. M. Leggette investigated dam sites on the Missouri River in South Dakota and prepared and submitted a report thereon to the Chief of Engineers, U. S. Army. A. G. Fiedler attended the annual meeting of the State Well Drillers Association.

Tennessee.—Work was continued on a systematic survey of the ground-water resources in Tennessee in cooperation with the State geologist. C. V. Theis was assigned to this work and spent several months in south-central Tennessee under the direction of D. G. Thompson. A report on ground water in north-central Tennessee was completed by A. M. Piper, and a report on the ground-water resources of western Tennessee was completed by F. G. Wells.

Texas.—The systematic survey of the ground-water resources of Texas was continued in cooperation with the State board of water engineers under the direction of W. N. White. Field work was done in the Winter Garden region by W. N. White, T. W. Robinson, P. P. Livingston, and W. A. Lynch. S. S. Nye began field work in the Toyah Basin in Reeves, Ward, and Pecos Counties. A. N. Sayre made a survey of the ground water of Duval County, and work was begun by P. P. Livingston and S. F. Turner on an investigation of the ground-water supply of Harris County and parts of adjoining counties, including the Houston area. J. C. Lonsdale began an investigation of the geology and ground-water resources of Webb County. Reports have been prepared by A. N. Sayre on Medina and Uvalde Counties; by T. W. Robinson, S. F. Turner, A. G. Fiedler, and P. P. Livingston on Zavala and Dimmit Counties and parts of Maverick and La Salle Counties; by J. C. Lonsdale on Atascosa and Frio Counties; and by A. G. Fiedler on the Glen Rose area, in Somervell County. A report summarizing the results of the Texas ground-water work up to January 1, 1931, was prepared by W. N. White in collaboration with O. E. Meinzer and issued as a 35-page press notice. The State depart-

ment of health and the bureau of engineering research, Agricultural and Mechanical College of Texas, continued to cooperate in the ground-water survey.

Virginia.—S. W. Lohman made an investigation of dam sites along the Rappahannock River under the direction of R. M. Leggette and prepared and transmitted a report thereon to the Chief of Engineers, United States Army. A report on the warm springs of Virginia was completed by Frank Reeves and transmitted to the State geologist. Water-stage recorders were operated on the ebbing and flowing spring near Broadway and on the observation well in Arlington County. A report on water-level fluctuations in the Arlington County well was prepared and issued as a press bulletin. An investigation of a proposed municipal water supply for Falls Church was made by R. M. Leggette and L. K. Wenzel, and a report submitted to the mayor of Falls Church. An examination of ground-water conditions at Camp Lee was continued by R. M. Leggette and S. F. Turner for the Department of Justice. The collection of surface-water samples from Virginia was concluded during the fiscal year. Daily samples were collected at 17 gaging stations, and samples were collected at different stages at other stations. A preliminary report was published by the State giving the results for the first year. A final report was prepared giving the analyses for all the stations from which samples were collected.

Washington.—A. M. Piper spent about two weeks investigating ground-water supplies available for the United States penitentiary at McNeil Island for the Department of Justice. He prepared and submitted a report to the conservation branch of the Geological Survey on dam sites on the Hoh and Calawah Rivers.

Wyoming.—A water-stage recorder was continued in operation on the ebbing and flowing spring near Afton.

CONSERVATION BRANCH

HERMAN STABLER, *Chief*

ORGANIZATION AND PERSONNEL

The volume and complexity of the work of the conservation branch, comprising the classification of public lands with respect to mineral, water power, and agricultural value and the technical supervision of mineral and power development on such lands and of mineral development on Indian lands, continued to increase during the fiscal year 1931 and was directed through four administrative divisions, as follows:

Mineral classification division, J. D. Northrop, geologist, in charge.
 Power division, B. E. Jones, hydraulic engineer, in charge.
 Agricultural division, J. F. Deeds, hydraulic engineer, in charge.
 Mineral leasing division, H. I. Smith, mining engineer, in charge.

Personnel changes during the fiscal year included 6 separations and 15 additions. On June 30, 1931, the personnel of the branch, both office and field, numbered 158, consisting of 5 geologists, 9 hydraulic engineers, 12 mining engineers, 45 petroleum engineers, 1 classification engineer, 7 agricultural classifiers, 1 chemist, 1 attorney, 22 accountants and draftsmen, and 55 clerical and miscellaneous employees.

FUNDS

The funds appropriated or transferred for the work of the conservation branch in the fiscal year were as follows:

Classification of lands.....	\$180,480
Supervision of leasing operations, public lands.....	271,820
Supervision of leasing operations, Indian lands.....	90,000
Supervision of naval-reserve operations.....	45,000
Plugging abandoned wells (balance on July 1, 1930).....	43,191
Federal Power Commission.....	2,500
	632,991

632,991

CORRESPONDENCE

During the year 26,981 letter requests for information or technical reports were received in the Washington office of the branch, together with 37,500 pieces of miscellaneous correspondence for filing or for transmission to the appropriate field office. Within the same period 20,941 letters were answered and 19,900 pieces of miscellaneous correspondence were sent out.

SUMMARY OF LAND-CLASSIFICATION CASES

The activities of the conservation branch with respect to land classification include the preparation of reports in response to requests for data or action on specific cases, the preparation of orders of withdrawal and restoration of lands not involved in specific requests, and the promulgation of broad areal classifications. The following table summarizes activity with respect to requests for data or action on specific cases. The terms "gain" and "loss" signify, respectively, decrease and increase in the number of cases pending. The number of cases acted on was less by about 2,600 than during the preceding year, and the number of cases pending at the end of the year was reduced more than 40 per cent.

General summary of cases involving land classification

Class of cases	Record for fiscal year 1931						Record since receipt of first case	
	Pending July 1, 1930	Received during fiscal year	Total	Acted on during fiscal year	Pending June 30, 1931	Gain or loss during fiscal year	Received	Acted on
General land office requests:								
General.....	407	815	1,222	980	242	+165		
Time extensions.....							2,313	2,313
Oil development.....	1	66	67	66	1		16,195	16,194
Concurrence.....	20	820	840	823	17	+3		
Committee cases—oil.....	609	1,677	2,286	2,214	72	+537	7,357	7,285
Applications for classification as to mineral:								
Oil.....	1,265	4,386	5,651	5,030	621	+644	17,566	16,945
Miscellaneous.....	8	11	19	15	4	+4	854	850
Applications for mineral permits.....	21	317	338	313	25	-4	53,115	53,090
Applications for mineral leases.....	7	159	166	156	10	-3	1,619	1,609
Applications for patent, potassium.....							124	124
Federal Power Commission cases:								
Preliminary permits.....	12	77	89	79	10	+2	196	186
Licenses.....							28	28
Determinations under sec. 24.....	13	42	55	47	8	+5	311	303
Applications for classification as to power resources.....	9	22	31	25	6	+3	448	442
Applications for agricultural classification.....	57	185	242	177	65	-8	1,029	964
Applications for rights of way.....	17	228	245	217	28	-11	6,629	6,601
Irrigation project reports.....	1	8	9	7	2	-1	922	920
Applications under enlarged homestead acts.....	163	270	433	305	128	+35	57,468	57,340
Applications under stock-raising homestead acts.....	1,852	3,807	5,659	4,300	1,359	+493	134,042	132,683
Applications under ground-water reclamation act.....	6	15	21	14	7	-1	965	958
Indian Service requests for information.....	3	3	6	6		+3	9,545	9,545
	4,471	12,908	17,379	14,774	2,605	+1,866		

SUMMARY OF FIELD OPERATIONS BY STATES

Alaska.—Supervised one power project. Expended \$10,000 through the Alaskan branch for supervision of 993 prospecting permits for oil and gas and of 7 leases, 3 licenses, and 25 prospecting permits for coal. Coal produced, 112,961.79 tons; accrued rent and royalty, \$8,612.01.

Alabama.—Examined one tract for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised one coal lease. Coal produced, 121,002 tons; accrued rent and royalty, \$12,100.20.

Arizona.—Supervised 11 power projects. Examined 28 tracts for agricultural classification. Supervised on public land 109 prospecting permits for oil and gas, 1 lease and 3 prospecting permits for sodium, and 1 prospecting permit for potassium. No production reported; accrued rent and royalty, \$101.50. Supervised on Indian land in 9 reservations 14 leases and prospecting permits for oil and gas, 9 agency coal mines, 5 leases for vanadium, 3 leases for asbestos, 2 leases for gold, 2 leases for copper, and 1 group of locations for iron ore.

Arkansas.—Supervised 15 prospecting permits for oil and gas and 1 for coal. No production reported.

California.—Investigated structural conditions affecting Goleta Sandspit, in Santa Barbara County, and in cooperation with the geologic branch began a detailed geologic examination of the Kettleman Hills anticline, in Kings and Kern Counties. Supervised 31 power projects. Examined 90 tracts for agricultural classification and began detailed studies of grazing conditions in Mono Lake and Owens Valleys preparatory to administration of lands withdrawn by the act of March 4, 1931 (46 Stat. 1530). Supervised on public land 189 leases and 444 prospecting permits for oil and gas, 5 prospecting permits for coal, 20 prospecting permits for sodium, and 4 leases and 5 prospecting permits for potassium. Oil produced, 9,164,952 barrels; natural gas, 16,994,596,000 cubic feet; natural-gas gasoline, 66,828,634 gallons; coal, 250 tons; sodium minerals, 30,226 tons; accrued rent and royalty, \$942,994.86. Supervised on naval petroleum reserves 25 leases for oil and gas. Oil produced, 5,590,418 barrels; natural gas, 5,123,456,000 cubic feet; natural-gas gasoline, 22,748,665 gallons; accrued rent and royalty, \$1,255,656.50.

Colorado.—Investigated structural and stratigraphic conditions in parts of Archuleta and Delta Counties; examined five tracts for mineral classification and in cooperation with the geologic branch began a detailed geologic survey of the Julesburg Basin. Supervised 11 power projects. Examined 70 tracts for agricultural classification and completed a land-classification map showing agricultural and grazing types in the southwestern part of the State. Supervised on public land 21 leases and 414 prospecting permits for oil and gas; 81 leases, 3 licenses, and 42 prospecting permits for coal; and 2 prospecting permits for sodium. Oil produced, 665,328 barrels; natural gas, 1,709,179,000 cubic feet; natural-gas gasoline, 17,916 gallons; coal, 396,389 tons; accrued rent and royalty, \$86,695.59. Supervised on Indian lands 1 oil and gas lease and 2 agency coal mines.

Florida.—Examined one tract for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State.

Idaho.—In cooperation with the geologic branch began a detailed geologic survey of the Afton quadrangle. Supervised 6 power projects. Investigated storage and power possibilities of the Henrys Fork Basin, the upper Snake River, and the Middle Fork of the Salmon River. Examined 82 tracts for agricultural classification. Supervised on public land 75 prospecting permits for oil and gas, 10 prospecting permits for coal, and 2 leases for phosphate. Coal produced, 987 tons; phosphate, 68,974 tons; accrued rent and royalty, \$6,480.84.

Kansas.—Examined 3 tracts for mineral classification. Supervised 1 prospecting permit for oil and gas.

Louisiana.—Examined 8 tracts for mineral classification. Investigated in the field the status of oil and gas prospecting operations throughout the State. Supervised 13 leases and 2 prospecting permits for oil and gas. Oil produced, 8,919 barrels; natural gas, 690,591,000 cubic feet; natural-gas gasoline, 53,347 gallons; accrued rent and royalty, \$5,048.47.

Mississippi.—Investigated in the field the status of oil and gas prospecting operations throughout the State.

Montana.—Continued detailed geologic investigations in the Sweetgrass Hills and completed a preliminary structure-contour map of the Bears Den-Flat Coulee-Whitlash district, in Liberty and Toole Counties, and a structure-contour map of the Conrad-Great Falls region. Made a geologic reconnaissance of the Crazy Mountain syncline. Prepared a structure-contour map of the eastern two-thirds of the State. Began a detailed geologic survey of the Cedar Creek anticline. Continued through the geologic branch detailed investigations of the coal resources of Richland, Custer, and Powder River Counties. Supervised 29 power projects. Examined 85 tracts for agricultural classification. Supervised on public land 75 leases and 493 prospecting permits for oil and gas, 61 leases, 29 licenses, and 27 prospecting permits for coal, and 1 lease for phosphate. Oil produced, 436,012 barrels; natural gas, 894,407,000 cubic feet; coal, 114,929 tons; accrued rent and royalty, \$72,000.01. Supervised on Indian lands in 3 reservations 144 leases for oil and gas, 2 agency coal mines, 1 prospecting permit for coal, and 1 lease each for silver-lead ore and vermiculite.

Nebraska.—Supervised 3 prospecting permits for potassium.

Nevada.—Supervised 6 power projects. Examined 75 tracts for agricultural classification and continued regional investigations of agricultural utility precedent to grazing classification in the northeastern part of the State. Supervised on public land 87 prospecting permits for oil and gas, 5 prospecting permits for coal, 1 lease and 3 prospecting permits for sodium, 1 lease for phosphate, and 2 prospecting permits for potassium. Coal produced, 29 tons; phosphate, 81 tons; accrued rent and royalty, \$2,247.25. Supervised on Indian land in 1 reservation 6 leases for silver-lead ores and 2 leases for marl.

