DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

THIRTY-SECOND ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1911

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

THIRTY-SECOND ANNUAL REPORT

OF THE

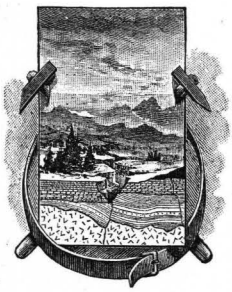
DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1911



WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

CONTENTS.

ILLUSTRATIONS.

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

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1910–11 comprised items amounting to $1,477,440. The plan of operations was approved by the Secretary of the Interior and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES.

WORK ON THE PUBLIC LANDS.

The scientific investigations of the Survey have been continued along lines similar to those followed in other years and the usual amount of contributions have been made to the knowledge of geology and related subjects. Among the special features of the year's activities the work in the public-land States should be given first place. The field examination of the public lands has become an increasingly important feature in the Survey's work, yet the standard attained is so dependent on past and present scientific investigations that the credit is necessarily given to the same field organization for both the scientific and the applied results.

In the last 12 months the amount of work done, both in field investigations contributing to the classification of the public lands and in the preparation of the results of land classification, has exceeded that done by the Survey during any preceding year. The field investigations and examinations have been more extensive and more detailed and reports covering a wider range of subjects have been prepared and submitted to the Secretary's office and to the General Land Office and the Office of Indian Affairs.

An illustration of the extent to which this contribution to public-land administration depends on the accumulated results of the field work of the Survey is afforded by the land-classification reports that are based in large part on the work of the water-resources branch.

These include reports to the Secretary of the Interior made in connection with the designation of nonirrigable lands under the enlarged-homestead act and with recommendations for the withdrawal from entry of lands valuable for water-power or reservoir sites under the withdrawal act, as well as similar reports furnished the Commissioner of the General Land Office on right-of-way applications and on applications for segregations of irrigable lands under the Carey Act. The preparation of these reports requires wide and intimate knowledge of the conditions existing in the public domain, as well as engineering judgment of a high order. Definite results concerning much of this work could not have been attained had not records of the surface and underground water resources of the public domain been available—records which represent the accumulated results of work done by the Geological Survey under appropriations covering many years.

The extent to which the work performed in other years by the geologic, topographic, and water-resources branches of the Survey has been utilized to the advantage of the public can be inferred from this year's records of the land-classification board, which in public-land matters acts as the clearing house of the Survey's field service.

PUBLIC-LAND LEGISLATION.

NATURE OF THE GEOLOGICAL SURVEY'S WORK.

The increasing share which the Geological Survey has been asked to take in the public-land administration by the Interior Department has brought many of the problems connected with the public-land laws more directly to the attention of those charged with the work of this bureau. For over 30 years, however, these problems have interested the Federal geologists, who have had exceptional opportunities for first-hand observation in nearly all the important mining districts of the country, and for almost as long a period the engineers of the Survey have been in touch with the irrigation and power developments in the public-land States. This intimate experience with both field conditions and administrative problems justifies an expression of opinion concerning the land laws, which, it is believed, will be appropriate to this administrative report. To a large extent the principles here presented and the specific provisions advocated have been expressed in memoranda submitted by the Geological Survey to the Secretary of the Interior during the last four years.

PROPOSED AMENDMENT OF PUBLIC-LAND LAWS.

PURPOSES AND MEANS OF AMENDMENT.

The objects to be sought by amendment of the public-land laws are, first, purposeful and economical development of resources for

which there is present demand, with retention of such control as may insure against unnecessary waste or excessive charges to the consumer, and, second, the reservation of title in the people of all resources the utilization of which is conjectural or the need of which is not immediate. The means that are essential to the attainment of these objects are, first, the classification of the public lands, second, the separation of surface and mineral rights, and third, the disposition of the lands on terms that will secure the highest use, enforce development, and protect the public interest. Legislation based on these principles will not only secure the positive benefits of immediate utilization, but will also avoid the evils of speculative holdings of lands by fictitious use or by admitted nonuse for the future enjoyment of the unearned increment or of the profits of monopolization. With actual development made a condition of possession, and with land classification and separation of estates made preliminaries of disposition, the present-day utilization by individuals or corporations and the reservation to the people for future use become at once possible without conflict of interests.

The classification of the public land is essential to the administration of not only such laws as express the principle of separation, but also of those whose purpose is to promote the highest use of the land. Land classification is first of all the determination of the best use to which each particular portion of the public domain can be put, and by the organic act of March 3, 1879, this duty was specifically imposed upon the Director of the Geological Survey. The progress now being made in this work is set forth in another part of this report. (See pp. 60–74.)

Separation of surface and mineral rights might be effected without classification of land by the automatic reservation of all mineral deposits to the United States in every patent issued as a result of nonmineral entry, selection, or purchase. Legislation of this type would possess the merit of simplicity and effectiveness, but the well-known objection to limited patents would with considerable reason be made the basis for the contention that the Government should assume the burden of classifying its land before disposition.

The classification of the public domain is itself an outgrowth of the principle of relative worth, which early found expression in the land laws of this country, in that they provided for the reservation of mineral lands from disposition for other purposes. The present coal-land law also expresses this principle of relative worth by giving deposits of gold, silver, and copper priority over coal, and coal, in turn, preference over agricultural values. Such distinctions necessitate land classification based on adequate field examination, and with the classification data at hand the principle of relative worth can be further developed. Wherever the different values of

the land conflict the highest use should prevail, and under legislation that does not oppose the principles of economic law the highest use will prevail.

Under the withdrawal act of June 25, 1910 (Stat. L., vol. 36, p. 847), classification is made possible in advance of disposition, and disposition can be postponed to await immediate legislation. Fully to accomplish this purpose, for which it was enacted, the withdrawal act itself needs amendment in several particulars. No withdrawal is effective against location or appropriation for minerals other than coal, oil, gas, and phosphate, the apparent intent of the law being to promote the exploration and discovery of metalliferous minerals. However, this exception to the application of the withdrawal law is far too broad, in that it would include such minerals as potash or nitrates, the disposition of which is a matter of no less vital concern to the agricultural interests of the nation than is the proper utilization of the phosphate deposits. So, too, it is true that attempts are being made to claim sand and gravel as minerals excepted by the law and under such contention to secure control of power sites, even in the face of an executive withdrawal. Connected with this defect in the law is the lack of recognition therein of the principle of relative worth. There is a too evident opportunity for a gypsum entryman, notwithstanding the fact that the gypsum, by reason of poor quality or lack of transportation facilities, may be worthless commercially, to set up a claim for title to a tract of great prospective value for oil—a tract which is protected from oil entry by an oil withdrawal. Similarly, under the mineral law it is possible to seek title to the walls of a narrow canyon, withdrawn as a power site, in spite of the great discrepancy between the utterly negligible value of the building stone it contains and the strategic importance of the dam site.

SEPARATION OF SURFACE AND MINERAL RIGHTS.

The first step, both in principle and practice, in any amendment of the land laws, appears to be that of making possible by legislation the separation of surface and mineral rights whenever the two estates have values which can be separately utilized. A notable advance in public-land legislation was the passage of the acts of March 3, 1909 (Stat. L., vol. 35, p. 844), and June 22, 1910 (Stat. L., vol. 36, p. 583), which provide that patents issued thereunder grant title to the surface of the land only and thus permit its agricultural development, while at the same time the United States retains title to the underlying coal deposits. The results have been of undoubted value in permitting homestead and desert-land entries, Carey Act selections, and reclamation-act withdrawals on lands which are withdrawn or classified as coal lands or are known to be valuable for coal.

A similar separation of surface and mineral rights should be extended to all other nonmineral entries, selections, or locations, to include oil, gas, and phosphate lands as well as coal lands, the mineral rights to be reserved to the United States until they can be disposed of most beneficially to the people. For all these lands the need of legislation for the separation indicated is not academic but actual, since under each class there are already requests for surface patents.

Similar legislation applying the principle of separation is demanded in order to reserve to the Government the exclusive right to grant easements for the future development of water resources, for either power or irrigation, and at the same time to make provision for grants of surface patents for the agricultural use of the land, or of mineral patents where mining may not interfere with water-power development. During the last year the principle involved in this proposed legislation was recognized by the enactment of an item in the Indian appropriation act which provides for the issuance of limited patents on the shores of Flathead Lake, in Montana, where increased storage for power and irrigation may be at some future time found to be advantageous. A further recognition of this principle was given in the water-power bill introduced by Representative Parsons at the third session of the Sixty-first Congress (H. R. 33000), wherein provision is made for a double use of land leased for water-power utilization and for the reservation in perpetuity to the United States of all rights to future occupancy and use for water-power development on all lands designated by the President. The need of statutory authority for limited patents is most evident in regions where, because of the possibility of future power development, lands are now withdrawn which possess present value for agricultural use. Provision should be made whereby future power development will be absolutely insured whenever the value of the lands for such use would exceed their actual agricultural value.

The chief advantage of land withdrawal and classification lies in its essential relation to the principle of proper disposition of the public domain, the real purpose of public-land administration being to insure such reservation or disposal of the people's land as will result in its highest use. The question of amendment of the present laws relating to the disposition of coal, oil, gas, and phosphate deposits on the public domain is recognized as fairly before the public by the specific mention of these minerals in the withdrawal act.

LAW APPLICABLE TO COAL LANDS.

The coal-land law is unquestionably the most satisfactory of the present mineral-land laws in that it admits of the placing of an adequate valuation upon the deposits, and in the administration of this law the purpose is not only to base the appraisal price upon

the quantity and quality of the coal present and to give consideration to every known physical and commercial factor affecting the value of the deposits, but also to make the selling price approach as nearly as possible the present purchase price of a royalty under a leasehold. Thereby it is intended to permit purchase for immediate development and at the same time to prevent, or at least discourage, purchase for long-time investment or for monopolization. So many factors, however, require consideration that an ideal adjustment of the values is well-nigh unattainable for many, if not for most, coal lands, and on this account a strong argument may be made for support of the lease over the sale system. Under leasehold it would be comparatively easy so to adjust the relationship between ground rental and royalty as to prevent the acquisition of coal deposits until such time as their development should be profitable. On the other hand, it is possible, under the present law, and it is the policy in its administration, to readjust the prices from time to time, either by reduction to encourage development in special cases or, more commonly, by raising the price on account of increased value due to new discoveries or to changed commercial conditions. The greatest advantage of the lease system to the operator directly, and to the public indirectly, is relief from the large capital outlay now required in the acquisition of the large acreage absolutely necessary for a modern mine. This argument advanced against the present policy of valuing the public coal lands at even conservative prices thus becomes an argument for a leasehold law. Thus contrasting the lease with sale outright to the coal operator, the reduction in capital necessary for original investment and the elimination of many of the risks in such investment must result in reducing the cost of operation to the mine owner and thus make possible a correspondingly lower price of coal to the consumer. Hardly less important, moreover is the better control possible under a lease system, although against the advantage of such control must be weighed the cost of Federal management and the possibilities of inefficient administration or even maladministration.

The present coal-land law, however, has one serious defect, which should be remedied if a leasing law is not enacted. The restriction of area that may legally be acquired to a maximum of 160 acres for an individual and 640 acres for an association is not in accord with good mining practice. The fixed charges on the cost of a modern coal mine, provided with the up-to-date equipment necessary to conserve life and property and to assure maximum recovery, are too high to be assessed against the output of so small a tract, especially if the coal seam is of only moderate thickness. A law designed to promote the practical utilization of coal deposits, whether the system contemplates sale or lease, must provide for

the holding of a large enough unit to permit the opening and equipment of a modern mine and to warrant its economical operation. Without such provision for commercial operation too great an advantage is given to the land-grant railroads and large coal companies already in possession of considerable areas of high-grade coal.

LAWS APPLIED TO PHOSPHATE LANDS.

The present uncertainty whether the phosphate rock of the public land should be entered under the lode law or under the placer law is conclusive evidence of the need of legislation. As a matter of fact neither of these laws is more applicable to the acquisition of beds of phosphate-bearing limestone than it would be to that of coal beds. The realization that the phosphate deposits are more extensive than was known or suspected when the Survey geologists began land classification work in Idaho and Wyoming does not lessen but rather increases the urgency for a leasing law which will provide for the utilization of this large supply of mineral fertilizer, so as to meet both present and future needs.

LAW NEEDED FOR OIL AND GAS LANDS.

The most urgent need of legislation for the disposition of mineral deposits is in the case of oil and gas. It is most apparent that the placer law, which is none too well adapted to meet modern conditions in mining placer gold, is wholly inadequate if applied to public oil lands, inasmuch as oil is discovered at a late stage in the exploration and development of the land claimed under the law. Thus, large expenditures, extending over several months, if not years, are necessary before any right is acquired against the Government, and during all this time there is no legal protection of the oil prospector against unscrupulous claimants or competitors better backed by capital. The need for remedial oil legislation is somewhat less pressing than it was a year ago, by reason of the passage of the act approved March 2, 1911 (Stat. L., vol. 36, p. 1015), the effect of which is to validate a class of claims that, although clouded by the construction which the department was forced to place upon the misfit placer law under which title to oil lands must now be gained, were bona fide in that the inception of their development antedated the oil-land withdrawals. This legislation was in accord with the spirit of the withdrawal act, which provides for the protection of equities already established. The need for a better law is, however, imperative, and the legislative action demanded by the situation should not be limited to an attempt to revamp the general placer law, but should consist of the enactment of an altogether new measure, especially adapted to provide for the sane and equitable development of this industry in the future. First,

the new law should authorize the issue of exploratory permits, granting to individuals or associations the exclusive privilege of occupation, the sole condition of such a grant being diligent and adequate prosecution of development work, measured by the expenditure of fixed sums within certain periods, with possibly the payment of a small fee to the Government in lieu of such expenditure during the first six months. The issue of this permit should preferably be limited to one to each citizen or association of citizens, although after the lapse or surrender of such a permit the former holder should be allowed to apply for another exploratory permit. In the second place, the law should provide that upon discovery the holder of the permit be given a leasehold title with a royalty varied to meet local and actual conditions. The " wildcatter " or prospector in unproved country, whether such unproved territory is classified on geologic evidence as oil land or not, should be given special privilege to offset his greater risk. This privilege might take the form of an increased acreage, held both under permit and under lease, or a practical exemption from the payment of royalty, merely a nominal rental being charged under the lease. The chief advantage of the leasehold for oil over a fee-simple title lies in the prevention of monopolization through large holdings. Such large holdings without production would be guarded against by a ground rental sufficiently high to discourage the acquisition of lands except for immediate and continued development, although provision should also be made in the lease for surrender under terms which would protect the Government. This indirect control of development would be preferable to the direct enforcement, by forfeiture, of continuous production, which should be avoided because of the danger of disturbing the delicate equilibrium between supply and demand. Transfers of interest, under either permit or lease, should be permitted because of the absolute necessity in most instances of procuring capital for both drilling and operating an oil well. The law, however, should set forth the purpose of the control of such transfer, which would be to provide protection for the original locators, most of them men of small means, and more especially to insure the prohibition of too large holdings of Government leases by big companies.

LAWS RELATING TO METALLIFEROUS MINERALS.

Proposed amendments of the well-established laws relating to metalliferous minerals always raise the warmest discussion. With the opinion of mining men in general favoring revision of mining laws of the United States and with commission after commission appointed by various bodies to suggest improvements, the statutes have remained practically unchanged for nearly 40 years, while the

geology of ore deposits and the technology of metal mining have made marvelous progress.

The law of the apex has proved more productive of expensive litigation than of economical mining. In many of the more recently established and more progressive mining districts this statute has been made inoperative either by common agreement or by compromise between adjoining owners. Its repeal could not affect established equities under patents already granted, but would render possible more certain property rights in large mining districts, not as yet discovered, where new and valuable claims will be located a hundred years from now. The unit of disposition should be the claim, preferably square, limited on its four sides by vertical planes, and of a size sufficient to allow the miner occupying two contiguous claims to follow the vein or lode to considerable depth, even if its dip is only 45°. Such definition of a mining claim is found practicable in both Mexico and British Columbia, and in the latter country the change from the apex law was effected without trouble or confusion.

The same knowledge of natural conditions that leads to the suggestion of a repeal of the law of the apex forces the further suggestion that discovery of ore in place can not be made universally a prerequisite to the location of a mining claim. Geologic study of ore deposits has furnished examples in a number of regions where the present law can not be complied with, although rich deposits exist underground and their extent can be more definitely surmised than in most places where ore is discovered at the surface. To meet such actual conditions the law should provide for the acquisition of metalliferous mineral land classified as such upon the basis of adequate geologic evidence, whether actual outcrops are present or not.

Most important, perhaps, in any amended mining law would be provision for enforced development, a principle expressed, it is true, in the present law but not made effective in its workings. A requirement of actual use as a condition of occupancy of mineral land can not be regarded as either novel or radical. As regards the large acreage of undeveloped land in many mining camps to which patent has already been issued, it is perhaps true that the situation is without relief, unless the western Australia plan is adopted, whereby the Government steps in and permits mining under a lease, the proceeds of which are assessed, collected, and paid over to the owner. The principle invoked seems to be that no property owner can rightfully oppose the development of the resources of the State.

In the case of unpatented claims a remedy should be sought for what has been termed "the paralysis of mining districts," and the rigid requirement of annual assessment work should be made actual and effective by inspection and supervision, in order to put an end to

the present procedure of allowing a claim to lie idle for practically two years after its location, not to mention the many localities where claims are held year after year with only perfunctory compliance, or even without any performance of assessment work—a type of local disregard for law that is in striking contrast to the observance accorded to the district customs and regulations of earlier days, whereby the right of possession was made absolutely dependent upon continuous operation.

The remedy, then, for the existing evil of idle mining property must be sought either in the adoption of leasehold, under which the Government can enforce operation, a system which fully attains the desired end of promoting mining development in Australia and New Zealand, according to the report made in 1907 by Geologist Veatch, of this Survey, to the President, or in the thorough revision of the existing system. Radical amendment to the present law would be necessary in order to secure something more nearly approaching equality of opportunity. Some limitation should be put on the number of claims which an individual can locate in each mining district, and the prevention of monopolization would be furthered by the rigid enforcement of assessment development. The record of claims kept by a local official elected by the miners should be reported to the nearest land office in order to furnish the Federal Government with a notice of the intention of the claimant, and thus to initiate the operation of effective inspection, the purpose of which would be to enforce the use and development of mineral land as comtemplated in the law.

LEGISLATION REQUIRED FOR WATER POWER.

On the subject of water-power legislation the position of the Geological Survey is essentially that set forth in January of this year in a report addressed to the Secretaries of the Interior and of Agriculture by a joint committee representing the two departments. The legislation there outlined would provide for leases of public and reserved lands of the United States valuable for water-power development for a fixed term, not to exceed 50 years, with moderate charges for use and occupancy of the land, revocable only upon breach of conditions or on account of the charge of excessive rates to consumers. These leases should be identical in terms, under whatever department they are granted, with joint and uniform regulations governing all matters relating to water-power development of land belonging to the United States. Provision should also be made for periodic and equitable readjustment of charges, transfer of leases, preferential rights to renewal, and compensation for improvements at the termination of the leasehold. The law should specifically recognize water-power use as dominant, should insure

to the lessee undisturbed occupancy of the land needed for such use, and should reserve for future utilization all land believed to possess value for water-power development, these lands to be designated by the President but to be open to other entry, subject to this reserved right wherever separation of the water-power use and other use is possible.

EXAMINATIONS UNDER THE WEEKS ACT.

The act approved March 1, 1911 (Stat. L., vol. 36, p. 961), which provides for the acquisition of land for the purpose of conserving the navigability of navigable streams, imposed a new duty on the Geological Survey. Section 6 of the law provides for an examination by the Geological Survey of land whose purchase is under consideration and the submission of a report based thereon to the Secretary of Agriculture, "showing that the control of such lands will promote or protect the navigation of streams on whose watersheds they lie." The law thus places upon the Geological Survey the determination of the fundamental question whether the control of the specific tract of land pertains to the promotion or protection of navigability, and stipulates that a favorable report to the Secretary of Agriculture must precede the purchase of the tract considered.

The report thus required of the Geological Survey is believed to involve something more than perfunctory action and to consist of a showing of facts rather than an expression of opinion. The solution of complex scientific problems is required in order to establish actual and substantial relationship between control of headwater tracts and the navigation of streams, and while the responsibility for this determination had not been sought by the Geological Survey, this new application of scientific investigation to an administrative problem has been accepted by the Survey as directly in line with its geologic and hydrographic work. It was at once recognized that as the determinative agent, whose favorable report must precede any action by the National Forest Reservation Commission, the Geological Survey would be exposed to criticism alike by those favoring a "broad interpretation" of both natural and statutory law and by those who had opposed the enactment of the Weeks law as embodying a subterfuge.

On the initiative of the Survey a conference was arranged between representatives of the Department of Agriculture and of the Department of the Interior, and an agreement was reached concerning procedure in the administration of this new law, so far as the Forest Service and the Geological Survey are concerned, to the end that the examinations of land by the two bureaus might be coordinated. In this agreement, which was approved by the two Secretaries on May 3, 1911, it is set forth that the examination by the Geological

Survey will include the determination of the relation of the headwater streams to the navigable streams to which they are tributary, the local observation of the headwater stream or streams draining the tract or tracts in question with reference to run-off characteristics and to nature and amount of suspended material, the classification of the surface formations of the tract with reference to permeability and storage capacity and to resistance to erosion, and the securing of such additional topographic data, in cooperation with the Forest Service, as are needed by the two bureaus in their examination of the tract.

In accordance with the terms of this agreement work was prosecuted in Georgia, Tennessee, and New Hampshire in May and June, resulting in the submission of two favorable reports to the Secretary of Agriculture before the end of the fiscal year.

Report No. 1 refers to a tract of 31,377 acres in Fannin and Union counties, Ga., and states the following general conclusions, based on local field examination, which support the proposition that the control of this tract in northern Georgia will promote and protect the navigation of Hiwassee and Tennessee rivers, in whose basins the land examined lies.

(*a*) Toccoa River is a headwater stream contributing a relatively large low-season flow, which makes its basin one of the class best adapted to promote the navigability of the river during the dry season.

(*b*) On the Gennett tract, as elsewhere in this general district, excessive soil wastage is in progress, which is chargeable to the practice of yearly burning over the forest lands, to the tillage of steep slopes, and to the presence of fallow fields.

(*c*) Control of these lands will to an appreciable extent insure the continuance and possible betterment of the important low-water contribution of Toccoa River and will diminish the present excessive delivery of sediment into this tributary of Hiwassee and Tennessee rivers.

The National Forest Reservation Commission, on the basis of this report and the report presented by the Forest Service, authorized the purchase of this tract.

Report No. 2 refers to a tract in Blount and Sevier counties, Tenn. This tract comprises 58,213 acres in the upper drainage basin of Little River, which enters Tennessee River below Knoxville. Little River itself is navigable in its lower part and the importance of the Tennessee as a navigable stream is well known.

The general conclusions based on the local examination and presented below support the proposition that the control of this tract will promote and protect the navigation of Little and Tennessee rivers, on whose watersheds the land examined lies. These conclusions are:

(*a*) Little River is a stream whose headwater branches contribute a low-season flow largely in excess of the average discharge of the Tennessee drainage basin.

(*b*) Excessive erosion is observed in various parts of the tract, especially in those parts which have been subject to repeated burning. A sensible reduction of the amount of sediment delivered to Little River seems possible through forest management.

Action on this report by the commission was postponed, because of questions as to terms and conditions of sale raised in the report submitted by the Forest Service.

Report No. 3, on adjoining tracts in Little River basin, aggregating 3,365 acres, based on the field examination covering the tract referred to in report No. 2, was transmitted to the Secretary of Agriculture in July.

The only topographic work thus far found necessary in these examinations has been a resurvey of the Little River drainage basin, in Tennessee. Hydrographic work in the White Mountain region was begun in May and will be continued through the summer, when the necessary geologic examination will also be made of the tracts selected by the Forest Service for proposed purchase. This plan of procedure was decided upon early in May, and the selection of tracts in the southern Appalachians for immediate examination and report before June 30 was actuated, first, by the fact that much more work had already been done in that area by the Geological Survey; second, by the fact that the geologic conditions in the region were believed to be much more favorable to the contention that an indisputable relation exists between forest lands and stream regulation, and further by the fact that the offering of two large tracts having an area of 90,000 acres in especially favorable localities, promised the maximum chance for favorable reports within a minimum time.

NECROLOGY.

SAMUEL FRANKLIN EMMONS.

The Geological Survey suffered an irreparable loss in the death of Samuel Franklin Emmons on March 28, 1911, after a brief illness. Mr. Emmons served the Survey as an administrative chief and a scientific leader from the first year of its history, so that mention of his attainments and his work furnishes also a record of the 32 years of achievement and progress by the organization.

Mr. Emmons was graduated from Harvard College in 1861, and after a period of study abroad joined Clarence King as an assistant in the United States Geological Exploration of the Fortieth Parallel. For nearly 10 years he remained with this organization, seeing varied service and gaining wide knowledge of the geology of the West.

With Mr. Arnold Hague he was joint author of the second volume of the great Fortieth Parallel series, entitled "Descriptive geology."

With the organization of the present Survey, in 1879, Mr. Emmons was placed by King in charge of the Rocky Mountain division, with instructions to give exclusive attention to the study of the mineral wealth, and soon thereafter he began his study of the Leadville district, then newly opened. His monograph and atlas on the "Geology and mining industry of Leadville"[1] were published by the Geological Survey in 1886, and at once established the reputation of their author. The Leadville report was preceded in publication by Becker's monograph on the "Geology of the Comstock lode and the Washoe district"[2] and by Curtis's less extensive report on the "Silver-lead deposits of Eureka, Nev.,"[3] but with these, and more decisively than these, it marked the beginning of a new era in economic geology and became a model for the numerous monographic reports on western mining districts that have since been published by the United States Geological Survey.

Until a few years ago Mr. Emmons continued in general charge of the investigations of western ore deposits carried on by the Survey, and many studies were planned and completed under his supervision and with his suggestive advice. In some reports he appeared as collaborator; in others his share was less patent, although perhaps scarcely less important. He was the senior author of the monograph on the "Geology of the Denver Basin" and was the sole or joint author of several folios of the Geologic Atlas of the United States. His contributions to scientific periodicals and to the transactions of societies were numerous and important. One of the most notable of these contributions was his paper on the "Secondary enrichment of ore deposits,"[4] which was the outcome of long-continued studies at Butte and elsewhere and which enunciated principles that were at once generally recognized as being not only of unusual scientific importance but also of great practical value.

During the later years of his life Mr. Emmons, freed from the cares of official administration, returned to his studies at Leadville, and, in association with Prof. J. D. Irving, of Yale University, was engaged in extending his earlier results in the light of additional facts brought out by extensive mining operations continued through three decades. Although some of his newer material was published in 1907 as the Survey's Bulletin 320, on the Downtown district of Leadville, Colo., Mr. Emmons did not live to see the publication of his final results. The task of completing the report has fallen to Prof. Irving.

---

[1] Mon. U. S. Geol. Survey, vol. 12, 1886.
[2] Idem, vol. 3, 1882.
[3] Idem, vol. 7, 1884.
[4] Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 177–217.

Mr. Emmons was a prominent member of many scientific societies and academies both in this country and abroad, including the National Academy of Sciences, of which he was treasurer at the time of his death. In 1903 he held the office of president of the Geological Society of America. In 1909 both Harvard and Columbia Universities conferred upon him the honorary degree of Sc. D.

The chief characteristics of his work were thorough painstaking honesty of method, wide and penetrating vision in the interpretation of his facts, remarkable soundness and stability of judgment, and clarity of exposition. Himself able to express his thought in unusually clear and felicitous language, Mr. Emmons was an invaluable critic, not only of substance but of form, and those geologists who in their younger days were so fortunate as to receive his kindly yet keen criticism have found their appreciation of what he did for them grow with the passing years and will always hold him in grateful remembrance. His own writings are an eloquent protest against the view that sound science can find appropriate expression in slovenly writing.

In the course of his long life Mr. Emmons had seen the Far West make astonishing progress, especially in the mining industry, and he had the satisfaction of knowing that by his work he had materially advanced this development. He had received unsought and bore modestly the honors that men of science most prize. His name not only stood high on the rolls of science but was known to miners throughout the Rocky Mountain region as that of the man who more than anyone else had applied geologic knowledge in a way to convince them of its value.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey's success in reaching the public with the results of its scientific work is directly measured by the distribution of its publications. In spite of the organization of the Bureau of Mines and the consequent removal of the deservedly popular technologic bulletins from the Survey's publications, the total number of reports and maps distributed by the Geological Survey in 1911 was 1,208,797, an increase of 6 per cent over the corresponding figures for 1910. An even larger percentage of increase is shown in the number of letters received containing remittances for sale publications, while the receipts for topographic maps increased about 10 per cent. The total distribution of topographic maps, which includes congressional distribution, exchanges, and issue for departmental use, as well as the half million maps sold, exhibits the gratifying increase of 15 per cent. The total distribution to the public of books and maps is equivalent

to more than 99 per cent of the number of copies received during the year from the Government Printing Office and the Survey's engraving and printing division.

The notable increase in the amount of editorial work also furnishes a gratifying item in the year's record. The number of manuscript pages read in 1911 exceeds the largest number read in any previous year by nearly 10 per cent and exceeds the work of some recent years by 100 per cent. In pages of final proof read and indexed this year's record has been exceeded by only two years, and this excess is in part apparent rather than real, by reason of changes in measure of page and size of type, while the cost of editorial work has been much less than in other years in which a comparable amount of work was performed.

The publications of the last fiscal year are briefly described in the following summaries:

Thirty-first Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the fiscal year ended June 30, 1910.

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

Professional Paper 68. The ore deposits of New Mexico, by Waldemar Lindgren, Louis C. Graton, and Charles H. Gordon. 1910. 361 pp., 22 pls., 33 text figures.

A detailed description of the commercially valuable ore deposits and an exhaustive exposition of the general features of the geology of the region, especially those related to the origin and occurrence of ores of metallic minerals, with descriptions of mines and prospects by counties and statistics of mineral production. Numerous maps and diagrams show the surface contour, the locations of particular mining districts, and the plans of workings of particular mines. Several plates show the appearance of typical minerals of the region in natural colors.

Professional Paper 72. Denudation and erosion in the southern Appalachian region and the Monongahela Basin, by Leonidas Chalmers Glenn. 1911. 137 pp., 21 pls., and 1 text figure.

A report on the nature, effects, and remedies of erosion in general, with a detailed account of special conditions in the region under discussion. The relations of such industries as agriculture, lumbering, mining, and power development to erosion are considered, and suggestions for improving conditions in the region are given. The effects of erosion are shown by numerous illustrations, and several photographs are introduced to indicate methods of regulating stream flow that have proved adaptable to particular conditions.

Bulletin 381. Contributions to economic geology, 1908—Part II, Mineral fuels. Marius R. Campbell, geologist in charge. 1910. 559 pp., 24 pls., 15 text figures.

A bulletin consisting of 27 short papers and preliminary reports on investigations, made in 1908, of deposits of coal, lignite, natural gas, and petroleum, including descriptions of mining districts, accounts of development work in particular localities, and results of the investigation of the character

of certain mineral fuels. The illustrations are mostly maps of coal fields and sections of mines. The bulletin includes a list of other publications of the survey on petroleum and natural gas. The bulletin includes papers having the following titles:

Stratigraphy and coal beds of the Indiana coal field, by G. H. Ashley.
The Washburn lignite field, North Dakota, by C. D. Smith.
The Fort Berthold Indian Reservation lignite field, North Dakota, by C. D. Smith.
The Fort Peck Indian Reservation lignite field, Montana, by C. D. Smith.
The central part of the Bull Mountain coal field, Montana, by R. W. Richards.
The Milk River coal field, Montana, by L. J. Pepperberg.
Notes on the coals of the Custer National Forest, Montana, by C. H. Wegemann.
The Powder River coal field, Wyoming, adjacent to the Burlington Railroad, by R. W. Stone and C. T. Lupton.
The Buffalo coal field, Wyoming, by H. S. Gale and C. H. Wegemann.
The coal field in the southeastern part of the Bighorn Basin, Wyoming, by E. G. Woodruff.
The eastern part of the Little Snake River coal field, Wyoming, by M. W. Ball and Eugene Stebinger.
The southern part of the Rock Springs coal field, Sweetwater County., Wyo., by A. R. Schultz.
Weathering of coal in the arid region of the Green River Basin, Sweetwater County, Wyo., by A. R. Schultz.
Coal of the Denver Basin, Colorado, by G. C. Martin.
The South Park coal field, Colorado, by C. W. Washburne.
The Colorado Springs coal field, Colorado, by M. I. Goldman.
The Canon City coal field, Colorado, by C. W. Washburne.
The Trinidad coal field, Colorado, by G. B. Richardson.
Isolated coal fields in Santa Fe and San Miguel counties, New Mexico, by J. H. Gardner.
The Carthage coal field, New Mexico, by J. H. Gardner.
The coal field between San Mateo and Cuba, New Mexico, by J. H. Gardner.
Geology and oil prospects of the Reno region, Nevada, by Robert Anderson.
Two areas of oil prospecting in Lyon County, western Nevada, by Robert Anderson.
Analysis of crude petroleum from Oklahoma and Kansas, by D. T. Day.
The Madill oil pool, Oklahoma, by J. A. Taff and W. J. Reed.
Development in the Boulder oil field, Colorado, by C. W. Washburne.
The Florence oil field, Colorado, by C. W. Washburne.
Survey publications on petroleum and natural gas.

Bulletin 425. The explosibility of coal dust, by George S. Rice, with chapters by J. C. W. Frazer, Axel Larsen, Frank Haas, and Carl Scholz. 1910. 186 pp., 14 pls., 28 text figures.

A summary of experiments and mine investigations showing the explosibility of coal dust and the available protective measures. A history of the discussion of coal-dust explosions is given and also a brief account of recent disasters. The origin of coal dust, its distribution and ignition, and the possible means of preventing the dangers it presents are considered in the light of the results of recent experiments made in America and in Europe. The value of exhaust steam to prevent the formation of coal dust is treated at length.

Bulletin 426. Granites of the southeastern Atlantic States, by Thomas Leonard Watson. 1910. 282 pp., 27 pls., 22 text figures.

A report on the commercial granites of Maryland, Virginia, Georgia, Alabama, Tennessee, North Carolina, and South Carolina. The introductory chapter includes a discussion of the mineral and chemical composition, the physical properties, and the geologic characteristics of granites in general. Under the headings of the States named the distribution of granites in the region is considered and the features of local varieties are described.

Bulletin 427. Manganese deposits of the United States, with sections on foreign deposits, chemistry, and uses, by Edmund Cecil Harder. 1910. 298 pp., 2 pls., 33 text figures.

Detailed descriptions of the deposits of manganese ores in the United States, with chapters on the sources of the metal, the production of manganese in foreign countries, its chemical compounds and alloys, its uses in metallurgy, chemistry, and as a coloring material, and the status of manganese production in the United States.

Bulletin 429. Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States, by G. D. Harris. 1910. 192 pp., 22 pls., 21 text figures.

Outlines the modes of occurrence and methods of exploitation of oil and gas in Louisiana. Saline-dome oil and gas and stratum oil and gas are considered separately, the numerous prospects and producing fields are described, and the condition of development work is reported.

Bulletin 430. Contributions to economic geology (short papers and preliminary reports), 1909—Part I, Metals and nonmetals except fuels. C. W. Hayes and Waldemar Lindgren, geologists in charge. 1910. 653 pp., 14 pls., 75 text figures.

Includes 42 short papers or preliminary reports on investigations made in 1909 of deposits of gold, silver, copper, lead, and other minerals. Some newly developed deposits are described and the results of special investigations of particular mineral fields are reported. In addition to chapters on the more common metallic substances, contains chapters on aluminum ores, asphaltum, structural materials, abrasives, mineral paints, salines, phosphates, sulphur and pyrite, and the rare metals. A complete list of the papers included in the report follows:

Notes on the placer deposits of Greaterville, Ariz., by J. M. Hill.
Gold mining in the Randsburg quadrangle, California, by F. L. Hess.
The Weaverville-Trinity Center gold gravels, Trinity County, Cal., by D. F. MacDonald.
Placer gravels of the Sumpter and Granite districts, eastern Oregon, by J. T. Pardee.
Survey publications on gold and silver.
The occurrence of copper in Shasta County, Cal., by L. C. Graton.
Geology of the copper deposits near Montpelier, Bear Lake County, Idaho, by H. S. Gale.
The copper deposits of South Mountain in southern Pennsylvania, by G. W. Stose.
Survey publications on copper.
Notes on the mineral deposits of the Bearpaw Mountains, Montana, by L. J. Pepperberg.
Survey publications on lead and zinc.

Notes on the occurrence of cinnabar in central western Arizona, by Howland Bancroft.

Some occurrences of molybdenite in the Santa Rita and Patagonia mountains, Arizona, by F. C. Schrader and J. M. Hill.

Note on the occurrence of tungsten minerals near Calabasas, Ariz., by J. M. Hill.

Some chromite deposits in western and central California, by E. C. Harder.

An occurrence of monazite in northern Idaho, by F. C. Schrader.

Platinum in southeastern Nevada, by Howland Bancroft.

The Virginia rutile deposits, by T. L. Watson and Stephen Taber.

Notes on tungsten deposits near Deer Park, Wash., by Howland Bancroft.

Survey publications on antimony, chromium, nickel, platinum, quicksilver, tin, tungsten, uranium, vanadium, etc.

Some iron ores of western and central California, by E. C. Harder.

The Iron Age iron-ore deposit, near Dale, San Bernardino County, Cal., by E. C. Harder and J. L. Rich.

Iron ores near Dayton, Nev., by E. C. Harder.

The Jauss iron mine, Dillsburg, Pa., by A. C. Spencer.

Deposits of brown iron ore near Dillsburg, York County, Pa., by E. C. Harder.

Preliminary report on pre-Cambrian geology and iron ores of Llano County, Tex., by Sidney Paige.

Survey publications on iron and manganese ores.

Survey publications on aluminum ores.

Survey publications on asphalt.

Field investigations of structural materials, by E. F. Burchard.

Structural materials available in the vicinity of Minneapolis, Minn., by E. F. Burchard.

Structural materials available in the vicinity of Austin, Tex., by E. F. Burchard.

The slates of Arkansas, by A. H. Purdue.

The oolitic limestone industry at Bedford and Bloomington, Ind., by J. A. Udden.

Supplementary notes on the granites of New Hampshire, by T. N. Dale.

Oolitic limestone at Bowling Green and other places in Kentucky, by J. H. Gardner.

Survey publications on building stone and road metal.

Cement materials in Republican Valley, Nebraska, by N. H. Darton.

Gravel and sand in the Pittsburg district, Pennsylvania, by E. W. Shaw.

Survey publications on cement and cement and concrete materials.

Fuller's earth and brick clays near Clinton, Mass., by W. C. Alden.

Survey publications on clays, fuller's earth, etc.

The gypsum deposits of the Palen Mountains, Riverside County, Cal., by E. C. Harder.

Gypsum deposits near Cane Springs, Kern County, Cal., by F. L. Hess.

Survey publications on gypsum and plasters.

Survey publications on lime and magnesite.

Survey publications on glass sand and glass-making materials.

Survey publications on abrasive materials.

Ocher deposits of eastern Pennsylvania, by J. C. Stoddard and A. C. Callen.

Paint-ore deposits near Lehigh Gap, Pennsylvania, by F. T. Agthe and J. L. Dynan.

Survey publications on mineral paints.
Preliminary report on the phosphate deposits in southeastern Idaho and adjacent parts of Wyoming and Utah, by H. S. Gale and R. W. Richards.
Phosphate deposits east of Ogden, Utah, by Eliot Blackwelder.
Survey publications on phosphates and other mineral fertilizers.
The salt resources of the Idaho-Wyoming border, with notes on the geology, by C. L. Breger.
Deposits of sodium salts in Wyoming, by A. R. Schultz.
Survey publications on salines, including salt, borax, and soda.
Survey publications on sulphur and pyrite.
Mica deposits of North Carolina, by D. B. Sterrett.
Supposed graphite deposits near Brigham, Utah, by H. S. Gale.
Survey publications on miscellaneous nonmetallic products.

Bulletin 431. Contributions to economic geology (short papers and preliminary reports), 1909—Part II, Mineral fuels. M. R. Campbell, geologist in charge. 1911. 254 pp., 12 pls., 4 text figures.

An introduction by Mr. Campbell gives a list of coal and oil fields examined in 1909 concerning which reports are being prepared for publication by the Survey. The body of the volume comprises the following papers:

Natural gas in North Dakota, by A. G. Leonard.
The San Juan oil field, San Juan County, Utah, by H. E. Gregory.
Gas and oil prospects near Vale, Oreg., and Payette, Idaho, by C. W. Washburne.
Gas prospects in Harney Valley, Oregon, by C. W. Washburne.
Preliminary report on the geology and oil prospects of the Cantua-Panoche region, California, by Robert Anderson.
The southern part of the Cahaba coal field, Alabama, by Charles Butts.
The Powell Mountain coal field, Scott and Wise counties, Va., by M. R. Campbell and E. G. Woodruff.
The eastern part of the Bull Mountain coal field, Montana, by C. T. Lupton.
Preliminary report on the Coos Bay coal field, Oregon, by J. S. Diller and M. A. Fishel.
The Black Mesa coal field, Arizona, by M. R. Campbell and H. E. Gregory.
Coal deposits near Pinedale, Navajo County, Ariz., by A. C. Veatch.
Coal in San Benito County, Cal., by M. R. Campbell.

Bulletin 432. Some ore deposits in Maine and the Milan mine, New Hampshire, by William H. Emmons. 1910. 62 pp., 3 pls., 23 text figures.

An account of the geology and ore deposits of Maine, with detailed descriptions of the mines and consideration of their commercial value. The area covered by the report includes Hancock, Somerset, Washington, and Oxford counties, Maine, and the Milan mine in New Hampshire.

Bulletin 433. Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by Philip S. Smith. 1910. 234 pp., 16 pls., 26 text figures.

An account of the geology and geography of Seward Peninsula, particularly of the Solomon and Casadepaga quadrangles, with a statement of present economic development in those quadrangles. The work of Mr. Smith establishes the geologic relations of the rocks of the district to the rest of Seward Peninsula and shows that their structure is very complex. Large-scale geologic and topographic maps, in colors, accompany the report.

Bulletin 434. Results of spirit leveling in Delaware, District of Columbia, Maryland, and Virginia, 1896 to 1909. R. B. Marshall, chief geographer. 1910. 74 pp.

Gives the elevation above sea level of about 600 points in the area considered, arranged by quadrangles. The work in Maryland and that in Virginia during a part of the year 1908 was done in cooperation with the States.

Bulletin 435. A reconnaissance of parts of northwestern New Mexico and northern Arizona, by N. H. Darton. 1910. 88 pp., 17 pls., 8 text figures.

A detailed description of the geology of the Rio Grande Valley and the Grand Canyon of the Colorado region, undertaken to determine the prospects for obtaining deep-seated underground water supplies. The peculiar formations of the Grand Canyon are described, the mineral resources of the region are considered briefly, and numerous well records are given.

Bulletin 436. The fauna of the phosphate beds of the Park City formation in Idaho, Wyoming, and Utah, by George H. Girty. 82 pp., 7 pls.

Descriptions of invertebrate fossils found in the phosphate beds near Park City, Utah, with illustrations showing the forms discovered.

Bulletin 437. Results of spirit leveling in Maine, New Hampshire, and Vermont, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 59 pp. 1910.

Gives elevations of about 500 points, arranged by quadrangles. The work in Maine was done in cooperation with the State from 1899 to 1909, inclusive.

Bulletin 438. Geology and mineral resources of the St. Louis quadrangle, Missouri-Illinois, by N. M. Fenneman. 1911. 73 pp., 6 pls., 1 text figure.

A brief geologic history of the district and descriptions of its topography, stratigraphy, and mineral resources. Contains a geologic map of the quadrangle and illustrations showing the structure and some other geologic features. The coal, clay, quarry rock, oil, gas, sand, gravel, and water resources of the quadrangle are described in connection with its economic geology.

Bulletin 439. The fauna of the Morefield shale of Arkansas, by George H. Girty. 1911. 148 pp., 15 pls.

Descriptions of invertebrate fossils of an important section of Mississippian rocks. The species are considered individually and in detail, and most of the forms are illustrated in the plates.

Bulletin 440. Results of triangulation and primary traverse for the years 1906, 1907, and 1908. R. B. Marshall, chief geographer. 1910. 668 pp., 1 pl.

Gives the results of triangulation and primary traverse in the United States from 1906 to 1908, inclusive, listing 716 triangulation stations and 6,243 primary traverse stations, nearly all on United States standard datum. The bulletin includes a map showing the condition of astronomic location and primary control to January 1, 1909.

Bulletin 441. Results of spirit leveling in Alabama, Georgia, North Carolina, South Carolina, and Tennessee, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 145 pp.

Gives the elevations of about 1,300 points in the States named. The report includes all leveling by the Geological Survey in this area, arranged by quadrangles. The work in Alabama from 1899 to 1905 and in North Carolina in 1896 and from 1902 to 1909 was done in cooperation with those States.

Bulletin 442. Mineral resources of Alaska—report on progress of investigations in 1909, by Alfred H. Brooks and others. 1910. 432 pp., 8 pls., 8 text figures.

An annual report on the work of the Geological Survey in Alaska. Includes, in addition to an administrative report, a large number of special reports on various features of the work, among which are papers on the mining industry in 1909, the utilization of Alaskan coal, the preparation and use of peat as a fuel, and the auriferous quartz veins of the Fairbanks district. The report includes papers having the following titles:

Administrative report, by Alfred H. Brooks.
The mining industry in 1909, by Alfred H. Brooks.
Alaska coal and its utilization, by Alfred H. Brooks.
The preparation and use of peat as a fuel, by Charles A. Davis.
Mining in southeastern Alaska, by Adolph Knopf.
Occurrence of iron ore near Haines, by Adolph Knopf.
Report of water-power reconnaissance in southeastern Alaska, by John C. Hoyt.
Mining in the Chitina district, by Fred H. Moffit.
Mining and prospecting on Prince William Sound in 1909, by U. S. Grant.
Preliminary report on the mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins.
Outline of the geology and mineral resources of the Iliamna and Clark lakes region, by G. C. Martin and F. J. Katz.
Gold placers of the Mulchatna, by F. J. Katz.
Sketch of the geology of the northeastern part of the Fairbanks quadrangle, by L. M. Prindle.
The auriferous quartz veins of the Fairbanks district, by L. M. Prindle.
Placer mining in the Yukon-Tanana region, by C. E. Ellsworth.
Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, by Bertrand L. Johnson.
Water supply of the Yukon-Tanana region, 1909, by C. E. Ellsworth.
The Koyukuk-Chandalar gold region, by A. G. Maddren.
Mineral resources of the Nulato-Council region, by Philip S. Smith and Henry M. Eakin.
Mining in Seward Peninsula, by Fred F. Henshaw.
Water-supply investigations in Seward Peninsula in 1909, by Fred F. Henshaw.

Bulletin 443. Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. 1910. 89 pp., 12 pls., 9 text figures.

Contains detailed descriptions of the many copper mines and prospects of the district and notes on the occurrence of gold and other metals of commercial importance. The topography and general geology of the region are fully considered and the report is accompanied by a large-scale geologic map.

Bulletin 444. Bibliography of North American geology for 1909, with subject index, by John M. Nickles. 1910. 174 pp.

A list, arranged alphabetically by authors' names, of publications bearing on the geology of North America, the adjoining islands, Panama, and the Hawaiian Islands, with summaries of many of the publications. The work is indexed and includes lists of chemical analyses and of minerals, rocks, and geologic formations described.

Bulletin 445. Geology of the pegmatites and associated rocks of Maine, including feldspar, quartz, mica, and gem deposits, by Edson S. Bastin. 1911. 152 pp., 19 pls., 8 text figures.

Describes in detail the general geology and the specific occurrence of pegmatites in Maine and the relations of granites and pegmatites, and discusses at length the economically important pegmatite minerals, in respect to their occurrence, uses, production, and prices. Among these minerals are feldspar, quartz, mica, tourmaline, and beryl.

Bulletin 446. Geology of the Berners Bay region, Alaska, by Adolph Knopf. 1911. 58 pp., 2 pls., 4 text figures.

A report on the geology and ore deposits of the Berners Bay region, at the northwest extremity of the Juneau gold belt, describing the mines and prospects of the region and the mineralogy of the ore deposits. Mr. Knopf's report shows that the mineralization of south-central Alaska was synchronous with that of the Mother Lode district in California.

Bulletin 447. Mineral resources of Johnstown, Pa., and vicinity, by W. C. Phalen and Lawrence Martin. 1911. 142 pp., 7 pls., 22 text figures.

A full discussion of the geology of this important coal-bearing region, with descriptions of its mineral resources. Coal and clay, the most valuable resources, are treated in detail by districts, and many analyses of coal and clay from particular districts are given. The occurrence of glass sand, building stone, lime, cement, and iron ores is also discussed.

Bulletin 449. A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska, by P. S. Smith and H. M. Eakin. 1911. 146 pp., 13 pls.

A report on the geography, geology, climate, vegetation, and mineral resources of a hitherto unexplored district. Illustrated by maps and half-tone plates. The gold placers and lode prospects of the region are described in detail, and the coal exposures are also considered.

Bulletin 452. The Lander and Salt Creek oil fields, Wyoming: The Lander oil field, Fremont County, by E. G. Woodruff; The Salt Creek oil field, Natrona County, by C. H. Wegemann. 1911. 87 pp., 12 pls., 1 text figure.

Descriptions of the stratigraphy and structure of the two fields and full accounts of the oil origin, condition of development, and available markets, with large-scale maps of the oil fields.

Bulletin 453. Results of spirit leveling in Minnesota, 1897 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 39 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 600 places. The work in 1909 and 1910 was done in cooperation with the State of Minnesota. This and similar bulletins contain a half-tone illustration showing designs for bench marks used by the United States Geological Survey, and all elevations are arranged by quadrangles.

Bulletin 457. Results of spirit leveling in the State of Washington, 1896 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 108 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 1,800 places. The work in 1909 and 1910 was done in cooperation with the State of Washington.

Bulletin 459. Results of spirit leveling in Missouri, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 48 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 450 places. The work from 1907 to 1909, inclusive, was done in cooperation with the State.

Bulletin 460. Results of spirit leveling in Iowa, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 32 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 250 places. The work from 1907 to 1909, inclusive, was done in cooperation with the State.

Bulletin 461. Results of spirit leveling in Michigan and Wisconsin, 1897 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 64 pp., 1 pl.

A report on precise and primary leveling in the two States, showing the altitudes above sea level of more than 550 places. The work from 1901 to 1909, inclusive, was done in cooperation with the States.

Bulletin 462. Results of spirit leveling in Oregon, 1896 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 82 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 750 places. The work from 1905 to 1910, inclusive, was done in cooperation with the State.

Bulletin 463. Results of spirit leveling in Arizona, 1899 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 94 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 800 places.

Bulletin 465. The State geological surveys of the United States, compiled under the direction of C. W. Hayes. 1911. 177 pp.

Brief sketches of the origin and history of the geological surveys in the several States and Territories of the United States, their organization, and the laws governing them, with statements showing the amounts appropriated and the purposes for which they have been expended. Compiled from reports submitted by the State geologists or by other officials of the surveys.

Advance chapters from Bulletin 470, "Contributions to economic geology (short papers and preliminary reports), 1910—Part I, Metals and nonmetals except fuels," as follows:

Bulletin 470–A. Phosphates in Montana, by Hoyt S. Gale. 1911. 7 pp., 2 text figures.

A report on the location and structure of phosphate deposits at Melrose, Mont., with reference to their value and accessibility.

Bulletin 470–D. Lead and zinc, by R. W. Richards and Howland Bancroft. 1911. 30 pp., 4 text figures.

Papers on the lead and zinc deposits in the Metaline mining district, Washington, and the lead and copper deposits in the Bear River Range, Idaho and Utah, with a list of Survey publications on lead and zinc.

Bulletin 470–E. Rare metals, by F. L. Hess. 1911. 12 pp., 1 text figure.

Includes a report on the arsenic deposits at Brinton, Va., and a list of Survey publications on antimony, chromium, monazite, nickel, platinum, quicksilver, tin, tungsten, uranium, and vanadium.

Bulletin 470–F. Iron and manganese, by Charles Butts. 1911. 22 pp., 4 text figures.

A report on the iron ores in the Montevallo-Columbiana region, Alabama, with sketch maps showing the location of the deposits and a list of Survey publications on iron and manganese.

Bulletin 470–I. Mineral paints, by B. L. Miller. 1911. 15 pp.

A paper on the paint shales of Pennsylvania and a list of Survey publications on mineral paints.

Bulletin 470–J. Sulphur and pyrite, by R. W. Richards and J. H. Bridges. 1911. 8 pp., 1 text figure.

A report on the sulphur deposits near Soda Springs, Idaho, and a list of Survey publications on sulphur and pyrite.

Bulletin 470–K. Miscellaneous nonmetallic products. 1911. 45 pp., 6 text figures. Contains the following papers:

The types, modes of occurrence, and important deposits of asbestos in the United States, by J. S. Diller.

Dolomite for flux in the vicinity of Montevallo, Shelby County, Ala., by Charles Butts.

Graphite near Dillon, Mont., by A. N. Winchell.

Fluorspar near Deming, N. Mex., by N. H. Darton and E. F. Burchard.

Water-Supply Paper 237. The quality of the surface waters of California, by Walton Van Winkle and Frederick M. Eaton, in cooperation with the California Department of Engineering. 1910. 142 pp., 1 pl.

A description of the drainage of the State, with analyses and assays of surface waters and general conclusions regarding the adaptability of the waters of the several streams for various uses.

Water-Supply Paper 240. Geology and water resources of the San Luis Valley, Colorado, by C. E. Siebenthal. 1910. 128 pp., 13 pls., 15 text figures.

A comprehensive view of the geology of the San Luis Valley and the surrounding rim, with a description of the artesian basin, its development and its prospects, and information in regard to climate, agriculture, irrigation, and water resources.

Water-Supply Paper 246. Surface water supply of the United States, 1907–8: Part VI, Missouri River basin, prepared under the direction of M. O. Leighton by Robert Follansbee and J. E. Stewart. 1910. 311 pp., 13 pls., 2 text figures.

Water-Supply Paper 251. Surface water supply of the United States, 1907–8: Part XI, California, prepared under the direction of M. O. Leighton by W. B. Clapp and W. F. Martin. 1910. 363 pp., 7 pls., 1 text figure.

Water-Supply Papers 246 and 251 contain the results of stream measurements in the United States during the calendar years 1907 and 1908, continuing the Survey's series of reports on stream gagings. These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharges at stations maintained, on many streams.

Water-Supply Paper 253. Water powers of the Cascade Range—Part I, Southern Washington, by J. C. Stevens. 1910. 94 pp., 21 pls., 3 text figures.

The first of a proposed series of reports dealing with the water powers on rivers flowing from the Cascade Range in Washington and Oregon. The area treated in this paper comprises the drainage basins of Klickitat, White Salmon, Little White Salmon, Lewis, and Toutle rivers and is located in the southern extremity of the Cascade Range in Washington. Descriptions of the several drainage areas are given, together with profiles of the streams and principal tributaries, discharge data, and detailed statements of the water powers capable of being developed at the average minimum stage of the streams.

Water-Supply Paper 254. The underground waters of north-central Indiana, by Stephen R. Capps, with a chapter on the chemical character of the waters by R. B. Dole. 1910. 279 pp., 7 pls., 12 text figures.

A report on the quantity, quality, distribution, accessibility, and proper safeguarding of the ground-water supplies of the farming districts and manufacturing centers of north-central Indiana. Conditions in 378 cities and towns were investigated in its preparation. The paper includes the results of numerous analyses and assays. The chapter by Mr. Dole considers not only the mineral composition of the waters of the region but their value for domestic and industrial uses as well. Methods of purification are also discussed.

Water-Supply Paper 255. Underground waters for farm use, by M. L. Fuller, 58 pp., 17 pls., 27 text figures.

A brief report discussing the sources of farm water supplies with especial reference to their protection from contamination and their conservation. Describes many kinds of wells and tells what factors should govern the selection of a certain type. Contains numerous illustrations showing water-bearing formations and methods of sinking wells and raising water, and diagrams showing different well conditions.

Water-Supply Paper 256. Geology and underground waters of southern Minnesota, by C. W. Hall, O. E. Meinzer, and M. L. Fuller. 1911. 406 pp., 18 pls., 9 text figures.

A sketch of the physiography and geology of the region with special reference to the water-bearing capacity of the different geologic formations, detailed descriptions by counties of the underground-water resources, and a chapter on problems relating to wells. The illustrations include maps showing underground-water conditions, geologic sections in the different counties, and diagrams of well-drilling tools.

Water-Supply Paper 257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls., 25 text figures.

Designed for the needs of drillers and others interested in the development of underground resources. Describes the occurrence of oil and gas in different parts of the United States so as to enable drillers to select well sites with a definite idea of the rock formations that may be encountered. Gives a short account of the development of well construction and describes methods of drilling and boring in detail. The illustrations include well sections and cuts of the different devices and tools employed.

Water-Supply Paper 258. Underground-water papers. 1910. 123 pp., 2 pls., 32 text figures.

The fifth of a series of collections of papers that give brief accounts of investigations of special underground-water problems by the United States Geological Survey. Discusses some peculiar conditions affecting the economic value of wells and the occurrence of water in certain rocks of widespread occurrence. Contains the following papers:

Drainage by wells, by M. L. Fuller.

Freezing of wells and related phenomena, by M. L. Fuller.

Occurrence and composition of well waters in the slates of Maine, by F. G. Clapp.

Occurrence and composition of well waters in the granites of New England, by F. G. Clapp.

Pollution of underground waters in limestone, by G. C. Matson.

Protection of shallow wells in sandy deposits, by M. L. Fuller.
Composition of mineral springs in Maine, by F. G. Clapp.
Saline artesian waters of the Atlantic Coastal Plain, by Samuel Sanford.
Magnetic wells, by M. L. Fuller.
The utilization of the underflow near St. Francis, Kans., by H. C. Wolff.

Water-Supply Paper 260. Preliminary report on the ground waters of Estancia Valley, New Mexico, by Oscar E. Meinzer. 1910. 33 pp.

A brief report summarizing the geology of the district, the character of the soils, the source, disposal, recovery, and quality of its waters, and the prospects of improving conditions by irrigation.

Water-Supply Paper 262. Surface water supply of the United States, 1909; Part II, South Atlantic coast and eastern Gulf of Mexico, prepared under the direction of M. O. Leighton by M. R. Hall and R. H. Bolster. 1910. 150 pp., 5 pls.

Water-Supply Paper 263. Surface water supply of the United States, 1909: Part III, Ohio River basin, prepared under the direction of M. O. Leighton by A. H. Horton, M. R. Hall, and R. H. Bolster. 1911. 192 pp., 6 pls.

Water-Supply Paper 264. Surface water supply of the United States, 1909: Part IV, St. Lawrence River basin, prepared under the direction of M. O. Leighton by C. C. Covert, A. H. Horton, and R. H. Bolster. 1911. 130 pp., 5 pls.

Water-Supply Paper 265. Surface water supply of the United States, 1909: Part V, Hudson Bay and upper Mississippi River basins, prepared under the direction of M. O. Leighton by Robert Follansbee, A. H. Horton, and R. H. Bolster. 1911. 231 pp., 4 pls.

Water-Supply Paper 270. Surface water supply of the United States, 1909: Part X, The Great Basin, prepared under the direction of M. O. Leighton by E. C. La Rue and F. F. Henshaw. 1910. 192 pp., 5 pls., 1 text figure.

Water-Supply Papers 262 to 265, inclusive, and 270 contain descriptions of the drainage basins named and the results of stream measurements in them, namely, gage-height records, results of current-meter measurements, and daily and monthly discharges. Illustrations showing typical gaging stations, current meters, and rating curves accompany each book.

Mineral resources of the United States, calendar year 1909; 54 advance chapters, namely:

Summary of mineral production in the United States in 1909, compiled by W. T. Thom. 59 pp.
Metals and metallic ores in 1908 and 1909, by Waldemar Lindgren. 7 pp.
Iron ore, pig iron, and steel, by E. F. Burchard. 31 pp.
Movement of Lake Superior iron ore in 1909, by John Birkinbine. 7 pp. Contains a map showing distribution of the ores.
Manganese ore, by E. F. Burchard. 15 pp.
Gold and silver, by H. D. McCaskey. 33 pp.
Copper, by B. S. Butler. 34 pp.
Lead, by C. E. Siebenthal. 25 pp.
Zinc and cadmium, by C. E. Siebenthal. 24 pp.
Gold, silver, copper, lead, and zinc in the Western States and Territories (mine production), by A. H. Brooks, C. N. Gerry, V. C. Heikes, C. W. Henderson, H. D. McCaskey, Chester Naramore, and C. G. Yale. 275 pp.

Silver, copper, lead, and zinc in the Central States (mine production), by B. S. Butler and C. E. Siebenthal. 41 pp.

Gold, silver, copper, lead, and zinc in the Eastern States (mine production), by H. D. McCaskey. 17 pp.

Quicksilver, by H. D. McCaskey. 13 pp.

Bauxite and aluminum, by W. C. Phalen. 14 pp.

Antimony, arsenic, bismuth, and selenium, by F. L. Hess. 9 pp.

Tungsten, nickel, cobalt, vanadium, titanium, molybdenum, tantalum, uranium, and tin, by F. L. Hess. 16 pp.

Chromic iron ore, by E. F. Burchard. 5 pp.

Platinum and allied metals, by Waldemar Lindgren. 9 pp.

Coal, by E. W. Parker. 195 pp., 4 text figures.

Anthracite coal, by E. W. Parker. 12 pp.

Coal briquetting, by E. W. Parker. 17 pp.

Coke, by E. W. Parker. 57 pp.

Natural gas, by B. Hill. 36 pp.

Petroleum, by D. T. Day. 129 pp.

Petroleum operators' statistics of petroleum production, by D. T. Day. 10 pp.

Peat, by C. A. Davis. 6 pp.

Cement industry, by E. F. Burchard. 22 pp., 2 text figures.

Clay-working industries, by Jefferson Middleton. 67 pp.

Building operations, by Jefferson Middleton. 17 pp.

Glass sand, other sand, and gravel, by E. F. Burchard. 26 pp.

Sand-lime brick, by Jefferson Middleton. 7 pp.

Slate, by A. T. Coons. 14 pp.

Stone and lime, by E. F. Burchard. 51 pp.

Abrasive materials, by W. C. Phalen. 21 pp.

Fluorspar and cryolite, by E. F. Burchard. 8 pp.

Borax, by C. G. Yale. 4 pp.

Gypsum, by E. F. Burchard. 11 pp.

Lithium, by F. L. Hess. 7 pp.

Phosphate rock, by F. B. Van Horn. 7 pp.

Salt and bromine, by W. C. Phalen. 25 pp.

Sulphur and pyrite, by W. C. Phalen. 14 pp.

Barytes and strontium, by E. F. Burchard. 6 pp.

Mineral paints, by E. F. Burchard. 22 pp.

Asbestos, by J. S. Diller. 11 pp.

Asphalt, related bitumens, and bituminous rock, by D. T. Day. 5 pp.

Fuller's earth, by F. B. Van Horn. 6 pp.

Gems and precious stones, by D. B. Sterrett. 74 pp.

Graphite, by E. S. Bastin. 34 pp.

Magnesite, by C. G. Yale. 5 pp.

Mica, by D. B. Sterrett. 14 pp.

Mineral waters, by Samuel Sanford. 41 pp.

Monazite and zircon, by D. B. Sterrett. 11 pp.

Quartz and feldspar, by E. S. Bastin. 9 pp.

Talc and soapstone, by J. S. Diller. 11 pp.

Geologic Folio 172. Description and maps of the Warren quadrangle, comprising 222 square miles in Pennsylvania and New York, by Charles Butts. 1910. 11 folio pages of text, including 17 text figures, and geologic and topographic maps. Published also in octavo form, 80 pages of text, with 17 figures; maps in pocket.

Geologic Folio 174. Description and maps of the Johnstown quadrangle, comprising 228 square miles in Pennsylvania, by W. C. Phalen. Surveyed in cooperation with the Topographic and Geologic Commission of Pennsylvania. 1910. 15 folio pages of text, including 12 text figures, with columnar and structure section sheets and topographic and geologic maps. Published also in octavo form, 110 pages, 12 figures; maps in pocket.

Geologic Folio 175. Description and maps of the Birmingham quadrangle, comprising 992 miles in north-central Alabama, by Charles Butts. 1910. 24 folio pages of text, columnar and structure section sheets, geologic and topographic maps, 12 plates, 17 text figures. To be published also in octavo form.

Geologic Folio 176. Description and maps of the Sewickley quadrangle, comprising 227 square miles in west-central Pennsylvania, by M. J. Munn. 1911. 16 folio pages of text, a columnar-section sheet, 8 text figures, and 4 maps showing topography, geology, and occurrence of oil and gas. Published also in octavo form, 121 pages, 8 figures; maps in pocket.

Geologic Folio 177. Description and maps of the Burgettstown and Carnegie quadrangles, comprising 455 square miles in Pennsylvania, by E. W. Shaw and M. J. Munn. 1911. 16 folio pages of text, columnar and well section sheets, geologic and topographic maps, and 10 text figures. To be published also in octavo form.