New Mexico.—Began geologic investigations of the coal resources and structural features of the western part of the San Juan Basin. Continued through the geologic branch similar investigations in the southern and eastern parts of the same basin. Investigated the power possibilities of the Rio Peñasco and supervised 3 power projects. Examined 75 tracts for agricultural classification. Supervised on public land 44 leases and 935 prospecting permits for oil and gas, 23 leases and 44 prospecting permits for coal, 3 leases and 55 prospecting permits for potassium, and 4 prospecting permits for sodium. Oil produced, 1,799,815 barrels; natural gas, 5,791,622,000 cubic feet; natural-gas gasoline, 672,848 gallons; coal, 50,713 tons; potassium salts, 4,727 tons; sodium salts, 31 tons; accrued rent and royalty, \$110,056.83. Supervised on Indian lands in 4 reservations 36 leases for oil and gas, 10 agency coal mines, and 1 lease for coal.

North Dakota.—Examined 3 tracts for agricultural classification. Supervised 13 prospecting permits for oil and gas; 60 leases, 13 licenses, and 1 prospecting permit for coal; and 3 prospecting permits for sodium. Coal produced, 363,476 tons; accrued rent and royalty, \$23,283.57.

Oklahoma.—Examined 9 tracts for mineral classification. Continued, in cooperation with the Oklahoma Geological Survey, detailed investigations of the coal resources of the McAlester, Wilburton, and Poteau districts, begun in 1927. Supervised 1 power project. Supervised on public land 17 leases and 11 prospecting permits for oil and gas. Oil produced, 418,063 barrels; natural-gas gasoline, 899,561 gallons; accrued rent and royalty, \$666,888.80. Supervised on Indian lands 9,006 leases for oil and gas, involving 5,018 oil wells and 251 gas wells, 108 leases for coal, and 39 leases for lead and zinc. Lead and zinc concentrates produced, 98,870 tons; market value \$2,694,145.86. Total accrued rent and royalty from all Indian land operations under supervision, \$4,416,079.14. Made 580 field investigations of Indian lands for regulatory, inspectional, or appraisal purposes. Began oil gaging and royalty accounting for 4 Indian reservations.

Oregon.—Investigated storage and power possibilities on the Grand Ronde, Innaha, Santiam, and Walla Walla Rivers. Examined 43 tracts for agricultural classification. Supervised 4 power projects. Supervised 14 prospecting permits for oil and gas, 2 leases and 8 prospecting permits for coal, 4 prospecting permits for potassium and 1 lease for oil shale. Coal produced, 756 tons; accrued rent and royalty, \$3,206.48.

South Dakota.—Examined 13 tracts for agricultural classification. Supervised 20 prospecting permits for oil and gas and 3 leases for coal. Coal produced, 489 tons; accrued rent and royalty, \$562.

Utah.—Examined for purposes of appraisal certain coal lands in Duchesne and Wasatch Counties. Examined through the geologic branch stratigraphic and structural conditions in parts of Grand and San Juan Counties. Super-

vised 8 power projects. Examined 106 tracts for agricultural classification. Supervised on public land 11 leases and 510 prospecting permits for oil and gas; 41 leases, 2 licenses, and 55 prospecting permits for coal; and 17 prospecting permits for potassium. Oil produced, 5,477 barrels; natural gas, 172,963,000 cubic feet; coal, 830,188 tons; accrued rent and royalty, \$118,549.06. Supervised on Indian land 6 leases for oil and gas and 1 agency coal mine.

Washington.—Supervised 10 power projects. Examined 15 tracts for agricultural classification. Supervised 18 prospecting permits for coal and 1 prospecting permit for sodium. Coal produced, 25,462 tons; accrued royalty, \$6,374.43.

Wyoming.—Investigated geologic structure in Goshen Hole, Goshen County, and examined 1 tract for mineral classification in Natrona County. In cooperation with the geologic branch began a detailed geologic survey of the Afton quadrangle. Furnished to the technical press the results of research investigations to determine the value of ceramic tests in subsurface correlation of Cretaceous shales in the central part of the State. Investigated storage and power possibilities in the Snake River Basin and supervised 4 power projects. Examined 153 tracts for agricultural classification and continued in the southwestern part of the State regional investigations precedent to grazing classification. Made 280 analyses of water, 67 of oil, 22 of natural gas, and 33,418 determinations of oil gravity. Supervised on public land 377 leases and 879 prospecting permits for oil and gas; 35 leases, 5 licenses, and 36 prospecting permits for coal; 2 prospecting permits for sodium; and 1 prospecting permit for potassium. Oil produced, 11,322,546 barrels; natural gas, 15,708,826,000 cubic feet; natural-gas gasoline, 43,027,293 gallons; coal, 1,035,558 tons; accrued rent and royalty, \$2,138,747.82. Made periodic inspection and pressure test of wells shut in on Naval Petroleum Reserve No. 3 and supervised operations begun near the end of the year for mudding and plugging certain reserve wells that were in unsatisfactory condition. Supervised on Indian land 42 leases for oil and gas involving 24 productive wells.

MINERAL CLASSIFICATION DIVISION

The work of the mineral classification division involves the withdrawal, classification, and restoration of public lands according to their mineral value and the determination of all questions of geologic fact or inference arising prior to the issuance of a prospecting permit or a lease for publicly owned mineral lands or mineral deposits. It includes also the planning and execution, through the geologic branch, of field investigations required to provide the basis for appropriate action or recommendation relative to mineral classifications and to orders of withdrawal, modification, and restoration. The results of these field investigations take the form of reports concerning the mineral character of specific lands for the information and guidance of Government bureaus and departments charged with the administration of the public land, Indian land, and naval oil reserves.

During the fiscal year requests for reports on the prospective value for oil and gas of lands involved in certain types of nonmineral entries and filings totaled 5,651, and reports on 5,030 cases were submitted to the General Land Office.

Some progress was made in 1931 in classifying the vast areas of public land that are still embraced in mineral withdrawals. The results accomplished include net decreases of 197,430 acres in outstanding coal withdrawals and of 15,475 acres in the total area of outstanding petroleum withdrawals.

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

Summary of outstanding mineral withdrawals and classifications June 30, 1931, in acres

81335-31-5

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		356						
Arkansas		61,160							
California	17,603	8,720	1,178,392						90,324
Colorado	4,142,233	3,082,272	215,370		64,560	952,239			
Florida							66,796	120	
Idaho	4,761	4,603					391,532	268,299	
Louisiana			466,990	4,233					
Montana	7,863,941	8,563,862	1,336,697	67,651			279,944	3,833	
Nevada	83,673				123				39,422
New Mexico	5,061,011	570,372							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	1,341,264		91,464	2,703,755	277,344	2,937	
Washington	691,801	141,444							
Wyoming	2,260,604	6,740,594	541,777			460,103	989,149	25,293	
	29,627,810	31,944,983	5,165,740	71,884	156,147	4,116,097	2,004,765	300,482	9,411,906

^a Includes 3,151 acres of coal land reserved for use of the United States (Coal Reserve No. 1).

^b Includes 2,078 acres of coal land reserved for use of the United States (Coal Reserve No. 2).

The following table summarizes the year's work to the extent that it involved technical reports on original applications for permit or lease rights on public lands:

Summary of applications under the mineral leasing acts, fiscal year 1931

Mineral	Prospecting permits				Leases			
	Pending July 1, 1930	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1931	Pending July 1, 1930	Received during fiscal year	Acted on during fiscal year	Pending June 30, 1931
Oil and gas.....	17	35	48	4				
Coal.....	2	186	175	13	7	149	147	9
Phosphate.....						9	8	1
Sodium.....	1	14	11	4		1	1	
Potassium.....	1	82	79	4				
	21	317	313	25	7	159	156	10

In conformity with departmental procedure under the administrative policy initiated March 12, 1929, reports to the number of 2,214 were prepared and submitted to the "Departmental committee to pass on claims in connection with oil and gas permits" during the fiscal year. These involved statements concerning the status of drilling operations, if any, on the permit land and the significance of such operations, active or projected, on adjacent land or elsewhere on the same geologic structure, and included appraisal of any geologic showing submitted by applicants for extension of time in which to comply with permit requirements, for reinstatement of canceled permits, or for allowance of rejected permit applications.

Lands interpreted as withdrawn for examination and classification as to oil shale by Executive order of April 15, 1930 (No. 5327), were classified as nonoil shale and reinterpreted as unaffected by that order as follows: In Sublette, Sweetwater, and Uinta Counties, Wyo., 1,678,108 acres; in Moffat County, Colo., 324,518 acres; and in Summit and Daggett Counties, Utah, 17,383 acres.

On behalf of the Indian Service field examination and appraisal were made of 36,204 acres of land in the Tabby Mountain coal field in Duchesne and Wasatch Counties, Utah, within the original limits of the Uintah Indian Reservation and now a part of the Uintah National Forest. Without specific field investigation, a report was also prepared for the Indian Service concerning the mineral production and mineral resources of the extensive area in southern Montana and northern Wyoming within the original boundaries of the Crow Indian Reservation as determined by the Fort Laramie treaty.

In accordance with the duty delegated to the Geological Survey, definitions of the "known geologic structure" of seven producing oil and gas fields were prepared and promulgated during the year—the Clay Basin gas field, Utah, 6,163 acres, promulgated January 14, 1931; Frannie oil field, Wyoming, 1,946 acres, promulgated January 21, 1931; Urado oil field, Colorado, 232 acres, promulgated January 24, 1931; and Cooper gas field, 5,120 acres; Eaves oil and gas field, 6,668 acres; Jal oil and gas field, 21,063 acres; Lynn oil and gas field, 12,240 acres, all in New Mexico, promulgated June 18, 1931.

The net area included in outstanding definitions of the "known geologic structure" of producing oil and gas fields on June 30, 1931, was 778,851 acres in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Geologic field work required in the solution of the problems of the division is performed in part by summer detail of Washington employees, in part by two division geologists and two assistants with permanent headquarters in Denver, Colo., and in part by the geologic branch at the expense of the conservation branch. The work accomplished in 1930 is included in the branch summary of field operations by States beginning on page 60. Publications in 1931 resulting from the work of division geologists include a preliminary structure contour map of the Bears Den-Flat Coulee-Whitlash districts, Liberty and Toole Counties, Mont., and a map of the Great Falls-Conrad region, accompanied by a brief text, showing areal and structural geology in parts of Cascade, Chouteau, Lewis and Clark, Liberty, Pondera, and Teton Counties, Mont., by the Geological Survey, and a paper on the value of ceramic tests in subsurface correlation of Cretaceous shales in central Wyoming by the American Institute of Mining and Metallurgical Engineers.

POWER DIVISION

The work of the power division consists primarily in obtaining and making available for use in the administration of the public land laws information as to the water-power resources of the public lands. The specific problems on which reports are made ordinarily involve the ascertainment of the potential power resources of areas that are or may be subject to disposal under public land laws. The extent of this task is indicated by the fact that areas aggregating more than 6,000,000 acres are now included in power reserves whose use will be required for the development of about 15,000,000 continuous horsepower.

In order that this information may be made substantially complete, areas not thoroughly surveyed are designated for examination by the topographic and water-resources branches. The field projects undertaken during the year are included in the branch summary of field operations by States (pp. 60-62).

Copies of many of the reports on the power possibilities of the streams examined have been placed in the district offices of the Geological Survey for public inspection, and notices of the availability of the reports have been sent to the press. Manuscript reports on the water-power resources of the Siletz River Basin, Oregon, and the Quinault, Bogachiel, and Ozette River Basins, Washington, were opened to public inspection during the year.

River surveys were made of the Middle Fork of the Salmon River to its junction with Bear Valley; Panther Creek from its mouth to Napias Creek; Napias Creek from its mouth to the head of the canyon; Loon Creek from its mouth to Warm Springs Creek; Camas Creek from its mouth to Meyers Cove; Big Creek from its mouth to Monumental Creek; Pistol Creek from its mouth to Little Pistol Creek; and Marble Creek from its mouth to the Mitchell ranch—a total of 198 miles in Idaho; and of the Grande Ronde River from the mouth to Rondowa; the Wallowa River from its mouth upstream

23 miles; and the Minam River from its mouth upstream 11 miles—a total of 115 miles in the Grande Ronde River Basin in Oregon.

A plan and profile of the South Fork of the Salmon River was prepared from surveys made the preceding year. These maps also include the East Fork, the Secesh River, Johnson Creek, the Middle Fork of the Payette River above Boom Creek, and Silver Creek, Idaho (220 miles).

A reservoir and dam site on Imnaha River and about 50 miles of the Walla Walla River and its South Fork in Oregon were surveyed. Five additional dam sites were surveyed in Oregon and one in Idaho.

A report on the water-power resources of the McKenzie River and its tributaries, Oregon, was published during the year. Storage and power examinations were also made in the Henrys Fork Basin, Idaho, and the upper Snake River Basin, Wyoming and Idaho. In New Mexico the power possibilities of the Rio Peñasco were investigated. Reports were obtained on field inspections of 55 power projects under permit from the Interior Department.

Administration of the supervision in the field of power projects for the Federal Power Commission is carried on in this office. Investigations and reports have been made on 27 projects, construction and operation are supervised on 128 projects, and cost accounting is being supervised on 10 projects.

The work of the division is briefly summarized in the accompanying tables and in the general summary on pages 60-62.

Pursuant to instructions of the Secretary of the Interior, dated August 24, 1916 (45 L. D. 326), permittees under the act of February 15, 1901 (31 Stat. 790), and grantees under the act of March 4, 1911 (36 Stat. 1253), were called upon for detailed reports of the operation or development of their power systems during the calendar year 1930. The total installation of the reporting companies is 3,276,000 horsepower, of which 2,284,000 horsepower is installed at hydraulic plants. The total energy generated was 7,850,000,000 kilowatt-hours, of which 6,866,000,000 kilowatt-hours was generated by water power. The energy generated was 1,502,000,000 kilowatt-hours less than in 1929 and was the smallest output since 1926. About one-third of the decrease was in the energy generated by water power, and about two-thirds in that generated by fuel.

Power output of permittees and grantees, 1916-1930

Calendar year	Kilowatt-hours	Increase or decrease		Calendar year	Kilowatt-hours	Increase or decrease	
		Kilowatt-hours	Per cent			Kilowatt-hours	Per cent
1916-----	1, 200, 000, 000			1924-----	6, 100, 000, 000	+190, 000, 000	+3
1917-----	2, 000, 000, 000	+800, 000, 000	+67	1925-----	6, 930, 000, 000	+830, 000, 000	+14
1918-----	3, 200, 000, 000	+1, 200, 000, 000	+60	1926-----	7, 800, 000, 000	+870, 000, 000	+13
1919-----	3, 100, 000, 000	-100, 000, 000	-3	1927-----	8, 116, 000, 000	+316, 000, 000	+4
1920-----	4, 300, 000, 000	+1, 100, 000, 000	+35	1928-----	8, 987, 000, 000	+871, 000, 000	+11
1921-----	3, 725, 000, 000	-575, 000, 000	-13	1929-----	9, 352, 000, 000	+365, 000, 000	+4
1922-----	4, 947, 000, 000	+1, 222, 000, 000	+33	1930-----	7, 850, 000, 000	-1, 502, 000, 000	-16
1923-----	5, 910, 000, 000	+963, 000, 000	+19				

The following table shows the revenue accrued for occupancy and use of public lands by the power projects mentioned above.

Accrued compensation for occupancy and use of lands under power permits and grants issued by the Interior Department, 1912-1931

State	1912-1915	1916-1920	1921-1925	1926-1930	1931
Alaska.....		\$6,960.00	\$9,280.00	\$2,900.00	\$580.00
Arizona.....	\$515.00	1,285.00	1,900.00	1,900.00	460.00
California.....	3,619.00	9,274.00	9,918.00	9,624.00	1,942.46
Colorado.....	315.00	875.00	1,765.00	1,465.00	250.00
Idaho.....	20.00	1,670.00	1,700.00	1,640.00	310.00
Montana.....	1,255.00	7,562.00	13,314.00	28,183.00	7,487.00
Nevada.....	281.00	2,245.00	2,570.00	3,565.00	1,442.63
New Mexico.....		20.00	60.00	275.00	95.00
Oregon.....	60.00	100.00	700.00	700.00	225.00
Utah.....		2,568.00	4,395.00	4,460.00	1,150.50
Washington.....	15.00	156.00	631.00	3,675.00	1,266.00
Wyoming.....		70.00	175.00	290.00	65.00
Minnesota.....		20.00	25.00	20.00	
Accumulation.....	6,080.00 6,080.00	32,805.00 38,885.00	46,433.00 85,318.00	58,697.00 144,015.00	15,273.59 159,289.00

Accrued charges for the unauthorized occupancy of public lands by power projects prior to the issuance of licenses therefor by the Federal Power Commission amount to \$94,605.

Power-site reserves, in acres

[Includes all areas reserved or classified as valuable for power purposes and withheld subject to disposal only under the Federal water-power act of June 10, 1920 (41 Stat. 1063). Designations, classifications, and other types of reserves are included in the total areas without distinction]

State	Reserved prior to July 1, 1930	Eliminated prior to July 1, 1930	Reserves outstanding prior to July 1, 1930	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June, 30, 1931
Alabama.....	2,377		2,377			2,377
Alaska.....	303,481	520	302,961	12,838	31,644	284,155
Arizona.....	1,338,719	139,844	1,198,875	159	1,353	1,197,681
Arkansas.....	29,674	360	29,314	44	80	29,278
California.....	1,456,388	39,122	1,417,266	9,649	14,707	1,412,208
Colorado.....	559,052	96,020	463,032	60	2,809	460,283
Florida.....	1,131		1,131			1,131
Idaho.....	652,696	201,211	451,485	815	3,541	448,759
Michigan.....	1,240		1,240	6		1,246
Minnesota.....	19,062	532	18,530			18,530
Mississippi.....	3		3			3
Missouri.....				11		11
Montana.....	307,609	97,653	209,956	820	2,270	208,506
Nebraska.....	761		761			761
Nevada.....	359,313	1,845	357,468	1,366		358,834
New Mexico.....	272,980	11,243	261,737		4,880	256,857
Oregon.....	812,517	159,181	653,336	8,207	28,078	633,465
South Dakota.....	636		636	160		796
Utah.....	782,306	130,985	651,321	3,939	6,357	648,903
Washington.....	472,954	107,716	365,238	7,572	1,141	371,669
Wisconsin.....	1,906	226	1,680			1,680
Wyoming.....	275,802	76,284	199,518	3	181	199,340
	7,650,607	1,062,742	6,587,865	45,649	97,041	6,536,473

Summary of outstanding water-resources withdrawals and classifications June 30, 1931, in acres

State	Power reserves					Reservoir withdrawals	Public water reserves
	Withdrawals	Classifications	Designations *	Miscellaneous	Total		
Alabama.....	120	1,735	-----	522	2,377	-----	-----
Alaska.....	88,275	109,655	-----	86,225	284,155	-----	-----
Arizona.....	373,899	49,861	524,200	249,721	1,197,681	23,040	20,935
Arkansas.....	21,954	1,550	-----	5,774	29,278	-----	-----
California.....	286,915	368,530	-----	756,763	1,412,208	45,264	200,031
Colorado.....	210,519	193,438	-----	56,326	460,283	1,728	9,365
Florida.....	-----	-----	-----	1,131	1,131	-----	-----
Idaho.....	196,031	234,098	-----	18,630	448,759	-----	17,097
Michigan.....	1,240	-----	-----	6	1,246	-----	-----
Minnesota.....	12,309	-----	-----	6,221	18,530	-----	-----
Mississippi.....	-----	-----	-----	3	3	-----	-----
Missouri.....	-----	-----	-----	11	11	-----	-----
Montana.....	126,994	55,547	-----	25,965	208,506	9,080	9,977
Nebraska.....	761	-----	-----	-----	761	-----	-----
Nevada.....	26,627	86,633	-----	245,574	358,834	-----	15,536
New Mexico.....	115,647	49	141,161	-----	256,857	-----	9,956
North Dakota.....	-----	-----	-----	-----	-----	1,091	-----
Oregon.....	319,195	204,248	14,692	95,330	633,465	18,603	28,301
South Dakota.....	-----	-----	-----	796	796	-----	240
Utah.....	435,235	178,126	-----	35,542	648,903	80	40,050
Washington.....	99,330	193,320	-----	79,019	371,669	31,797	920
Wisconsin.....	-----	-----	-----	1,680	1,680	-----	-----
Wyoming.....	79,935	77,563	-----	41,842	199,340	1,714	85,945
	2,394,986	1,754,353	680,053	1,707,081	6,536,473	132,397	438,353

* Designated and not otherwise withdrawn.

AGRICULTURAL DIVISION

The functions of the agricultural division consist of the classification of lands under the enlarged homestead law as nonirrigable; the classification of lands under the Nevada ground-water reclamation law as nontimbered and not known to be susceptible of successful irrigation; the preparation of reports on the sufficiency of the water supply and the general feasibility of irrigation projects that require some form of Federal approval in connection with the administration of public land laws; the initiation of withdrawals of land for reservoir sites and for public watering places; the classification as stock-raising lands under the stock-raising homestead law of tracts whose surface is chiefly valuable for grazing and raising forage crops, does not contain merchantable timber, is not susceptible of successful irrigation from any known source of water supply, and is of such character that 640 acres is reasonably required for the support of a family; and the preparation of areal-classification reports showing the agricultural utility of lands in important public-land regions.

Classifications are made in accordance with the results of field examinations by the members of the division and with information obtained from other sources. The work of the division is planned with the primary purpose of acting on pending applications for classification under the above-mentioned laws and to provide in advance the basis for appropriate action on new applications. The number of cases received and acted on during the fiscal year is shown in the general summary of cases (p. 59). There was a decrease of about 5 per cent in the number received, and the arrearage was 24 per cent less at the end of the year than at the end of the fiscal year 1930.

Summary of enlarged homestead designations, in acres

[Areas classified as arid and nonirrigable; residence by entrymen required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Arizona, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; act of June 17, 1910 (36 Stat. 531), applicable to Idaho; act of June 13, 1912 (37 Stat. 132), applicable to California, North Dakota; act of Mar. 3, 1915 (38 Stat. 953), applicable to Kansas; act of Mar. 4, 1915 (38 Stat. 1163), applicable to South Dakota). Areas classified as arid, nonirrigable, and lacking domestic water supply; residence by entrymen not required (act of Feb. 19, 1909 (35 Stat. 639), applicable to Utah; act of June 17, 1910 (36 Stat. 531), applicable to Idaho)]

State	Designations prior to July 1, 1930	Cancellations prior to July 1, 1930	Designations outstanding prior to July 1, 1930	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1931
Arizona	31,533,384	13,363,989	18,169,395	800	16,040	18,154,155
California	13,382,193	240,453	13,141,740	2,354	216,880	12,927,214
Colorado	33,976,042	196,428	33,779,614	2,740		33,782,354
Idaho:						
Total	13,756,316	461,405	13,294,911	1,840	320	13,296,431
Nonresidence	573,227	4,233	568,994	480		569,474
Kansas	652,244		652,244	160		652,404
Montana	53,494,879	245,728	53,249,151	2,077		53,251,228
Nevada	50,219,304	3,580,717	46,638,587		320	46,638,267
New Mexico	43,853,436	227,892	43,625,544	1,400	120	43,626,824
North Dakota	12,281,527	3,848	12,277,679	1,030		12,278,709
Oregon	21,283,751	989,902	20,293,849	800	11,320	20,283,329
South Dakota	16,343,341	348,170	15,995,171			15,995,171
Utah:						
Total	11,754,830	1,190,607	10,564,223	2,467	7,220	10,559,470
Nonresidence	1,656,151	502,883	1,153,268	1,947	6,220	1,148,995
Washington	6,660,772	251,842	6,408,930	320		6,409,250
Wyoming	29,790,181	162,043	29,628,138	1,588		29,629,726
	338,982,200	21,263,024	317,719,176	17,576	252,220	317,484,532

* 320 acres in Idaho and 1,000 acres in Utah previously designated under secs. 1-5, now under sec. 6.

Summary of stock-raising homestead designations, in acres

[Areas classified as nonirrigable, nontimbered, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres is reasonably required for the support of a family (act of Dec. 29, 1916, 39 Stat. 862)]

State	Designations prior to July 1, 1930	Cancellations prior to July 1, 1930	Designations outstanding prior to July 1, 1930	Designations during fiscal year	Cancellations during fiscal year	Designations outstanding June 30, 1931
Arizona	14,217,259	1,022,890	13,194,369	56,250	15,040	13,235,579
Arkansas	1,120		1,120			1,120
California	8,127,965	3,400	8,124,565	58,274	8,040	8,174,799
Colorado	9,202,446	20,400	9,182,046	187,151	680	9,368,517
Florida	480					
Idaho	5,636,527	1,894	5,634,633	100,625	120	5,735,138
Kansas	115,779		115,779	520		116,299
Michigan	3,491		3,491			3,491
Mississippi	160		160			160
Montana	15,794,733	17,241	15,777,492	155,018	33,960	15,898,550
Nebraska	209,199		209,199	3,560		212,759
Nevada	636,088	3,120	632,968	20,754		653,722
New Mexico	31,635,775	756	31,635,019	257,616	27,360	31,865,275
North Dakota	399,459		399,459	4,948		404,407
Oklahoma	86,434		86,434	2,696		89,130
Oregon	6,416,476	3,128	6,413,348	80,254	40	6,493,562
South Dakota	6,536,333	550	6,535,783	11,797		6,547,580
Utah	2,073,242	7,875	2,065,367	94,135	400	2,159,102
Washington	7,702,735	1,174	7,01,561	10,933	120	712,374
Wyoming	20,840,850	7,653	20,833,197	274,037	80	21,107,154
	122,636,551	1,090,561	121,545,990	1,318,568	85,840	122,778,718

By blanket order of withdrawal creating Public Water Reserve No. 107, which received Executive approval April 17, 1926, every smallest legal subdivision of the public-land surveys which is vacant unappropriated public land and contains a spring or water hole and

all land within a quarter of a mile of every spring or water hole located on unsurveyed public land were reserved for public use and in aid of pending legislation. This order obviated the necessity for future withdrawals of specific tracts containing springs or water holes valuable for stock watering, but it requires a determination with respect to all entries of public land whether or not any of the subdivisions involved are in fact affected by it. On the basis of such determination, orders of interpretation are issued from time to time, listing by legal subdivisions of the public-land survey any tracts found to contain a water supply affected by the order. New withdrawals of this type are made to reserve lands along streams and are also made from time to time for special public purposes. The extent of outstanding reserves of this type and of current action affecting them is shown in the following table:

Public water reserves, in acres

[Includes areas withdrawn under the act of June 25, 1910 (41 Stat. 1063), as amended by the act of August 24, 1912 (37 Stat. 497), and reserved for public use of springs or water holes in accordance with the provisions of sec. 10 of the act of December 29, 1916 (39 Stat. 862), or for watershed protection, drainage reservoirs, or other similar miscellaneous public purposes involving water conservation.]