Topographic maps as follows:

Abingdon, Va.–Tenn.–N. C.[1]
Antelope, Cal.
Antrim, Ohio.
Antwerp, N. Y.
Arcade, Cal.
Barrett, Minn.
Bath, N. Y.
Bouldin, Cal.
Bruceville, Cal.
Butler, Pa.
Calumet special, Mich.
Carlyle, Ill.
Circle, Alaska.
Clay City, Ind.
Coahoma, Miss.
Columbiana, Ala.
Covington, Ohio.
Crater Lake National Park.[1]
Danforth Hills, Colo.
Dawson Springs, Ky.
Dundee, Miss.
Eaton, Colo.
Ellijay, Ga.–N. C.–Tenn.[1]
Ellsworth, Me.
Emmittsburg, Md.–Pa.
Fayetteville, W. Va.
Fond du Lac, Wis.
Fort Bayard special, N. Mex.
Fowlerville, Mich.
Frazeysburg, Ohio.
Frisco special, Utah.[1]
Fryeburg, Me.–N. H.
Galt, Cal.
Greenwood Lake, N. J.–N. Y.[1]
Hardinville, Ill.
Hawthorne, Nev.–Cal.
Headreach, Cal.
Hennepin, Ill.[1]
Herman, Mich.
Jersey, Cal.
Jonestown, Miss.
Knights Landing, Cal.
La Salle, Ill.[1]
Leadville special, Colo.
Leavenworth, Kans.
Lincoln, Cal.
McComb, Okla.
McConnelsville, Ohio.
Macon, Mo.
Marcuse, Cal.
Meadows, Idaho.
Monticello, N. Y.
Montevallo, Ala.
Mount Vernon, Wash.
Murphysboro, Ill.
Neenah, Wis.
Neversink, N. Y.
New Hope, Cal.
New Kensington, Pa.
New Lexington, Ohio.
Nicolaus, Cal.
Okawville, Ill.
Parker, Ariz.–Cal.
Peytona, W. Va.
Philo, Ohio.
Pikeville special, Tenn.
Prince Frederick, Md.
Princeton, Ky.
Pullman, Wash.–Idaho.
Quincy, Wash.
Ramapo, N. Y.–N. J.[1]
Red Rock, Wash.
Rio Vista, Cal.
Roseville, Cal.
San Marcos, Tex.
Sheridan, Cal.
Sheridan, Wyo.–Mont.
Southern California No. 3.
Sutton special, W. Va.
Taneytown, Md.–Pa.
Uncompahgre, Colo.
U. S. base, 8 by 12½ inches.
U. S. base, 49 by 76 inches.[1]
Vernon, Cal.
Walnut Lake, Miss.
Wheatland, Cal.
Winchester, Wash.
Winnebago special, Wis.
Woodbridge, Cal.
Zelienople, Pa.

[1] New editions.

FIELD WORK BY THE DIRECTOR.

The Director did not make the usual inspection visits to field parties in the summer of 1910 for the reason that he attended the International Geological Congress held in Stockholm, Sweden, which afforded opportunity for conference with the administrative officers of the official geological surveys of other countries. The Director also visited the French Army Geographic Service, which makes the official topographic surveys, and the office of the Geological Survey of Great Britain. The delegation representing the United States Geological Survey at the Stockholm congress included also Messrs. Emmons, Hague, Becker, Lindgren, and Cross.

In November the Director visited the California oil fields with a view of ascertaining present conditions and made a report on the results to the Secretary of the Interior, urging remedial legislation. In May and June, 1911, in company with a geologist and an engineer, he made a preliminary examination of the two forest tracts in Georgia and Tennessee, on which favorable reports were afterwards submitted to the Secretary of Agriculture for the use of the National Forest Reservation Commission.

GEOLOGIC BRANCH.

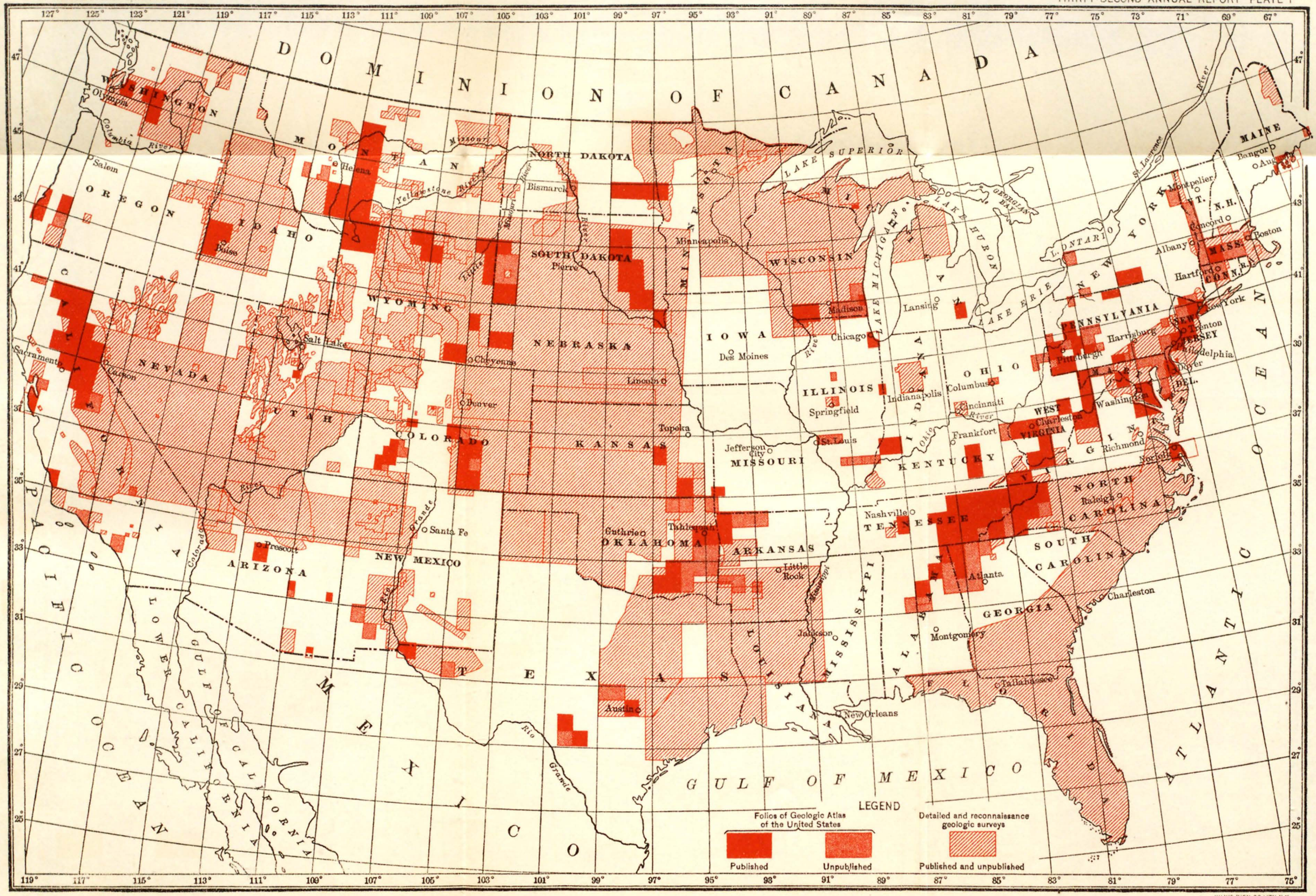
ADMINISTRATION.

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

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

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 5 geologic folios, 1 professional paper, 19 bulletins, and the annual volumes on mineral resources. Besides these publications a considerable number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies. Such publications are ordinarily restatements



MAP OF UNITED STATES, SHOWING AREAS COVERED BY GEOLOGIC SURVEYS

Scale
100 0 100 200 300 Miles

1911

JULIUS BIEN CO LITH. N.Y.

of results in a more technical form, and are usually prepared by members of the Survey without compensation. Some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications.

The progress of geologic mapping during the year is shown on Plate I.

DIVISION OF GEOLOGY.

ORGANIZATION.

The scientific force at the beginning of the year consisted of 54 geologists, 58 assistant geologists, and 11 junior geologists. During the year there were 4 resignations, 1 death, and 39 appointments, resulting in a net gain of 34, the total being 157 at the end of the year. Of the total number, 92 were continuously employed, 37 carried on the per diem roll gave only a portion of their time to Survey work, and 33 were not employed during the year. In addition to the regular force 15 field assistants were employed for a portion of the year.

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

Areal and structural geology, Arthur Keith in charge.
Paleontology and stratigraphic geology, T. W. Stanton in charge.
Economic geology, metalliferous ores, Waldemar Lindgren in charge.
Economic geology, nonmetalliferous minerals, F. B. Van Horn in charge.
Economic geology, fuels, M. R. Campbell in charge.
Land-classification board, W. C. Mendenhall in charge.

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

FIELD WORK OF THE CHIEF GEOLOGIST.

The administrative duties of the chief geologist are such as to prevent him from carrying on systematic field work. His work outside of the office, therefore, consists chiefly of field conferences for determining questions in dispute and for planning future work.

During November, 1910, the chief geologist was temporarily assigned to the War Department to procure data relating to the geologic conditions in the Canal Zone, and especially in the Culebra cut, for the use of the President. He made a study of the causes of landslides and other failures in the sides of the cut and of means for their prevention, and submitted to the Secretary of War a report on the subject, embodying conclusions and recommendations. A summary statement of the results of the work was included in the

President's message to Congress. As a result of recommendations contained in the chief geologist's report the Isthmian Canal Commission in December applied to the Survey for a geologist to make a thorough geologic study of the Culebra cut and of the Canal Zone generally. Assistant Geologist D. F. MacDonald was selected for the work, and in January was assigned to the Canal Commission and reported for duty to the chairman and chief engineer.

In March the chief geologist made a visit to southern Utah to determine the geologic relations of certain potash-bearing minerals reported to occur there. In May he attended a field conference with several Survey geologists in the Ducktown copper district, Tennessee, and another in Vermont in relation to certain disputed points in the geologic structure near Brandon.

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

WORK OF THE CHIEFS OF SECTIONS.

Section of areal and structural geology.—The work of Arthur Keith has been, for the most part, of an administrative character, consisting mainly of conferences with other geologists and supervision and inspection of results in areal and structural geology, both in the field and in the office. Much of this work comes in connection with the geologic folios, in which responsibility for form and adequate treatment rests on Mr. Keith. The attainment of harmony and unity in the folios requires frequent conferences on all matters treated in them. Such conferences are also necessary for the maps and descriptions in reports dealing with areal geology, which form a large part of the survey publications.

A great deal of Mr. Keith's time has been devoted to service on committees, including those on geologic names, illustrations, plans, and maps. The largest single element of the committee work has been that on geologic names, under his chairmanship.

Maps submitted for folio publication of the following quadrangles were inspected: Boston, Marlboro, Greylock, Mass.; Taconic, Mass.-Vt.; Ellijay, Ga.; Ducktown, Tenn.; Frostburg, Md.

Field conferences were held by Mr. Keith with the geologists responsible for the areal geology in the following quadrangles: Sheffield, Pittsfield, Boston, Mass.; Peterboro, N. H.; Brandon, Vt.; Dahlonega, Ga.; Ducktown, Tenn.

Mr. Keith made a review of the areal geology of the Cowee and Kings Mountain quadrangles (N. C.), and continued, with D. B. Sterrett, the joint study of the areal geology of the Gaffney quadrangle (S. C.).

Special investigations were continued by Mr. Keith into the faulted structure of Hoosac Mountain, in the Greylock and Becket quad-

rangles, Mass. In association with L. M. Prindle, Mr. Keith made a special study of the subdivisions of the Cambrian and Ordovician strata in the northeastern part of the Hoosick quadrangle (N. Y.-Vt.) and the adjoining corner of the Cambridge quadrangle (N. Y.).

Reconnaissances were made by Mr. Keith in the following quadrangles: Dover, N. H.; Framingham, Mass.; Winston Salem, N. C.; Abbeville, S. C.; Suwanee and Atlanta, Ga.

The greater portion of Mr. Keith's office time was occupied with investigations and discussions in connection with geologic folios. The descriptive texts of eight folios in course of preparation were critically read, and the structural geology and areal mapping of these and many others were specially considered. In the editorial work Mr. Keith was assisted in the last half of the year by Laurence La Forge.

Numerous papers presented for publication by the Survey were critically read, and the geologic maps for Survey reports were examined. The scheme of separate representation on a single map of the faunal and lithologic elements involved in a geologic formation, which was proposed by Mr. Keith three years ago, is now being carried out in some of the folios and other publications of the Survey.

Section of paleontology and stratigraphic geology.—T. W. Stanton was absent from Washington on field duty from July 6 to October 1, 1910. His field studies were made mostly in cooperation with geologic parties engaged in areal and land-classification work in the coal and phosphate fields of the Rocky Mountain region, their main object being to gain personal detailed knowledge of the stratigraphic sections and to collect paleontologic evidence for use in correlation and definition of formations. The areas visited were Vermejo Park, N. Mex.; the Canon City coal field (Colo.) with W. T. Lee; the Apishapa quadrangle (Colo.) with G. W. Stose, for the purpose of identifying the Comanche series; the Colorado Springs and Denver areas (Colo.) with G. B. Richardson; Newcastle, Wyo.; a large area in eastern Wyoming, covered by wagon reconnaissance with A. R. Schultz, to visit parties under J. A. Davis near the Montana line, V. H. Barnett southeast of Gillette, D. E. Winchester near Douglass and the Lance Creek area, and C. H. Wegemann on the upper Powder River and in the Salt Creek oil field; Columbus, Mont., and the region to the north with W. R. Calvert and F. H. Knowlton; and the phosphate field of southeastern Idaho with R. W. Richards.

All of Mr. Stanton's time in the office has been occupied in the usual routine work, including the examination of the numerous current collections of fossils and the preparation of reports on them for the use of geologists, committee work, reading of referred manuscripts, and other administrative duties connected with the supervision of the section of paleontology and stratigraphy and the preser-

vation and classification of the collections. Under the last item, with the assistance of T. E. Willard, nearly all the large collections of Mesozoic invertebrates which were recently moved into the new building of the National Museum have been classified and arranged in cases so that they are easily accessible for study or quick reference.

Section of economic geology, metalliferous ores.—During the early part of July Waldemar Lindgren was engaged chiefly in administrative work in connection with the section of metalliferous deposits and paid a brief visit to Ducktown, Tenn., to inspect the geologic work there in progress. From July 23 to September 14 he was in attendance at the Eleventh International Geological Congress in Sweden. After his return he was engaged in administrative work for the division of mineral resources and for the section of metalliferous deposits, his time being about equally divided between the two. From December 1 to 22 he was on leave without pay, lecturing at the Massachusetts Institute of Technology. On his return he was occupied chiefly with administrative duties, except during about one week, which was devoted to a report on the Republic district, Washington. On May 19 he proceeded to Arizona, where he examined mines at Bisbee and inspected geologic work in the Tucson quadrangle. He spent the greater part of June in a geologic study of the new district at National, Nev. During the year he compiled and submitted for publication a report on the production of platinum in 1909.

Section of economic geology, nonmetalliferous minerals.—During the first half of the year F. B. Van Horn was occupied by administrative duties in Washington. From February 16 to March 10 he was in Florida and South Carolina, and from April 3 to April 14 in Tennessee and Arkansas, studying the occurrence and methods of mining of the phosphate deposits of those States. The rest of the year he spent in administrative work, mainly for the geologic branch, and as acting chief geologist.

Plans were formulated for a systematic search for commercial deposits of potash in this country. The appropriation for this work was not available until July 1, 1911, but it was thought desirable to do as much as possible toward getting the work well under way. As a result sites have been selected which appear most favorable for the accumulation of potash deposits, and drilling will be commenced very early in the new fiscal year.

Mr. Van Horn also prepared reports on the production of phosphate rock in 1909 and 1910 for publication in the volume "Mineral Resources."

Section of economic geology, fuels.—As in previous years, the work on fuels was in charge of M. R. Campbell, who divided his time between the field and the Washington office.

Mr. Campbell left Washington July 12, 1910, going first to the Yellowstone National Park to see if it was possible to prepare a popular description of the natural features of this park. This work was interrupted by a request from the Interior Department that Mr. Campbell should accompany C. S. Ucker, chief clerk, in an official trip of inspection through the new Glacier National Park. This trip extended from July 28 to August 9.

After a brief trip to Denver to attend to administrative duties, Mr. Campbell, at the request of Mr. Ucker, returned to the Glacier National Park to make an examination of mineral claims in the park. Forest fires prevented field work from August 18 to August 28, but active service began on the latter date and continued to October 3. Mr. Campbell visited parties engaged on coal work in the vicinity of Grand Junction, Colo., and then proceeded east, reaching Washington October 19, 1910.

In order to obtain information regarding reported coal fields on the Pacific coast of Mexico, Mr. Campbell made a hasty trip to the States of Sonora and Sinaloa, returning to Washington November 22, 1910.

During the winter the results of the field examinations were compiled in the office. This work involved the preparation of geologic maps of township plats showing the classification and valuation of the coal and oil lands examined, of special reports on the geology and economic resources of certain regions, and of the annual volume "Contributions to economic geology, Part II," which was submitted for publication.

Mr. Campbell left Washington June 6, 1911, to begin a study of the general geology of the Glacier National Park. After outfitting at Belton, Mont., he continued field work to the end of the present fiscal year.

Subsection of fuels east of meridian 97°.—In addition to supervising the work of the survey on the coal fields of Alabama, Tennessee, Illinois, and Missouri, David White made paleobotanic field examinations in the western Kentucky coal field, the Cherokee series of southern Iowa, the Cahaba Basin of Alabama, and the "Red Beds" of Oklahoma and Texas, the object of the work in the area last named being to obtain evidence as to the age of the rocks supposed to be near the horizon of the Wreford limestone of Kansas. Preliminary results of the work on the "Red Beds" have been reported in unofficial publications. Mr. White's other paleobotanic studies have been limited to those necessary for informal reports and correlations based on current collections submitted by Survey geologists.

The microscopic investigations of coals undertaken by the technologic branch of the Geological Survey to ascertain the relation of the kinds of plant material forming coals and the state of its preser-

vation to the chemical qualities and economic value of the coals have passed out of the hands of the Geological Survey since the organization of the Bureau of Mines, but by request of that bureau the supervision of this work was continued in Mr. White's charge. Mr. White's connection with this work, however, was terminated in June, 1911, by his submission of manuscripts discussing the local geologic relations of the coals examined, the general physiographic conditions attending the formation of the great coal beds, and the part played by metamorphism in the development of coals of different grades, the whole matter constituting his part of a report to be published by the Bureau of Mines.

GEOLOGIC WORK IN NEW ENGLAND STATES.

A small amount of geologic work was done in Maine in continued cooperation with the State, $350 being spent by each Survey. Office work on the Eastport folio was continued by E. S. Bastin, who was assisted during the fall of 1910 by C. L. Breger. The office work on the maps and text has been carried as far as it can be until further paleontologic work is completed.

Mr. Breger left the survey December 31, 1910, when the paleontologic work in Maine was taken over entirely by H. S. Williams, under whose general direction Mr. Breger had been working. Prof. Williams has been engaged on the systematic determination and description of the large collections of fossils from the Eastport quadrangle and other portions of Maine. Work was continued on the preparation of the Mount Desert folio by C. W. Brown.

The final maps and text of the geologic folio covering the Ware quadrangle, Massachusetts, have been completed and submitted for publication by B. K. Emerson. Prof. Emerson has also completed the final revision of the geologic map of Massachusetts and Rhode Island on the scale of 4 miles to the inch.

In the northeastern part of the Hoosick quadrangle (Mass.-N. Y.) and the adjoining part of the Cambridge quadrangle (N. Y.-Vt.) special studies were carried on by L. M. Prindle and Arthur Keith in order to subdivide the Cambrian and Ordovician formations and to determine the structural relations of the region. Preliminary maps covering this work have been prepared by Mr. Prindle.

The preparation of the manuscript for the Housatonic (Mass.) folio by Joseph Barrell, in association with B. K. Emerson and T. N. Dale, is well advanced.

A folio covering the Boston and Boston Bay quadrangles has been in preparation for a number of years by members of the geological departments of Harvard University and the Massachusetts Institute of Technology. The completion of the folio was assigned to Laurence

La Forge and during the year the field work was finished; the office work on the folio is now well advanced. Although many facts concerning the geology of this region were known it was necessary for Mr. La Forge to cover the ground practically anew.

The marble quarries of Vermont have been examined by T. N. Dale, who has collected material for the preparation of an economic report on the marble belts of the western part of the State. Mr. Dale also prepared a supplementary report on the commercial granites of Massachusetts, to be published in Bulletin 470, and, together with H. E. Gregory, a report on the granites of Connecticut (Bulletin 484).

In addition to performing his duties as geologist in charge of the section of areal and structural geology, Arthur Keith devoted considerable time during the year to the study of some of the more obscure and complicated problems of New England geology. Among these are the structure of Hoosac Mountain and the Berkshire Hills, in Massachusetts; the age of the metamorphosed gneisses and schists northeast of Worcester, Mass.; the age of the quartzite and schist bodies west of the Boston Basin; and the stratigraphy of the district between Newburyport, Mass., and Portsmouth, N. H.

WORK IN NORTHERN APPALACHIAN REGION.

Several years ago G. K. Gilbert surveyed the Niagara Falls quadrangle in connection with his study of the history of the falls, but was unable to prepare the folio for publication. The completion of this work was assigned to E. M. Kindle and F. B. Taylor, Mr. Kindle taking the geology of the hard rocks and Mr. Taylor the Pleistocene deposits and the physiography of the region. Necessary additional field work was completed and the preparation of the folio is well advanced.

In continuation of a cooperative agreement with the State Geological Survey of New Jersey, the Survey's work on the Greenwood Lake-Ramapo folio was completed by W. S. Bayley. The discussion of the Paleozoic and later geology for this folio is being prepared by State geologist H. B. Kümmel. The manuscript of the descriptions of the pre-Cambrian rocks for the Delaware Water Gap folio has also been completed by Mr. Bayley, and Mr. Kümmel will prepare a description of the geology of the later formations on the New Jersey side of Delaware River. This work completes the mapping and description of the Paleozoic and pre-Cambrian formations of New Jersey.

The preparation of the text for folios on the Reading and Boyertown and the Honeybrook and Phoenixville quadrangles, in eastern Pennsylvania, was continued by Florence Bascom. Miss Bascom also completed a survey and petrographic study of the volcanic rocks of the Fairfield, Gettysburg, and Carlisle quadrangles and

made progress in the preparation of the text and description of these rocks for the Fairfield-Gettysburg folio, by G. W. Stose and Florence Bascom.

Work on the coal fields in Pennsylvania, prosecuted in cooperation with the State, has for the most part been confined to the preparation of reports on quadrangles previously studied. The folio manuscripts for the Hollidaysburg and the Barnesboro and Patton quadrangles were revised and completed by Charles Butts. On account of the intimate connection between the complex stratigraphic problems of the Hollidaysburg quadrangle and those of the adjacent Bellefonte quadrangle, now under study, further steps in the preparation and publication of the Hollidaysburg folio are temporarily postponed. Progress on the Punxsutawney, Houtzdale, and Curwensville folios, by G. H. Ashley, and on the Newcastle folio, by F. W. De Wolf, has been delayed by their duties as State geologists of Tennessee and Illinois, respectively, but it is confidently expected that the Punxsutawney and Newcastle folios will be submitted by the authors during the current year.

The Warren, Johnstown, Sewickley, and Burgettstown-Carnegie folios have been published, as also has a bulletin (No. 447) on the "Mineral resources of Johnstown, Pa., and vicinity." The Foxburg-Clarion folio was in press at the close of the year. The bulletin on the "Geology of the oil and gas fields in the Sewickley quadrangle," submitted by this Survey to the Topographic and Geologic Survey Commission of Pennsylvania in 1908 for publication, has recently been published by the State.

An arrangement was made with Prof. E. S. Moore, of Pennsylvania State College, for the survey of the Bellefonte quadrangle and the preparation of the geologic folio. It is expected that this folio will be submitted for publication during the coming year.

The manuscript for the Frostburg-Flintstone (Md.) folio, by G. W. Stose and C. K. Swartz, was submitted for publication, in cooperation with the Maryland Geological Survey.

WORK IN SOUTHERN APPALACHIAN REGION.

M. J. Munn has practically completed the field work for a report on the oil and gas fields of eastern Kentucky, in cooperation with the State Survey, and has submitted preliminary reports on the Campton oil field and on the oil and gas developments of Knox County, Ky., for publication in Bulletin 471.

Some additional field work was done by W. C. Phalen on the Kenova quadrangle (Ky.), and the folio has been submitted for publication.

Field work was carried on by G. W. Stose in the Abingdon quadrangle, in southern Virginia, and progress was made in the prepara-

tion of a geologic folio. The Cambrian and older rocks in about half of the quadrangle had already been surveyed by Arthur Keith, but the completion of the work was delayed pending topographic revision. Mr. Stose gave special attention to the examination of deposits of salt, gypsum, and iron in this area.

In Tennessee the survey of the Pikeville special quadrangle, in cooperation with the State, was nearly completed by W. C. Phalen, assisted by Henry Hart, of the Tennessee State Survey. A preliminary report by Mr. Phalen on the coal resources of the quadrangle has been submitted for publication by the State. In June, 1911, work was resumed on the Pikeville folio by Charles Butts, and a special study of the paleontology and stratigraphy of the region was undertaken by George H. Girty.

In cooperation with the State Survey a preliminary report on the oil and gas developments in Tennessee was prepared by M. J. Munn and published by the State Survey.

A detailed study has been made of the copper deposits at Ducktown, Tenn., and the areal and structural geology of the Ducktown special area. W. H. Emmons and F. B. Laney were associated in this work, Mr. Emmons studying especially the ore deposits and Mr. Laney the geology of the district. A brief paper on the ore deposits has been prepared by Mr. Emmons and Mr. Laney for publication in Bulletin 470 and also by the State Survey. A full report embodying the results of the investigation is nearly completed.

M. J. Munn made a reconnaissance examination of the Fayette gas field, Alabama, in cooperation with the Alabama Geological Survey, and has prepared a report for publication by the State. He has also prepared a briefer paper on this field for publication in Bulletin 471.

The survey of the Bessemer quadrangle (Ala.) was completed by Charles Butts for folio publication. From December to May Mr. Butts was occupied in office work in preparing reports on iron, marble, and dolomite of the Bessemer region for publication in Bulletin 470.

A report on the coal of the Dan River field (N. C.), based on a brief field examination made near the close of the previous fiscal year, has been submitted by R. W. Stone.

The areal and economic survey of the Gaffney and Kings Mountain region (N. C.–S. C.) was continued by Arthur Keith and D. B. Sterrett, and that of the Gaffney quadrangle was completed as far as the field surveys have gone.

The revision of the areal mapping of the Cowee quadrangle (N. C.) was completed by Mr. Keith and Mr. Sterrett. A report on the economic deposits of the Cowee quadrangle was prepared by

Mr. Sterrett, and the Cowee areal map for the folio was completed by Mr. Keith.

A reconnaissance of the Lincolnton quadrangle (N. C.) was made by Mr. Sterrett, and one of the Winston-Salem (N. C.), Abbeville (S. C.), and Suwanee and Atlanta (Ga.) quadrangles by Mr. Keith.

The areal and economic survey of the Dahlonega quadrangle (Ga.) was continued by F. B. Laney, the mapping for the northern half of the quadrangle being completed. In connection with this work Mr. Laney revised the areal mapping of the gneisses in adjoining parts of the Ellijay quadrangle (Ga.). The office work on the Dahlonega map was completed by Mr. Laney for the area covered in the field. The manuscript for the Ellijay folio has been submitted by Laurence La Forge for publication.

WORK IN ATLANTIC AND GULF COASTAL PLAIN.

In cooperation with the State geological surveys, a systematic study of the Atlantic and Gulf Coastal Plain was continued throughout the year. The work was carried on under the general supervision of T. W. Vaughan, who personally inspected several critical localities. W. B. Clark continued in immediate charge of the Coastal Plain work north of and including North Carolina, and Mr. Vaughan has immediate charge of the work in the remainder of the Coastal Plain.

Work was continued by W. B. Clark and his assistants on the State Survey in preparation of folios on the Coastal Plain of Maryland. This work is done in cooperation between the Federal and State surveys, and the manuscript for the Choptank folio, by B. L. Miller, was submitted for publication.

Field work was continued in western Florida and southern Alabama and Mississippi by G. C. Matson. Mr. Matson was for several months employed by the General Land Office to examine and classify public lands in Florida with reference to their value as phosphate lands.

L. W. Stephenson continued investigations of the Cretaceous rocks of the Coastal Plain in Alabama, Mississippi, Tennessee, Kentucky, Illinois, and Arkansas. During the year he completed reports on the stratigraphy of the Cretaceous deposits of Georgia and on the underground waters of the Cretaceous of Georgia. Mr. Stephenson also submitted two memoirs for publication as a professional paper—one on the Cretaceous deposits of the eastern Gulf region and the other on the species and varieties of Exogyra from the eastern Gulf region and the Carolinas.

Systematic investigations of the fossil plants found in the Tertiary and Cretaceous formations of the Coastal Plain were con-

tinued during the year by E. W. Berry. Field work was done in Georgia, Florida, Alabama, Mississippi, and Arkansas. In addition to this field work and the work of preparing reports on collections made by him and others, Mr. Berry has completed the manuscript for a bulletin on the Upper Cretaceous floras of South Carolina.

The study of the central Coastal Plain of Texas was continued by Alexander Deussen, who made reconnaissance surveys of Comal, Guadalupe, Gonzales, Dewitt, Victoria, and Calhoun counties. Analyses were made of 62 samples of water from typical wells in this region. Mr. Deussen also completed a short report on the clays of Texas for publication in Bulletin 470.

WORK IN CENTRAL STATES EAST OF MERIDIAN 97°.

In Illinois geologic investigations were continued under the cooperative agreement with the State, by which the results obtained by each Survey are made available for the use of the other. For the Federal Survey E. W. Shaw mapped the geology of the Tallula quadrangle and of one-half of the Illinois portion of the Galena and Elizabeth quadrangles. He also reviewed the Quaternary geology and physiography of several quadrangles previously surveyed in the southern part of the State. In the course of geologic work in southern Illinois during the last two years Mr. Shaw has worked out evidence of a new system of extinct lakes and has followed the lake beds southeastward as far as Madisonville, Ky. Mr. Shaw prepared a report on these lakes and transmitted it to the State Survey. In cooperation with members of the State Survey, Mr. Shaw prepared texts for the Murphysboro-Herrin and Tallula-Springfield folios. A report on the coal of the Springfield district was nearly completed and a general geologic report on the Belleville and Breese quadrangles was put in the form of a folio text. A paper on the clay resources of the Murphysboro quadrangle was prepared for publication in Bulletin 470. For the State Survey A. C. Trowbridge mapped the remaining areas in Illinois in the Galena and Elizabeth quadrangles, and U. S. Grant and G. H. Cady surveyed the greater part of the La Salle and Hennepin quadrangles. The results of Mr. Trowbridge's work will be published jointly with those obtained by Mr. Shaw. Messrs. Grant and Cady are preparing the La Salle-Hennepin folio, which will be furnished to this Survey by the State.

In cooperation with the State Geological Survey of Missouri, a survey of the coal fields of the State was begun, the work being placed in charge of Henry Hinds, of the Federal Survey, assisted by F. C. Greene, of the State Survey. The field investigations that will serve as the basis for economic reports on the coal resources and the

geologic structure of the coal fields of the State are approaching completion.

Additional work was done in July and August by C. E. Siebenthal in the Joplin lead and zinc district (Mo.) for the purpose of studying the deeper ore deposits in this district. At the same time Mr. Siebenthal revisited the Wyandotte quadrangle (Okla.) and brought up to date the notes on the mining geology, preparatory to writing the Wyandotte report and folio.

In Arkansas A. H. Purdue, assisted by H. D. Mizer, made a reconnaissance from the Hot Springs special quadrangle, the survey of which was completed last year, westward to the Caddo Gap quadrangle, for the purpose of connecting the two areas and correlating their stratigraphy. After completing this reconnaissance, Mr. Mizer devoted the remainder of the season to the areal mapping of the northern or mountainous portion of the De Queen quadrangle. The manuscript for the Eureka Springs-Harrison folio was completed and submitted for publication, and preparation of the Caddo Gap folio was advanced.

Some additional field work in the Lake Superior iron districts was undertaken during the year by C. K. Leith and W. J. Mead, under the direction of C. R. Van Hise. The results of this work were incorporated in the monograph on the Lake Superior region (Monograph LII), which is in press and will be published in October, 1911. The results of practically all exploratory work by the mining companies is placed at the disposal of Mr. Van Hise and his associates, so that the conclusions regarding the structure of the region and the distribution of the formations embody the best information obtainable.

The detailed study and areal mapping of the Pleistocene formations of southeastern Wisconsin has been completed by W. C. Alden northward to latitude 44°. In addition, during the last season, he surveyed portions of Manitowoc, Calumet, Winnebago, Waushara, Adams, and Juneau Counties. In the office Mr. Alden has nearly completed the manuscript for a professional paper covering the results of his work in southeastern Wisconsin.

The investigation of the Pleistocene geology in northern Michigan and adjacent portions of Wisconsin and Minnesota was continued by Frank Leverett, with the assistance of F. W. Sardeson. The State surveys of Wisconsin and Michigan cooperated to some extent in this work. Field work in northern Michigan was completed by Mr. Leverett, with the assistance of I. D. Scott, of the State Survey, and the map and report on the Northern Peninsula of Michigan, for publication by the State Survey, were completed. The monograph on the Pleistocene geology of Indiana and Michigan was completed by Mr. Leverett in association with F. B. Taylor.

WORK IN THE WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Central States west of meridian 97°.—N. H. Darton spent some months of the field season of 1910 in the Black Hills of South Dakota, mapping the pre-Cambrian rocks in the northern portion of the Deadwood quadrangle. He also adjusted the boundaries of several sedimentary formations in the Sturgis, Spearfish, and Rapid quadrangles and prepared portions of the text and maps for the Deadwood-Rapid folio. On October 15, Mr. Darton was transferred to the Bureau of Mines as geologist in that bureau. This transfer terminated his connection with the Geological Survey, a connection covering nearly 25 years.

Work was begun in June by Sidney Paige on the pre-Cambrian rocks of the Harney Peak quadrangle (S. Dak.) for folio publication.

The manuscript for the Bismarck (N. Dak.) folio has been submitted by A. G. Leonard for publication in cooperation with the State survey.

Progress has been made in preparing the Rapid-Deadwood (S. Dak.) folio, by N. H. Darton and Albert Johannsen.

At the time of the resignation of J. A. Taff from the Geological Survey (October 31, 1909) to accept employment as geologist in California, he had surveyed a number of quadrangles in Oklahoma, but had not completed the folios. The work of preparing these folios was assigned to C. D. Smith, who had acted as Mr. Taff's assistant and who was sent to California in order that he might readily confer with Mr. Taff concerning the work. Mr. Smith made considerable progress toward the completion of these folios. An arrangement was made with the State Survey of Oklahoma for cooperation in the survey of the Nowata quadrangle. The field work was three-quarters done by D. W. Ohern under the supervision of Mr. Smith, and was completed in the spring of 1911 by Mr. Smith, assisted by R. H. Wood. During the last three months of the year Mr. Smith has been engaged in surveying the Claremore quadrangle. This work is also being done in cooperation with the State and is practically completed.

Rocky Mountain region.—Work in the San Juan region, Colo., which has for several years been in charge of Whitman Cross, was continued by E. S. Larsen, jr., Mr. Cross being absent from the country attending the International Geological Congress at Stockholm. The survey of the San Cristobal quadrangle was practically completed by Mr. Larsen and some work was done on the Cebolla quadrangle. During the office season both Mr. Cross and Mr. Larsen continued the preparation of reports on the San Juan region.

During the year a systematic detailed study of the physiographic history of the San Juan district, with the areal mapping of the Quaternary deposits, was undertaken by W. W. Atwood, assisted

by K. F. Mather. Mr. Atwood completed the areal work for the Durango quadrangle and half of the La Plata quadrangle. He also made excursions into the higher mountains and to the southwest, over the adjoining plateaus, for comparative studies. This work is being carried on in close association with the studies of Whitman Cross and assistants on the geology of the older rock formations. The execution of the comprehensive plan adopted will require several years of field and office work.

The Apishapa quadrangle, in central Colorado, was mapped geologically several years ago by G. K. Gilbert, who was, however, unable to complete the folio for the quadrangle. Later the base map was improved and the geologic mapping was revised by G. W. Stose. The revision consisted chiefly of the mapping of a newly recognized Cretaceous formation. The folio covering this quadrangle is well advanced.

The mapping of the Deming quadrangle (N. Mex.) was completed by N. H. Darton. This work was begun several years ago in connection with studies of underground waters.

The bulletin on the Shinumo quadrangle (Ariz.), including an interesting portion of the Grand Canyon, has been completed by L. F. Noble, who has also completed a description of the Bright Angel quadrangle (Ariz.) to be printed on the back of the topographic sheet.

The manuscript for the Colorado Springs (Colo.) folio has been submitted by G. I. Finlay.

In New Mexico the Silver City quadrangle was surveyed by Sidney Paige, assisted by J. L. Rich, and the geologic folio was nearly completed. In addition to studies of the areal and structural geology, investigations were made of a number of mining districts in the quadrangle and several reports were prepared for publication in Bulletin 470. The quadrangle contains the Santa Rita mining district for which a special topographic map has been prepared. Detailed study of this mining district was not included in the work of Mr. Paige.

In connection with the investigation of underground waters by the Indian Office a geologic reconnaissance was made of the northwestern part of the Navajo Indian Reservation in Arizona and Utah by H. E. Gregory, assisted by J. E. Pogue. This was in continuation of work of the same character carried on during the preceding year.

During the summer of 1910 a beginning was made in the survey of the Glacier National Park in Montana by M. R. Campbell. Owing to the extensive forest fires the work was greatly impeded. In June, 1911, Mr. Campbell resumed field work in this park accompanied by W. C. Alden, who will make a special study of the Pleistocene deposits and glacial phenomena of the region.

Classification of mineral lands.—The study of the areal distribution and structure of the phosphate deposits in the northern Rocky Mountain region was continued during the year. R. W. Richards, assisted by G. R. Mansfield and J. H. Bridges, made a detailed examination of about 500 square miles of the withdrawn lands in Idaho, lying between the towns of St. Charles and Soda Springs, in Bear Lake and Bannock counties. Sufficient information was acquired to enable the Survey to place a valuation on these lands based on their content of phosphate. This information is available at any time that Congress enacts the necessary legislation for disposing of the lands at their appraised value. The area examined is estimated to contain over a billion tons of high-grade phosphate rock. A report on these deposits has been completed and submitted for publication in Bulletin 470. T. W. Stanton, G. H. Girty, and J. P. Smith spent considerable time with this party studying the associated paleontologic and stratigraphic problems. In June the field work on these phosphate deposits was resumed by Mr. Richards, assisted by Mr. Mansfield and E. L. Troxell.

A brief report on sulphur deposits near Soda Springs, Idaho, was prepared by Messrs. Richards and Bridges, and a report on the lead and copper deposits in the Bear River Range, Utah and Idaho, was prepared by Mr. Richards, both for publication in Bulletin 470.

A reconnaissance of parts of northwestern Wyoming and eastern Idaho, between Lander and Afton, was made by Eliot Blackwelder, assisted during a part of the season by C. L. Breger. The purpose of this reconnaissance was to determine the extent and character of the phosphate deposits northeast of the well-known Bear Lake region of southeastern Idaho. A brief report on the results has been submitted for publication in Bulletin 470, and the lands have been classified provisionally, preliminary to more detailed surveys which are contemplated in the immediate future.

Deposits of commercial rock phosphate in Montana, similar to those in Idaho, Wyoming, and Utah, were discovered in the vicinity of Melrose, Mont., and an area covering the known extent of the deposit was withdrawn from entry pending further field examination. A short report on these deposits by H. S. Gale was published as an advance chapter (A) from Bulletin 470, and a revision of this report is included in another advance chapter (470–H) now in press.

The description of the general geology of the Philipsburg quadrangle (Mont.) was completed by F. C. Calkins for publication as a professional paper on the geology and ore deposits, and the folio on the quadrangle was prepared in collaboration with W. H. Emmons, who wrote the sections relating to ore deposits.

An item in the sundry civil act of June 25, 1910, being an amendment to the act of February 26, 1895 (Stat. L., vol. 28, p. 683), en-

titled "An act to provide for the examination and classification of certain mineral lands in the States of Montana and Idaho," made an appropriation to the General Land Office for the completion of the classification as mineral or nonmineral of certain specified lands within the grant of the Northern Pacific Railroad Co. in Montana and Idaho. Under the authority of the Secretary of the Interior the field examination and classification of these lands was assigned to the Geological Survey. This work was done under the supervision of Waldemar Lindgren and the field and office work were placed in charge of H. S. Gale. D. F. MacDonald, assisted by E. L. Jones, jr.; F. C. Calkins, assisted by G. F. Loughlin; R. W. Stone, assisted by W. R. Hill; J. T. Pardee; and E. E. Smith were engaged in this work. A total area of 288,465 acres in Montana and Idaho has been examined and classified, as shown in the reports of the land-classification board. (See p. 68.)

From observations made in connection with his classification work Mr. Stone prepared a paper on the geologic relations of the ore deposits in the Elkhorn Mountains, Mont., for publication in Bulletin 470. In May and June the classification of Northern Pacific lands was resumed by parties in charge of F. C. Calkins, J. T. Pardee, and R. W. Stone.

Classification of public lands.—The field examinations necessary for the classification and valuation of the coal and oil lands of the West were continued throughout the year. As in previous years, the field work was in charge of M. R. Campbell. The following is a brief statement of the work accomplished and in progress at the end of the fiscal year, with the names of the geologists who are directly responsible for its prosecution:

Fort Berthold Indian Reservation, N. Dak. Examination made by M. A. Pishel. Land classified and report submitted.

Williston lignite field, N. Dak. Examination in progress by F. A. Herald, under the supervision of E. G. Woodruff.

Marmarth coal field, N. Dak. Examination in progress by C. J. Hares, under the supervision of E. G. Woodruff.

Perkins County coal field, S. Dak. Examination in progress by D. E. Winchester, under the supervision of E. G. Woodruff.

Harding County coal field, S. Dak. Examination in progress by E. M. Parks, under the supervision of E. G. Woodruff.

Coal near the Black Hills, Wyo.–S. Dak. Report submitted for publication by R. W. Stone. (Bulletin 499.)

Southern part of the Sidney coal field, Mont. Detailed examination made by Eugene Stebinger, under the supervision of W. R. Calvert. Land classified and report in preparation.

Culbertson coal field, Mont. Examined by A. L. Beekly, under the supervision of W. R. Calvert. Land classified and report in hand.

Glendive lignite field, Mont. Mapped and studied by J. H. Hance, under the supervision of W. R. Calvert. Land classified and report prepared.

Baker lignite field, Mont. Mapped by M. A. Pishel (temporarily in charge) and C. F. Bowen, under the supervision of W. R. Calvert. Land classified and report prepared.

Terry lignite field, Mont. Examination made by F. A. Herald, under the supervision of W. R. Calvert. Land classified and report well advanced. Investigation being continued by E. T. Hancock (temporarily in charge) and G. S. Rogers, under the supervision of E. G. Woodruff.

Part of Milk River coal field, Mont. Report begun by L. J. Pepperberg in 1909, completed by G. B. Richardson.

Big Snowy Mountains coal field, Mont. Geologic study for the purpose of ascertaining the eastern extent of the Judith Basin coal region, in progress by W. R. Calvert.

Flathead Indian Reservation, Mont. Examination of town and villa sites, in progress by Eugene Stebinger.

Tertiary coal fields of western Montana. Examination in progress by J. T. Pardee.

Belle Fourche Valley lignite field, Wyo. Examination in progress by V. H. Barnett, under the supervision of E. G. Woodruff.

Little Powder River coal field, Wyo. Examination made of the eastern part of the Little Powder River coal field by J. A. Davis, under the supervision of A. R. Schultz. Land classified and preliminary report prepared.

Western County coal field, Wyo. Examined by V. H. Barnett, under the supervision of A. R. Schultz. About 700 square miles classified; about 600 square miles withheld pending examination of the area to the east.

Lost Springs coal field, Wyo. Examined by D. E. Winchester, under the supervision of A. R. Schultz. Land classified and report in hand.

Platte River coal field, Wyo. Examined by D. E. Winchester, under the supervision of A. R. Schultz. Land classified and report in preparation.

Buffalo-Sheridan coal field, Wyo. Examination of the formations outcropping along the eastern base of the Bighorn Mountains being continued by C. H. Wegemann.

Sussex coal field, Wyo. Examined by C. H. Wegemann, under the supervision of A. R. Schultz. Land classified and report well in hand.

Powder River oil field, Wyo. Examined by C. H. Wegemann. Land classified and report practically completed (to appear in Bulletin 471).

Wiley quadrangle, Wyo. Examination to determine primarily the possible accumulation of oil, in progress by D. F. Hewett, under the supervision of E. G. Woodruff.

Southern part of Denver Basin coal field, Colo. Examination made by G. B. Richardson. Land classified and report practically prepared.

North Park coal field, Colo. Examination in progress by A. L. Beekly.

De Beque oil field, Colo. Examined by E. G. Woodruff and report well advanced.

Grand Mesa and West Elk Mountain coal field, Colo. Report submitted for publication by Willis T. Lee.

Coal resources of Gunnison Valley, Colo. Studied by E. G. Woodruff in company with G. B. Richardson. Report in hand.

Mancos coal field, Colo. Reconnaissance examination in progress by M. A. Pishel.

Canon City and Raton Mesa coal fields, Colo. and N. Mex. Stratigraphic studies made along the eastern front of the Rocky Mountains from Denver southward, by W. T. Lee, to determine the extent and value of certain unconformities and also for the general purpose of determining the geologic age of the coal-bearing rocks. Report in preparation.

New Mexico coal fields. Examination in progress by W. T. Lee.

Dayton and Toyah oil fields, N. Mex. and Tex. Examination made by G. B. Richardson.

Tertiary "lake beds" of the Snake River valley, Idaho. Segregation of noncoal or nonmineral areas in progress by C. F. Bowen.

Uinta Basin, Utah. Examination made of the Cretaceous coal-bearing rocks along the south flank of the Uinta Mountains, from a point near the Colorado line westward to Currant Creek Valley, by C. T. Lupton. Investigation southward through Strawberry Valley in progress. The report is well in hand.

Sunnyside quadrangle, Utah. Examination in progress by F. R. Clark, under the supervision of C. T. Lupton.

San Juan oil field, Utah. Report completed and submitted by E. G. Woodruff (in Bulletin 471).

Part of Parowan Range, Utah. Rapid reconnaissance of coal geology made by M. W. Ball.

Washington. Report on "Coals of the State of Washington," by E. E. Smith, submitted for publication (Bulletin 474). Land classified by M. W. Ball.

Oil prospects of northwestern Oregon. Report in preparation by C. W. Washburne.

WORK IN ROCKY MOUNTAIN MINING DISTRICTS.

The mining districts of the Dillon quadrangle (Mont.) were examined in July and August, 1910, by A. N. Winchell, who submitted for publication a preliminary report on these districts. Mr. Winchell also examined graphite deposits near Dillon and prepared a report for publication in Bulletin 470. A scientific discussion of the probable origin of graphite deposits in veins and pegmatites was published by Mr. Winchell in the journal Economic Geology.

The mineral resources of Lemhi County, Idaho, and the Bay Horse district, Custer County, Idaho, were examined by J. B. Umpleby, who has made progress in preparing a report embodying the results of his observations.

About four and a half months were spent in field work by E. S. Bastin, who was assisted by J. M. Hill, on the economic geology of the Central City quadrangle (Colo.). The areal mapping was completed, and the underground work was well advanced. In May Mr. Bastin resumed field work on this quadrangle.

At the request of the Department of Justice, J. M. Hill was detailed to make an examination of certain lands in the Olinghouse district, Washoe County, Nev. As a result of this work he prepared a paper on the Olinghouse and Ramsey mining districts, Nevada, for publication in Bulletin 470.

The report on the Breckenridge district, Colorado, was completed by F. L. Ransome during the summer of 1910 and is in press as Professional Paper 75.

During the winter Mr. Ransome, assisted by J. B. Umpleby, completed the mapping and study of the Ray quadrangle, Ariz. Mr. Ransome spent a short time at Tombstone, Ariz., studying mine levels

that there was reason to suppose would be submerged when pumping stopped. The mapping of the area covered by the Ray special map was completed, and work was begun on the area covered by the Miami special map, adjacent to the disseminated copper deposits. Progress has been made in the preparation of reports on the Ray and Miami areas, but additional study of the disseminated copper deposits is required before they can be completed.

At the request of the Post Office Department four groups of mining claims in the Cœur d'Alene district, Idaho, and two groups in western Montana were examined by F. C. Schrader, who subsequently submitted reports on them and gave testimony in the Federal district court at Spokane, Wash. Mr. Schrader's observations made during these examinations and earlier examinations for the Forest Service and Land Office in neighboring fields in 1908 enabled him to prepare a paper on gold-bearing ground moraine in northwestern Montana, with generalizations on similar occurrences of placer gold elsewhere in the Northwest. The report is now in press as a paper in Bulletin 470.

A geologic reconnaissance of the Jarbidge, Contact, and Elk Mountain mining districts in Elko County, Nev., was made by Mr. Schrader, assisted at Jarbidge by R. D. Pickett and at Contact by N. W. Sweetser. A report with maps and illustrations (Bulletin 497) was subsequently submitted on these districts.

The geologic map and the study of the ore deposits of the Ely special area, Nevada, were completed by A. C. Spencer, who also studied in detail the relations of the important deposits of disseminated copper ore of the district. The report on this district is well advanced and will soon be submitted for publication.

Field work was completed on the Frisco district, Utah, by B. S. Butler, who also made a reconnaissance of the Lincoln, Granite, Pine Grove, Gold Springs, and State Line districts, Utah, and of the Fay district, Nevada. Reports on these districts are in preparation.

The final report on the Park City district, Utah, the preparation of which has been delayed by the resignation of J. M. Boutwell from the survey, was completed by him and submitted for publication in May, 1911.

Progress was made on the revision of the Leadville monograph until its interruption by the death of S. F. Emmons on March 28, 1911. Mr. Emmons was assisted in this work by J. D. Irving, of Yale University, with whom arrangements have been made for its completion.

A report on the ore deposits of Lake City, Colo., has been completed during the year by J. D. Irving and Howland Bancroft, and is in press as Bulletin 478.

WORK ON THE PACIFIC COAST.

An additional investigation of the ore deposits of northeastern Washington was made by Howland Bancroft, and a report covering his work has been completed. He also wrote a report on the lead and zinc deposits of the Metaline mining district, Washington, which forms a part of Bulletin 470.

The survey of the Klamath Mountains of northern California and Oregon has been continued by J. S. Diller, who, during the year, has mapped in detail one-third of the Big Bar quadrangle and prepared a paper on the auriferous gravels of the Trinity River basin, to be published in Bulletin 470.

Additional field work in the copper-mining districts of Shasta County, Cal., was done by L. C. Graton, who made considerable progress toward completing the final report being prepared by him and B. S. Butler, which will be published as a professional paper of the Survey.

The field work on the Randsburg quadrangle (Cal.) was completed by F. L. Hess, and the report is in progress.

The manuscript for the San Francisco (Cal.) folio has been submitted for publication by A. C. Lawson. In this work Prof. Lawson was assisted by several instructors and graduate students in the University of California.

The manuscript for the Ventura (Cal.) folio has been nearly completed for publication by Ralph Arnold and J. R. Pemberton.

Additional work was done in the Corona quadrangle (Cal.) by E. S. Larsen, jr., and progress is being made on the folio.

The investigations of the California oil fields were continued by Robert Anderson, assisted by R. W. Pack. Special attention was given to regions having prospective value for oil, with the aim of carrying the geologic work ahead of development and outlining the areas in which oil is likely to occur. During the summer and fall of 1910 the east flank of the Diablo Range between Panoche and Livermore valleys was examined in detail, thus completing a study of the whole west side of the San Joaquin Valley. In addition, a reconnaissance examination was made around the south end of the San Joaquin Valley. This work resulted in the classification of several areas as possible oil land and the restoration to entry of other areas which had been temporarily withdrawn pending examination but which proved to afford no promise of oil. A preliminary report on the Cantua-Panoche region by Robert Anderson (in Bulletin 431) was published in the fall of 1910. In the spring of 1911 a full report on the entire east flank of the Diablo Range north of Coalinga was brought well toward completion, and a preliminary report on the south end of the San Joaquin Valley was prepared for publication in Bulletin 471.

GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

During the year W. H. Dall continued his studies on the Tertiary faunas of North America. He spent some time in visiting a large number of private and public collections of Tertiary and later fossils on the Pacific coast, thus accumulating a large amount of interesting material and information concerning the Pacific coast Tertiary deposits, in the study of which he is engaged. Good progress has been made in the preparation of a card catalogue of the Tertiary fossils of the Pacific coast, supplementary to that already in use for the eastern Tertiary fossils. Large collections of Tertiary fossils have been received from geologists working on the Atlantic and Gulf coastal plains and have been arranged and identified.

In addition to supervising paleontologic work, T. W. Stanton has continued his studies of the Mesozoic fossils, giving special attention to the correlation of the coal-bearing formations of the Rocky Mountain region. He has also rendered material assistance in determining Cretaceous fossils from the Atlantic and Gulf coastal plains.

In connection with his stratigraphic work T. W. Vaughan continued his studies of the Florida keys, reefs, and marine bottom deposits, under the auspices of the Carnegie Institution of Washington, in cooperation with the Geological Survey, having been engaged in these investigations from May 31 to June 30, inclusive. Besides preparing a summary report of his investigation of the physical conditions under which reef corals live and their rate of growth, for the Carnegie Institution Yearbook No. 9, 1910, he wrote an article entitled "The physical conditions under which Paleozoic coral reefs are formed," which has been published in the bulletin of the Geological Society of America. Mr. Vaughan has succeeded in rearing coral colonies from larvæ at the Tortugas laboratory of the Carnegie Institution. In estimating the rate of growth of coral reefs it is essential to know the rate of growth of the various kinds of coral composing the reefs, and the results obtained by Mr. Vaughan constitute the first trustworthy data that have been obtained for a solution of this problem. Mr. Vaughan also obtained additional information on the calcareous bottom deposits now forming in shallow water along the Florida coast.

The investigation of Triassic paleontology and stratigraphy in Utah and Idaho has been continued by J. P. Smith, of Leland Stanford Junior University. Mr. Smith visited the parties engaged in the study of the phosphate deposits in Idaho and rendered material assistance in their work. The monograph on the marine Middle Triassic fossils of America has been completed by Mr. Smith and transmitted for publication. His report on the Lower Triassic

faunas is well advanced, although descriptions of the species are still in preliminary form and will require much revision.

Investigation of Carboniferous invertebrate paleontology was continued by G. H. Girty, who spent four months in field work, chiefly in Idaho, New Mexico, Texas, and Tennessee, with less time in Ohio, Utah, and West Virginia. He made extensive collections of fossils and exact stratigraphic observations relating to them, and determined the geologic age and correlation of horizons for the parties with which he was associated. He completed a report describing the fauna of the Wewoka formation of Oklahoma and spent much time in arranging collections and preparing reports on fossils referred to him from different field parties in connection with their work.

In addition to his work on the Niagara quadrangle, mentioned elsewhere, E. M. Kindle continued investigations, begun the preceding season, of problems of stratigraphy and correlation relating to the Devonian formations of Pennsylvania and the southern Appalachian region. He also spent much time in preparing and studying Devonian fossils collected by geologists and submitted to him for determination.

Studies of the Cambrian, Ordovician, and Silurian rocks in the Appalachian and Mississippi valleys were continued by E. O. Ulrich, with the assistance of Edwin Kirk. The general results of Mr. Ulrich's stratigraphic studies of American Paleozoic deposits during the past 20 years are presented in a work entitled "Revision of Paleozoic systems," published by the Geological Society of America.

In connection with the classification of coal land F. H. Knowlton, assisted by A. C. Peale, spent the field season in studying paleontologic and geologic problems in the Rocky Mountain region. He procured a large amount of paleobotanic and other material for use in correlating several upper Cretaceous and Tertiary formations. During the office season Mr. Knowlton studied and reported on more than 400 collections of fossil plants for the use of geologists in locating and correlating Mesozoic and Cenozoic horizons, mainly in the Rocky Mountain region. One of these collections, that from the Trinidad-Raton coal field, comprised nearly 3 tons of material. A number of scientific papers were prepared for outside publication.

Under the joint supervision of Messrs. Knowlton and White the work on the bibliography and compendium of paleobotany has been continued by Miss C. H. Schmidt. The estimate made in January, 1910, that this work would be completed by the end of the fiscal year 1912 seems likely to be fully justified, as satisfactory progress has been made during the year.

The geologic map of North America, which has been compiled under the general supervision of Bailey Willis, is now in press.

During the last year, owing to the absence of Mr. Willis from this country, the work on this map has been in charge of G. W. Stose, who has given to the work a large amount of attention. Credit is also due in this connection to the geologists of the Survey generally, who have contributed largely to the completeness of the work. Mr. Stose has continued in charge of the editing of the maps of geologic folios, his detailed report as editor of geologic maps appearing on pages 134–135.

During June, 1911, A. C. Spencer devoted his attention to the study of certain tracts of land on the headwaters of Tennessee River in Fannin County, Ga., and Blount County, Tenn., which had been offered to the Secretary of Agriculture under the Weeks Act, providing for the acquisition of lands for the purpose of conserving the navigable rivers. Careful examination of these tracts resulted in reports affirming that forest control would tend to ameliorate existing conditions, which were found to be favorable to rapid erosion and soil waste in the forested areas. The greatest factor in excessive erosion has been the frequent burning over of forest lands, which destroys the leaf mat and underbrush that naturally prevents the soil from washing. If fires can be kept out permanently a very material decrease is to be expected in the amount of sediment delivered to the local creeks, and the sediment eventually delivered to Tennessee River would be lessened in proportion.

WORK OF COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is composed of Arthur Keith (chairman), M. R. Campbell (vice chairman), W. C. Alden, W. C. Mendenhall, F. L. Ransome, T. W. Stanton, G. W. Stose, and David White. The clerical work of the committee is performed by one clerk, Miss M. G. Wilmarth, who is designated as the secretary.

According to the Director's instructions of January 30, 1909, "It is the duty of the committee on geologic names to consider all geologic names used by members of the Geological Survey in both official and unofficial publications. When manuscripts are received by the committee they shall be examined as soon as practicable and the committee shall decide whether the names employed are permissible or not."

The chief objects of the committee are to insure uniformity in geologic classification and nomenclature in Survey publications, to prevent unnecessary duplication of geologic names, and to reduce the number of names employed, through correlation of the formations from one area to another. The main criteria on which the decisions of the committee are based are priority of publication, significance acquired by usage, and adequacy of definition and type locality. No one of these criteria is relied on to the exclusion of the others.

The records of the committee comprise (1) a catalogue of geologic names considered by the committee, arranged alphabetically, the action taken for each manuscript being recorded; (2) a catalogue of American geologic names in the literature, also arranged alphabetically, each published description of a formation being recorded (this catalogue is the work of J. M. Nickles, of the library staff); (3) a catalogue of the geologic names in the literature, arranged by States; (4) a catalogue of geologic columnar sections approved by the committee, arranged by States, the area to which each columnar section applies being located on the appropriate State map; and (5) a catalogue of geologic columnar sections in the United States, classified by States, compiled from existing literature, the areas being located on a set of State maps. The last catalogue is not complete but is being brought up to date as rapidly as possible. It is designed to prevent unnecessary duplication of geologic names. All these records, except as noted above, have been prepared and are kept up to date by the secretary of the committee.

The amount of labor and research which devolves upon the committee can be understood from the statement that during the last fiscal year it considered 125 manuscripts, comprising a total of about 17,000 pages and more than 2,500 geologic names. These manuscripts discussed the geology of all parts of the United States.

LAND-CLASSIFICATION BOARD.

ORGANIZATION.

The organization of the land-classification board during the fiscal year 1910–11 has continued along the general lines indicated in previous annual reports. The board is a section of the geologic branch administered by a chairman and a general advisory committee, the latter made up of the chiefs of branches, divisions, and sections, whose field work supplies the greater part of the fundamental data that form the basis of the board's action. Within the land-classification board are subordinate boards, each of which deals directly with one of the natural resources and certain public-land problems related thereto. The number of these subordinate boards may be increased or diminished from time to time as the exigencies of the work require. At present there are subboards that deal with the classification of coal, oil and gas, phosphate, and metalliferous deposits and with irrigation and power matters. On December 1, 1910, A. C. Veatch, until that date in charge of the board, applied for and was granted leave of absence. This, together with other changes in the personnel, necessitated certain measures of reorganization, which were effected on January 1, 1911. By virtue of these changes and

others made later in the fiscal year, the organization of the board on June 30, 1911, is as follows:

W. C. Mendenhall, in charge of the board, chairman of the advisory committee, and ex officio chairman of each of the classification boards.

N. C. Grover, chief engineer of the board and ex officio member of irrigation and power boards.

W. R. Calvert, chairman of the coal board.

M. W. Ball, chairman of the oil, phosphate, and metalliferous deposits boards.

W. B. Heroy, chairman of the irrigation and power boards.

The additional members of the advisory committee and subboards are as follows:

Advisory committee: C. W. Hayes, M. O. Leighton, Waldemar Lindgren, M. R. Campbell, A. H. Brooks.

Coal-classification board: M. W. Ball, A. L. Beekly, C. T. Lupton.

Oil-classification board: Robert Anderson, C. H. Wegemann.

Phosphate-classification board: H. S. Gale, R. W. Richards.

Metalliferous deposits classification board: H. D. McCaskey, E. S. Bastin.

Irrigation board: J. C. Hoyt, O. E. Meinzer.

Power board: M. O. Leighton, Herman Stabler.

The fundamental purpose for which the board and subboards were created is to carry out the mandate of the organic act of the Geological Survey, in which it is charged primarily with the classification of the public lands. This work of classification involves many questions as to procedure in public-land matters, partly incidental to the classifications and partly the result of statutes recently enacted, in the administration of which certain responsibilities devolve upon the Survey, either directly or in cooperation with other bureaus in the Interior Department.

The board's operations during the year 1910–11 differed from those of previous years rather in the volume of the work done than in the nature of the work. The amount has been increased, for example, by certain cooperative agreements with the General Land Office, by virtue of which the commissioner requests information on the mineral or power value of lands for which patent is asked, either before or after examination by special agents. The Indian Office, under the Secretary's orders, likewise refers to the Geological Survey lands listed for patent and lands which it is proposed to eliminate from the reservations and throw open for settlement, in order that the mineral or nonmineral character or the power value of the lands affected may be determined. Proposed eliminations from national forests are likewise referred for report as to mineral character and power value, and all Carey Act lists are submitted to the Survey for a statement as to the sufficiency of the water supply and the adequacy of the proposed plan of irrigation before the lists are approved for segregation.

These various types of work are more fully discussed under appropriate headings in the statements which follow.

COAL.

Classifications.—Coal lands have been classified during the year at an increased rate. The area appraised as coal land during the fiscal year 1909–10 was 4,876,196 acres; during 1910–11 the area so appraised was 7,821,508 acres. The area classified as noncoal land during 1910–11 is 2,386,444 acres greater than that so classified in 1909–10. On the other hand, the average price fixed per acre and the total appraised value are notably less for the last year than for the preceding year. The difference is due to a concentration of work in the lignite and low-grade subbituminous fields of eastern Montana and Wyoming, where the appraised values under the regulations are the minimum fixed by law. The following table shows the progress of coal-land classification, by States, during the year:

Progress of classification of coal land during the year ending June 30, 1911.

[Areas in acres.]

State.	Date, June 30—	Areas classified as coal land and appraised.		Areas classified as noncoal land.		Valuation fixed.		Total minimum valuation.		Average price per acre.	
		Under old regulations.	Under new regulations.	Under old regulations.	Under new regulations.	Under old regulations.	Under new regulations.	Under old regulations.	Under new regulations.	Old regulations.	New regulations.
Arizona	1910										
	1911				42,492						
Arkansas	1910	60,715		70,038		$1,473,762		$1,214,280		$24.3	
	1911	60,715		70,038		1,473,762		1,214,280		24.3	
California	1910		7,720		6,242		$585,086		$154,404		$75.8
	1911		7,720		6,242		585,086		154,404		75.8
Colorado	1910	354,478	1,703,616	1,867,474	2,992,896	10,185,620	108,633,375	4,531,619	33,380,110	28.7	63.1
	1911		2,873,929	882,897	4,542,167		167,775,104		50,309,589		58.4
Idaho	1910										
	1911				1,280,553						
Montana	1910	486,140	791,351	3,824,383	3,651,139	8,618,264	22,038,767	8,364,798	15,032,754	17.7	27.8
	1911	201,743	3,310,605	3,489,322	6,845,842	3,075,233	91,388,414	3,000,433	73,397,947	15.2	27.6
New Mexico	1910	1,808,738	7,406	2,414,270	249,748	21,997,786	274,486	21,970,526	148,128	12.2	37.1
	1911	363,767	590,447	2,065,217	739,739	6,714,123	14,547,541	6,702,063	6,821,729	18.5	24.6
North Dakota	1910	530,491			686,468	7,579,630		7,579,630		14.3	
	1911	230,814			1,020,999	4,582,860		4,582,860		19.9	
Oregon	1910		80	893,318			1,600		1,600		20.0
	1911		1,897	893,318	176,785		49,909		37,919		26.3
South Dakota	1910				4,340,366						
	1911				4,835,334						
Utah	1910	400,948	67,092	1,098,036	286,942	11,459,844	3,521,591	5,755,586	1,201,591	28.6	52.5
	1911		636,479	712,675	1,212,838		36,576,849		8,287,783		57.5
Washington	1910			627,198	6,240						
	1911		40	627,198	6,240		2,000		800		50.0
Wyoming	1910	1,561,886	2,896,265	577,988	5,693,302	30,417,405	220,601,996	26,871,977	49,532,042	19.5	76.2
	1911	1,273,798	5,873,921	1,760,217	8,073,626	21,899,566	359,905,292	20,080,162	89,853,555	17.2	61.3
Total areas recorded as classified	1910	5,203,396	5,473,530	13,372,705	17,913,343	91,732,311	355,656,901	76,288,416	99,450,629	17.6	65.0
	1911	2,130,837	13,295,038	10,500,882	28,782,857	37,745,544	670,830,195	35,579,798	228,863,726	17.7	50.5
Total areas covered during fiscal year.		[a] 3,072,559	7,821,508	[a] 2,871,823	10,869,514	[a] 53,986,767	315,173,294	[a] 40,708,618	129,413,097	17.6	40.3

[a] Total reduction in area classified under old regulations, comprising lands either rewithdrawn or reclassified under new regulations.

The charge has been made that the classification policy has been harmful to the coal industry of the West by placing prohibitive prices on the public coal lands. The fact that the coal production of the Rocky Mountain States in 1910 showed an increase of 14.7 per cent over the production of 1909 indicates that the coal industry has not been seriously injured. The following table refutes any statement that the prices fixed are prohibitive, by showing that the sale of coal lands during the four fiscal years since the adoption of the classification policy has been 12½ per cent greater than during the four preceding years, while the increase in receipts from the sales has been 36 per cent.