State	Reserved prior to July 1, 1930	Eliminated prior to July 1, 1930	Reserves outstanding prior to July 1, 1930	Reserved during fiscal year	Eliminated during fiscal year	Reserves outstanding June 30, 1931
Arizona.....	23,347	2,607	20,740	330	135	20,935
California.....	207,009	7,658	199,351	920	240	200,031
Colorado.....	10,145	500	9,645	160	440	9,365
Idaho.....	15,827	410	15,417	1,680	-----	17,097
Montana.....	11,089	1,392	9,697	440	160	9,977
Nevada.....	17,591	3,250	14,341	1,560	365	15,536
New Mexico.....	12,401	2,205	10,196	640	880	9,956
Oregon.....	28,189	1,288	26,901	1,680	280	28,301
South Dakota.....	240	-----	240	-----	-----	240
Utah.....	45,826	7,596	38,230	1,820	-----	40,050
Washington.....	920	-----	920	-----	-----	920
Wyoming.....	98,285	14,140	84,145	1,880	80	85,945
	470,869	41,046	429,823	11,110	2,580	438,353

In the field broad areal studies were continued in the Colorado Basin region in southwestern Wyoming, and a land-classification map of southwestern Colorado was published. Intensive grazing studies were begun in Mono Lake and Owens Valleys, Calif., preparatory to the administration of lands withdrawn under the act of March 4, 1931.

During the fiscal year the area designated under the Nevada ground water reclamation act was increased 8,800 acres, to a total of 1,699,975 acres. Outstanding withdrawals under the act of October 2, 1888 (25 Stat. 527), on the basis of a selection by the Director of the Geological Survey, aggregating 61,397 acres, remained unchanged. Other results of the division's work are tabulated in the summaries of enlarged and stock-raising homestead designations and the general summary of cases.

MINERAL-LEASING DIVISION

WORK OF THE DIVISION

The work of the mineral-leasing division is supervisory (both inspectional and regulatory) with respect to operations on the public domain for the discovery and development of petroleum, natural gas,

oil shale, coal, phosphate, sodium, potassium, and sulphur; on certain land grants for gold, silver, and mercury; on naval petroleum reserves for petroleum and natural gas; and on Indian lands for coal, oil and gas, zinc, lead, iron, silver-lead, uranium, vanadium, and radium ores, vermiculite, asbestos, asphalt, volcanic ash, and stone. This work is done with a minimum of administrative supervision from Washington through district offices at or near the primary centers of mining or drilling activity, under the direction of responsible engineers who have full authority to represent the Secretary within their jurisdiction and to order compliance with the law and regulations under which operations are conducted.

BENEFITS DERIVED FROM MINERAL LEASING

Since October 20, 1914, the date of approval of the law providing for the leasing of coal lands in Alaska, \$69,299,916.91 has accrued from royalties, rentals, and bonuses by reason of mineral production on public land. During the past fiscal year \$3,607,396.19 accrued from 6,573 leases, licenses, and prospecting permits, involving more than 10,000,000 acres of land in 19 States and Alaska.

Under the mineral-leasing act of 1920 the public-land States receive, without expense, 37.5 per cent of all money derived from leases and permits within their respective borders and participate in the benefits resulting from the expenditure of an additional 52.5 per cent of the income by the Bureau of Reclamation. Incidental benefits include taxes on production and on property used in the development of leases, which in some States amount to more than one-fifth of the total income from taxes. Only 10 per cent of the income from mineral-leasing operations is retained in the United States Treasury.

Alaska, by special legislation, receives all net profits from the operation of Government mines and all royalties and rentals from mineral leases. The money thus derived is applied to the reimbursement of the Federal Government for the construction of railroads in that Territory.

ACTIVITIES ON PUBLIC LAND

Supervisory activity on public land is governed by the principles of true conservation—that is, wise use—of the mineral resources involved and is directed to enforcement of provisions included by Congress in the various leasing laws to assure the development of publicly owned mineral deposits with reasonable diligence, skill, and care, without undue waste and without monopoly; with payment of royalties on the amount or value of product; with sale of product at reasonable prices; and with protection of the interests of the United States and due safeguard to the public interest.

An outstanding example of conservation during the fiscal year was the consummation of cooperative or unit plans of development for the Kettleman Hills North Dome oil and gas field, California, and the Little Buffalo Basin gas field, Wyoming. This was accomplished pursuant to an act of Congress approved July 3, 1930, which expired January 31, 1931. A further act approved March 4, 1931, amending the general leasing law of February 25, 1920, reaffirmed the policy of conservation and reauthorized cooperative or unit plans for the purpose of conserving the natural resources in any single oil

or gas pool or field. Under this later act unit plans for several other oil and gas fields are being perfected.

Waste of natural gas in two fields in southern California was decreased more than 50 per cent during the last five months of the fiscal year as a result of the Secretary's order of January 20, 1931 (No. 482), imposing a penalty on all gas wasted or blown into the air. A curtailment in the production of oil and gas and in the drilling of unnecessary wells was effected pursuant to another provision of the same departmental order, which stipulated, in lieu of actual drilling and production from Federal properties, the payment of an amount estimated to reimburse the United States for current loss of royalty by reason of oil or gas drainage through neighboring wells.

Special effort was made during the year to establish the double-entry system of mining in all wagon coal mines under supervision. In one district 16 miles of coal outcrop was surveyed and mapped, and plans for the development of 29 mines were prepared and given to the respective lessees and permittees. Similar work was conducted in other States where there are coal mines on public land.

Contrary to normal expectation, the general decrease in development and production activities during the year resulted in a substantial increase in supervisory duties necessary to prevent loss of or damage to minerals and mineral-bearing formations by reason of suspension or curtailed operations and of economy measures adopted by the operators. In general the demands for engineering advice and assistance are continually increasing as the number of permittees, lessees, and licensees increases, as the supervisory duties under the leasing laws are more clearly defined and enlarged, and as the competence and impartiality of the supervisors become more widely known.

Engineers were called on during the year to assist in fighting and sealing off six fires in abandoned coal mines. Eight coal-outcrop fires in four States were also extinguished, and work is continuously in progress to reduce both the number and effect of such fires.

During the year 29 improperly abandoned oil and gas test wells on public land were properly plugged and abandoned, at a cost to the Government of \$40,000, making a total of 52 such wells abandoned at an aggregate cost of \$80,000 since 1928. Reimbursement to the Government under surety bonds is expected to amount to approximately 20 per cent of these expenditures. Action under departmental instructions of April 23, 1928, resulted in the plugging, without expense to the Government, of 18 such wells during the year, making an aggregate of 81 wells so abandoned since 1928, with an estimated saving of \$30,000 to the Government.

The conservation and protection of human life and health has always been an important factor in the mineral-leasing program. Since the beginning of supervisory work in 1920 there have been no fatal accidents in coal mines on leased Government lands in the States of California, Montana, Nevada, Oregon, South Dakota, and Washington. The prevention of mining accidents and the conservation of natural resources have been materially aided by the continued introduction of improved mining methods, including during the year the extension of the use of rock dust in seven additional mines and the use of electric cap lamps in four additional mines.

The Joseph A. Holmes Safety Association presented a certificate of honor to the Tri-State Zinc and Lead Ore Producers Association, of Picher, Okla, for its effective work in increasing health and safety in the mines of that region, most of which are on restricted Indian lands under supervision by this division. The association cited, in cooperation with the Metropolitan Life Insurance Co. and the United States Bureau of Mines, organized and operated the first health clinic for miners in the United States.

During the fiscal year 426 leases, licenses, and prospecting permits were issued, involving 433,277.54 acres.

Leases, licenses, and permits issued, fiscal year 1931

	Number	Acres		Number	Acres
Leases:			Permits:		
Oil and gas.....	103	63, 102. 26	Oil and gas.....	91	142, 196. 47
Coal.....	34	3, 876. 47	Coal.....	93	76, 868. 04
Potash.....	1	1, 320. 00	Potash.....	58	125, 678. 87
Phosphate.....	1	1, 280. 00	Sodium.....	11	17, 110. 23
Sodium.....	1	405. 20			
	140	69, 983. 93		253	361, 853. 61
Licenses.....	33	1, 440. 00	Grand total.....	426	433, 287. 54

During the same period 20 coal leases, 20 coal permits, 1 coal license, 1 potash lease, 9 potash permits, 4 sodium permits, 7 oil and gas leases, and 1,558 oil and gas permits were canceled, and 55 coal permits, 11 coal licenses, 29 potash permits, and 6 sodium permits expired by limitation—a total of 1,721 for 1931 as compared with 9,195 for 1930.

The following table shows the total number of leases, licenses, and permits involving public land in effect at the end of the year :

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey, June 30, 1931

State	Coal						Oil and gas			
	Leases		Permits		Licenses		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Alaska.....	7	7, 867. 28	25	35, 325. 07	3	30. 00			993	2, 481, 624
Alabama.....	1	1, 840. 00								
Arizona.....									109	228, 406. 47
Arkansas.....			1	2, 079. 88					15	23, 776. 20
California.....			5	7, 375. 29			214	61, 503. 68	444	387, 153. 04
Colorado.....	81	12, 609. 20	42	22, 952. 03	3	120. 00	21	16, 495. 13	414	588, 598. 30
Idaho.....			10	9, 894. 19					75	146, 432. 60
Kansas.....									1	155. 32
Louisiana.....							13	1, 076. 07	2	323. 80
Montana.....	61	6, 203. 38	27	9, 698. 50	29	1, 158. 60	75	15, 424. 26	493	571, 655. 03
Nevada.....			5	9, 484. 04					87	209, 292. 90
New Mexico.....	23	14, 743. 38	44	66, 290. 65			44	38, 010. 34	935	2, 011, 174. 52
North Dakota.....	60	6, 615. 08	1	40. 00	13	599. 93			13	20, 011. 25
Oklahoma.....									6	2, 469. 28
Red River.....							17	730. 20	5	106. 50
Oregon.....	2	1, 895. 24	8	5, 039. 54					14	30, 799. 35
South Dakota.....	3	159. 04							20	25, 812. 09
Utah.....	41	27, 298. 77	55	71, 717. 43	2	160. 00	11	6, 543. 26	510	931, 766. 55
Washington.....			18	15, 300. 86						
Wyoming.....	35	14, 096. 45	36	29, 325. 55	5	200. 00	377	115, 402. 25	879	1, 806, 850. 80
	314	93, 327. 82	277	284, 523. 03	55	2, 268. 53	772	255, 185. 19	5, 015	9, 465, 908. 00

* Includes 15 leases on Naval Petroleum Reserves Nos. 1 and 2 under the act of Feb. 25, 1920, and 10 on Naval Petroleum Reserves Nos. 1 and 2 under the act of Oct. 2, 1917; total area, 10,608.97 acres.

° Oil and gas permits in Louisiana include the right to lease sulphur deposits discovered while prospecting for oil and gas.

Mineral leases, licenses, and permits on the public domain and naval petroleum reserves under supervision of the Geological Survey, June 30, 1931—Contd.

State	Sodium				Potash			
	Leases		Permits		Leases		Permits	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Arizona.....	1	405.20	3	5,163.84			1	634.77
California.....			20	34,386.77	4	7,783.80	5	10,871.91
Colorado.....			2	2,160.00				
Nebraska.....							3	510.00
Nevada.....	1	1,440.00	3	6,400.00			2	5,121.49
New Mexico.....			4	4,931.97	3	7,674.39	55	121,317.15
North Dakota.....			3	524.83				
Oregon.....	1						4	5,848.94
Utah.....							17	27,720.00
Washington.....			1	40.00				
Wyoming.....			2	1,045.78			1	1,760.00
	2	1,845.20	38	54,653.19	7	15,458.19	88	173,784.26

Also Idaho, 2 phosphate leases, 1,700 acres; Montana, 1 phosphate lease, 1,280 acres; Nevada, 1 phosphate lease, 160 acres; Oregon, 1 oil shale lease, 2,680 acres. Total leases, 1,100; licenses, 55; permits, 5,418; grand total, 6,573.

Although the total number of leases, licenses, and permits under supervision decreased 16.5 per cent during the past fiscal year, the number of leases increased 10.9 per cent and of licenses 61.8 per cent. The only decrease was in the number of oil and gas permits, amounting to 22.8 per cent, and was a consequence of the President's policy of oil and gas conservation, announced March 12, 1929.