Sales of coal lands at all prices, in the United States, exclusive of Alaska, from 1903 to 1911.

Fiscal year.	Entries.	Acres.	Receipts.	Average price per acre.
1903–4	190	28,827.42	$395,209.90	$13.74
1904–5	158	20,456.35	277,402.40	13.56
1905–6	244	42,143.39	538,683.70	12.54
1906–7	157	20,387.02	303,255.60	14.80
Four years prior to July 1, 1907	749	111,814.18	1,514,551.60	13.54
1907–8	299	58,047.10	647,584.55	11.15
1908–9	182	26,590.68	502,743.65	18.90
1909–10	189	26,074,16	657,175.80	25.20
1910–11	83	15,284.89	251,323.03	16.44
Four years since July 1, 1907	753	125,996.83	2,058,827.03	16.34

Many of the lands sold since July 1, 1907, have doubtless been unclassified lands sold at the minimum price, but the following table shows that by no means all the sales have been at minimum, and that the increase in sales since July 1, 1907, is much more than equaled by the sales at classified prices greater than the minimum. In other words, the acreage sold at the minimum has been less since classification begun than in the same period preceding, although the total acreage sold has increased, indicating, certainly, that the classifications have not prohibited the purchase of coal lands.

Sales of coal lands at various rates since July 1, 1907.

Price per acre.	Entries.	Acres.	Receipts.	Price per acre.	Entries.	Acres.	Receipts.
$10.00	328	46,022.21	$461,099.33	$75.00	2	161.23	$12,092.25
15.00	15	2,310.55	34,658.25	90.00	1	121.69	10,952.10
17.50	1	40.00	700.00	92.00	1	40.00	3,680.00
20.00	258	52,833.03	773,028.80	100.00	1	38.48	3,848.00
25.00	37	11,171.68	131,671.70	120.00	1	40.00	4,800.00
30.00	23	3,159.81	94,794.30	135.00	1	80.00	10,800.00
35.00	2	239.78	8,392.30	140.00	1	120.00	16,800.00
40.00	8	800.06	32,002.40	170.00	1	39.89	6,781.30
45.00		240.00	10,800.00	180.00	1	40.00	7,200.00
49.00	1	40.00	1,960.00	270.00	1	39.79	10,743.30
50.00	69	8,218.63	409,023.00				
65.00		200.00	13,000.00		753	125,996.83	2,058,827.03

Withdrawals.—Two great withdrawals of land for determination of its content of coal were made during the year, one in the Dakotas and one in Idaho. The areas withdrawn in the Dakotas, judged from the facts gathered in field examinations made up to date, promise to be very largely coal land. The area withdrawn in Idaho, on the other hand, is being shown by field survey to be mainly noncoal land, and more than a million acres have already been classified as noncoal land. It is significant that the area withdrawn for examination for coal has been increasing year by year, rather than decreasing constantly by restorations made as a result of classification, as might be expected. Although the field examinations have each year increased the area classified, and therefore subtracted from the areas withdrawn, the restorations have been more than offset by the withdrawal of areas indicated as coal bearing by new information or by a study of data already at hand. However, in Colorado, Montana, and Wyoming, where the field work was concentrated during the season of 1910, the restorations far outbalance the withdrawals. It is probable that the maximum withdrawn area has been reached this year and that the withdrawals will steadily decrease hereafter.

Withdrawals of coal lands, fiscal year 1910–11, in acres.

States.	Withdrawals outstanding July 1, 1910.	New withdrawals.	Restorations.	Withdrawals outstanding June 30, 1911.
Alaska	(a)			(a)
Arizona	161,210		42,492	118,718
California		239,903		239,903
Colorado	6,656,518	977,944	2,117,124	5,517,338
Idaho		8,265,970	1,280,553	6,985,417
Montana	23,920,978	740,849	4,771,356	19,890,471
Nevada		92,141		92,141
New Mexico	3,155,295	3,120,530	466,335	5,809,490
North Dakota		18,454,490		18,454,490
Oregon	379,452		375,931	3,521
South Dakota		2,869,377	494,114	2,375,263
Utah	5,897,958	1,054,154	730,798	6,221,314
Washington	2,210,847		40	2,210,807
Wyoming	10,854,704	780,731	4,621,892	7,013,543
	53,236,962	36,596,089	14,900,635	74,932,416

a Area unknown.

Applications for reclassification.—The beneficial effects of the act of June 22, 1910 (Stat. L., vol. 36, p. 583), providing for agricultural entries for surface rights only on lands classified as coal lands, are shown by the decreased number of applications for the reclassification of areas so classified. Whereas 127 applications were received during the fiscal year 1909–10, but 48—only a little over one-third that number—were received during the year 1910–11. Before the passage of this act lands classified as coal bearing could not be disposed of except

as coal land at the appraised price. As a result agricultural development of these areas was impossible, and many applications were received alleging the classification to be erroneous and praying for its reversal in order that agricultural entries might be made. Now agricultural entries may be made upon coal lands, the entryman receiving title to the surface only and the United States reserving title to all underlying deposits of coal. A summary of the applications acted upon during the year follows:

Applications for reclassification of coal land, fiscal year 1910–11.

State.	Number received.	Denied.	Pending.
Colorado	2	4	0
Montana	18	18	1
North Dakota	1	.....	1
Utah	7	.....	7
Wyoming	20	1	19
	48	23	[a] 28

[a] One application from Montana and two from Colorado received before June 30, 1910.

Applications for classification.—Agricultural entries for surface rights only may not be commuted, a certain proportion of the entry must be cultivated each year, and the total area which may be included in a desert-land entry for surface rights is restricted to 160 acres. These conditions lead to the submission of applications for the classification as noncoal land of areas withdrawn pending their classification as to coal. As these withdrawals are usually made in order to retain the title to the coal deposits in the Government until field examination can be made on which to base a classification, most of such applications can not be granted. It has, however, been possible, from information at hand, to grant 4 of the 46 such applications received during the year.

The following table shows the distribution of the applications:

Applications for classification of coal land, fiscal year 1910–11.

State.	Number received.	Approved.	Denied.	Pending.
Colorado	2	1	1	.....
Idaho	26	.....	26	.....
Montana	11	2	5	4
New Mexico	4	.....	3	1
South Dakota	1	1	.....	.....
Washington	1	.....	1	.....
Wyoming	1	.....	.....	1
	46	4	36	6

OIL.

Pending the enactment of legislation for disposing of oil and gas deposits on the public domain, and because it seems desirable to retain certain of these deposits for use as fuel by the American Navy, all public lands known or thought to contain valuable deposits of oil or gas are withdrawn from all forms of disposal. During the year 640,604 acres of possible oil land in California and Wyoming were withdrawn from entry, and 1,232,719 acres in the same States, shown by field examination to be nonoil lands, were restored. In addition, all oil lands in Alaska, comprising an unknown area, were withdrawn during the year. In the early part of the year the outstanding withdrawals made by the Secretary of the Interior were ratified, confirmed, and continued in full force and effect by the President under the act of June 25, 1910. The following table contains a summary of all action affecting the status of oil lands prior to June 30, 1911:

Withdrawals of oil lands, fiscal year 1910–11, in acres.

State.	Outstanding July 1, 1910.	New withdrawals.[a]	Restorations.	Outstanding June 30, 1911.
Alaska	.....	Unsurveyed.	.....	Unsurveyed.
Arizona	230,400	.....	.....	230,400
California	2,498,173	305,802	1,211,271	1,592,704
Colorado	87,474	.....	.....	87,474
Louisiana	414,720	.....	.....	414,720
New Mexico	419,901	.....	.....	419,901
Oregon	74,849	.....	.....	74,849
Utah	581,566	.....	.....	581,566
Wyoming	255,461	334,802	21,448	568,815
	4,562,544	640,604	1,232,719	3,970,429

[a] Excluding changes in forms of withdrawals.

PHOSPHATE.

During the year a deposit of phosphate rock in southwestern Montana, similar in character to the deposits of Utah, Idaho, and Wyoming and at the same geologic horizon, was discovered by H. S. Gale, of the Survey. This discovery is important not only because of the quantity of phosphate found, but because it indicates the possibility that the deposits of phosphate rock are distributed over a much wider territory than had formerly been supposed.

In the early part of the year the outstanding withdrawals of phosphate land made by the Secretary of the Interior were ratified and continued in full force and effect by the President under the act of June 25, 1910 (Stat. L., vol. 36, p. 847). The area withdrawn as a result of the discovery in Montana comprises 33,950 acres, which, with withdrawals in Florida and Utah, makes a total of 65,589 acres

withdrawn during the year. Field examinations in Idaho resulted in the restoration of 149,929 acres, leaving in phosphate withdrawals June 30, 1911, a total of 2,399,416 acres. A summary of the outstanding withdrawals follows:

Withdrawals of phosphate lands, fiscal year 1910–11, in acres.

State.	Outstanding July 1, 1910.	New withdrawals.[a]	Restorations.	Outstanding June 30, 1911.
Florida	2,400	35,439	.....	37,839
Idaho	1,102,317	.....	149,929	952,388
Montana	.....	33,950	.....	33,950
Utah	107,545	200	.....	107,745
Wyoming	1,267,494	.....	.....	1,267,494
	2,479,756	69,589	149,929	2,399,416

[a] Excluding changes in form of withdrawals and rewithdrawals.

METALLIFEROUS DEPOSITS.

Under the act of February 26, 1895 (Stat. L., vol. 28, p. 683), provision was made for classifying with regard to their mineral or nonmineral character the lands within the Northern Pacific Railroad grant in Montana and Idaho. The classification made proved unsatisfactory for many areas and a reclassification was provided for in the sundry civil act of June 25, 1910 (Stat. L., vol. 36, p. 703). At the request of the General Land Office the reclassification was made by the Survey. The results of the work of the year are shown in the following table:

Lands in Northern Pacific Railroad grant in Montana and Idaho classified during fiscal year 1910–11, in acres.

State.	Mineral.	Nonmineral.	Total.
Montana	130,386	21,722	152,108
Idaho	45,645	90,712	136,357
	176,031	112,434	288,465

WATER POWER.

Withdrawals and restorations.—During the year the work of classifying the public lands with relation to their value for water-power development has followed the general plan pursued in previous years. On July 2, 1910, the earlier withdrawals, amounting to 1,454,499 acres, were ratified and continued by the President under the authority conferred by the act of June 25, 1910 (Stat. L., vol. 36, p. 847). As a result of field investigations, 143,555 acres included

in withdrawals were determined to be without value for power purposes and were restored to the public domain and 204,460 acres were included in new withdrawals, the total area withdrawn at the close of the fiscal year amounting to 1,515,423 acres.

The status of power-site withdrawals by States is shown in the following table:

Water-power site withdrawals, fiscal year 1910–11, in acres.

State.	Outstanding July 1, 1910.	New withdrawals during fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1911.
Alaska				
Arizona	107,550	106,000	160	213,390
California	47,819	5,870	0	53,689
Colorado	201,549	10,131	2,506	209,174
Idaho	230,971	16,458	17,756	229,692
Minnesota		8,388		8,388
Montana	122,515	16,803	11,631	127,687
Nevada	14,091	1,284		15,375
New Mexico	14,536		4,830	9,706
North Dakota				
Oregon	176,721	7,948	22,874	161,795
South Dakota				
Utah	379,912	1,080	33,740	347,252
Washington	55,439	26,404	1,457	80,386
Wyoming	103,396	4,094	48,601	58,889
	1,454,499	204,460	143,555	1,515,423

Applications for reclassification.—Twenty-one applications for reclassification of lands withdrawn because of their value for power purposes have been received during the fiscal year. Action has been taken on nine of them.

Right-of-way applications.—The examination of applications for right of way across the public lands for railroads, canals, ditches, and reservoirs for irrigation, mining, and municipal supply and structures for power development has been continued by the Survey. At first the inquiry was made primarily for the purpose of determining the effect which the approval of the application and the construction of the proposed works would have on future power development, but its scope has been broadened to include the investigation of the water supply and the general engineering feasibility of power and irrigation projects. If it appears that the approval of a right of way would tie up large bodies of public land without reasonable probability of future utilization for the purpose contemplated, the facts determined are reported to the department with a recommendation that the right of way be not granted. If a proposed railroad is to approach a stream which may be utilized for power development an examination is made to determine whether the grade proposed will interfere with the future development of power. Where the railroad location is found to conflict with reservoir or dam sites, a careful

study of all the conditions is made to determine whether or not the conflict may be minimized or avoided by relocating the railroad grade and thus preserving the possibility of power development and at the same time permitting the development of transportation facilities.

It frequently appears that the value of lands for power sites is contingent upon future irrigation development, irrigation being recognized as the higher use. Applications for rights of way for irrigation across lands withdrawn for power are therefore carefully considered, and if the projects of which they are a part appear meritorious, a modification of the order of withdrawal to permit the granting of the application is recommended. Pending the construction of the project and the use of the water for irrigation the lands affected are retained in withdrawal, so that if the grantee shall default in construction the power value of the lands may still be considered and controlled. The character of the applications received and the action taken thereon is shown by the accompanying table:

Applications for rights of way.[a]

	Railroad.	Irrigation.	Water power.	Miscellaneous.	Total.
Pending July 1, 1910	1	44	10	3	58
Received July 1, 1910, to June 30, 1911	386	655	31	47	1,119
Acted on July 1, 1910, to June 30, 1911	277	516	19	39	851
Pending June 30, 1911	110	183	22	11	326

[a] First application received from Secretary's office Oct. 11, 1909; first application received from General Land Office Nov. 11, 1909; first application received from Indian Office Dec. 23, 1909.

IRRIGATION.

Carey Act segregations.—Thirty-one segregation lists prepared under the Carey Act have been referred during the year to the board for report on the water supply available and the general feasibility of the projects contemplated. Five of these lists were recommended for approval unconditionally, and three others, covering projects that involved pumping, were determined to have sufficient water supply for reclaiming the lands considered. Examination of 18 applications showed that under the plan of irrigation proposed by the State the projects contemplated would have an insufficient water supply, and reports were made accordingly. At the close of the year three applications were awaiting a detailed statement by the applicant of the plan of reclamation proposed, and two were under consideration in the Survey.

Enlarged-homestead designations.—The designation of additional nonirrigable areas as subject to entry under the enlarged-homestead

act and the refinement of the boundaries of such areas has called for an increasing amount of field investigation during the year. As the larger areas of nonirrigable lands were included in the earlier designations, the amount of additional land designated is relatively small in proportion to the total area open to entry. By the act of Congress of June 17, 1910, the provisions of the original act, somewhat modified, were extended to the State of Idaho, both as regards the enlargement of the entry and as regards nonresidence on lands that are without a sufficient supply of water suitable for domestic purposes. A large area in Idaho has been designated under the general provisions of the act, and detailed investigations of specific tracts for the determination of the water supply available for domestic purposes are in various stages of completion.

The following table indicates the amount designated in each State and summarizes the work of the year:

Enlarged-homestead designations, fiscal year 1910–1911, in acres.

State.	Outstanding July 1, 1910.	New designations during fiscal year.	Cancellation during fiscal year.	Outstanding June 30, 1911.
Arizona	26,657,280	90,400	157,763	26,589,917
Colorado	20,303,720	50,789	.....	20,354,509
Idaho:				
Under sections 1–5 of the act	.....	5,347,383	10,545	5,336,838
Under section 6 of the act	.....	3,841	.....	3,841
Montana	29,686,126	2,167,404	.....	31,853,530
Nevada	49,512,960	.....	.....	49,512,960
New Mexico	15,883,343	423,332	.....	16,306,675
Oregon	9,166,960	2,071,661	24,960	11,213,661
Utah:				
Under sections 1–5 of the act	6,654,469	111,311	.....	6,765,780
Under section 6 of the act	1,245,818	129,129	.....	1,374,947
Washington	3,401,816	1,080	.....	3,402,896
Wyoming	16,904,673	634,268	.....	17,538,941
	179,417,165	11,030,598	193,268	190,254,495

Enlarged-homestead petitions.—The greater part of the investigations and designations under the enlarged-homestead act have been made in response to petitions for action on specific tracts. During the fiscal year 248 petitions were received and 162 were acted upon. At the close of the year 137 petitions were pending, most of them awaiting reports on uncompleted field examinations. The geographic distribution of these petitions among the 10 States now affected by the act is shown in the table on page 72.

Action on enlarged-homestead petitions during the fiscal year ending June 30, 1911.

State.	Outstanding July 1, 1910.	Received during the year.	Designations made.		Refused.	Total acted on.	Pending.
			All.	Part.			
Arizona	1	2	1	0	1	2	1
Colorado	0	11	6	0	0	6	5
Idaho	0	99	12	6	2	20	79
Montana	28	59	25	17	21	63	24
Nevada	0	0	0	0	0	0	0
New Mexico	8	31	18	5	5	28	11
Oregon	2	24	8	8	2	18	8
Utah	1	5	2	0	1	3	3
Washington	2	2	1	0	0	1	3
Wyoming	9	15	2	17	2	21	3
	51	248	75	53	34	162	137

COOPERATION WITH OTHER BUREAUS OF THE DEPARTMENT.

Important action taken during the year to promote the efficient and economical handling of public-land questions has consisted of the adoption of a plan of cooperation between the Geological Survey and the General Land Office. The Land Office has a field force engaged in investigating the validity of entries on public land and in preventing land frauds against the Government. The decision of many of the cases investigated by the field service depends upon the mineral or the water-power value of the land, and the members of the field force make examination on the ground to determine these values. As a rule the Geological Survey has sufficiently definite information with regard to the mineral or water-power value either to obviate the necessity of an examination by the Land Office field service or to facilitate to a considerable degree the making of such examination. This information, in so far as it relates to coal, was placed at the disposal of the Land Office by an agreement that was embodied in a circular of that office, dated July 9, 1910, in which it is provided that before the Land Office shall make field examination of lands involved in certain cases the Geological Survey shall be requested to furnish information as to the tracts involved; that the survey shall thereupon promptly transmit to the Land Office such information as it has on record, together with any suggestions that may be of assistance; that if a field examination in any case is made by a member of the Land Office force a copy of his report will be sent to the Geological Survey, and that if this report differs as to facts or conclusions from the information given by the Survey, the Land Office will suspend action upon the case involved until advice is received from the Survey. On January 27, 1911, the Secretary extended the cooperation thus established so that it covers lands valuable for coal, oil, phosphate, and water power. By these agreements the Land

Office profits by the facts that many examinations that would otherwise be required need not be made and that those which are made can be made more advantageously, and the Survey profits by the information obtained from the reports of the General Land Office field agents.

In order to make even more fully available in the administration of the public lands the fund of information on file in the Survey with regard to the character of the public domain, two further orders have been issued by the Secretary. One dated March 27, 1911, directs that before requesting the survey of a proposed town site or the issuance of patent under a tribal allotment, the Office of Indian Affairs shall call upon the Survey for a report as to whether the tract considered is coal, agricultural, or mineral land and whether it has any value for power or reservoir sites; the other, dated April 27, 1911, directs that before lands included within a national forest are restored to the public domain a report shall be required from the Geological Survey as to whether or not the lands are valuable for coal or have possibilities for the development of power.

Requests for information under these various phases of cooperative agreement and other requests similar in character, but not covered by formal agreement, have during the year numbered 10,747 as to mineral lands and 545 as to lands having power value. Of the former requests 2,722 have been answered and of the latter 369. The distribution of the lands involved in the requests for information regarding mineral character is shown in the following table:

Requests for information regarding mineral character of public lands.

State.	Received.	Information furnished.	Pending.
Alaska	69	60	9
Arizona	125	1	124
California	3,461	181	3,280
Colorado	165	59	106
Florida	28	14	14
Idaho	193	142	51
Iowa	1	0	1
Louisiana	14	14	0
Montana	1,783	558	1,225
Minnesota	4	2	2
Nebraska	6	5	1
Nevada	21	2	19
New Mexico	708	628	80
North Dakota	857	258	[a] 586
Oregon	431	28	403
South Dakota	301	145	156
Utah	1,009	261	748
Washington	241	125	116
Wyoming	1,330	239	1,091
	10,747	2,722	8,012

[a] 13 cases recalled by General Land Office.

During the year the board has acted on 854 reports of the Land Office field force on the mineral character of lands, involving an

area of 125,800 acres. The table below shows in detail the action taken on these cases. Fifty-two reports as to the water-power value of lands have been considered, leaving 39 pending at the close of the year.

Action on reports of Land Office field service regarding the mineral character of lands.

State.	Approved.		Approved in part.	Disapproved.		Pending.		Total.	
	Number.	Area.		Number.	Area.	Number.	Area.	Number.	Area.
Arkansas	0	.....	.....	3	360	.....	.....	3	360
California	4	400	.....	0	.....	20	6,640	24	7,040
Colorado	59	8,180	1	13	1,960	14	1,840	87	11,980
Florida	62	7,660	.....	0	.....	3	200	65	7,860
Idaho	108	14,840	.....	0	.....	14	1,960	122	16,800
Louisiana	4	280	.....	0	.....	10	1,320	14	1,600
Montana	54	10,000	.....	4	320	50	7,440	108	17,760
New Mexico	28	4,160	.....	1	80	1	120	30	4,360
North Dakota	11	1,360	.....	9	1,120	6	840	26	3,320
Oregon	20	2,480	.....	0	.....	44	15,420	64	17,900
South Dakota	10	1,480	.....	0	.....	.....	.....	10	1,480
Utah	35	4,920	3	3	1,280	127	23,560	168	29,760
Washington	407	62,920	.....	1	80	2	120	410	63,120
Wyoming	8	1,120	.....	6	760	38	4,400	52	6,280
	810	119,800	4	40	5,960	329	63,860	1,183	189,620

DIVISION OF ALASKAN MINERAL RESOURCES.

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

PERSONNEL.

The personnel of the division varied greatly during the year on account of transfers of employees to and from other divisions and on account of temporary employment of additional technical and clerical assistants. On July 1, 1910, there were employed in the division 1 geologist in charge, 9 geologists, 7 topographers, 2 engineers, and 3 clerks on annual salaries, 1 topographer on monthly salary, 1 temporary clerical assistant, 2 geologic field assistants, and 26 camp hands. Of the topographers 4 were employed in subdivisional surveys paid for by the General Land Office. (See pp. 82–84.) On June 30, 1911, the personnel of the division included 1 geologist in charge, 12 geologists, 4 topographers, 2 engineers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist on per diem salary, 2 geologic field assist-

ants, and 31 camp hands. During the year there were also employed 1 geologist and 1 clerk, and for short periods several clerical assistants who are not included in the above enumeration.

FIELD OPERATIONS IN SEASON OF 1910.

Allotments and areas covered.—Twelve parties were engaged in surveys and investigations in Alaska during the season of 1910 for varying periods between April 1 and October 17. Four parties were also employed in subdivisional surveys of public lands. (See pp. 82–84.) In addition to these the geologist in charge spent a part of the summer in Alaska carrying on geologic investigations and visiting field parties.

During the year 13,815 square miles were covered by reconnaissance topographic surveys and 36 square miles by detailed topographic surveys.[1] Detailed geologic surveys were made of 321 square miles and geologic reconnaissance surveys of 8,635 square miles. Most of the geologists also spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of approximately 6,500 square miles and included 69 gaging stations maintained and 429 measurements of stream volume. Fifteen of the thirty mining districts of Alaska which are being developed were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work, as well as inspection.

Allotments to surveys and investigations in Alaska, 1910–11.

Southeastern Alaska	$5,100
Copper River and Susitna region	27,000
Matanuska region	9,600
Upper Yukon basin	23,800
Innoko-Iditarod region	14,100
Northwestern Alaska, including Seward Peninsula	10,400
	90,000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, for some of the parties and some of the men carried on two different kinds of work; but this statement will help to elucidate the table given on page 76, which summarizes the complete areal surveys.

[1] Reconnaissance surveys published on a scale of 1 : 250,000 or 1 : 500,000 and detailed surveys on a scale of 1 : 62,500.

Approximate allotment of funds to different classes of surveys and investigations in Alaska, 1910–11.

Geologic reconnaissance surveys	$26,500
Detailed geologic surveys	11,500
Special geologic investigations	2,500
Topographic reconnaissance surveys	32,000
Detailed topographic surveys	1,600
Investigation of water resources	4,600
Collection of statistics of mineral production	1,100
Miscellaneous expenditures, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	10,200
	90,000

Allotments for salaries, field and office expenses, 1910–11.

Scientific and technical salaries	$29,330
Field expenses, including equipment and supplies	51,765
Clerical and other office salaries	8,905
	90,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a variable amount is expended each year on special investigations that yield results which can not be expressed areally.

Progress of surveys in Alaska, 1898–1910.[a]

Year.	Appropriation.	Areas covered by geologic surveys.			Areas covered by topographic surveys.[b]				Water-resources investigations.		
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, or 100 foot contours).	Lines of levels.	Bench marks set.	Gaging stations maintained part of year.	Stream volume measurements.
		Sq. m.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*			
1898	$46,189.60	9,500	.....	.....	12,840	2,070	.....	.....	.....	.....	.....
1899	25,000.00	6,000	.....	.....	8,690	.....	.....	.....	.....	.....	.....
1900	60,000.00	3,300	6,700	.....	630	11,150	.....	.....	.....	.....	.....
1901	60,000,00	6,200	5,800	.....	10,200	5,450	.....	.....	.....	.....	.....
1902	60,000.00	6,950	10,050	.....	8,330	11,970	96	.....	.....	.....	.....
1903	60,000.00	5,000	8,000	96	.....	15,000	.....	.....	.....	.....	.....
1904	60,000.00	4,050	3,500	.....	800	6,480	480	86	19	.....	.....
1905	80,000.00	4,000	4,100	536	.....	4,880	787	202	28	.....	.....
1906	80,000.00	5,000	4,000	421	.....	13,500	40	.....	.....	14	286
1907	80,000.00	2,600	1,400	442	.....	6,120	501	95	16	48	457
1908	80,000.00	2,000	2,850	604	.....	3,980	427	76	9	53	556
1909	90,000.00	6,100	5,500	450	6,190	5,170	444	.....	.....	81	703
1910	90,000.00	.....	8,635	321	.....	13,815	36	.....	.....	69	429
	871,189.60	60,700	60,535	2,870	47,680	99,585	2,811	459	72	.....	.....
Percentage of total area of Alaska		10.35	10.33	0.49	8.16	16.98	0.48	.....	.....	.....	.....

[a] The areas presented in this table differ somewhat from those previously published. This is due in part to the reclassification of the work and in part to the fact that the areas have been more carefully scaled from the maps than formerly.

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

General investigations.—A. H. Brooks, geologist in charge of the division, was engaged in office work at Washington until August 3, when he proceeded to Alaska, reaching Valdez on August 15. He spent a day in visiting the Cliff mine, and continued his journey to Seward and thence to Knik, spending two days, while en route, in studying the geology in the vicinity of Kern Creek. From Knik Mr. Brooks proceeded to Mr. Martin's camp, which he reached on August 23. He spent the following two weeks in studying the geology of the Matanuska coal field and then returned to Seward. A day at Knik and several days at Seward were utilized in collecting data to be used for planning subdivisional surveys in this general region. Returning, Mr. Brooks reached Washington on September 30.

Of the time spent in the office the geologist in charge has devoted about 30 days to completing the Mount McKinley report, about 46 days to the progress reports for 1909 and 1910, about 25 days to administration of the subdivisional surveys (see pp. 82–84), and the remainder to routine and miscellaneous work.

R. H. Sargent continued his general supervision of the topographic surveys and map compilation, as in the previous year, but his time up to May 1 has been largely devoted to subdivisional surveys of Alaska public lands.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the latter's absence in the field. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

The office study of problems relating to the stratigraphy of Tertiary coal measures in Alaska was continued by W. W. Atwood during such time as he could spare from his college work. As the correlating of the coal measures of different parts of the Territory must depend on the determination of their fossil plants, Arthur Hollick was employed for six months in a systematic study of the large collection of paleobotanic material already gathered.

Southeastern Alaska.—The detailed geologic mapping and study of the mineral resources of the Eagle River region were completed by Adolph Knopf, who mapped a total area of about 125 square miles.

J. W. Bagley, assisted by C. E. Giffin, spent the time from May 6 to June 6 in detailed topographic mapping in the vicinity of Mendenhall River, thus completing the survey of the Eagle River district.

C. W. Wright was employed from July 6 to September 17 in continuing the preparation of a report on the geology and mineral resources of Kasaan Peninsula and Hetta Inlet region. Unfortunately, he was called back to his professional work in Sardinia

before he could complete his report, but he has promised its early completion.

Copper River and Susitna region.—D. C. Witherspoon and C. E. Giffin made a topographic reconnaissance survey of the upper Chistochina and Susitna basins, including the Valdez Creek placer district. The party mapped an area of 4,980 square miles.

F. H. Moffit, assisted by B. L. Johnson, made a geologic reconnaissance survey of the southern front of the Alaska Range between the Fairbanks trail and Valdez Creek. Mr. Moffit also made a reexamination of the Chistochina placer district. A geologic reconnaissance map covering about 1,000 square miles was completed, in addition to which the topographic surveys and geologic notes furnished by the Witherspoon party afford a general knowledge of the areal distribution of the principal formations over about 2,000 square miles.

Prince William Sound and Kenai Peninsula.—No field work was done in the Prince William Sound and Kenai Peninsula regions other than that accomplished by the geologist in charge (p. 77). U. S. Grant has continued, so far as his collegiate duties permitted, the work of writing a report on the eastern part of Kenai Peninsula.

Matanuska Valley.—A detailed geologic survey was made by G. C. Martin, assisted by F. J. Katz and Theodore Chapin, of that part of the Matanuska coal field lying between Moose Creek on the west and Chickaloon River on the east. An area of 196 square miles was surveyed. Mr. Katz, assisted by Mr. Chapin, spent about a week in studying mineral resources of the Willow Creek region.

Upper Yukon basin.—No geologic field work was done in the Yukon-Tanana region, but L. M. Prindle spent nine months of the year in preparing a detailed report on the region adjacent to Fairbanks and a more general report on the Fairbanks quadrangle. C. E. Ellsworth and G. L. Parker continued the study of the water resources of the Yukon-Tanana region which was begun in 1907. They began field work at Fairbanks on April 1 and later extended it into the Birch Creek and Fortymile districts. Mr. Parker continued stream gaging in the Fairbanks and Birch Creek districts until September 1, when he went to Nome (p. 79).

J. W. Bagley, topographer, and S. R. Capps, geologist, carried a topographic and geologic reconnaissance survey from the upper Nenana Valley eastward to Delta River, including the Bonnifield placer district and the Nenana coal field. The area surveyed includes 3,135 square miles and is bounded on the south by the crest of the Alaska Range and on the north by the lowlands of the Tanana Valley.

Innoko-Iditarod region.—The continued interest in the placer-gold deposits of the Innoko basin, including the newly discovered Iditarod placers, led to an extension of the work previously done in this field.

G. C. Anderson made a topographic reconnaissance survey of an area of 3,200 square miles, extending southward from Ruby Creek, on the Yukon, across the upper Innoko Valley, and including much of the Iditarod basin. A. G. Maddren, assisted by H. E. Birkner, made a geologic reconnaissance survey of about 2,000 square miles of the most important part of the same region, besides investigating the placers of the Innoko and Iditarod districts.

Northwestern Alaska.—A geologic and topographic reconnaissance survey was carried from the Koyukuk to Kobuk River by P. S. Smith and H. M. Eakin. The party landed near the mouth of Hogatza River and traveled overland to Dahl Creek, on the Kobuk. (See p. 81.) A contract had been made to have supplies delivered at this point, but their delivery had been prevented by an accident. The party was therefore forced to abandon the plan of extending the survey northward and made its way down the Kobuk by small boat. This, however, gave opportunity for a hasty visit to the newly discovered Squirrel River placer district. An area of 2,500 square miles was covered by geologic and topographic reconnaissance surveys.

Systematic investigations of the water supply of Seward Peninsula have been carried on each year since 1906. The need of investigations in other parts of Alaska made it impossible to detail an engineer to continue this work in 1910. Through the cooperation of mine operators it has been possible to keep up some gaging stations during the open season of 1910. G. L. Parker also spent the period from September 15 to October 18 in Seward Peninsula in collecting the gage readings furnished by several mine operators and in making stream measurements.

Collection of statistics.—The work of collecting statistics of the production of gold, silver, and copper begun in 1906 was continued during the year. The progress report for 1909, completed in July, 1910, and published as Bulletin 442, contained preliminary figures showing the mineral production, which were changed but little when the final report was transmitted in October for inclusion in the Survey's annual volume "Mineral resources of the United States" for the calendar year 1909.

FIELD OPERATIONS FOR THE SEASON OF 1911.

Under an appropriation of $100,000 fourteen parties were dispatched to Alaska during the months of March, April, May, and June. One geologic and one topographic party are making reconnaissance surveys in the lower Copper River basin. One topographic party is making detailed surveys of the Port Valdez mining district. Two topographic parties and one geologic party are making reconnaissance and detailed geologic surveys in Kenai Peninsula. One geologic party is making a reconnaissance of the

Yentna placer district in the Susitna basin. Two geologic parties are making reconnaissance surveys of the Circle and Rampart quadrangles. Geologic surveys are being made north of Porcupine River, in cooperation with the International Boundary Commission. One party is to make an exploratory survey of the upper Alatna River basin and of the Noatak Valley. The investigation of the water resources of the Fairbanks, Circle, and Fortymile districts is being continued by two engineering parties. The geologist in charge will leave for Alaska in July to visit Prince William Sound, Kenai Peninsula, and the Fairbanks region.