PRODUCTION ON PUBLIC LANDS

Coal.—During the fiscal year 1931 3,053,189.08 tons of coal was produced from public land in 14 States, from which \$370,350.52 accrued in rents, royalties, and bonuses. This was an increase in production of 0.43 per cent over the preceding year, and the number of operating coal mines increased 17 per cent, to a total of 79 railroad shipping mines and 303 wagon mines. In Wyoming the Union Pacific Coal Co. recently completed a 790-foot shaft and the Rock Springs Fuel Co. a 350-foot shaft, and the Blue Blaze Coal Co. started sinking a new air shaft. In addition to these, many new developments are under way in Wyoming and elsewhere. The Union Pacific, the Northern Pacific, and the Denver & Rio Grande Western Railroads are all operating, through subsidiaries, coal mines on leased public lands, and the Great Northern Railway has applied for a coal lease in Montana. The installation of mechanical stokers in heating plants has greatly increased the use of slack coal, which heretofore has been a drug on the market. Eight core-drill test holes for coal were completed during the year, to an aggregate depth of 3,600 feet, and eight churn-drill holes to an aggregate depth of 910 feet, in four States.

Potash.—There were 7 potash leases involving 15,458.19 acres and 88 potash permits involving 173,784.26 acres in effect in eight States at the end of the fiscal year. From one leasehold in New Mexico 4,726.94 tons of potash (K₂O) was produced. The first commercial shipment of potash from leased public land contained 26.80 per cent K₂O and was made March 7, 1931.

The importance to the American farmer of this new domestic source of potash can not be overemphasized. It is the culmination of a nation-wide search for potash begun as a result of the abrogation of American contracts in 1910 and the shortage felt when German potash supplies were cut off during the World War. In 1913 the United States imported 270,720 short tons of potash (K₂O), valued at \$18,073,865, and in 1930 domestic production amounted to 61,270 short tons, or only about 15 per cent of the current American demand. Under the stimulus of war prices domestic production of potash reached a peak of 54,803 short tons (K₂O) in 1918, but production costs were so high that the American industry could not meet foreign competition.

Despite the known existence of potash brine in the Permian salt beds of Texas since 1912, the collapse of the war-time potash industry made private capital hesitant to attempt exploitation. The results of the first governmental core tests for potash, authorized March 4, 1911, only added to the general impression that potash could not be produced from the American sources then known at a cost low enough to compete with foreign supplies.

In August, 1925, the Snowden-McSweeney interests drilled a test hole for oil on public land in Eddy County, N. Mex., and the potassium mineral sylvite was recognized in the cuttings. The first application for a potash prospecting permit in this area was made August 6, 1925, and the first lease was issued November 21, 1929. Since the identification of sylvite in the Snowden-McSweeney well in 1925 more than 100 test holes have been drilled in the Permian salt basin, 50 of them diamond-drill holes with an aggregate depth in excess of 76,000 feet. Twenty-one of these core tests were drilled at Federal expense under a program approved June 25, 1926, and in all of them potash-bearing salts were discovered.

In some parts of the area under lease as many as 40 potash-bearing zones have been recognized, among them 10 sylvite zones and many beds of polyhalite. The advantage of sylvite over polyhalite as a potash ore is evident from the relative potassium content of the two minerals. Pure sylvite is 100 per cent KCl, equivalent to 63.2 per cent of K_2O , whereas polyhalite contains the equivalent of only 15.6 per cent K_2O . Only a very small amount of sylvite ore richer than 30 per cent K_2O is mined in Europe.

In December, 1929, after prospecting for five years, the United States Potash Co. started an exploratory shaft 3 miles from the Snowden-McSweeney well. The shaft was completed to a depth of 1,062 feet one year later. When a commercial bed containing sylvite was cut in the shaft at a depth of 980 feet, an analysis of it showed a K_2O equivalent of 29.86 per cent, which checked within 2 per cent the amount of potash expected from the core drill records. Drifts were begun, and shipments were started soon after this bed was reached.

It is estimated that nearly a million dollars had been spent by various interests in southeastern New Mexico up to the end of the fiscal year, in prospecting and drilling for potash, sinking the shaft referred to, and purchasing the equipment necessary for preliminary mine development.

Three churn-drill test holes for potash were sunk during the year to an aggregate depth of 300 feet in New Mexico, and three similar holes having an aggregate depth of 2,067 feet were drilled in Salt Valley, Utah. In the Utah locality a well drilled for oil to a depth of 3,500 feet entered the salt-bearing zone at 885 feet and passed out of it at a depth of 3,350 feet. Core was taken for 680 feet of this distance, and more than 200 analyses for potash were made. The location for the first Government test for potash in Utah, in Salt Valley, was approved in June, 1931, and drilling was expected to begin in August.

Sodium.—There are two sodium leases, involving 1,845.20 acres, and 38 sodium permits, involving 54,653.19 acres, in effect in 8 States. From one leasehold in Nevada 40 tons of salt cake was sold and approximately 700 tons was harvested and stored. From the leasehold in Arizona no sodium was produced during the year. Prospecting by drilling was begun under one prospecting permit in California, and prospecting by shaft and open-cut methods was begun by permittees in Colorado. Sodium minerals were also produced under potash leases in California to the extent of 7,508 tons of borax and 22,718 tons of soda ash.

Phosphate.—Four phosphate leases were in effect at the end of the fiscal year, two in Idaho and one each in Nevada and Montana. The production of phosphate from the Idaho leases amounted to 68,974.33 tons, and from the Nevada lease to 80.72 tons. No phosphate was produced in Montana, but two core test holes were drilled to a depth of 675 feet.

Oil shale.—Under one outstanding oil-shale lease involving public land in Oregon no development work was undertaken during the year.

Oil and gas.—Production of oil and gas from public lands during the fiscal year compared with production during 1930 as follows: Crude oil decreased 3,598,398 barrels, or 13.12 per cent; natural gas increased 2,838,068,000 cubic feet, or 7.25 per cent; natural gasoline increased 10,029,297 gallons, or 9.88 per cent. The effect of overproduction and low prices on public-land activities in the major oil-producing States is shown by a decrease in the number of wells completed to production and an increase in the number of wells shut in. Completions decreased from 209 during the calendar year 1929 to 146 during

1930, or 30 per cent, and from 73 during the first 6 months of 1930 to 30 during the corresponding period in 1931, or approximately 59 per cent; wells shut in increased from 599 on July 1, 1930, to 699 on July 1, 1931, or approximately 17 per cent.

Detailed statistics are shown in the following tables, in which the figures for 1930 are included in the 5-year total for 1926-1930 and also shown separately for comparison with 1931.

Coal produced from leases, licenses, and permits on public lands, in tons, by fiscal years

State	1912-1925	1926-1930	1930	1931	1912-1931
Alaska	455,497.43	527,740.36	121,825.20	112,961.79	1,096,499.58
Alabama		322,926.00	136,661.00	121,002.00	443,928.00
California		104.00	62.00	250.00	354.00
Colorado	2,028,940.29	2,166,953.40	434,871.08	396,389.11	4,592,282.80
Idaho		1,833.30	1,366.65	986.52	2,819.82
Montana	252,973.58	1,304,053.74	247,854.94	114,929.27	1,671,956.59
Nevada		91.15		29.00	120.15
New Mexico	74,427.26	357,129.62	74,857.99	50,713.21	482,270.09
North Dakota	453,695.38	1,693,443.14	447,627.36	363,476.32	2,510,614.84
Oregon	688.97	8,798.66	3,231.70	755.50	10,243.13
South Dakota	1,842.63	2,772.82	402.58	489.29	5,104.74
Utah	487,303.62	2,117,190.17	649,383.27	830,187.56	3,434,681.35
Washington	164,280.43	88,508.03	6,899.43	25,461.74	278,250.20
Wyoming	4,465,885.23	5,137,978.53	914,932.11	1,035,557.77	10,639,421.53
	8,385,534.82	13,729,522.92	3,039,975.31	3,053,189.08	25,168,248.82

Sodium salts produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1930	1930	1931	1921-1931
California	3,145.30	73,362.37	28,736.47	30,226.00	106,733.67
Nevada	248.25	2,546.08	585.59		2,794.33
New Mexico				30.52	30.52
	3,393.55	75,908.45	29,322.06	30,256.52	109,558.52

Phosphate and potash produced from public lands, in tons, by fiscal years

State	1921-1925	1926-1930	1930	1931	1921-1931
Idaho (phosphate)	6,132.44	91,505.02	22,100.65	68,974.33	166,611.79
Nevada		45.45		80.72	126.17
New Mexico (potash)				4,726.94	4,726.94
	6,132.44	91,550.47	22,100.65	73,781.99	171,464.90

Operating mines, fiscal year 1931

	Phosphate	Potash	Sodium	Coal		Total
				Shipping	Wagon	
Alaska				4	1	5
Alabama				1		1
Arizona			1			1
California			1		1	2
Colorado				16	63	79
Idaho	2				2	4
Montana				3	96	89
Nevada	1		1		1	3
New Mexico		1		8	11	20
North Dakota				7	64	71
Oregon				1	3	4
South Dakota					3	3
Utah				24	26	50
Washington				1		1
Wyoming				14	32	46
	3	1	3	79	303	389

Petroleum, natural gas, and natural-gas gasoline produced from public lands

1931, by States

	Petroleum (barrels)	Natural gas (cubic feet)	Gasoline (gallons)
California.....	9, 164, 952. 16	16, 994, 596, 000	66, 828, 634. 00
Colorado.....	665, 327. 80	1, 709, 179, 000	17, 916. 00
Louisiana.....	8, 918. 91	690, 591, 000	53, 346. 80
Montana.....	436, 011. 79	894, 407, 000	-----
New Mexico.....	1, 799, 815. 30	5, 791, 622, 000	672, 848. 00
Oklahoma.....	418, 063. 05	-----	899, 560. 59
Utah.....	5, 476. 69	172, 963, 000	-----
Wyoming.....	11, 322, 545. 63	15, 708, 826, 000	43, 027, 293. 00
	23, 821, 111. 33	41, 962, 184, 000	111, 499, 598. 39

Total

1921-1925.....	118, 333, 954. 01	60, 298, 796, 000	63, 997, 718. 97
1926-1930.....	128, 609, 878. 94	117, 075, 826, 640	264, 503, 664. 58
1930.....	27, 419, 509. 35	39, 124, 116, 000	101, 470, 301. 33
1931.....	23, 821, 111. 33	41, 962, 184, 000	111, 499, 598. 39
1921-1931.....	270, 764, 944. 28	219, 336, 806, 640	440, 000, 981. 94

New wells and wells shut in in major oil-producing public-land States

	Wells completed to production on public lands				Wells completed to production on all lands			
	1928	1929	1930	Jan. 1- July 1, 1931	1928	1929	1930	Jan. 1- July 1, 1931
Wyoming.....	91	91	61	12	138	134	115	28
Utah.....	6	0	4	1	10	9	13	2
Idaho.....	0	0	0	0	0	0	0	0
Colorado.....	5	4	6	2	55	35	14	10
Montana.....	21	24	19	4	283	292	125	36
New Mexico.....	11	27	24	8	19	42	169	23
California.....	50	63	32	3	688	874	752	235
	184	209	146	30	1, 193	1, 386	1, 188	318

	Wells shut in on public lands		Wells shut in on all lands		Oil and gas permits under supervision		
	July 1, 1930	July 1, 1931	July 1, 1930	July 1, 1931	Mar. 1, 1929	July 1, 1930	July 1, 1931
Wyoming.....	204	259	465	549	4, 049	1, 471	879
Utah.....	9	13	24	30	3, 014	579	510
Idaho.....	0	0	2	2	363	122	75
Colorado.....	2	6	9	15	2, 696	507	414
Montana.....	40	43	189	191	1, 672	570	493
New Mexico.....	33	39	70	124	4, 184	326	935
California.....	311	339	5, 431	7, 180	1, 453	519	444
	599	699	6, 190	8, 091	17, 431	5, 094	3, 750

NOTE.—Naval reserves and Indian lands not included.