OFFICE WORK.

During the year five bulletins (Nos. 433, 442, 443, 446, and 449) containing results of the work of the Alaska division have been issued. Four bulletins (Nos. 448, 467, 480, and 485) and one professional paper (No. 70) are in press. All these publications contain maps. There have also been issued as publications for sale two reconnaissance maps, those of the Circle and Fortymile (second edition) quadrangles.

The following manuscripts and maps have been submitted for publication:

Geology and mineral resources of the Eagle River region, by Adolph Knopf, including detailed geologic and topographic maps. (Bulletin 502.)

The Sitka mining district, by Adolph Knopf. (Bulletin 504.)

The headwater region of Gulkana and Susitna rivers, with an account of the Chistochina and Valdez Creek placers, by F. H. Moffit, including geologic and topographic reconnaissance maps. (Bulletin 498.)

Coastal glacers of Prince William Sound and Kenai Peninsula, by U. S. Grant.

Geology and coal fields of the lower Matanuska Valley, by G. C. Martin and F. J. Katz. (Bulletin 500.)

Geology and mineral resources of the Fairbanks quadrangle, by L. M. Prindle and F. J. Katz, including reconnaissance and detailed topographic and geologic maps.

The Bonnifield region, by S. R. Capps, including geologic and topographic reconnaissance maps. (Bulletin 501.)

The surface-water resources of Seward Peninsula, by F. F. Henshaw and G. L. Parker, with an account of the geography and geology by P. S. Smith and of the placer mining by A. H. Brooks, including reconnaissance map.

Topographic map of Kasaan Peninsula region; scale, 1:62,500; contour interval, 50 feet. Topography by R. H. Sargent, D. C. Witherspoon, and J. W. Bagley.

Topographic map of Copper Mountain and vicinity; scale, 1:62,500; contour interval, 50 feet; by R. H. Sargent.

The following reports are in hand:

Geology and ore deposits of Kasaan Peninsula and the Copper Mountain region, Prince of Wales Island, by C. W. Wright, including detailed geologic and topographic maps.

Geology of Glacier Bay and Lituya region, by F. E. Wright and C. W. Wright, including geologic reconnaissance maps.

Geology and mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins, including geologic reconnaissance maps.

The Koyukuk-Chandalar gold region, by A. G. Maddren, including geologic and topographic reconnaissance maps.

The Iditarod-Innoko region, by A. G. Maddren, including geologic and topographic reconnaissance maps.

Geology of the Nome and Grand Central quadrangles, by F. H. Moffit and Philip S. Smith, including detailed geologic map.

The following topographic maps have been completed during the year and are in process of publication as illustrations to reports:

Map of Eagle River region, by J. W. Bagley; scale, 1:62,500; contour interval, 50 feet.

Reconnaissance map of headwater region of Gulkana and Susitna rivers, by D. C. Witherspoon and C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

Reconnaissance map of Bonnifield region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

GEOLOGIC RESULTS.

Mr. Moffit's studies in the upper Gulkana and Susitna basins show that the auriferous slates of this region are of Mesozoic age and that the mineralization is probably genetically related to intrusive granites and diorites. In the Matanuska region Mr. Martin and Mr. Katz have divided the Eocene, formerly mapped as a unit, into three formations. They have also found extensive strata of fossiliferous Cretaceous and Jurassic rocks in this field. Their studies have shown that there is a zone of intense deformation along the southern margin of the Talkeetna Mountains and that pronounced disturbances, including a large number of thrust faults, took place in post-Eocene time. Mr. Maddren had found that the gold of the Iditarod placer district is closely associated with intrusive rocks. In the Bonnifield region Mr. Capps has been able to divide the crystalline schists into two groups—an older, probably of pre-Ordovician age, made up chiefly of metamorphosed sediments, and a younger, composed largely of altered igneous rocks, probably of Paleozoic age. He has also found some evidence that the heavy terrace gravel deposits of this district may be preglacial. Mr. Smith and Mr. Eakin have traced the Cretaceous rocks of the lower Koyukuk into the Kobuk Valley. They have also found that the Squirrel River placers, in this region, occur in association with metamorphic rocks similar to those of the Seward Peninsula. Mr. Hollick's studies of the coal-measure floras are not yet complete. It appears probable, however, that the coal-bearing rocks, hitherto classed as Kenai, may on account of their contained floras be divided into three groups, of which the oldest will be Cretaceous, the middle true Kenai (Eocene), and the youngest post-Eocene.

SURVEY OF PUBLIC LANDS.

Plans, personnel, etc.—An item in the sundry civil act approved June 25, 1910, provided "for the survey of the lands in the United States in the District of Alaska, $100,000." In accordance with instructions the Director of the Geological Survey, on June 25, 1910, submitted plans for the surveys authorized by this item to the Secretary of the Interior through the Commissioner of the General Land Office. These plans were approved by the Commissioner and by the Secretary on June 29. In a letter dated June 29 the Director instructed the geologist in charge of the division of Alaskan mineral resources to put the plans into execution.

The approved plans authorized the following surveys:

1. The astronomic determination of the latitude, longitude, and azimuth in the vicinity of the initial point of the proposed surveys, near Fairbanks.

2. Time permitting, the astronomic determination of latitude, longitude, and azimuth at another point near the mouth of Tanana River, which might be used as a reference point for future surveys in this district.

3. The establishment of a triangulation system in the vicinity of Fairbanks, by which the location of land lines and corners could be accurately determined and which could also be so developed as to permit extensions into other areas where subdivisional surveys are needed.

4. The extension of a base and meridian from the initial point near Fairbanks.

5. The survey of such township exteriors as were considered desirable.

6. Time permitting, the subdivision of these townships.

7. The making of reconnaissance surveys in the Copper River, Seward, and Matanuska regions to obtain information on which to plan surveys in these provinces.

As provided in the plans submitted, the Superintendent of the Coast and Geodetic Survey detailed the engineers required to make determinations of latitude, longitude, and azimuth at Fairbanks and at the mouth of the Tanana.

R. H. Sargent, topographer, was put in charge of the field parties at Fairbanks. C. L. Nelson, W. N. Vance, and S. G. Lunde, topographers, were detailed to assist Mr. Sargent. In addition to these four engineers, who were detailed from the permanent staff of the Geological Survey, four chainmen and one recorder accompanied the party from Seattle. At Fairbanks 21 other men were engaged as rodmen, axmen, packers, cooks, and in other minor capacities.

The personnel of the two line parties and the triangulation party were as follows:

Line parties:
- 1 engineer in charge.
- 4 chainmen.
- 2 flagmen.
- 3 axmen.
- 1 cook.
- 1 teamster.

Triangulation party:
- 1 engineer in charge.
- 1 axman.
- 1 packer.
- 1 cook.
- 1 recorder.

Mr. Sargent was directed, after starting the work at Fairbanks, to proceed by trail to Valdez and make the investigations along this route that were necessary to procure information required for planning future work in this field.

Mr. Brooks undertook similar investigations in the northeastern part of Kenai Peninsula and in the Matanuska region.

Although the money was not available for these surveys until July 1, the parties sailed from Seattle on July 5, arrived at Fairbanks on July 22, and began work on the following day. Mr. Sargent organized the work at Fairbanks and then returned to the coast by way of the Valdez trail, making investigations on the way for land surveys in this district. Mr. Brooks spent a month in the Kenai Peninsula and Seward Peninsula, devoting a part of the time to collecting information to be used in planning land surveys in this district. The other parties continued work in the Fairbanks district until about the middle of October. The office work was completed after the return of the field parties, and on May 15, 1911, the resulting plats and notes were transmitted to the Commissioner of the General Land Office. The total expenditure for this work was $35,132.27.

Astronomic determinations.—An astronomic determination of latitude, longitude, and azimuth was made at a station near Fairbanks by the Coast and Geodetic Survey. A similar determination was made at Tanana, a settlement on the west bank of the Yukon, at the mouth of Tanana River. This work was done in accordance with the approved plans and with an agreement made between the Secretary of the Interior and the Secretary of Commerce and Labor, under date of July 5, 1910. The Superintendent of the Coast and Geodetic Survey transmitted the results of the final computations of these observations on February 6, 1911.

Triangulation.—A base line was measured and a system of triangulation was established, the geodetic position of which was based on the astronomic observations. This triangulation not only checked the line surveys, but can also be extended into adjacent parts of the

Tanana Valley to provide points from which land surveys of important areas may be made in the future. By this means the projection of long standard parallels and guide meridians through areas of no commercial importance will be avoided.

The primary triangulation stations are marked by bronze tablets, furnished by the General Land Office, firmly set in concrete or solid rock. In preparation for the future expansion of the triangulation system six signals have been constructed on prominent hills in the Tanana Valley.

Summary of triangulation.

Base line measured----------feet--	13,876,674
Primary stations occupied----------	12
Secondary stations occupied----------	15
Points intersected ----------	3
Signals constructed ----------	6

Line work.—The line work consisted chiefly of extending base and meridian lines and the survey of township exteriors. Some section lines and a few meanders were also run. The geodetic position of the initial point was determined by triangulation. It seemed desirable not to attempt the sectionizing of the townships until the matter of the rights of the homesteaders had been settled.

Summary of line surveys.

	Miles.
Principal meridians----------	23.7
Base line----------	18
Township exteriors----------	43.7
Section lines----------	11.8
Meanders ----------	11.7
	108.9

It was impossible to ship iron posts to Fairbanks in time to make them available for the season's work. Wooden posts were therefore set, properly inscribed and witnessed in accordance with the regulations of the General Land Office.

The number of corners set was as follows:

Corners set.

Initial point----------	1
Township corners----------	7
Standard township corners----------	3
Closing township corners----------	3
Section corners----------	76
Quarter corners----------	86
Meander corners----------	8
Witness corners----------	8

DIVISION OF MINERAL RESOURCES.

The work of the division of mineral resources consists primarily of the preparation of the annual report on the mineral resources of the United States. This work was organized under the act of August 7, 1882, authorizing the United States Geological Survey to procure statistics in relation to mines and mining. Since that time the reports have appeared annually, except that the data for 1883 and 1884 were published in one volume and those for 1889 and 1890 in one volume. Since 1907, on account of the increase in the quantity of material available for publication, it has been necessary to publish the report in two volumes. At first only the more important lines of inquiry were taken up and the statistics were largely estimates. As the work progressed and the mineral industries increased in importance the necessity for more accurate statistics became more apparent, the character of the publication changed, and for many years this report has been an annual census of the mineral industries.

The plan pursued in the first report—that of publishing chapters devoted to each mineral, prepared by or under the supervision of some one who makes a special study of the subject, rather than chapters devoted to each State—has never been changed. The practice of publishing in pamphlet form each chapter for distribution to those especially interested in the subject has been carried out from the second report. This practice permits early publication and also makes for economy in printing, as generally correspondents, especially producers, are interested in only one or two subjects. The publication of separate chapters also permits the information on any particular subject to be distributed as soon as it is ready. The complete report can be published only after the last chapter is ready, but all the information contained in the report has already been given to the public, some of it months before.

In the desire to carry out the section of the organic act of the Survey providing for the examination of the mineral resources and products of the national domain, the study of the occurrence and utilization of the economic minerals of the country has been taken up in addition to the compilation of the statistics of production. As a result of this work maps have been published showing the coal fields, the oil and gas fields, and the iron-ore regions of the United States, and similar maps showing the distribution of other minerals are in preparation. The policy is to make the volumes of "Mineral resources" a cyclopedia of information relative to the sources of our mineral production, including a study of the reserves available for future use, and a discussion of their application to the needs of man.

Cooperation between the United States Geological Survey and the State geological surveys in collecting mineral statistics in many of the States was resumed for 1910. For 1909 it had been suspended on account of the cooperative arrangement made by the Survey with the Bureau of the Census. This cooperation with the State surveys has the primary object of saving labor for the producers, who can make one report that will serve for both organizations. A secondary result is that by this cooperation the statistics of production obtained by the State and Federal surveys are believed to be more accurate and are in exact agreement. On the whole this plan has been satisfactory and its continuance is believed to be to the advantage of all concerned.

During the fiscal year the work of the division consisted of the preparation of reports on mineral resources of the United States for the calendar years 1909 and 1910. The statistics for 1909 were collected in cooperation with the Bureau of the Census. In accordance with the agreements between the two bureaus, approved by the Secretary of Commerce and Labor and the Secretary of the Interior, the field work of collecting the statistics was done by the Bureau of the Census by personal visits of a large force of agents. It was thought that this plan would greatly expedite the work. Experience showed, however, that it took very much longer to get the data in this way than it would have taken by correspondence, the usual method pursued by the Survey. The following table gives the estimated percentage of schedules returned at the close of the fiscal years 1909, 1910, and 1911 for some of the more important products, the period covered by the returns being the preceding calendar year:

Percentage of schedules returned from producers at end of fiscal years 1909, 1910, and 1911.

Industry.	June 30, 1909.	June 30, 1910.	June 30, 1911.
Building stone	97	26	90
Clay working	98	35	95
Coal	98	26	99
Coke	100	15	100
Iron ore	100	24	100
Natural gas	90	43	80
Quicksilver	99	33	100

In consequence of the tardy receipt of the schedules for 1909 the report for that year, to be published in two volumes, has not yet appeared, though both parts are well advanced toward completion in the hands of the printer. At the beginning of the present calendar year preliminary estimates of the production in 1910 of coal, cement, petroleum, gold, silver, copper, lead, and zinc were given

to the public through the press. Advance preliminary statements of the production of copper, lead, and zinc in 1910 have also been published.

Advance chapters from the report for 1910 have been published as follows: Asbestos, Fuller's earth, Graphite, Mica, Monazite, Potash salts, and Quartz and feldspar. The following were in the hands of the printer at the close of the year: Chromic iron ore, Coke, Gypsum, Sand-lime brick, and Talc and soapstone.

The cooperative plan carried on between this division and the division of geology for several years was continued to the mutual advantage of both. By this plan geologists are assigned to supervise the compilation of the statistical data relating to certain mineral products and to prepare the reports on these products. This plan gives to the statistical work the benefit of the cooperation of the geologist trained in economic work and gives to the geologist the opportunity to study the industrial and commercial conditions which affect the demand for the minerals. This method is also economical because the work for the division of mineral resources does not require the entire time of the geologist, but allows him opportunity to engage in his scientific pursuits, thus permitting the division to pay simply for the actual cost of its work.

The number of permanent employees in Washington who devote their entire time to the work of the division is 28. In addition 13 members of the division of geology devote a portion of their time to the work of this division and 7 persons are employed in the offices of the Survey outside of Washington, making a total of 48 persons engaged on the work under appointments from the Secretary of the Interior.

Three offices are maintained in the West, at Denver, Salt Lake City, and San Francisco, where the local representatives gather statistics and other data for the division and disseminate information.

E. W. Parker continued as administrative head of the division, and Waldemar Lindgren exercised supervision over the preparation of chapters on metalliferous ores. In addition to his administrative duties Mr. Parker has prepared reports on the production of coal, the manufacture of coke, and the briquetting industry for 1909. E. S. Bastin prepared reports on quartz and feldspar and graphite; E. F. Burchard on barytes and strontium, cement, fluorspar, and cryolite, glass sands and other sands, gypsum, iron ore, manganese and manganiferous ores, mineral paints, and stone; B. S. Butler on copper; D. T. Day on asphaltum and bituminous rock, and natural gas and petroleum; J. S. Diller on asbestos and talc and soapstone; J. P. Dunlop on secondary metals; F. L. Hess on antimony, arsenic, bismuth, nickel, cobalt, and steel-hardening metals; H. D. McCaskey on gold, silver, and copper in the Central States and the Eastern States;

Jefferson Middleton on clay, clay-working industries, fuller's earth, and sand-lime brick; W. C. Phalen on abrasive materials, aluminum and bauxite, bromide, potash salts, sodium salts, and sulphur and pyrite; C. E. Siebenthal on lead and zinc; D. B. Sterrett on gems and precious stones, mica, and monazite and zircon; F. B. Van Horn on phosphate rock, and C. G. Yale on borax and magnesite. A few unimportant changes in the assignments have been made for the fiscal year 1912. In addition to his reports Mr. McCaskey has general supervision of the offices of this division in the Western States. These offices are under the direct charge of the following persons: Denver, C. W. Henderson; Salt Lake City, V. C. Heikes; San Francisco, C. G. Yale.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 440 quantitative analyses and 838 qualitative determinations, chiefly of minerals sent in for examination by persons not connected with the survey, were reported during the year.

G. F. Becker has been engaged chiefly in studying the bearing of radioactivity upon geologic phenomena and has practically completed an investigation of the cooling of a radioactive earth. As an incident to this investigation he has discovered a whole system of novel and extremely efficient formulas for mechanical quadratures. He has also completed a biographic notice of Samuel Franklin Emmons for the American Institute of Mining Engineers.

F. W. Clarke has been engaged mainly in revising the Data of Geochemistry, the republication of which has been made desirable by the large use of this bulletin in educational institutions and by professional students of geology.

Chase Palmer made a number of analyses of rocks and minerals and continued his study of the surface waters of the United States.

R. C. Wells, besides assisting in the analytical work of the chemical laboratory, collaborated with C. E. Van Orstrand, of the physical laboratory, in his experiments on the diffusivity of metals by electroplating the metallic junctions. His research work consisted of a study of the fractional precipitation of metallic carbonates with reference to problems of ore deposition. Special determinations concerning ore deposition were made for several of the Survey geologists. The following papers by Mr. Wells were published during the year: "The sensitiveness of the colorimetric estimation of titanium," "The rôle of hydrolysis in geological chemistry," and, jointly with F. L. Hess, a paper describing an occurrence of the mineral strüverite and its analysis by a new method.

George Steiger gave most of his time to routine quantitative analyses. He represented the laboratory at the meetings of the com-

mittee to award contracts for supplies for 1911 and 1912 and made a study of the composition of muscovite and prepared a short paper on the subject.

W. T. Schaller devoted his time largely to routine analyses consisting of qualitative chemical and mineralogical determinations, as well as quantitative rock analyses. He published descriptions of the minerals barbierite and mosesite and analyzed and described for publication three additional new minerals—beaverite, from Utah; hinsdalite, from Colorado; and ferritungstite, from Washington. He also analyzed and described a number of rare minerals, among them pucherite, bismite, and cuprodescloizite, from California, and thaumasite, plumbojarosite, corkite, and variscite, from Utah. Crystallographic studies were made on ferberite from Colorado, wurtzite and variscite from Utah, and several minerals from Hawaii. A new silicate mineral from New Jersey and a new copper phosphate from Virginia were investigated, and a theoretical study of the rutile group was continued and extended. The relations of podolite to dahllite, of stelznerite to antlerite, and of the members of the alunite group were investigated. Mr. Schaller visited mineral collections in New York City and in Dover and Trenton, N. J., making a special study of the California tourmalines with a view to finishing a paper on that subject. He published the following papers during the year:

Ludwigite from Montana: Am. Jour. Sci., 4th ser., vol. 30, 1910, p. 146.

Mosesite, a new mercury mineral from Terlingua, Tex. [with F. A. Canfield and W. F. Hillebrand]: Idem, p. 202.

The probable identity of podolite with dahllite; the identity of stelznerite with antlerite: Idem, p. 309.

Barbierite, a monoclinic soda feldspar: Idem, p. 358.

Natramblygenite, a new mineral: Am. Jour. Sci., 4th ser., vol. 31, 1911, p. 48.

Thaumasite from Beaver County, Utah [with B. S. Butler]: Idem, p. 131.

Bismuth ochers from San Diego County, Cal.: Jour. Am. Chem. Soc., vol. 33, 1911, p. 162.

Axinit von Californien: Zeitschr. Kryst. Min., vol. 48, 1910, p. 148.

Die chemische Zusammensetzung von Jamesonit und Warrenit: Idem, 1911, p. 562.

Krystallographische Notizen uber Albit, Phenakit und Neptunit: Idem, 1911, p. 550.

Wismutocker [with F. L. Ransome]: Idem, 1910, p. 16.

Die Brechungsexponent von Kanada-Balsam: Centralbl. Min., 1910, No. 13, p. 390.

H. A. Lepper was employed as laboratory assistant from July 18 to October 18, 1910. His time was given exclusively to the analysis of phosphate rocks sent in by Eliot Blackwelder and R. W. Richards.

J. G. Fairchild was appointed assistant chemist in the survey and began his duties in the chemical laboratory on November 1. His time was mostly given to the analyses of phosphates, with occasional analyses of minerals and rocks. He also critically investigated methods for the determination of phosphoric acid.

In the physical laboratory C. E. Van Orstrand has continued experiments on the elasticity and diffusivity of metals, the experiments on diffusivity having been carried on in cooperation with Mr. Wells, of the chemical laboratory, and Dr. F. P. Dewey, assayer in the office of the Director of the Mint at Washington. Theoretical work supplementing these investigations has been continued throughout the year. Some time has been given to the preparation of certain mathematical tables which are of general application, but of particular value to the student of geophysics. In this connection a complete ten-place table of the circular sines and cosines to radian argument has been begun, and two tables have been completed. The first consists of 16,000 five-place values of the natural logarithm and the second consists of 2,500 five-place values to radian argument of the circular tangent and cotangent and their logarithms. The last two tables are to be included in the revised edition of "Smithsonian mathematical tables of hyperbolic functions."

TOPOGRAPHIC BRANCH.

ORGANIZATION.

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

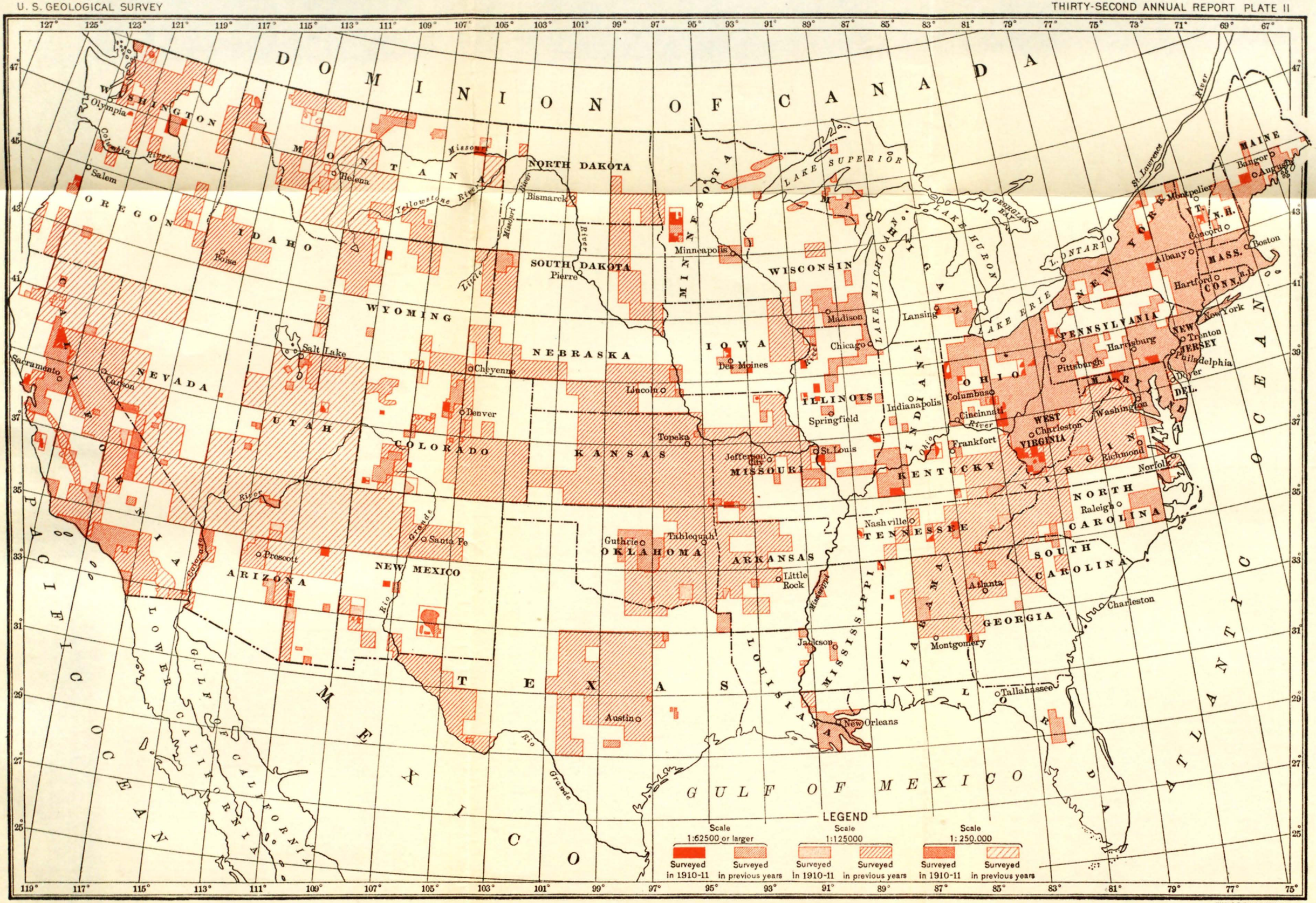
Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer in charge.
Central division, W. H. Herron, geographer in charge.
Rocky Mountain division, Sledge Tatum, geographer in charge.
Pacific division, T. G. Gerdine, geographer in charge.
Inspectors of topography: J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 1 topographer, 3 assistant topographers, 21 junior topographers, and 2 draftsmen. It was reduced 26 by transfers, resignations, etc. With these changes the technical force now includes 1 chief geographer, 10 geographers, 47 topographers, 44 assistant topographers, 51 junior topographers, and 9 draftsmen—a total of 162. In addition to the above, 68 technical field assistants were employed during a whole or a part of the field season. One geographer and 7 topographers are on leave without pay.

PUBLICATIONS.

The work of the topographic branch is represented by 11 publications issued during the year, namely, Bulletins 434, 437, 440, 441, 453, 457, 459, 460, 461, 462, and 463, titles and brief summaries of which are given on pages 27–30. At the end of the year Bulletins



MAP OF UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE SCALE EMPLOYED FOR EACH AREA

Scale

100 0 100 200 300 Miles

1911

JULIUS BIEN CO. LITH. N.Y.

458, 464, 468, 469, 472, 473, 476, and 477 (Results of spirit leveling in Arkansas, Louisiana, Mississippi, New Mexico, Texas, North Dakota, South Dakota, Kansas, Nebraska, Ohio, and West Virginia, respectively) were at the Government Printing Office nearly ready for publication. In addition, the manuscripts for 9 bulletins were assembled near the close of the fiscal year and transmitted to the editor for publication as Bulletins 466 (Idaho-Washington boundary line), 481 (Results of spirit leveling in California), 482 (Results of spirit leveling in Montana), 486 (Results of spirit leveling in Colorado), 487 (Results of spirit leveling in Idaho), 488 (Results of spirit leveling in Nevada), 489 (Results of spirit leveling in Utah), 493 (Results of spirit leveling in Illinois), and 496 (Triangulation and traverse results for 1909–10). During the year 83 topographic maps were issued, the titles of which are given on page 35.

GENERAL OFFICE WORK.

In the triangulation and computing section progress maps were kept up to date and new ones were compiled when necessary; field notes in connection with horizontal and vertical control work were catalogued and copied; instructions relating to triangulation, traverse, levels, and the adjustment of instruments were prepared; and work was done in connection with a committee appointed to determine the areas of the several States and of Alaska.

SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1911, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 23,272 square miles, making the total area surveyed to date in the United States 1,131,037 square miles, or about 37 per cent of the entire country. In addition, 6,460 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 29,732 square miles.

Triangulation stations to the number of 99 were occupied and permanently marked. There were run 3,837 miles of primary traverse, in connection with which 467 permanent marks were set. In the course of the work 22,350 square miles were covered by primary control.

In connection with these surveys 5,998 linear miles of primary levels were run, making the total amount of primary and precise levels run since the authorization of this work by Congress, in 1896, 230,430 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1910–11, as reported in detail on pages 76–79, was 13,851 square miles—36 for publication on the scale of 1:62,500 and 13,815 for publication on the scale of 1:250,000.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 224 square miles, part for publication on the scale of 1:31,680 and part for publication on the scale of 1:62,500, making the total area in Hawaii surveyed to date 598 square miles.

Present condition of topographic surveys of the United States and new areas surveyed in 1910–11.

State or Territory.	New area surveyed in 1910–11.	Total area surveyed to June 30, 1911.	Percentage of total area of State surveyed to June 30, 1911.
	Sq. miles.	*Sq. miles.*	
Alabama	356	18,639	36
Arizona	958	64,436	57
Arkansas	245	21,043	39
California	6,412	99,326	63
Colorado	993	42,744	41
Connecticut	.....	4,965	100
Delaware	.....	1,008	43
District of Columbia	.....	70	100
Florida	.....	1,821	3
Georgia	.....	17,337	29
Idaho	811	19,009	23
Illinois	1,011	11,093	20
Indiana	100	3,041	8
Iowa	328	10,776	19
Kansas	.....	64,159	78
Kentucky	666	17,142	42
Louisiana	.....	8,283	17
Maine	470	8,271	25
Maryland	333	11,104	90
Massachusetts	.....	8,266	100
Michigan	193	5,117	9
Minnesota	719	4,301	5
Mississippi	38	1,834	4
Missouri	351	35,043	52
Montana	1,075	53,723	37
Nebraska	.....	25,974	34
Nevada	200	50,675	46
New Hampshire	.....	3,380	36
New Jersey	.....	8,224	100
New Mexico	1,672	33,579	27
New York	698	40,919	83
North Carolina	.....	17,661	34
North Dakota	.....	9,716	14
Ohio	1,504	28,823	70
Oklahoma	14	38,691	55
Oregon	391	18,670	19
Pennsylvania	794	23,607	52
Rhode Island	.....	1,248	100
South Carolina	.....	5,640	18
South Dakota	638	18,594	24
Tennessee	448	20,793	49
Texas	.....	66,807	25
Utah	480	67,905	79
Vermont	139	3,676	38
Virginia	.....	29,980	70
Washington	840	21,594	31
West Virginia	50	24,170	100
Wisconsin	.....	11,789	21
Wyoming	345	26,371	27
	23,272	1,131,037	.....
Hawaii	224	598	.....

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Maine, Maryland, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Vermont, and West Virginia. This work comprised the survey of 11 quadrangles and 1 special area and the resurvey or revision of 7 quadrangles and 2 special areas. In addition, 11 quadrangles were partly surveyed and 6 were partly resurveyed. The total new area mapped was 3,326 square miles—3,148 for publication on the sale of 1:62,500, 80 for publication on the scale of 1:31,680, and 98 for publication on the scale of 1:24,000. The area resurveyed was 1,753 square miles—1,710 for publication on the scale of 1:62,500, 40 for publication on the scale of 1:125,000, and 3 for publication on the scale of 1:12,000. In connection with this work 1,541 miles of primary levels were run and 351 permanent bench marks were established. Profile surveys were also made of 9 rivers, the total distance traversed being 439 miles, and in connection with this work areas aggregating 117 square miles were mapped for publication on the scale of 1:24,000.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of Georgia, Florida, Maine, Pennsylvania, Tennessee, New York, Virginia, West Virginia, and Delaware. The total area covered by the primary control was about 4,450 square miles, of which 4,000 were controlled by primary traverse, 1,263 miles being run and 188 permanent marks set. Thirty-one triangulation stations were occupied and 24 were marked. The result of this work was to make control available in thirty-one 15-minute quadrangles.

Topographic surveys in Atlantic division from July 1, 1910, to June 30, 1911.

States.	Contour interval.	For publication on scale of—				Total area surveyed.	Primary levels.		Primary traverse.	
		1:24,000. New.	1:62,500. New.	1:62,500. Resurvey.	1:125,000. Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Alabama	10–20	61	295	.....	.....	356	11	.....	.....	.....
Maine	20	37	433	.....	.....	470	38	8	.....	.....
Maryland	5–20	.....	333	.....	.....	[1] 336	74	28	.....	.....
Mississippi	20	.....	38	.....	.....	38	50	12	.....	.....
New York	20	.....	698	218	.....	916	245	50	84	11
North Carolina	100	.....	.....	.....	5	5	.....	.....	.....	.....
Pennsylvania	20	.....	794	.....	.....	794	41	12	.....	.....
Tennessee	5–20–100	.....	368	101	35	[2] 584	329	57	478	50
Vermont	20	.....	139	.....	.....	139	55	11	.....	.....
West Virginia	20–50	.....	50	1,391	.....	1,441	327	76	.....	.....
Delaware	.....	.....	.....	.....	.....	.....	.....	.....	139	24
Florida	.....	.....	.....	.....	.....	.....	278	73	368	84
Georgia	.....	.....	.....	.....	.....	.....	93	24	65	6
Virginia	.....	.....	.....	.....	.....	.....	.....	.....	129	13
	.....	98	3,148	1,710	40	5,079	1,541	351	1,263	188

[1] 3 square miles resurveyed in Maryland for publication on scale of 1:12,000.
[2] 80 square miles surveyed in Tennessee for publication on scale of 1:31,680.

DETAILS OF WORK BY STATES.