ROYALTY, RENT, AND BONUSES

The following tables summarize accrued income from all mineral leases, licenses, and prospecting permits under the various leasing acts applicable to the public lands:

Royalties, rentals, and bonuses accrued from all mineral operations on public lands, by fiscal years

State	1912-1925	1926-1930	1930	1931	1912-1931
Alabama	\$86,380.00	\$32,292.60	\$13,666.10	\$12,100.20	\$130,772.80
Alaska	27,836.57	42,317.06	8,034.14	8,612.01	78,765.64
Arizona				101.50	101.50
California	4,676,746.55	5,294,564.92	1,034,629.91	942,994.86	10,914,306.33
Colorado	216,853.81	548,473.71	98,639.99	86,695.59	852,023.11
Idaho	1,111.38	10,872.37	2,712.97	6,480.84	18,464.59
Louisiana	1,508.59	35,799.11	3,583.40	5,048.47	42,356.17
Montana	891,278.79	847,528.76	100,988.67	72,000.01	1,810,807.56
Nevada	301.07	8,062.79	1,520.00	2,247.25	10,611.11
New Mexico	13,883.64	240,997.69	129,514.38	110,056.83	364,938.16
North Dakota	29,144.79	111,092.55	28,490.14	23,283.57	163,520.91
Oklahoma		596,553.53	105,776.14	70,335.27	666,888.80
Oregon	952.15	10,280.38	6,124.48	3,206.48	14,439.01
South Dakota	399.60	521.52	130.00	562.00	1,483.12
Utah	131,898.78	334,719.29	46,040.86	118,549.06	585,167.13
Washington	22,215.91	10,037.69	1,724.86	6,374.43	38,628.03
Wyoming	31,206,133.17	20,262,481.95	2,906,186.96	2,138,747.82	53,607,362.94
	37,306,644.80	28,381,595.92	4,487,763.00	3,607,396.19	69,300,131.91

Royalties, rentals, and bonuses accrued from mining operations on public lands, by States for 1931 and by fiscal years in summary

	Coal	Sodium	Phosphate	Potash	Bonuses	Total
1931						
Alabama	\$12,100.20					\$12,100.20
Alaska	8,612.01					8,612.01
Arizona		\$101.50		\$15,922.59		101.50
California	62.50					15,985.09
Colorado	52,540.21				\$1,000.00	53,540.21
Idaho	246.63		\$6,234.21			6,480.84
Montana	16,432.98		320.00			16,752.98
Nevada	7.25	2,160.00	80.00	3,838.00		2,247.25
New Mexico	9,040.72					12,878.72
North Dakota	23,249.57				34.00	23,283.57
Oregon	3,206.48					3,206.48
South Dakota	110.00				452.00	562.00
Utah	117,022.54				587.00	117,609.54
Wyoming	121,345.00				1.00	121,346.00
	370,350.52	2,261.50	6,634.21	19,760.59	2,074.00	401,080.82
SUMMARY						
1912-1925	776,069.09	301.07	1,111.38	24,458.65	148,384.00	950,324.19
1926-1930	1,609,049.71	7,200.00	10,534.05	51,776.51	4,495.00	1,683,055.27
1930	317,015.68	1,440.00	2,451.31	18,135.40	113.00	339,155.39
1931	370,350.52	2,261.50	6,634.21	19,760.59	2,074.00	401,080.82
1912-1931	2,755,469.32	9,762.57	18,279.64	95,995.75	154,953.00	3,034,460.28

Royalties and bonuses accrued from oil and gas operations on public lands

1931, by States

	Petroleum	Natural gas	Gasoline	Bonuses	Total
California	\$764,365.48	\$69,295.17	\$93,349.12		\$927,009.77
Colorado	28,610.61	4,529.36	15.41		33,155.38
Louisiana	974.16	3,371.08	106.98	\$596.25	5,048.47
Montana	46,078.84	3,348.19		5,820.00	55,247.03
New Mexico	74,717.87	21,992.47	467.77		97,178.11
Oklahoma	68,288.71		2,046.56		70,335.27
Utah	370.05	569.47			939.52
Wyoming	1,584,621.98	73,981.31	94,106.64	264,691.89	2,017,401.82
	2,568,027.70	177,087.05	190,092.48	271,108.14	3,206,315.37

Royalties and bonuses accrued from oil and gas operations on public lands—Con.

Total

	Petroleum	Natural gas	Gasoline	Bonuses	Total
1921-1925.....	\$32,938,494.47	\$398,543.30	\$251,197.70	\$2,768,085.14	\$36,356,320.61
1926-1930.....	24,460,387.20	591,767.49	714,943.75	935,722.21	26,702,820.65
1930.....	3,809,947.58	172,878.79	164,181.04	1,600.20	4,148,607.61
1931.....	2,568,027.70	177,087.05	190,092.48	271,108.14	3,206,315.37
1921-1931.....	59,966,909.37	1,167,397.84	1,156,233.93	3,974,915.49	66,265,456.63

ACTIVITIES ON NAVAL PETROLEUM RESERVES

Production from Naval Petroleum Reserve No. 3, in Wyoming, was definitely suspended December 31, 1927, and the total royalty accrued from 1923 to the date of suspension amounted to \$848,947.91. Supervision on this reserve is confined at present to periodic observation of gas pressure, inspection of repairs to the wells from time to time, and consultation with the Navy Department.

Royalties accrued from 23 oil and gas leases embracing 10,608.97 acres of land in Naval Petroleum Reserves Nos. 1 and 2 in California during the fiscal year were as follows: Petroleum, \$1,105,540.06; natural gas, \$43,307.17; gasoline, 106,809.27. The total receipts from these reserves for the fiscal years 1921 to 1931 amount to \$25,166,801.14.

Petroleum, natural gas, and gasoline produced from naval reserves

	Fiscal year	Petroleum (barrels)	Natural gas (M cubic feet)	Gasoline (gallons)
California.....	1921-1925	37,882,945.09	35,544,349.81	34,508,751.07
	1926-1930	49,389,149.93	48,852,746.46	119,177,197.23
	1930	6,978,922.16	6,817,458.00	25,567,986.00
	1931	5,590,418.46	5,123,456.00	22,748,665.00
	1921-1931	92,862,513.48	89,520,552.27	176,434,613.30
Wyoming.....	1923-1925	2,523,213.05	950,520.00	7,829.00
	1926-1928	1,027,014.58	4,212,349.00	2,476,067.00
	1923-1928	3,550,227.63	5,162,869.00	2,483,896.00
Total.....	1921-1925	40,406,158.14	36,494,869.81	34,516,580.07
	1926-1930	50,416,164.51	53,065,095.46	121,653,264.23
	1930	6,978,922.16	6,817,458.00	25,567,986.00
	1931	5,590,418.46	5,123,456.00	22,748,665.00
	1921-1931	96,412,741.11	94,683,421.27	178,918,509.30

ACTIVITIES ON INDIAN LANDS

Cooperation with the Indian Service during the fiscal year 1931 included technical supervision of mining and drilling operations on tribal, segregated, and restricted allotted lands and on Indian lands set aside by Executive order. This work entails the enforcement of lease terms and operating regulations, the making of technical investigations of threatened impairment of mineral deposits, determinations of the adequacy of bonus offers and of threatened damage to surface improvements, appraisals of unleased property, investigations of domestic water supply contaminated by waste, and

the preparation of engineering and geologic reports on leased and unleased lands subject to mineral development. Field offices for the performance of these duties are maintained at Miami, McAlester, Muskogee, Oklahoma City, Red River, Shawnee, and Tulsa, Okla.; Billings and Shelby, Mont.; Farmington, N. Mex.; Thermopolis, Wyo.; Denver, Colo; and Salt Lake City, Utah. Service was performed by other officers of the mineral-leasing division as required.

Oil and gas.—Supervision of oil and gas operations on behalf of the Indian Service during the fiscal year 1931 included 9,253 leaseholds on which there were 5,301 producing wells and 18 wells in process of drilling. This work was conducted at 38 different agencies in 7 States and included all Indian lands in those States except the Osage Reservation in Oklahoma. Production from Indian lands in Oklahoma resulted in royalties approximately as follows: Oil, \$2,477,000; gas, \$48,000; natural-gas gasoline, \$153,000. The total income from oil and gas is reported at \$4,173,046.89. A total of 580 field investigations and 287 reports on lease conditions resulted in increased revenue to the Indians of the western agencies in Oklahoma. Cooperation with lessees resulted in increased production and accruing royalties by the deepening and plugging back of several wells on Indian lands in Oklahoma. In western Oklahoma 658 appraisals of bonus value were made prior to lease sales.

Oil and gas leases on Indian lands in Oklahoma exclusive of the Osage Reservation

Agency	Leases			Wells		Total royalty and rentals
	Nonproducing	Producing	Total	Producing	Being drilled	
Five Civilized Tribes:						
Cherokee.....	} 5,367	251	} 6,487	5,028	10	
Choctaw.....		61				
Creek.....		532				
Chickasaw.....		20				
Seminole.....		156				
	5,367	1,120	6,487	5,028	10	\$3,364,728.95
Kiowa Indian Agency:						
Kiowa.....	232		232			
Comanche.....	285	14	299	23		
Apache.....	37	6	43	18		
Wichita.....	316		316			
Caddo.....	254		254			
	1,124	20	1,144	41		296,446.27
Pawnee Indian Agency:						
Ponca.....	102	13	115	43		
Otoe.....	167	2	169	2		
Tonkawa.....	21		21			
Pawnee.....	139	20	159	65		
Kaw.....	14	4	18	33		
	443	39	482	143		130,428.92
Shawnee Indian Agency:						
Iowa.....	25		25			
Kickapoo.....	81		81			
Pottawatomie.....	63	10	73	31		
Sac and Fox.....	122	9	131	26		
Shawnee.....	200		200			
	491	19	510	57		162,460.49
Cheyenne and Arapahoe Indian Agency:						
	383		383			101,715.04
Grand total.....	7,808	1,198	9,006	5,269	10	4,055,779.67

Outside of Oklahoma supervision was exercised over 247 oil and gas leases on Indian lands in Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming. There was no production from Arizona, Montana, and Utah during the year. A report was made on the advisability of piping natural gas to the Shiprock Agency, Northern Navajo Reservation, N. Mex.

Oil and gas leases on Indian lands outside Oklahoma

State and tribe	Leases			Wells	
	Non-producing	Producing	Total	Producing	Being drilled
Arizona:					
Navajo Executive order	14		14		
Colorado:					
Ute tribal		1	1	3	
Ute allotted					
Ceded Ute tribal	3	1	4		2
Montana:					
Blackfeet tribal	1		1		
Blackfeet allotted	39		39		1
Blackfeet Executive order					
Crow tribal	6	1	7		
Crow allotted	95	2	97		
Crow Executive order					
New Mexico:					
Navajo tribal		4	4	2	1
Navajo allotted	19		19		2
Navajo Executive order	9		9		1
Ute tribal	3	1	4	3	1
Utah:					
Navajo Executive order	6		6		
Wyoming:					
Shoshone tribal	30	1	31	4	
Shoshone allotted	3	8	11	20	
	2287	19	247	32	8

Coal.—Supervision of coal-mining operations on behalf of the Indian Service in 1931 included 160 leases, 27 coal-prospecting permits, 1 coal license, and 24 agency coal mines. In Oklahoma supervision was maintained over 34 shipping mines and 17 wagon mines on 51 coal leases on segregated Choctaw-Chickasaw Indian Nation land and 57 leases on restricted allotted lands of individual Cherokee, Choctaw, and Creek Indians. From these lands was produced 389,232.69 tons of coal having a royalty value of \$34,645.86. Cooperation was maintained with the Oklahoma Geological Survey on the geologic examination of the coal resources of segregated Choctaw and Chickasaw lands, particularly in the McAlester, Wilburton, and Poteau districts. This work was begun in 1927, and the results obtained indicate that many tracts in which only one coal bed was known to exist at the time of the appraisal of 1917 in reality contain two and in places three beds.

In Colorado supervision included 42 coal leases, 1 coal license, 26 coal permits, and 9 awarded coal-lease applications on ceded Ute lands, from which \$16,952.71 in rentals and royalties accrued to the Indians. Periodic inspections and reports were made on the agency coal mines, 9 of which are in Arizona, 2 each in Colorado and Montana, 10 in New Mexico, and 1 in Utah.

Lead and zinc.—Supervision on behalf of the Indian Service of lead and zinc mining operations on restricted lands of Quapaw Indians in Ottawa County, Okla., included 39 leases, involving 5,524.43 acres, from which was produced 98,870 tons of concentrates with a sale value of \$2,694,145.86; the accrued royalty amounted to \$262,438.47. Lead and zinc were first mined on the Quapaw Reservation in 1902; in 1907 mines were opened near Commerce, and in 1914 the Picher field was discovered. Production has increased until it now amounts to 16.76 per cent of the lead and 28.13 per cent of the zinc output from the Tri-State district. This production equals 9.64 per cent of the zinc and 0.72 per cent of the lead mined in the United States last year. A subsurface map of the northwest corner of the Quapaw Reservation and an accompanying

paper on ore-finding guides used in the Tri-State district were prepared for publication. Six nonproductive leases for lead and zinc were under supervision in Nevada, two in Montana, and one on restricted allotted Cherokee land in Oklahoma.

Miscellaneous minerals.—Inspectional and advisory service was rendered in connection with existing or proposed operations involving 2 gold, 1 iron, 5 vanadium, and 2 copper ore leases, 3 asbestos leases, and 1 miscellaneous mineral lease in Arizona; 2 sodium prospecting permits in Colorado; 1 vermiculite lease in Montana; 2 marl leases in Nevada; and 1 volcanic-ash lease in Oklahoma.

COOPERATIVE WORK

Cooperative work was continued with the Bureau of Mines in oil and gas technologic investigations; with the Bureau of Reclamation in conjunction with its lease on the power plant and coal mine at Williston, N. Dak.; with the National Research Council on the conservation of scientific data obtained as the result of drilling and the improvement of drilling methods and equipment; with the Oklahoma State Geological Survey in the study and preparation for publication of geologic data relative to the coal resources of the segregated lands of the Choctaw and Chickasaw Nations, Oklahoma; and with the American Institute of Mining and Metallurgical Engineers on methods of coal-land valuation.

The chief mining supervisor, as a representative of the Interior Department, attended the World Power Conference in Berlin, Germany, in the summer of 1930 and later investigated methods of open-pit mining of coal in parts of Europe, zinc and lead mining in Poland, and potash mining in France, Poland, and Germany.

COST OF SUPERVISION

Preliminary estimates indicate that the cost of supervisory work on public and Indian lands during the fiscal year 1931 averaged less than 4.36 per cent of the aggregate income from the leases, licenses, and permits in effect on these lands. This is an increase of 1.3 per cent over the supervisory cost of the preceding year; the increase is chargeable principally to the decline in value of the minerals produced.

WORK ON PUBLICATIONS

TEXTS

BERNARD H. LANE, *Editor*

During the year 24,701 pages of manuscript were edited and prepared for printing by the section of texts, and 3,758 galley proofs and 14,420 page proofs were read and corrected. Indexes were prepared for 52 publications, covering 8,089 pages. Copy and proof or stencils for 1,418 pages of multigraph and mimeograph matter were read. At the end of the year five persons were employed in this section. The publications issued during the year are listed on pages 4, 5.

The editor has continued to serve as a member of the departmental subcommittee to assist in the revision of the Style Manual of the Government Printing Office.

ILLUSTRATIONS

C. A. WECKERLY, Chief Illustrator

The number of drawings and photographs prepared by the section of illustrations was 3,839, including 111 maps, 1,309 sections and diagrams, 3 plates of sections, 79 charts and plans, 815 photographs, 1,517 paleontologic drawings, and 5 wash drawings; 154 miscellaneous jobs were also done by the section. The illustrations transmitted to accompany 31 reports numbered 1,033, to be reproduced by chromolithography, photolithography, halftone, and zinc etching. The number of proofs received and examined was 887. At the end of the year material for illustrating 17 reports was in hand. The section consists of nine employees.

GEOLOGIC EDITING AND DRAFTING OF MAPS AND ILLUSTRATIONS

GEORGE W. STOSE, Editor of Geologic Maps

The geologic maps and sections of the Gaffney-Kings Mountain (S. C., N. C.) folio were approved for printing. The geologic maps of the Coatesville-West Chester (Pa.) folio reached the stage of color proof, and the sections were transferred to stone ready for color proof. The geologic maps and sections of the Somerset-Windber (Pa.) folio were transferred to stone ready for color proof. The geologic maps of the Montevallo-Columbiana (Ala.) folio were made ready for transfer to stone, and the sections were sent for engraving. No progress was made on the Hollidaysburg-Huntingdon (Pa.) folio. The Boston folio was withdrawn and submitted for publication as a bulletin.

Topographic and mineral industry maps of Arkansas were published for the Arkansas Geological Survey. A block diagram of the Tonopah mining district, Nevada, was published for the Nevada Bureau of Mines in cooperation with the United States Geological Survey. Stone proof of the geologic map of Pennsylvania on a scale of 1:500,000, prepared for the Pennsylvania Geological Survey, was read. The preliminary draft of the geologic map of California on a scale of 1:500,000, for the California Division of Mines, was nearly completed. The compilation of the geologic map of Texas on a scale of 1:500,000 was well advanced. Preliminary geologic maps of Oregon and Colorado and of parts of Georgia, North Carolina, South Carolina, Alabama, Virginia, and Montana on a scale of 1:500,000 were compiled by this section and other members of the Geological Survey for use on the geologic map of the United States. Two parts of the geologic map of the United States on a scale of 1:2,500,000 were completed and sent for engraving, and progress was made on most of the rest of the map.

Illustrations for 24 reports were examined and edited for the section of illustrations, and other geologic and drafting assistance was rendered to that section. In addition, 24 illustrations for 15 reports were drawn for geologists. The oil and gas maps of the United States, California, Wyoming, and Illinois were compiled and drawn

for photolithography, and the drawing of the oil map of Texas was revised. Two new draftsmen were assigned to the section, which now consists of six employees.

INSPECTION AND EDITING OF TOPOGRAPHIC MAPS

W. M. BEAMAN, Chief

During the year 101 new topographic maps were edited and transmitted for engraving, 231 published topographic maps, 6 State maps, and 7 State index circulars were edited for reprint, and 287 maps were edited as illustrations for Geological Survey reports—a total of 632 maps edited. First, second, combined, and woodland proofs of engravings for new topographic maps and reprints numbering 425 and proofs of maps reproduced by photolithography in one to three colors numbering 230 were read. At the end of the year 210 new topographic maps were in progress of engraving and printing and 181 new topographic maps were in preparation for submission for reproduction. The topographic maps published during the year are listed on pages 5-7.

DISTRIBUTION

R. C. SHELSE, Chief

A total of 317 publications, comprising 47 new books and pamphlets, 78 new or revised topographic and other maps, and 192 reprinted topographic and other maps, were received by the division of distribution 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 109,574 books and pamphlets and 712,570 topographic and other maps, a grand total of 822,144.

The division distributed 116,298 books and pamphlets, 4,282 geologic folios, and 776,851 maps, a grand total of 897,431, of which 4,009 folios and 651,907 maps were sold. The sum received and deposited in the Treasury as the result of sales of publications was \$42,788.68, including \$41,756.71 for topographic and geologic maps and \$1,031.97 for geologic folios. In addition to this \$1,648.70 was repaid by other establishments of the Federal Government at whose request maps or folios were furnished. The total receipts, therefore, were \$44,437.38.

The division received and answered 49,973 letters.

ENGRAVING AND PRINTING

S. J. KUBEL, Chief Engraver

TOPOGRAPHIC MAPS AND GEOLOGIC FOLIOS

During the fiscal year 74 new topographic maps were engraved and printed, including two revised maps. Four new maps were photolithographed and printed, making a total of 78 new maps printed and delivered. One fractional sheet for La Crosse County, Wis., and the United States 2-sheet map were engraved but not printed. Corrections were engraved on the plates of 229 maps. Re-

print editions of 184 engraved topographic maps and 8 photolithographed State and other maps were printed and delivered. In addition, 68 new topographic maps had been engraved and were in press June 30, and the engraving of 38 other new topographic maps was nearly completed. Of new and reprinted maps, 270 different editions, amounting to 712,570 copies, were delivered.

OTHER GOVERNMENT MAP PRINTING

A large amount of work was done for the Government Printing Office, the office of the Secretary of the Interior, the Bureau of Reclamation, Office of Education, General Land Office, National Park Service, Indian Service, Alaska Railroad, Forest Service, Plant Quarantine and Control Administration, Bureau of Public Roads, Weather Bureau, Bureau of Agricultural Economics, Bureau of Plant Industry, Bureau of Biological Survey, Bureau of Entomology, Bureau of Mines, Bureau of Lighthouses, Bureau of Foreign and Domestic Commerce, Aeronautics Branch, Federal Radio Commission, Bureau of Standards, Federal Farm Loan Bureau, United States Marine Corps, Hydrographic Office, Department of State, War Department, Post Office Department, Department of Agriculture, Department of Commerce, Department of Labor, Department of Justice, Interstate Commerce Commission, National Capital Park and Planning Commission, Commission of Fine Arts, Federal Power Commission, New Mexico-Texas Boundary Commission, Alaska Road Commission, International Boundary Commission, George Washington Bicentennial Commission, Office of the Chief Signal Officer, Office of the Chief of Engineers, Engineer Map Reproduction Plant, Coast Artillery School, Engineer School, General Staff School, Panama Canal, Federal Farm Board, Federal Board for Vocational Education, United States Veterans Bureau, International and Overseas Exposition, Regional Planning Federation of the Philadelphia Tri-State District, Public Buildings and Public Parks, Sanitary District of Decatur, Ill., and the States of Nevada, Arkansas, Missouri, Kentucky, Louisiana, and Wisconsin. This work, done for the other branches of the Government and State governments, included many reprints, and the charges for it amounted to about \$146,500, for which the appropriation for engraving and printing geologic and topographic maps was reimbursed.

Transfer impressions numbering 365 were made during the year, including 168 furnished to contracting lithographic printers on requisition of the Government Printing Office, 18 furnished to other branches of the Government, 21 furnished to State surveys, and 158 furnished to private firms. The amount turned over to miscellaneous receipts was \$520.43.

Of contract and miscellaneous work of all kinds, 2,794,964 copies were printed. Including topographic maps a grand total of 3,507,534 copies were printed and delivered.

PHOTOGRAPHIC LABORATORY

The output of the photographic laboratory consisted of 15,088 negatives (4,863 wet (of which 3,658 were for photolithographs), 65 paper, 2,196 dry, 7,278 field negatives, and 686 lantern slides), 35,820 prints (4,443 maps and diagrams and 31,377 photographs for illustrations), 3,236 zinc plates, 294 zinc etchings, 33 celluloid prints, 217 lantern slides colored, 29 transparencies colored, 3 prints colored, and 2,916 prints mounted.

ADMINISTRATION

JULIAN D. SEARS, *Administrative Geologist*

JOHN J. MADIGAN, *Chief Clerk*

The administrative geologist assists the director in all phases of general administration, performs special tasks assigned to him by the director from time to time, serves as acting director in the director's absence, and has special supervision over the section of illustrations.

The chief clerk, in addition to performing the duties usually pertaining to that office, serves as budget officer and exercises administrative supervision over the division of engraving and printing, the division of distribution, the section of correspondence and records, the section of accounts, the library, and the division of field equipment.

CORRESPONDENCE AND RECORDS

C. A. KING, *Chief*

The work of the section of correspondence and records was of the same general character as during the fiscal year 1930.

Mails, files, and records.—During the year 97,834 pieces of mail, of which 2,125 were registered, were opened and referred. In addition, 149,068 letters were received direct by the other units, making a total of 246,902, an increase of 7 per cent compared with 1930. Of the letters opened in this section 18,863 contained \$43,104.30 remitted for Geological Survey publications. The number of ordinary letters mailed through the section was 57,878; of registered letters and packages, 1,212. In addition, 152,170 pieces of mail were sent out direct from other units. The total number of outgoing pieces of mail for the Geological Survey was 211,260.

Freight and express.—During the year 3,255 pieces of freight and express were handled, 1,689 outgoing and 1,566 incoming.

Personnel.—The roll of Secretary's appointees numbered 1,127 at the end of the fiscal year, 62 more than at the end of 1930. The total number of changes in personnel was 1,110, including 139 appointments, 77 separations, and 894 miscellaneous changes.

During the calendar year 1930, 20,324 days of annual leave and 3,667 days of sick leave were granted, being 71 per cent of the amount of annual leave that could have been taken and 12 per cent of the sick leave that it would have been possible to grant. In addition, 8,383 days of leave without pay and furloughs were also granted.

*ACCOUNTS**C. K. FRANCIS, Chief*

During the year 20,312 field accounts, 1,793 transportation bills, and 216 telegraph bills were audited and transmitted for payment. In the audit of these accounts 1,039 suspensions and disallowances were made. The section received 262 printing and binding requisitions, 879 stationery requisitions, 3,095 miscellaneous supply requisitions, 2,714 letters of employment, and 375 contracts.

Condensed statements covering expenditures from Federal funds during the year are given on the following pages. The amounts expended by States for cooperative work are set forth in the reports of the field branches.

	Funds available			Expenditures			Balance	
	Amount of appropriation	Repayments on account of work performed		Total	Disbursements	Outstanding liabilities		Total
		Made	To be made					
APPROPRIATIONS								
Salaries.....	\$141,320.00	\$245.00		\$141,565.00	\$140,721.96		\$140,721.96	\$843.04
Topographic surveys.....	744,000.00	281,733.44	\$59,625.30	1,085,358.74	940,780.59	\$11,813.97	952,594.56	132,764.18
Shenandoah and Great Smoky Mountains National Parks.....	75,000.00	3.57		75,003.57	63,346.79	8,888.61	72,235.40	2,768.17
Geologic surveys.....	400,000.00	39,891.23	11,573.31	451,464.54	426,323.31	19,255.11	445,578.42	5,886.12
Fundamental research in geologic science.....	100,000.00	241.78		100,241.78	98,593.67	735.40	99,329.07	912.71
Volcanologic surveys.....	21,000.00		7.50	21,007.50	18,867.42	2,101.94	20,969.36	38.14
Alaskan mineral resources.....	75,000.00	316.90		75,316.90	60,802.43	14,446.31	75,248.74	68.16
Gaging streams.....	510,000.00	206,445.33	76,179.51	792,624.84	752,368.55	14,238.29	766,606.84	26,018.00
Classification of lands.....	180,480.00	823.35		181,303.35	178,405.11	2,215.68	180,620.79	682.56
Printing and binding.....	150,000.00	36.44		150,036.44	31,284.72	118,751.72	150,036.44	
Preparation of illustrations.....	20,800.00	651.76		21,451.76	21,418.77	8.96	21,427.73	24.03
Geologic and topographic maps.....	125,060.00	124,377.27	21,400.12	270,837.39	259,526.35	10,033.87	269,560.22	1,277.17
Mineral leasing.....	251,820.00	501.92	1,187.13	253,509.05	244,140.03	9,369.02	253,509.05	
U. S. Geological Survey, 1931 (Alaskan mineral resources).....	300.00			300.00			300.00	
U. S. Geological Survey, 1930-31 (Mammoth Cave National Park).....	25,000.00	5.75		25,005.75	22,765.59	2,240.16	25,005.75	
U. S. Geological Survey, 1930-31 (plugging wells).....	43,190.75		344.17	43,534.92	16,071.89	27,445.00	43,516.89	18.03
Great Smoky Mountains National Park in North Carolina and Tennessee, 1929-30 (available for 1931).....	7,020.10			7,020.10	7,020.10		7,020.10	
	^d 2,869,990.85	^e 655,273.74	170,317.04	3,695,581.63	3,282,737.28	241,544.04	3,524,281.32	171,300.31
TRANSFERS								
Acquisition of lands for protection of watersheds of navigable streams (Agriculture Department, act May 14, 1930), 1931.....	276.04			276.04	276.04		276.04	
Alaska Railroad fund (act May 14, 1930).....	30,000.00		98.70	30,098.70	13,617.16	14,804.58	28,421.74	1,676.96
Ammunition storage facilities, Navy (Navy Department, act May 14, 1930).....	1,000.00			1,000.00	501.94	434.68	936.62	63.38
Aviation, Navy (Navy Department, act May 14, 1930), 1931.....	13,900.00			13,900.00	11,716.30	1,588.42	13,304.72	595.28
Cheyenne Bottoms Migratory Bird Refuge (Agriculture Department, act May 14, 1930), 1931.....	600.00			600.00	261.05	328.42	589.47	10.53
Federal Power Commission (act May 14, 1930), 1931.....	6,075.00			6,075.00	5,150.61	318.33	5,468.94	606.06
Flood control, Mississippi River and tributaries (War Department, act May 14, 1930).....	275,122.00	2,149.92	17.06	277,288.98	201,481.94	20,532.09	222,014.03	55,274.95
Fredericksburg and Spotsylvania County Battle Fields Memorial, Virginia (War Department, act May 14, 1930), 1931-32.....	5,000.00			5,000.00	3,779.01	65.56	3,844.57	1,155.43