Alabama.—Under an allotment of $800 made by the State geologist, which was met with an equal amount by the United States Geological Survey, the mapping of the Fayette special area, comprising 61 square miles in Fayette County, was completed by R. H. Reineck, for publication on the scale of 1:24,000, with a contour interval of 10 feet. In addition to the cooperative work, the survey of the Seale quadrangle, in Russell and Lee Counties, was completed by R. D. Cummin and Olinus Smith, the area mapped being 252 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. M. Rawls and A. F. McNair ran 11 miles of primary levels. (See also pp. 95–96.)

Delaware.—For the control of the Seaford and Georgetown quadrangles, in Sussex County, E. L. McNair ran 139 miles of primary traverse and set 24 permanent bench marks.

Florida.—The primary control of the Palatka, Interlachen, Hawthorne, and Starke quadrangles, in Bradford, Clay, St. John, Putnam, and Alachua counties, was completed. For this control J. B. Metcalfe and C. W. Arnold ran 278 miles of primary levels and established 73 permanent bench marks; C. B. Kendall, J. H. Wilson, and S. E. Taylor ran 368 miles of primary traverse and set 84 permanent marks.

Georgia.—For the control of the White Plains, Eatonton, Greensboro, and Milledgeville quadrangles, in Greene, Hancock, Morgan, Oconee, Oglethorpe, Putnam, and Taliaferro Counties, J. B. Metcalfe and C. W. Arnold ran 93 miles of primary levels and established 24 permanent bench marks; for the control of the White Plains quadrangle C. B. Kendall ran 65 miles of primary traverse and set 6 permanent marks.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted $4,500 and the United States Geological Survey allotted a like sum. In addition, an allotment of $5,000 was made by the State for river-profile surveys. The survey of the Livermore quadrangle, in Androscoggin, Franklin, Kennebec, and Oxford counties, was completed by Hersey Munroe and Charles Hartmann, jr., the area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Buckfield and Bryants Pond quadrangles, in Franklin, Oxford, and Androscoggin counties, was begun by Messrs. Hartmann and Munroe, the area surveyed being 219 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Livermore and Buckfield quadrangles, Mr. Hartmann and H. P. Kilby ran 38 miles of primary levels and established 8 permanent bench marks. The survey of Dead

River and Sandy River, in Somerset and Franklin counties, was begun by Jay De Puy, the distance traversed being 214 miles, and an area of 37 square miles being topographically mapped, for publication on the scale of 1:24,000, with contour intervals of 5 and 20 feet. The survey of Piscataquis, Pleasant, Schoodic, and Sebec rivers, in Penobscot and Piscataquis counties, and of Silver Lake and Houston Pond, in the same counties, was begun by Olinus Smith, the distance traversed being 183 miles. For the control of the Bethel and Bryants Pond quadrangles, in Oxford County, E. L. McNair occupied 3 triangulation stations.

Maryland.—For the continuation of cooperative topographic surveys in Maryland the State geologist allotted $2,000, which was met with a like sum by the Geological Survey. The survey of the Hagerstown quadrangle, in Washington and Frederick Counties, Md., and Franklin County, Pa., and of the Williamsport quadrangle, in Washington County, Md., Berkeley County, W. Va., and Franklin County, Pa., was completed by J. H. Wheat, R. L. Harrison, Olinus Smith, and R. A. Kiger, the total area mapped being 363 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area 40 square miles lies in Pennsylvania and 50 square miles lies in West Virginia, and the mapping of those portions of the quadrangles was paid for from funds of the respective States. For the control of the Williamsport quadrangle, C. H. Semper ran 17 miles of primary levels and established 6 permanent bench marks in Washington County, Md., 7 miles of primary levels and 3 permanent bench marks in Berkeley County, W. Va., and 3 miles of primary levels and 1 permanent bench mark in Franklin County, Pa. The mapping of the Indian Head and Nanjemoy quadrangles, in Charles County, was begun by R. L. Harrison, the area mapped being 60 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles, A. F. McNair and C. W. Arnold ran 42 miles of primary levels and established 13 permanent bench marks. In addition to the cooperative work in Maryland a special resurvey was made along Potomac River between Lock No. 10 and Great Falls, in the District of Columbia, Montgomery County, Md., and Fairfax County, Va. The area mapped was 3.3 square miles, for publication on the scale of 1:12,000, with a contour interval of 5 feet. This work was done by R. T. Evans, E. P. Davis, C. E. Cooke, and R. L. Harrison. D. H. Baldwin ran 15 miles of primary levels and set 9 permanent bench marks.

Mississippi.—The survey of the Iuka quadrangle, in Tishomingo County, Miss., and Colbert and Lauderdale Counties, Ala., was continued by J. F. McBeth, the area mapped being 81 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. B. Metcalfe and J. M. Rawls

ran 50 miles of primary levels and established 12 permanent bench marks. Of the Iuka quadrangle, 43 square miles lies in Alabama.

New York.—The State engineer and surveyor of New York allotted $10,000 for the continuation of cooperative topographic surveys in the State and the Federal Survey allotted a like sum for the same purpose. The survey of the New Berlin, Canton, and McKeever quadrangles, in Otsego, Chenango, Madison, St. Lawrence, Herkimer, Oneida, and Lewis counties, was completed by C. E. Cooke, R. C. McKinney, J. I. Gayetty, S. P. Floore, J. H. Lee Feaver, J. F. McBeth, and H. L. Dodge, the total area mapped being 609 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The mapping of the Lowville quadrangle, in Lewis County, was begun by J. M. Whitman, S. P. Floore, and J. H. Lee Feaver, the area mapped being 89 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the New Berlin, McKeever, and Lowville quadrangles and of the No. 4 quadrangle, in Lewis and Herkimer counties, C. H. Semper, K. E. Schlachter, and James Rayburn ran 245 miles of primary levels and established 50 permanent bench marks, and D. H. Baldwin ran 84 miles of primary traverse and set 11 permanent marks. Revision of culture was completed on the Rochester quadrangle, in Monroe County, by C. E. Cooke, the area revised being 218 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

North Carolina.—(See Tennessee-North Carolina, pp. 97–98.)

Pennsylvania.—The Topographic and Geological Survey Commission of Pennsylvania allotted $5,183 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted a like sum for the same purpose. The survey of the McCalls Ferry, Quarryville, and Hilliards quadrangles, in York, Lancaster, Chester, Venango, Butler, and Mercer counties was completed, and that of the Mercer and Stoneboro quadrangles, in Mercer and Crawford counties, was begun; the total area mapped being 754 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Duncan Hannegan, R. C. McKinney, J. H. Renshawe, R. A. Kiger, Robert Muldrow, J. M. Whitman, and W. N. Vance. For the control of these areas and of the Lancaster and New Holland quadrangles, in Lancaster County, C. H. Semper, James Rayburn, and Howard Mellinger ran 38 miles of primary levels and established 11 permanent bench marks. For the control of the Winter, Somerset, Ligonier, Windber, and Stahlstown quadrangles, in Somerset and Westmoreland counties, George T. Hawkins and J. B. Metcalfe occupied and marked 13 triangulation stations. The survey of the Pennsylvania portions of the Hagerstown and Williamsport quad-

rangles (the greater part of which lies in and is reported under Maryland), in Franklin County, was also completed, the area mapped being 40 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 3 miles of primary levels were run and one permanent bench mark was set.

Tennessee.—The North Fork of the Forked Deer River drainage commission and the Rutherford Fork of Obion River drainage commission allotted, through the State geologist, the sums of $1,000 and $1,250, respectively, for cooperative topographic surveys of those rivers and the United States Geological Survey made like allotments for the same purpose. Areas of 37 square miles in Gibson County, on North Fork of Deer River, and of 43 square miles on Rutherford Fork of Obion River were surveyed by W. H. Griffin, Charles Hartmann, jr., S. P. Floore, J. M. Rawls, and J. De Puy for publication on the scale of 1:31,680, with a contour interval of 5 feet. The State geologist allotted $2,000 and the Federal Survey a like sum for the completion of primary control in the Trenton, Alamo, Greenfield, Obion, Martin, and Union City quadrangles, in Gibson, Madison, Crockett, Weakley, Obion, and Dyer counties. For this control E. L. McNair and J. M. Rawls ran 79 miles of primary levels, established 16 permanent bench marks, ran 415 miles of primary traverse, and set 46 permanent marks. In addition to the cooperative work in Tennessee, the survey of the Crossville quadrangle, in Cumberland, Bledsoe, White, and Van Buren counties, was completed and that of the Hollow Springs quadrangle, in Cannon, Coffee, Bedford, and Rutherford counties, was begun, the area mapped being 368 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Oscar Jones, J. F. McBeth, T. F. Slaughter, J. G. Stelzenmuller, F. W. Farnsworth, and E. E. Witherspoon. For the control of the Hollow Springs and Crossville quadrangles, Messrs. Witherspoon and Farnsworth and S. E. Taylor and F. W. Crisp ran 250 miles of primary levels and established 41 permanent bench marks, and Oscar Jones ran 63 miles of primary traverse and established 4 permanent marks. Under the terms of the Weeks Act a special resurvey was made of an area covering 101 square miles in the Great Smoky Mountain National Forest, Blount and Sevier counties, for publication on the scale of 1:62,500, with a contour interval of 100 feet. This work was done by Oscar Jones, W. H. S. Morey, Charles Hartmann, jr., R. A. Kiger, S. E. Taylor, J. M. Rawls, A. F. McNair, C. W. Arnold, and C. S. Wells, the expenses being paid from the appropriation made in the act above named.

Tennessee-North Carolina.—J. I. Gayetty completed the revision of the Mount Guyot quadrangle, in Cooke, Lewis, and Jefferson

counties, Tenn., and Haywood, Swain, and Jackson counties, N. C., the area resurveyed being 35 square miles in Tennessee and 5 square miles in North Carolina, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Virginia.—For cooperative topographic surveys in Virginia the State geologist and the United States Geological Survey each allotted $1,750. For the control of the Gold Belt region (Palmyra, Gordonsville, and Spottsylvania quadrangles), in Louisa, Fluvanna, Goochland, Orange, Spottsylvania, and Albemarle counties, D. H. Baldwin ran 129 miles of primary traverse and set 13 permanent marks.

Vermont.—The survey of the Woodstock quadrangle, in Windsor County, was begun by R. D. Cummin, T. F. Slaughter, W. H. S. Morey, and Homer Dodge, the area mapped being 139 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area A. F. McNair ran 55 miles of primary levels and set 11 permanent bench marks.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the State geologist allotted $12,000 and the United States Geological Survey allotted $10,000. The resurvey of areas previously mapped resulted in the completion of the work on the Welch, Pineville, Mullen, Holden, and Bald Knob quadrangles and the West Virginia portions of the Iaeger, Naugatuck, and Maxwell quadrangles, and of part of the work on the Logan, Louisa, and Marshes quadrangles, in McDowell, Wyoming, Logan, Raleigh, Mingo, Wayne, Boone, Lincoln, Fayette, and Welch counties, the total area mapped being 1,391 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by E. I. Ireland, Fred McLaughlin, S. E. Taylor, C. P. McKinley, C. S. Wells, A. J. Dailey, C. W. Arnold, J. H. Wilson, S. R. Truesdell, and F. E. Hale. For the control of these areas S. E. Taylor, J. B. Metcalfe, Fred McLaughlin, C. P. McKinley, and F. E. Hale ran 320 miles of primary levels and established 73 permanent bench marks. For the control of the Alton and Crawford quadrangles, in Upshur, Barbour, and Randolph Counties, D. H. Baldwin and J. I. Gayetty occupied and marked 9 triangulation stations for the control of the Red Star, Hinton, Flat Top, and Meadow Creek quadrangles, in Fayette, Summers, Mercer, Raleigh, and Wyoming counties, and C. B. Kendall and C. P. McKinley occupied 6 triangulation stations and marked 2. The survey of the West Virginia portion of the Williamsport quadrangle (the greater part of which lies in and is reported under Maryland), in Berkeley County, was also completed, the area mapped being 50 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 7 miles of primary levels were run and 3 permanent bench marks were set.

OFFICE WORK.

The drafting of the following sheets was completed: Fayette special, Ala.; Livermore and Kezar Falls, Me.; Hagerstown, Md.-Pa.; Williamsport, Md.-Pa.-W. Va.; New Berlin, Hartwick, McKeever, Hammond, and Canton, N. Y.; Hilliards, Quarryville, and McCalls Ferry, Pa.; Crossville, Mount Guyot revision, Rutherford Fork of Obion River, and North Fork of Forked Deer River, Tenn.; Mullen, Pineville, Welch, Bald Knob, Holden, W. Va., and West Virginia portions of Iaeger and Naugatuck.

Progress in the drafting of additional sheets was made as follows: Seale, Ala., 60 per cent; Buckfield, Me., 52 per cent.

In the triangulation and computing section the following work was completed:

Latitudes, departures, and geographic positions for the Stockley (Del.) and Seaford (Del.-Md.) quadrangles were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Hawthorn, Interlachen, Palatka, and Starke quadrangles (Fla.). Latitudes, departures, and geographic positions for the Greencove Springs, Hague, and Welaka quadrangles (Fla.) were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Greensboro, Shoulder, and Sparta quadrangles (Ga.).

Primary level circuits were adjusted and geodetic distances and positions were computed for the Buckfield and Livermore quadrangles (Me.). Geodetic distances and positions in the Bryants Pond and Sango Pond quadrangles (Me.) were computed.

Primary and precise level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Great Falls power project special survey (Md.-Va.).

Primary level circuits in the Hagerstown (Md.-Pa.) and Williamsport (Md.-W. Va.-Pa.) quadrangles were adjusted.

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

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Lowville and No. 4 quadrangles (N. Y.). Primary level circuits in the McKeever, New Berlin, and Port Leyden quadrangles (N. Y.) were adjusted. The geodetic position of the seismograph site in the American Museum of Natural History grounds in New York City was computed.

Primary level circuits in the Hilliards, McCalls Ferry, and Quarryville quadrangles (Pa.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Alamo, Crossville,

Greenfield, and Trenton quadrangles (Tenn.). Latitudes, departures, and geographic positions for the Dresden, Martin, Trenton, Trimble, and Union City (Tenn.) and Tiptonville (Tenn.-Mo.) quadrangles were computed.

Primary level notes for the Woodstock quadrangle (Vt.) were checked.

Latitudes, departures, and geographic positions for the Gordonsville, Palmyra, and Spottsylvania quadrangles (Va.) were computed.

Primary level circuits in the Holden, Mullen, and Pineville (W. Va.) and Iaeger and Welch (W. Va.-Va.) quadrangles were adjusted.

Level lists were revised and assembled, after all necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for West Virginia (Bulletin 477) and New York.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arkansas, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. This work comprised the survey of 16 quadrangles and 1 special area and the revision of 1 special area. In addition, 20 quadrangles and 2 river projects were partly surveyed. The total new area mapped was 5,131 square miles—259 for publication on the scale of 1:125,000, 4,730 for publication on the scale of 1:62,500, and 142 for publication on the scale of 1:24,000. The area resurveyed was 57 square miles, for publication on the scale of 1:62,500. In connection with this work 2,074 miles of primary levels were run and 519 permanent bench marks were established.

Primary traverse and primary triangulation were carried on at different times by four parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. The total area covered by this primary control was about 5,300 square miles, of which 4,840 were controlled by primary traverse, 2,088 miles being run and 218 permanent marks set. Six triangulation stations were occupied and 4 were marked. The result of this work was to make control available in 59 quadrangles.

Topographic surveys in central division from July 1, 1910, to June 30, 1911.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Primary levels.		Primary traverse.	
		1:125,000.	1:62,500.			Distance run.	Bench marks.	Distance. run.	Permanent marks.
		New.	New.	Resurvey.					
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*		*Miles.*	
Arkansas	20–50	245	.....	57	302	.....	.....	.....	.....
Oklahoma	50	14	.....	.....	14	.....	.....	.....	.....
Illinois	5–20	.....	869	.....	[a]1,011	293	47	291	37
Indiana	20	.....	100	.....	100	27	9	.....	.....
Iowa	20	.....	328	.....	328	108	34	50	3
Kentucky	20	.....	666	.....	666	262	98	10	3
Michigan	20	.....	193	.....	193	.....	.....	466	58
Minnesota	10	.....	719	.....	719	374	101	233	28
Missouri	10	.....	351	.....	351	80	19	174	15
Ohio	10–20	.....	1,504	.....	1,504	930	211	864	74
	.....	259	4,730	57	5,188	2,074	519	2,088	218

[a] 142 square miles in Illinois, for publication on the scale of 1:24,000.

DETAILS OF WORK BY STATES.

Arkansas.—The survey of the De Queen quadrangle, in Polk, Howard, and Sevier counties, Ark., and McCurtain County, Okla., was continued by H. H. Hodgeson and W. R. Schreiner, the area mapped being 259 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. Of this area, 14 miles lies in Oklahoma. A portion of the Hot Springs special quadrangle, in Garland and Hot Springs counties, was revised by C. L. Sadler and F. B. Barrett, the area revised being 57 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Illinois.—The governor of Illinois allotted $10,000 for the continuation of cooperative topographic surveys in Illinois, and the United States Geological Survey an equal amount for the same purpose. The governor also made an additional allotment of $3,750 for a survey of the overflowed lands within the State, which was met by an allotment of $1,250 by the Federal Survey. The survey of the Milan quadrangle, comprising 224 square miles in Rock Island and Mercer counties, Ill., and Scott County, Iowa, was completed. Of this area, 25 square miles lie in Iowa, and the cost of mapping that portion was paid from Federal funds. The survey of the Waterloo quadrangle, comprising 234 square miles in St. Clair and Monroe counties; of the Canton quadrangle, comprising 227 square miles in Fulton and Knox counties; and of the Illinois portion of the Kimmswick quadrangle, comprising 84 square miles in St. Clair and Monroe counties, was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Frank Tweedy, F. W. Hughes, E. L. Hain, B. A. Jenkins, O. H. Nelson, and W. S. S.

Johnson. The survey of the Colchester quadrangle, in McDonough County, was begun by Mr. Tweedy, the area mapped being 100 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Illinois portion of the Renault quadrangle, in Monroe and Randolph counties, was begun by F. W. Hughes, the area mapped being 25 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Milan quadrangle, C. B. Kendall ran 89 miles of primary traverse and set 16 permanent marks. For the control of the Renault quadrangle, C. R. French ran 20 miles of primary levels and set 5 permanent bench marks. For the control of the Waterloo quadrangle, S. R. Archer ran 67 miles of primary levels and established 17 permanent bench marks. For the control of the Kimmswick quadrangle, Mr. Archer ran 27 miles of primary levels and established 8 permanent bench marks. For the control of the Carthage, Colchester, Lomax, Keokuk, Macomb, and Vermont quadrangles, in Hancock, Schuyler, Fulton, and McDonough counties, C. B. Kendall ran 159 miles of primary traverse and set 17 permanent marks. For the control of the Marseille, Ottawa, and Earlville quadrangles, in Lasalle County, J. R. Ellis ran 43 miles of primary traverse and set 4 permanent marks. Under the allotment for surveying overflowed lands, C. C. Gardner and B. A. Jenkins continued the survey of the Spoon River project, in Fulton County, the area mapped being 11 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the control of this area S. R. Archer ran 11 miles of primary levels and set 3 permanent bench marks. The survey of the Embarrass River project, in Lawrence County, was continued by L. L. Lee, H. W. Peabody, and J. B. Leavitt, the area mapped being 131 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the control of this area Messrs. Peabody and Leavitt and R. G. Clinite ran 107 miles of primary levels and established 14 permanent bench marks. For the control of the Big Muddy River project, in Union, Jackson, Williamson, and Franklin counties, S. R. Archer ran 61 miles of primary levels.

Indiana.—The survey of the Indiana portion of the Kosmosdale quadrangle, in Floyd, Harrison, and Jefferson counties, was completed by Fred Graff, jr., the area mapped being 100 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area E. C. Bibbee ran 27 miles of primary levels and set 9 permanent bench marks.

Iowa.—The State geologist of Iowa allotted $1,750 for the continuation of the cooperative topographic surveys in that State and the Federal Survey allotted an equal amount for the same purpose. The survey of the Pella quadrangle, in Marion and Mahaska coun-

ties, was completed by H. W. Peabody, the area mapped being 120 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Slater quadrangle, in Polk and Story counties, was begun by B. A. Jenkins, L. B. Roberts, and W. L. Miller, the area mapped being 156 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Slater quadrangle and of the Madrid quadrangle, in Boone, Polk, and Story counties, C. B. Kendall ran 50 miles of primary traverse and set 3 permanent marks, and C. H. Semper and Howard Clark ran 108 miles of primary levels and established 34 permanent bench marks. In addition to the cooperative work in Iowa the survey of the Iowa portion of the Galena quadrangle, in Jackson and Dubuque counties, was completed by B. A. Jenkins, the area mapped being 27 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. (See also p. 101 for the mapping of the Iowa portion of the Milan quadrangle.)

Kentucky.—The Kentucky Geological Survey allotted $10,000 for the continuation of cooperative topographic surveys in Kentucky and the Federal Survey allotted an equal amount for the same purpose. The survey of the Nortonville quadrangle, comprising 238 square miles in Hopkins, Christian, and Muhlenberg counties, and of the unmapped portion of the Monticello quadrangle, comprising 108 square miles in Wayne, Pulaski, and Russell counties, was completed. This work was done by C. W. Goodlove, N. E. Ballmer, W. A. Reiter, C. L. Sadler, Fred Graff, jr., and F. B. Barrett. The survey of the Drakesboro quadrangle (formerly called Greenville), in Muhlenberg, Logan, and Todd counties, was begun by C. W. Goodlove, N. E. Ballmer, and W. A. Reiter, the area mapped being 202 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the La Grange and Taylorsville quadrangles, in Jefferson County, was begun by Fred Graff, jr., the area mapped being 88 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Crockettsville quadrangle, in Perry, Breathitt, and Knott counties, was begun by J. R. Eakin, the area mapped being 30 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Nortonville quadrangle C. B. Shaw and Ed. Shea ran 83 miles of primary levels and established 29 permanent bench marks. For the control of the Monticello quadrangle F. B. Barrett ran 32 miles of primary levels and established 9 permanent bench marks. For the control of the Taylorsville quadrangle E. C. Bibbee ran 10 miles of primary levels and established 9 permanent bench marks. For the control of the Drakesboro quadrangle E. C. Bibbee ran 81 miles of primary levels

and established 25 permanent bench marks. For the control of the Crockettsville quadrangle and of the Troublesome quadrangle, in Perry, Breathitt, and Knott counties, J. R. Eakin and George T. Hawkins occupied 6 triangulation stations and marked 5, and S. R. Archer ran 42 miles of primary levels and set 7 permanent bench marks. For the control of the Hickman quadrangle, in Fulton County, E. L. McNair ran 10 miles of primary traverse and set 3 permanent marks.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted $2,000, which was met with a like sum by the United States Geological Survey. The survey of the Lansing quadrangle, in Ingham and Eaton counties, was completed by L. L. Lee, the area mapped being 166 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Grand Rapids quadrangle, in Kent County, was begun by A. M. Walker, the area mapped being 27 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Marcellus, Schoolcraft, Gobleville, Allegan, Kalamazoo, Wayland, Jenison, Cedar Springs, Jones, Centerville, Lowell, Blissfield, Adrian, Grand Rapids, Hastings, Ionia, Vermontville, Charlotte, Muir, Reading, Hillsdale, and Hudson quadrangles, in Kalamazoo, St. Joseph, Allegan, Kent, Lowell, Lenawee, Barry, Eaton, and Hillsdale counties, J. R. Ellis and J. H. Wilson ran 296 miles of primary traverse and set 35 permanent marks. In addition to the cooperative work in Michigan, the control of the Houghton, Beacon Hill, Kenton, Winona, Watersmeet, Sidnaw, Rubicon, Perch Lake, Greenland, and Paynesville quadrangles, in Houghton, Iron, Ontonogan, Gogebic, and Baraga counties, was begun by E. L. McNair, 170 miles of primary traverse being run and 23 permanent marks being set.

Minnesota.—The State drainage engineer of Minnesota allotted $8,000 for the continuation of cooperative topographic work in that State and the United States Geological Survey made an equal allotment. The survey of the uncompleted portion of the Morris quadrangle, comprising 131 square miles in Stevens County, of the Wendell quadrangle, comprising 207 square miles in Grant and Ottertail counties, and of the Chokio quadrangle, comprising 210 square miles in Stevens, Bigstone, and Traverse counties, was completed. The survey of the Ashby quadrangle, in Grant, Ottertail, and Douglas counties, was begun, the area mapped being 120 square miles; the survey of the Fergus Falls quadrangle, in Ottertail County, was begun, the area mapped being 37 square miles; and the survey of the Underwood quadrangle, in Ottertail County, was begun, the area mapped being 14 square miles. All surveys in Minnesota were made for publication on the scale of 1:62,500, with a contour interval of

10 feet. This work was done by C. L. Sadler, O. H. Nelson, W. S. S. Johnson, E. L. Hain, and F. B. Barrett. For the control of the Wendell quadrangle J. M. Ray ran 17 miles of primary levels and established 2 permanent bench marks. For the control of the Chokio quadrangle E. C. Bibbee ran 45 miles of primary levels and established 13 permanent bench marks. For the control of the Ashby quadrangle J. M. Ray ran 78 miles of primary levels and established 19 permanent bench marks. For the control of the Fergus Falls, Underwood, and Battle Lake quadrangles, in Ottertail County, J. M. Ray and E. C. Bibbee ran 234 miles of primary levels and established 67 permanent bench marks, and C. B. Kendall ran 233 miles of primary traverse and set 28 permanent marks.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted $4,000 and the United States Geological Survey allotted an equal amount. The survey of the Aurora special area, embracing 331 square miles, in Barry, Jasper, Lawrence, and Newton counties, was completed by H. H. Hodgeson, W. H. Phelps, and W. R. Schreiner, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The survey of the Queen City quadrangle, in Putnam, Adair, and Schuyler counties, was begun by W. J. Lloyd and P. W. McMillen, the area mapped being 20 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Queen City quadrangle and of the Green City quadrangle, in the same counties, P. W. McMillen ran 80 miles of primary levels and established 19 permanent bench marks, and C. B. Kendall ran 174 miles of primary traverse and set 15 permanent marks.

Ohio.—The governor of Ohio allotted $25,000 and the United States Geological Survey allotted $15,000 for the continuation of cooperative topographic surveys in Ohio. The survey of the unmapped portion of the Carrollton quadrangle, covering 164 square miles in Carroll, Stark, and Columbiana counties, and of the Laurelville quadrangle, covering 150 square miles in Pickaway, Ross, Vinton, and Hocking counties, was completed. The survey of the Oak Hill quadrangle, comprising 232 square miles in Jackson, Gallia, Lawrence, and Scioto counties, and of the Scioto quadrangle, comprising 232 square miles in Scioto, Jackson, and Pike counties, was completed. The survey of the Jackson quadrangle, in Jackson, Vinton, and Ross counties, was begun, the area mapped being 145 square miles; that of the Navarre quadrangle, in Tuscarawas, Stark, Holmes, and Wayne counties, was begun, the area mapped being 49 square miles; that of the Sidney quadrangle, in Shelby, Logan, and Champaign counties, was begun, the area mapped being 60 square miles; that of the New Comerstown quadrangle, in Tuscarawas, Coshocton, and Holmes counties, was begun, the area mapped being

74 square miles; that of the Celina quadrangle, in Mercer and Van Wert counties, was begun, the area mapped being 176 square miles; that of the Circleville and Era quadrangles, in Pickaway, Fairfield, Ross, and Fayette counties, was begun, the area mapped being 170 square miles; and that of the Van Wert quadrangle, in Van Wert and Paulding counties, was begun, the area mapped being 52 square miles. The total area mapped in Ohio was 1,504 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, M. Hackett, L. D. Townsend, W. S. S. Johnson, J. A. Duck, E. L. Hain, W. N. Vance, Fred Graff, jr., O. H. Nelson, A. P. Meade, W. H. Griffin, W. H. Rayner, and F. W. Hughes. For the control of the Oak Hill quadrangle C. E. Mills ran 31 miles of primary levels and established 8 permanent bench marks. For the control of the Scioto quadrangle Mr. Mills ran 19 miles of primary levels and established 6 permanent bench marks. For the control of the Van Wert and Paulding quadrangles Mr. Mills, A. D. Duck, and Howard Clark ran 107 miles of primary levels and set 31 permanent bench marks. For the control of the Celina quadrangle Mr. Clark ran 73 miles of primary levels and established 18 permanent bench marks. For the control of the Circleville and Era quadrangles James Rayburn and A. D. Duck ran 93 miles of primary levels and established 23 permanent bench marks. For the control of the Navarre quadrangle E. C. Bibbee and C. W. Howell ran 25 miles of primary levels and established 6 permanent bench marks. For the control of the Otway quadrangle, in Scioto and Pike counties, C. B. Shaw, C. E. Mills, and Howard Clark ran 119 miles of primary levels and established 26 permanent bench marks; for the control of the Vanceburg quadrangle, in Adams and Lewis counties, 34 miles of primary levels and 4 permanent bench marks; for the control of the Portsmouth quadrangle, in Scioto County, 13 miles of primary levels and 2 permanent bench marks; for the control of the Peebles quadrangle, in Adams County, 120 miles of primary levels and 24 permanent bench marks; for the control of the Marysville and Manchester quadrangles, in Brown and Adams counties, 19 miles of primary levels and 5 permanent bench marks; for the control of the Berne quadrangle, in Mercer and Van Wert counties, 22 miles of primary levels and 6 permanent bench marks; for the control of the West Union quadrangle, in Brown and Adams counties, 90 miles of primary levels and 14 permanent bench marks; for the control of the Bobo quadrangle, in Van Wert County, 20 miles of primary levels and 6 permanent bench marks. For the control of the Brinkhaven and Plimpton quadrangles, in Coshocton, Holmes, Knox, Wayne, and Ashland counties, E. C. Bibbee ran 47 miles of primary levels and established 10 permanent bench marks; for the control of the Millers-

burg quadrangle, in Holmes and Wayne counties, Mr. Bibbee ran 46 miles of primary levels and established 11 permanent bench marks, and for the control of the Sidney quadrangle 52 miles of primary levels and 11 permanent bench marks. For the control of the Bethel, Georgetown, Maysville, West Union, Lawrenceburg, Harrison, Bucyrus, Fort Recovery, Lexington, Liberty, Norwalk, Paulding, Plymouth, Richmond, Siam, Union City, Brinkhaven, Cardington, Fredericktown, Marysville, Mount Gilead, Mount Vernon, Perrysville, Plimpton, Urbana, Larue, Mechanicsburg, Kenton, East Liberty, Bellefontaine, Halls Corners, and Alger quadrangles, in Clermont, Brown, Adams, Hamilton, Butler, Crawford, Darke, Mercer, Morrow, Knox, Richland, Preble, Huron, Paulding, Seneca, Coshocton, Morris, Delaware, Marion, Union, Madison, Champaign, Hardin, and Clark counties, J. R. Ellis ran 864 miles of primary traverse and established 74 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Hot Springs, Ark., revision; Waterloo, Canton, Milan, and Galena, Ill.; Pella, Iowa; Kosmosdale, Ind.-Ky.; Nortonville and Prospect, Ky.; Lansing, Mich.; Chokio, Morris, and Wendell, Minn.; Aurora special, Mo.; Laurelville, Carrollton, Oak Hill, and Canal Dover, Ohio.

Progress in the drafting of additional sheets was made as follows: De Queen, Ark., 40 per cent; La Grange, Ky., 8 per cent; Taylorsville, Ky., 33 per cent; Jackson, Ohio, 41 per cent; Scioto, Ohio, 18 per cent; Kimmswick, Ill., 32 per cent; Embarrass River project, Ill., 47 per cent; Spoon River project, Ill., 80 per cent; Ashby, Minn., 12 per cent.

In the triangulation and computing section the following work was completed:

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Carthage, Colchester, La Harpe, and Lomax quadrangles (Ill.). Primary level circuits in the Birds, Hardinville, Newton, and Waterloo (Ill.), Kimmswick (Ill.-Mo.), and Vincennes (Ill.-Ind.) quadrangles were adjusted and latitudes, departures, and geographic positions for the Augusta, Avon, Canton, Galesburg, Glasford, Good Hope, Havana, Macomb, Manilo, Maquon, and Vermont (Ill.), Milan, and Madison (Ill.-Iowa), and Keokuk (Ill.-Mo.-Iowa) quadrangles were computed. Primary level notes were checked and latitudes, departures, and geographic positions were computed for the Madrid and Slater quadrangles (Iowa). Primary level circuits in the Dawson Springs, Nortonville, and Taylorsville quadrangles (Ky.) were adjusted;

latitudes, departures, and geographic positions for the Water Valley (Ky.) and Hickman (Ky.-Tenn.-Mo.) quadrangles were computed; and geodetic distances and positions for the Crockettsville and Troublesome quadrangles (Ky.) were computed. Latitudes, departures, and geographic positions for the Gobleville, Marcellus, and Schoolcraft (Mich.) and Centerville and Jones (Mich.-Ill.) quadrangles were computed. Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Ashby and Wendell quadrangles (Minn.). Primary level circuits in the Chokio quadrangle (Minn.) were adjusted and latitudes, departures, and geographic positions for the Axel, Battle Lake, Dora, Fergus Falls, Henning, New York Mills, Pelican Rapids, Perham, Rothsay, and Underwood quadrangles (Minn.) were computed. Latitudes, departures, and geographic positions for the Boynton, Edina, Green City, Kirksville, Queen City, and Winigan (Mo.) and Centerville and Moulton (Mo.-Iowa) quadrangles were computed. Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Brinkhaven, Otway, Peebles, Plimpton, and West Union (Ohio) and Georgetown, Maysville, Portsmouth, Rectorville, and Vanceburg (Ohio-Ky.) quadrangles. Primary level circuits in the Bainbridge, Canal Dover, Hillsboro, Jackson, Laurelville, Millersburg, Navarre, New Comerstown, Scioto, and Wooster (Ohio) and Greenup (Ohio-Ky.) quadrangles were adjusted and latitudes, departures, and geographic positions for the Batavia, Bucyrus, Cardington, Celina, Defiance, Fredericktown, Hamilton, Mark Center, Mason, Mount Gilead, Mount Vernon, Paulding, Perrysville, Shauck, and Van Wert (Ohio), Bobo, Halls Corners, Harrison, Liberty, Lynn, Portland, Richmond (Ohio-Ind.), Bethel (Ohio-Ky.), and Lawrenceburg (Ohio-Ind.-Ky.) quadrangles were computed.