Investigating potash deposits, Bureau of Mines (Commerce Department, act Apr. 18, 1930), 1931.....	12,500.00			12,500.00	11,788.64	633.91	12,422.55	77.45
Irrigation, Indian reservations (reimbursable), 1930-31 (act May 14, 1930).....	600.00			600.00	187.56	117.56	305.12	294.88
Maintenance and improvement of existing river and harbor works (War Department, act May 14, 1930).....	220,111.00	806.47	16.81	220,934.28	186,806.77	13,356.76	200,163.53	20,770.75
Military surveys and maps (War Department, act May 14, 1930), 1930-Dec. 31, 1931.....	6,000.00			6,000.00	5,449.48	110.72	5,560.20	439.80
National Park Service (act May 14, 1930), 1930-31.....	500.00	254.19		754.19	754.19		754.19	
National Park Service (act May 14, 1930), 1931-32.....	5,000.00			5,000.00	4,479.37	272.20	4,751.57	248.43
National Park Service, donations (act May 14, 1930).....	2,000.00	.75		2,000.75	1,999.98		1,999.98	.77
Operation and conservation of naval petroleum reserves (Navy Department, act May 14, 1930), 1931.....	45,000.00			45,000.00	44,796.36	43.10	44,839.46	160.54
Supervising mining operations on leased Indian lands (act May 14, 1930), 1931.....	85,000.00	446.40	38.89	85,485.29	84,148.16	1,337.13	85,485.29	
Support of United States prisoners (Justice Department, act May 14, 1930), 1931.....	2,500.00			2,500.00	1,341.34		1,341.34	1,158.66
United States Northeastern Penitentiary (Justice Department, act May 21, 1920).....	2,174.34			2,174.34	2,174.34		2,174.34	
United States Southwestern Reformatory (Justice Department, act May 21, 1920).....	2,500.00			2,500.00	1,096.02	456.19	1,552.21	947.79
United States Yorktown Sesquicentennial Commission (act May 14, 1930), 1931.....	4,500.00	60.01		4,560.01	4,560.01		4,560.01	
Water boundary, United States and Mexico (State Department, act Apr. 18, 1930), 1931.....	18,440.00	26.08		18,466.08	17,131.86	1,256.42	18,388.28	77.80
Waterways treaty, United States and Great Britain (State Department, act Apr. 18, 1930), 1931.....	67,640.00	441.66	1.31	68,082.97	65,804.78	953.48	66,758.26	1,324.71
Grand total.....	3,676,429.23	659,459.22	170,489.81	4,506,378.26	3,952,040.19	298,153.59	4,250,193.78	259,184.48

* In addition to these appropriations, there was an allotment of \$13,013.75 for miscellaneous supplies from the appropriation for contingent expenses of the Interior Department.

^b Of this amount, \$68,513.18 has been expended for the purposes shown below, as provided for in the second deficiency act, 1931:

Gaging streams.....	\$42,405.49
Mineral leasing.....	18,174.04
Supervising mining operations on leased Indian lands.....	4,013.67
Mammoth Cave National Park.....	3,919.98
	<u>68,513.18</u>

* Balance represents estimated cost of printing cooperative reports, the charge for which will be made against the appropriation for printing and binding in a subsequent year.

^d Includes the following amounts appropriated for salary increases by the Second Deficiency Act, 1931:

Salaries.....	\$1,320
Alaskan mineral resources.....	300
Classification of lands.....	480
Geologic and topographic maps.....	1,060
Mineral leasing.....	1,820
	<u>4,980</u>

* Included in this amount is \$54,332.14 covering work performed by Geological Survey units for other Geological Survey units, necessarily reported in combining totals but otherwise a duplication.

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1931

Object of expenditure	Geological Survey salaries	Topographic surveys and national parks	Geologic surveys	Volcanologic surveys	Alaskan mineral resources	Gaging streams	Classification of lands	Geologic and topographic maps of the United States	Preparation of illustrations	Mineral leasing	Fundamental research	Printing and binding	Total
Personal services.....	\$140,721.96	\$891,159.14	\$356,368.68	\$17,784.50	\$63,170.50	\$823,642.30	\$151,292.77	\$212,054.04	\$20,666.92	\$314,010.22	\$87,897.78		\$3,078,768.81
Stationery and office supplies.....		4,055.54	1,657.96	238.49	317.88	5,629.16	195.06	23,849.02	103.94	2,260.07	25.01		38,332.13
Scientific and educational supplies.....		309.14	1,483.38	23.90	29.40	560.88	63.97			429.42	3.23		2,903.32
Sundry supplies.....		2,344.62	995.23	161.66	578.18	3,043.46	165.62	6,440.61	57.29	750.16	38.07		14,574.90
Subsistence and care of animals and storage and care of vehicles.....		2,376.41	433.69		443.30		281.35						3,534.75
Telegraph service.....		662.24	259.19		62.61	730.90	47.89	6.88	.99	868.85	5.00		2,644.55
Telephone service.....		217.27	151.95	26.05	6.80	2,050.55	7.54			2,650.13	5.20		5,115.49
Other communication service.....		13.50	3.60	.45		37.07				76.51			131.13
Travel expenses.....		123,254.63	38,143.74	1,413.97	24,544.12	84,621.52	13,535.65	104.20		22,213.77	6,315.19		314,446.79
Attendance at meetings.....		65.14	2,178.91		65.00	1,247.89				330.72			3,887.66
Hire, maintenance, operation, repair of horse-drawn and motor-propelled passenger-carrying vehicles.....		2,620.94	5,316.34	250.69		33,314.45	4,893.77			21,475.63	713.21		68,585.03
Transportation of things.....		58,249.96	8,658.75	391.02	3,981.91	27,002.61	3,456.70	38.02	2.51	2,388.16	1,155.85		105,325.49
Printing and binding.....												\$150,036.44	150,036.44
Lithographing, engraving, and engrossing.....		15,618.75	1,007.56			798.16	1,668.65	161.70	282.81	102.22			19,639.85
Stenographic work, typewriting, and duplicating work, etc. (job work).....		22.55	2.50			59.60	1.00			40.00			125.65
Photographing and making photographs and prints.....		49,654.20	4,889.89	186.41	330.26	3,689.44	905.42		245.50	518.50	1,867.97		62,287.59
Heat, light, power, water, and electricity.....			71.55	72.37	50.16	318.85				4,031.82			4,544.75
Rents.....		467.33				5,496.84				8,218.44			14,182.61
Repairs and alterations.....		276.03	553.60	234.49	225.29	4,393.04	2.06	2,283.30	2.50	45,274.94	5.10		53,250.35
Special and miscellaneous current expenses.....		555.89	373.95		547.55	510.00	25.65			292.64	10.00		2,315.68
Purchase of passenger-carrying vehicles.....		2,247.65	3,505.82			8,416.98	3,054.00			11,925.18	514.38		29,664.01
Furniture, furnishings, and fixtures.....		1,976.04	1,452.07	55.70	3,474.63	7,571.59	239.10	50.00		3,778.89			18,598.02

Educational and scientific equipment.....	19,798.16	24,437.92	4.20	1,486.27	51,389.19	1,080.91	3,189.70	10.24	2,864.78			104,261.37	
Livestock.....				1,798.00								1,798.00	
Other equipment.....	26,048.77	3,233.98	69.23	1,923.70	17,195.60	1,167.22	21,076.46		3,307.42	11.85		74,034.23	
Structures.....	786.75				54,223.20				289.49			55,299.44	
Miscellaneous transfers and adjustments.....	10,880.14	3,686.22	56.23	934.92	3,342.74	442.50	306.29	55.03	1,440.44	761.23		21,905.74	
	140,721.96	1,213,660.79	458,866.48	20,969.36	103,970.48	1,139,286.02	182,826.83	269,560.22	21,427.73	449,538.40	99,329.07	150,036.44	4,250,193.78

LIBRARY

GUY E. MITCHELL, *Librarian*

During the year more than 500 Government publications, paper bound or in dilapidated covers, have been replaced on the shelves by good bound copies in the original binding.

Binding allotments, fiscal years 1928-1931, and number of books bound

Fiscal year	Allotment for year	Cost	Number of books bound	Fiscal year	Allotment for year	Cost	Number of books bound
1928.....	\$5,000	\$4,205	1,300	1930.....	\$4,500	\$4,454	1,305
1929.....	2,500	3,506	1,100	1931.....	3,500	3,079	1,163

During the last year the library has had a substantially increased allotment for the purchase of new books and periodicals. This increase has been of material assistance in making needed book purchases.

Allotments and expenditures for new books and periodicals, 1928-1931

Fiscal year	Allotment	Expenditures	Fiscal year	Allotment	Expenditures
1928.....	\$2,000	\$1,198	1930.....	\$2,000	\$1,998
1929.....	2,000	1,997	1931.....	2,500	2,463

Not all of these expenditures are for the library itself. About 25 per cent of the money is used for periodicals for field offices and "working tools" for the office and field—dictionaries, atlases, etc.

During the year the cumulated bibliography of North American geology for 1919-1928 (Bulletin 823) was printed and delivered. The bibliography for 1929 and 1930 (Bulletin 834) was completed and sent to the printer, and work was in progress on the bibliography for 1931 and 1932.

The Geological Survey library cooperated with other important libraries of the country in checking two serial lists, whose purpose is to show the libraries throughout the United States and Canada where the publications listed may be found. One of these was the "List of serial publications of foreign governments," Sections V and VI, including the countries of Austria, Germany, Czechoslovakia, Hungary, Poland, the Balkan states, France and French possessions, Great Britain, and Ireland and British possessions in Europe. For this list 428 titles were examined, of which 319 were compared with the records and holdings reported; and 15 new titles not on the list were added, making a total of 334 titles reported. The other was the "Union list of serials, supplement, 1926-1930," which was checked throughout the alphabet. This supplement is designed to bring the large list of 1925 down to the end of 1930 and include all general serials exclusive of Government publications. For this work 751 titles were examined for holdings, changes of holdings, or discontinuance, and 228 were compared with the records and reported.

The accessions during the year comprised 13,180 books, pamphlets, and periodicals and 900 maps. The readers and users of books and maps in the library numbered 8,132, of whom 2,874 were not members of the Geological Survey. The loans for use outside the library included 5,817 books and 222 maps. In the work of cataloging 7,714 cards were added to the catalog, 1,203 catalog cards were revised, 433 titles were sent to the Library of Congress for printing, and 125 galley proofs were read. The books collated and sent to the bindery numbered 1,163, and 676 newly bound books were recorded and labeled. Translations of 76 communications were made for other divisions of the Geological Survey.

FIELD EQUIPMENT

R. L. ATKINSON, *Chief*

The instrument shop designed and constructed a temperature apparatus, precise tool-steel measuring wheels, steel weirs, a gage for meter parts, a testing apparatus for meters, an apparatus for measuring the power, pupil, and effective aperture of telescopes, an airplane-camera mount, ground rods for electric apparatus, high-pressure bombs, and depth bombs; made an apparatus for measuring water flow and 2,607 miscellaneous pieces of equipment; repaired and rebuilt 2,936 instruments of different kinds; and did work for the Corps of Engineers, Bureau of Agricultural Economics, Weather Bureau, National Park Service, Bureau of Mines, Bureau of Reclamation, Indian Service, and Forest Service.

The cabinet shop constructed a paper jogger for offset press, a large sectional frame for exhibits, sensitizing tubs and cradles for the photographic laboratory, 45 special cases for apparatus of different kinds, 2 shadowgraphs, 60 stadia rods, 23 precise rods, 36 plane-table boards, 8 compass beams, 2 tables, and 2 special benches, besides the routine cabinet work.

The electrical shop designed and installed lighting and ventilation on line-up machine, wired 2 shadowgraphs, redesigned electric drive on plate-whirling machine, changed signal system on multi-color press, installed control panels on temperature apparatus, and made monthly inspection and repairs of 78 electric motors, electric heaters, and temperature apparatus.

The clerical force filled 2,653 requisitions for instruments, issued 26,511 pieces of equipment, mailed 3,975 packages, shipped 1,698 pieces of express and freight weighing 112,646 pounds, and received 1,566 pieces of express and freight weighing 116,249 pounds.

Overtime amounting to 1,614 hours was reported by 17 employees.

W. C. MENDENHALL,
Acting Director.

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