Level lists were revised and assembled after all necessary computations and readjustments had been made and transmitted to the editor for publication as bulletins for the following States or groups of States: Illinois (Bulletin 493), Iowa (Bulletin 460), Minnesota (Bulletin 453), Missouri (Bulletin 459), Ohio (Bulletin 476), Michigan and Wisconsin (Bulletin 461), and Arkansas, Louisiana, and Mississippi (Bulletin 458).

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, New Mexico, Oklahoma, South Dakota, and Wyoming. This work comprised the survey of 5 quadrangles and

3 special areas, and the revision of 5 quadrangles and 1 national park. In addition, 9 quadrangles, 1 special area, and 1 national park were partly surveyed and 1 quadrangle was partly revised. The total new area mapped was 4,661 square miles—1,095 for publication on the scale of 1:250,000, 2,865 for publication on the scale of 1:125,000, 377 for publication on the scale of 1:62,500, 180 for publication on the scale of 1:31,680, 134 for publication on the scale of 1:24,000, and 10 for publication on the scale of 1:12,000. The area resurveyed was 3,335 square miles—229 for publication on the scale of 1:62,500 and 3,106 for publication on the scale of 1:125,000. In connection with this work 607 miles of primary levels were run and 156 permanent bench marks were established. A profile survey of 1 river was also made, the distance traversed being 213 miles.

Primary triangulation was carried on at different times by two parties, the work being distributed over portions of Colorado and Wyoming. The total area covered by this primary control was about 6,300 square miles, and 24 triangulation stations were occupied and 27 marked. The result of this work was to make control available in 8 quadrangles and 1 national park.

Topographic surveys in Rocky Mountain division, July 1, 1910, to June 30, 1911.

State.	Contour interval.	For publication on scale of—						Total area mapped.	Primary levels.	
		1:250,000.	1:125,000.		1:62,500.		1:31,680.		Distance run.	Bench marks.
		New.	New.	Resurvey.	New.	Resurvey.	New.			
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*	
Colorado	25, 50, 100	.....	715	170	.....	229	144	[a] 1,392	303	92
Montana	5, 20, 100	.....	837	.....	167	.....	36	1,040	97	30
New Mexico	25, 100, 200	1,095	522	30	45	.....	.....	[b] 1,702	77	12
Oklahoma	50	.....	.....	2,906	.....	.....	.....	2,906	.....	.....
South Dakota	50	.....	638	.....	.....	.....	.....	638	60	14
Wyoming	25, 50	.....	153	.....	165	.....	.....	318	70	8
	.....	1,095	2,865	3,106	377	229	180	7,996	607	156

[a] 134 square miles in Colorado for publication on scale of 1:24,000.
[b] 10 square miles in New Mexico for publication on scale of 1:12,000.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Creede special area, covering the Creede mining district, in Mineral County, was completed by R. H. Reineck, the total area mapped being 26 square miles, for publication on the scale of 1:24,000, with a contour interval of 50 feet. The survey of the De Beque oil field, in Mesa and Garfield counties, was completed by A. P. Meade, jr., the area mapped being 140 square miles, for publication on the scale of 1:31,680, with a contour interval of 25 feet. The survey of the Mesa Verde National Park, in

La Plata and Montezuma counties, was begun by R. W. Berry, the area mapped being 108 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The survey of the Hahns Peak quadrangle, in the Park Range National Park, Routt and Jackson counties, and of the Price quadrangle, in the San Juan National Forest, Archuleta County, was begun by Gilbert Young, J. F. McBeth, Lee Morrison, P. W. McMillen, and S. T. Penick, the total area mapped being 715 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The revision of the Central City quadrangle, in Gilpin, Grand, and Clear Creek counties, was completed by Lee Morrison, the area revised being 229 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. The revision of the Castle Rock quadrangle, in Douglas, Elbert, and El Paso counties, was commenced by C. G. Anderson, the area mapped being 170 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

For the control of these areas and of the Meeker, Piceance, Pagoda, Lily, Elkhead, Hahns Peak, Lay, and Pinon Valley quadrangles, in Garfield, Rio Blanco, Routt, and Mesa counties, C. H. Semper, P. W. McMillen, M. R. McDanal, and F. H. Nelson ran 303 miles of primary levels, and established 92 permanent bench marks, and C. F. Urquhart occupied 17 triangulation stations and marked 18.

Montana.—The survey of the Cherry Ridge quadrangle (formerly called Avery), in Chouteau County, was completed by Basil Duke, C. A. Leonard, and C. Ecklund, the area mapped being 395 square miles, for publication on the scale of 1:125,000, with a 20-foot contour interval. The survey of the Poplar, Chelsea, and Brockton quadrangles, in Valley and Dawson counties, was commenced by W. L. Miller and J. H. Wilke, the total area mapped being 167 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Melrose special area, in Silver Bow and Beaverhead counties, was begun by R. H. Reineck, the area mapped being 36 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. The survey of the Nyack and Midvale quadrangles, lying partly in the Glacier National Park and the Blackfeet, Flathead, and Lewis and Clark national forests, Teton and Flathead counties, was begun by R. T. Evans, S. T. Penick, C. A. Ecklund, W. J. Foster, and F. L. Whaley, the area mapped being 442 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. A survey of Clark Fork, in Powell, Granite, and Missoula counties, was begun by R. C. Seitz, the distance traversed being 213 miles. For the control of the Cherry Ridge quadrangle C. A. Leonard ran 44 miles of primary levels and established 17 permanent bench marks. For the control of the Poplar, Chelsea, and Brockton quadrangles J. H. Wilke ran 53 miles of

primary levels and established 13 permanent bench marks. (See also p. 112.)

New Mexico.—The survey of the Kelly special area, in Socorro County, was completed by R. H. Reineck, the area mapped being 10 square miles, for publication on the scale of 1:12,000, with a contour interval of 25 feet. The survey of the Cloudcroft 1-degree quadrangle, in the Alamo National Forest, Otero and Chaves counties, was completed by J. H. Wilke and C. A. Ecklund, the area mapped being 1,095 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Camp Vincent quadrangle, in the Datil National Forest, Grant and Socorro counties, was begun by A. B. Searle and S. T. Penick, the area mapped being 522 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. A small area within the Silver City quadrangle, comprising 30 square miles, was revised by A. B. Searle, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Raton quadrangle, in Colfax County, was commenced by E. P. Davis, the area mapped being 45 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle a primary level line was started at Thatcher, Colo., by C. P. Gross, who ran 77 miles of primary levels and established 12 permanent bench marks. For the control of the Camp Vincent and Fairview quadrangles R. B. Robertson occupied 1 triangulation station and marked 7.

Oklahoma.—The revision of culture in the Antlers, Nowata, and Claremore quadrangles, in Atoka, Bruan, Choctaw, Pushmataha, Nowata, Washington, Rogers, and Tulsa counties, was completed by Lee Morrison, C. C. Gardner, A. O. Burkland, F. B. Barrett, and C. J. Ballinger, the total area revised being 2,906 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

South Dakota.—The survey of the unmapped portion of the Newell quadrangle (formerly called Empire, the southwest quarter of which is the Vale 15-minute quadrangle, surveyed in 1904) was completed by G. S. Smith and C. P. Gross, the area mapped being 638 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area H. L. Caldwell ran 60 miles of primary levels and established 14 permanent bench marks.

Wyoming.—The survey of the Wiley quadrangle, in Bighorn County, was begun by C. C. Gardner, the area mapped being 165 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Cheyenne quadrangle, in Laramie County, was begun by E. P. Davis and continued by Basil Duke and H. L. Caldwell, the area mapped being 153 square miles, for publication on the scale of 1:125,000, with a contour interval of

50 feet. For the control of the Wiley quadrangle C. W. Rowell ran 70 miles of primary levels, and established 8 permanent bench marks. For the control of the Cheyenne quadrangle G. T. Hawkins occupied 6 triangulation stations and marked 2.

In addition to the work mentioned above, culture was revised and brought up to date in the Gallatin, Canyon, Shoshone, and Lake quadrangles, comprising the Yellowstone National Park, Wyoming, Montana, and Idaho, under a special allotment by the Department of the Interior for the preparation of an administrative map of the Yellowstone National Park.

OFFICE WORK.

The drafting of the following sheets was completed: De Beque oil field, Creede special, and Central City, Colo.; Chelsea, Cherry Ridge, Hay Creek, Smoke Creek, and Poplar, Mont.; Nowata, Okla.; Newell, S. Dak.; Kelly special and Mogollon, N. Mex.; Millican and Washington, Tex.

Progress in the drafting of additional sheets was made as follows: Price, Colo., 18 per cent; Hahns Peak, Colo., 45 per cent; Mesa Verde, Colo., 85 per cent; Midvale, Mont., 19 per cent; Nyack, Mont., 25 per cent; Camp Vincent, N. Mex., 40 per cent; and Wiley, Wyo., 50 per cent.

In the triangulation and computing section the following work was completed:

Primary level circuits were adjusted and geodetic distances and positions were computed for the Cortez, De Beque special, Elkhead, Hahns Peak, Hesperus, Meeker, Pagoda, and Rifle quadrangles (Colo.). Primary level circuits in the Durango, Grand Junction, Ignacio, La Plata, Lewis Creek, and Rabbits Ears Peak quadrangles (Colo.) were adjusted, and geodetic distances and positions for the Cameo, Hotchkiss, Lay, Lily, Montrose, Piceance, and Pinon Valley quadrangles (Colo.) were computed.

Primary level circuits in the Brockton, Cherry Ridge, Harlem, Poplar, Red Lodge, and Wolf Point quadrangles (Mont.) were adjusted. The single spur line running through the Willis quadrangle (Mont.) and the Polaris quadrangle (Mont.–Idaho) was checked. Primary level circuits run by the General Land Office in the Milk River, No. 2, Whiskey Butte, and Wolf Point quadrangles (Mont.) were adjusted.

Partial computations of geodetic distances and positions in the Mescalero and Tularosa quadrangles (N. Mex.) were made.

Primary level circuits run by the General Land Office in the Blue Butte, Elbowoods, and Ryder quadrangles (N. Dak.) were adjusted.

Primary level circuits in the Empire quadrangle (S. Dak.) were adjusted.

Primary level circuits in the Baggs, Rawlins, Savery Creek, and Wiley quadrangles (Wyo.) were adjusted and geodetic distances and positions for the Cheyenne quadrangle (Wyo.) were computed.

Level lists were revised and assembled, after all necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for the following States or groups of States; Colorado (Bulletin 486), Montana (Bulletin 482), New Mexico (Bulletin 464), North Dakota (Bulletin 469), South Dakota (Bulletin 472), Texas (Bulletin 468), and Kansas and Nebraska (Bulletin 473).

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. This work comprised the survey of 12 quadrangles, the partial survey of 30 quadrangles, 1 special area, and 1 national park, the resurvey or revision of 8 quadrangles, 3 special areas, and 1 national monument, and the partial resurvey of 8 quadrangles. The total new area mapped was 10,154 square miles—3,610 for publication on the scale of 1:250,000, 5,447 for publication on the scale of 1:125,000, 952 for publication on the scale of 1:62,500, and 145 for publication on the scale of 1:31,680. The area resurveyed was 1,315 square miles, 600 for publication on the scale of 1:125,000, 268 for publication on the scale of 1:62,500, 430 for publication on the scale of 1:31,680, and 17 for publication on the scale of 1:12,000. In connection with this work 1,776 miles of primary levels were run and 358 permanent bench marks were established. In addition, profile surveys of 11 rivers were made, the distance traversed being 541 miles. Topographic surveys were also carried on in the Territory of Hawaii, the area mapped being one island, embracing portions of four 15-minute quadrangles, and the partial survey of one island, covering portions of three quadrangles, the area mapped being 224 square miles, for publication on the scale of 1:31,680, in connection with which 178 miles of primary levels were run and 60 permanent bench marks set.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of California, Idaho, Oregon, Utah, and Washington. The total area covered by this primary control was about 6,300 square miles, of which 3,000 were controlled by primary traverse, 486 miles being run and 61 permanent marks set; 38 triangulation stations were occupied and 44 were marked. The result of this work was to make control available in 24 quadrangles.

Topographic surveys in Pacific division from July 1, 1910, to June 30, 1911.

State.	Contour interval.	For publication on the scale of—						Total area mapped.	Primary levels.		Primary traverse.	
		1:230,000.	1:125,000.	1:62,500.		1:31,680.						
		New.	New.	New.	Resurveyed.	New.	Resurveyed.		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Sq. m.*	*Miles.*		*Mi.*	
Arizona	25–100	.....	958	.....	268	.....	.....	[a] 1,843	40	10	.....	.....
California	5–25–50	2,919	3,178	170	.....	145	430	6,842	414	90	.....	.....
Nevada	100–200	200	.....	.....	.....	.....	.....	200	.....	.....	.....	.....
Idaho	5–50	491	100	220	.....	.....	.....	811	237	57	.....	.....
Montana	100–200	.....	35	.....	.....	.....	.....	35	.....	.....	.....	.....
Oregon	5–7–100	.....	244	147	.....	.....	.....	391	258	73	219	39
Utah	50–100	.....	415	65	.....	.....	.....	480	535	60	.....	.....
Wyoming	100	.....	27	.....	.....	.....	.....	27	.....	.....	.....	.....
Washington	5–25–100	.....	490	350	.....	.....	.....	840	292	68	267	22
	.....	3,610	5,447	952	268	145	430	11,469	1,776	358	486	61
Hawaii	.....	.....	.....	.....	.....	.....	.....	224	178	60	.....	.....

[a] 600 square miles resurveyed in Arizona for publication on scale of 1:125,000, and 17 square miles for publication on scale of 1:12,000.

DETAILS OF WORK BY STATES.

Arizona.—The survey of the Winkleman quadrangle, in Pinal and Gila counties, Ariz., was completed by J. E. Blackburn, Pearson Chapman, J. G. Staack, S. T. Penick, and T. P. Pendleton, the total area mapped being 958 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of the Miami and Ray special areas, in Gila and Pinal counties, was completed by W. M. Beaman, for publication on the scale of 1:12,000,with a contour interval of 25 feet, the total area mapped being 17 square miles. The resurvey of the Petrified Forest National Monument, in Navajo and Apache counties, was completed by Pearson Chapman and J. G. Staack, the total area mapped being 268 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of this area 40 miles of primary levels were run and 10 permanent bench marks established. The revision of a portion of the Flagstaff quadrangle, in the Coconino and Tusayan national forests, in Coconino County, was completed by W. M. Beaman, the total area revised being 600 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

California.—The department of engineering of California allotted $14,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of the Marysville quadrangle and of the Sacramento Valley portions of the Smartsville and Chico quadrangles, in Yuba, Sutter, Colusa.

Butte, Glenn, and Tehama counties, was completed, and resulted in the completion of the Nelson, Marysville Buttes, Pennington, Nord, Dayton, Durham, Newhard, and Dry Creek 7½-minute quadrangles, and of the valley portions of the Spenceville, Oroville, Singer Creek, Keefers, Clear Creek, and Bangor 7½-minute quadrangles, the total are resurveyed being 430 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet.

In the Salinas Valley the mapping of the Gonzales and Soledad quadrangles, in Monterey and San Benito counties, was started, the total area mapped being 99 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The mapping of the Stockton and Brentwood 7½-minute quadrangles, in the San Joaquin Valley, in San Joaquin and Contra Costa counties, was commenced, the area mapped being 57 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The work in the Sacramento, Salinas, and San Joaquin valleys was done by Duncan Hannegan, W. H. Griffin, T. H. Moncure, J. W. Muller, M. A. Knock, Bayard Knock, J. L. Lewis, J. P. Harrison, A. T. Fowler, A. J. Ogle, W. R. Chenoweth, R. M. La Follette, and A. E. Bungay. For the control of the Byron, Stockton, and Tracy 15-minute quadrangles, in the San Joaquin Valley, in San Joaquin, Contra Costa, and Alameda counties, L. F. Biggs and G. L. Hagman ran 269 miles of primary levels and established 62 permanent bench marks, and occupied 10 and marked 9 triangulation stations.

In addition to the cooperative work in California, the survey of the Bakersfield quadrangle, in Kern County, was completed by J. L. Lewis and Bayard Knock, the total area mapped being 567 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Mariposa quadrangle, in Mariposa, Fresno, and Madera counties, was completed by E. R. Bartlett, T. P. Pendleton, and J. W. Muller, the total area mapped being 345 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Coalinga and Panoche quadrangles, in Kings, Monterey, Fresno, San Benito, and Merced counties, was completed by H. L. McDonald and J. L. Lewis, the total area mapped being 879 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Petaluma quadrangle, in Sonoma and Marin counties, was commenced by J. G. Staack and M. A. Knock, the total area mapped being 170 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. A small area, covering about half a square mile in the Randsburg quadrangle, in San Bernardino and Kern counties, was revised by T. P. Pendleton. The survey of the Weaverville, Big Bar, and Korbel quadrangles, in the Trinity National Forest, in Trinity and Humboldt counties, was continued by

J. P. Harrison and Oscar Jones, the total area mapped being 259 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet, and 54 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Bishop quadrangle, in the Inyo National Forest, in Inyo County, was continued by G. R. Davis and B. A. Jenkins, the total area mapped being 720 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Caliente quadrangle, in the Sequoia National Forest, was continued by C. F. Eberly, R. M. La Follette, and J. W. Muller, the total area mapped being 613 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the additional control of the Caliente quadrangle 145 miles of primary levels were run and 28 permanent bench marks were set by K. W. Trimble and G. L. Hagman.

California-Nevada.—The survey of the western half of the Ballarat 1-degree quadrangle, in Inyo County, Cal., and of the southwest quarter of the Lida 1-degree quadrangle, in Inyo County, Cal., and Esmeralda County, Nev., was completed by J. E. Blackburn and T. P. Pendleton, the total area mapped being 2,860 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. Of this area, 200 square miles are in Nevada.

Idaho.—The survey of the Panhandle 1-degree quadrangle in the Pend Oreille National Forest, in Kootenai, Shoshone, Saunders, and Lincoln counties, was continued by J. W. Muller and T. P. Pendleton, the total area mapped being 491 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Wayan quadrangle, which lies partly in the Caribou National Forest, in Bannock and Bear Lake counties, was continued by Albert Pike and W. O. Tufts, the total area mapped being 220 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Wayan quadrangle 73 miles of primary levels were run and 20 permanent bench marks were established by Mr. Tufts, D. S. Birkett, and O. G. Taylor, and 6 triangulation stations were occupied and 4 marked by G. T. Hawkins. For the control of the Lolo quadrangle L. F. Biggs ran 75 miles of primary levels and set 18 permanent bench marks.

Idaho-Montana.—The survey of the St. Regis and Taft quadrangles, in the Cœur d'Alene National Forest, in Shoshone County, Idaho, and Missoula and Sanders counties, Mont., was commenced by J. E. Blackburn, the total area mapped being 135 square miles, of which 35 are in Montana, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Salmon quadrangle, lying partly in the Shoshone National Forest, and the Dillon quadrangle, in Lemhi County, Idaho, and Beaverhead

County, Mont., W. H. Barringer ran 89 miles of primary levels and established 19 permanent bench marks. A profile survey of Salmon River, in the Salmon, Idaho, and Nez Perce national forests, was also commenced by Mr. Barringer and continued by O. G. Taylor, the total number of miles traversed being 107.

Oregon.—The State engineer of Oregon allotted $2,500 for the continuation of the cooperative topographic surveys in that State, which was met by a like sum for the same purpose from the United States Geological Survey. The survey of the Willamette Valley was continued and resulted in the completion of the Halsey 15-minute quadrangle (Shedds and Peoria 7½-minute) in Linn and Benton counties, the total area mapped being 108 square miles, for publication on the scale of 1:62,500, with a contour interval of 7 feet; and of parts of the Monroe, Albany, and Brownsville quadrangles, in Linn and Benton counties, the area mapped being 21 square miles, for publication on the scale of 1:62,500, with a contour interval of 5 feet. This work was done by H. L. McDonald, E. R. Bartlett, A. J. Ogle, J. M. Rawls, and A. F. McNair. For the control of these areas A. Finlay, J. M. Rawls, and A. G. Humphreys ran 101 miles of primary levels and established 28 permanent bench marks. The survey of the Boring and Oregon City quadrangles, in Multnomah and Clackamas counties, was begun by J. H. Wheat, the area mapped being 18 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas C. F. Urquhart ran 82 miles of primary traverse and set 16 permanent marks, and E. M. Bandli ran 33 miles of primary levels and established 10 permanent bench marks. The survey of the Pine quadrangle, in the Wallowa National Forest, in Baker and Union counties, was commenced by S. G. Lunde and G. S. Smith, the area mapped being 49 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In addition to the cooperative work, the survey of the Cazadero quadrangle, in the Oregon National Forest, in Clackamas and Multnomah counties, was commenced by A. E. Murlin, the area mapped being 49 square miles, for publication on a scale of 1:125,000, with a contour interval of 100 feet. For the control of this area E. M. Bandli ran 124 miles of primary levels and established 35 permanent bench marks, and O. C. Kintner ran 137 miles of primary traverse and set 23 permanent marks.

Oregon-Washington.—The survey of the Mount Hood special quadrangle, which lies partly in the Bull Run National Forest, in Multnomah, Clackamas, and Wasco counties, Oreg., and Clarke and Skamania counties, Wash., was continued by R. M. La Follette and T. P. Pendleton, the area mapped being 251 square miles, for publi-

cation on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 105 square miles lies in Washington.

Utah.—The survey of the Sunnyside quadrangle, in Carbon County, was commenced by T. M. Bannon and S. P. Floore, the area mapped being 65 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle and of the Salt Lake, Fort Douglas, Provo, Millfork, Soldiers Summit, Kyune, Castlegate, Wellington, Mounds, Grassy, and Beckworth Peak quadrangles, in Utah and Salt Lake counties, L. F. Biggs ran 535 miles of double primary levels and established 60 permanent bench marks. For the control of the Kyune, Wellington, Soldiers Summit, Westwater, Mount Wass, Moab, Ninemile Creek, Sunnyside, and Tidwell quadrangles, in Carbon, Emery, Grand, Utah, and Wasatch counties, T. M. Bannon occupied 22 triangulation stations and marked 31.

Utah-Wyoming.—The survey of the Randolph quadrangle, which lies partly in the Cache National Forest, in Rich and Cache counties, Utah, and Uinta County, Wyo., was completed by A. E. Murlin, the total area mapped being 442 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 27 square miles lie in Wyoming.

Washington.—Under the allotment of $12,500 each, made by the Board of Geological Survey of Washington, and the United States Geological Survey, topographic mapping was continued and resulted in the completion of the mapping of the Beverly and Moses Lake quadrangles, in Grant County, and of part of the Cedar Lake quadrangle, in King and Pierce counties, the total area mapped being 526 square miles—276 for publication on the scale of 1:62,500, and 385 for publication on the scale of 1:125,000. This work was done by W. O. Tufts, Robert Muldrow, C. F. Eberly, O. G. Taylor, and L. R. Ebert. The survey of the Palisades quadrangle, in Grant County, and of the Grays Harbor quadrangle, in Pacific County, was begun by H. L. McDonald and Charles Hartmann, the total area mapped being 38 square miles, for publication on the scale of 1:62,500, with a 25-foot contour interval. For the control of the Moses Lake and Cedar Lake quadrangles, D. S. Birkett ran 191 miles of primary levels and established 42 permanent bench marks; G. T. Hawkins and O. C. Kintner ran 267 miles of primary traverse and set 22 permanent marks. For the control of the Grays Harbor quadrangle, G. L. Hagman ran 56 miles of primary levels and set 14 permanent bench marks. Profile surveys were also made by Bayard Knock, W. B. Lewis, and T. H. Moncure of portions of Cowlitz, Cispus, Nisqually, Carbon, Puyallup, White, American, Bumping, Naches, and Tieton rivers, the total distance traversed being 434 miles. In addition to the cooperative work in Washing-

ton, a survey of the Mount Rainier National Park, in Pierce County, was started by F. E. Matthes and G. R. Davis, the total area mapped being 36 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. For the control of this area E. M. Bandli ran 45 miles of primary levels and established 12 permanent bench marks.

Hawaii.—In 1909 a cooperative agreement was entered into between the superintendent of public works of the Territory of Hawaii and the United States Geological Survey whereby the Survey loaned instruments and detailed topographers to the Territory to begin the topographic survey of the island of Kauai, the entire expense of the work, including transportation of instruments and salaries and expenses of the topographers, being borne by the Territorial government. Under this arrangement a portion of the island of Kauai embracing 374 square miles was surveyed prior to June 30, 1910. This work was done by G. R. Davis, H. L. McDonald, A. J. Ogle, O. G. Taylor, A. T. Fowler, J. L. Lewis, T. H. Moncure, W. H. Barringer, and C. H. Birdseye, under the immediate charge of Mr. Birdseye, topographer. For the control of this area L. F. Biggs ran 184 miles of primary levels and established 44 permanent bench marks.

On July 1, 1910, an agreement was entered into for the fiscal year beginning July 1, 1910, and ending June 30, 1911, whereby the Territory allotted $15,000 and the United States Geological Survey $5,000 for the continuation of the cooperative survey of the island of Kauai, begun in 1909. Since that date the mapping of the island of Kauai has been completed, the area mapped being 173 square miles, making a total area surveyed of 547 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet, in one sheet as the island of Kauai. A map of a portion of this area, embracing about 100 square miles of irrigable land, will be published separately on the scale of 1:31,680, with a contour interval of 10 feet. After the completion of the mapping of the island of Kauai a survey was begun of the northern portion of the island of Hawaii, the area mapped to June 30, 1911, being 51 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The work during this fiscal year was done by C. H. Birdseye, A. T. Fowler, and W. H. Barringer, under the immediate direction of Mr. Birdseye. For the control of these areas W. H. Barringer ran 178 miles of primary levels and established 60 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Biggs, Gridley, Dayton, Durham, Newhard, Mount Goddard, Eddys, Salinas, Marysville Buttes, Bangor, Pennington, Dry Creek, Oroville,

Honecut, Palermo, Mariposa, French Crossing, Keefers, Clear Creek, Randsburg (revision), Butte Creek, Nord, Nelson, and Tisdale Weir, Cal.; Ivanpah, Cal.-Nev.; Miami special, Ray special, and Petrified Forest, Ariz.; Salmon River profile, Idaho; Randolph, Utah; Moses Lake and Beverly, Wash.; Shedds and Peoria, Oreg.; Mana, Na Pali, Hanapepe, Kilauea, Kapaa, Lihue, Hanalei, and Waimea, Hawaii.

Progress in the drafting of additional sheets was made as follows: Soledad, Cal., 19 per cent; Big Bar, Cal., 80 per cent; Bishop, Cal., 15 per cent; Gonzales, Cal., 45 per cent; Singer Creek, Cal., 70 per cent; Ballarat, Cal.-Nev., 50 per cent; Panhandle, Idaho, 30 per cent; Wayan, Idaho, 20 per cent; Mount Hood, Oreg., 85 per cent; Cedar Lake, Wash., 25 per cent; Mount Rainier National Park, Wash., 11 per cent.

In the triangulation and computing section the following work was completed:

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

Primary level circuits were adjusted and preliminary geodetic distances and positions were computed for the Byron, Holt, Lathrop, Stockton, Tracy, and Union Island quadrangles (Cal.). Primary level circuits in the Bakersfield, Caliente, McKittrick, Mojave, and Tejon quadrangles (Cal.) were adjusted, and preliminary geodetic distances and positions for the Avena, Clyde, Copperopolis, Monteca, Oakdale, Peters, and Trigo quadrangles (Cal.) were computed. A double primary line of levels run by the water resources branch in the Hanford quadrangle (Cal.) was adjusted.

Primary level circuits run with a prism level in the Kapaa, Lihue, Na Pali, and Waimea quadrangles, in Kauai Island, Hawaii, were adjusted.

A spur line of primary levels through the Junction, May, and Salmon quadrangles (Idaho-Mont.) was checked. Geodetic distances and positions in the Wayan quadrangle (Idaho-Wyo.) were computed.

Primary level circuits in the Brownsville and Halsey quadrangles (Oreg.) were adjusted, and latitudes, departures, and geographic positions for the Cazadero and Oregon City (Oreg.) and the Portland and Troutdale (Oreg.-Wash.) quadrangles were computed.

A primary level circuit extending through the Desert Lake, Moab, Price, Provo, Salt Lake, Scofield, Tidwell, and Woodside (Utah), and Mount Wass and Westwater (Utah-Colo.) quadrangles was adjusted, and geodetic distances and positions for the Castlegate, Kyune, Ninemile Creek, Poison Spring, Sunnyside, and Wellington quadrangles (Utah) were computed. A spur line of levels in the Sunnyside quadrangle (Utah) was checked.

Primary level circuits were adjusted, and latitudes, departures, and geographic positions were computed in the Cedar Lake, Seattle, Snoqualmie, Sultan, and Tacoma quadrangles (Wash.), and latitudes, departures, and geographic positions for the Mount Rainier quadrangle (Wash.) were computed. Primary level circuits in the Moses Lake quadrangle (Wash.), run by the United States Geological Survey, and in the Pasco and Wallula quadrangles (Wash.), run by the United States Reclamation Service, were adjusted.

Geodetic distances and positions in the Soda Springs quadrangle (Wyo.) were computed.

Level lists were revised and assembled, after necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for the following States: Arizona (Bulletin 463), California (Bulletin 481), Idaho (Bulletin 487), Nevada (Bulletin 488), Oregon (Bulletin 462), Utah (Bulletin 489), and Washington (Bulletin 457). The manuscript for the report on the Idaho-Washington boundary line survey was assembled and transmitted to the editor for publication as Bulletin 466.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

The field time of the inspectors was devoted largely to regular and special topographic work. J. H. Renshawe spent the early part of the season on inspection duty in portions of the Atlantic, Central, and Rocky Mountain divisions, and six weeks in the fall in topographic sketching in the Quarryville quadrangle (Pa.). W. M. Beaman examined and revised 600 square miles in the Flagstaff quadrangle (Ariz.), surveyed and inked in the field the Ray special map (Ariz.), and started control for the Miami special map (Ariz.). F. E. Matthes was engaged during the field season in topographic work on the map of the Mount Rainier National Park, completing 36 square miles.

The office duties of Messrs. Renshawe and Beaman involved a careful supervision of the inking and preparation of the final drawings of the topographic branch and their final examination prior to submission for engraving or photolithography. Mr. Matthes's time was devoted to the inking of his field work and to the revision of the book of instructions for the topographic branch.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

As in past years the repairs to all topographic instruments were made under the supervision of E. M. Douglas, who is also in charge of the topographic records.

The additions to the topographic records consisted of 263 triangulation or primary traverse books, 221 level books, nearly 300 vertical-

angle or stadia books, and 125 plane-table sheets, all of which have been numbered and catalogued. Four new iron filing cases for records were purchased.

MAP OF THE UNITED STATES.

Of the work begun last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, base maps of the following States have been completed: Vermont (portions of sheets K and L 18 and L 19), Massachusetts (portions of sheets K 18 and 19), Rhode Island (portion of sheet K 19), Connecticut (portions of sheets K 18 and 19), Michigan (portions of sheets K 16 and 17 and L 15, 16, and 17), Wisconsin (portions of sheets K and L 15 and 16), Minnesota (portions of sheets K, L, and M 14 and 15), Indiana (portions of sheets J and K 16), and North Carolina (portions of sheets I 16 and I and J 17 and 18). Seventy per cent of the lettering was completed on the New York and Pennsylvania portions of sheet K 18, and 80 per cent of the lettering on the Ohio portion of sheet K 17. The Ohio portion of sheet K 16 was lettered, completing the sheet, and 75 per cent of sheet J 18 was compiled and inked.

New work included the following:

Sheets K 14 and 15, Iowa portions, completed.

Sheets L and M 11, 12, and 13, Montana portions, 60 per cent compiled and inked.

Sheets K 12 and 13, Wyoming portions, 7 per cent compiled and inked.

Sheets H and I 15 and 16, Mississippi portion, 80 per cent compiled and inked.

Sheets H and I 16, the coastal plain area of Alabama, 80 per cent compiled and inked.

Sheet K 19, contours compiled for the land and ocean floor, and the sheet transmitted for engraving.

WATER-RESOURCES BRANCH.

AUTHORITY FOR INVESTIGATIONS.

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

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

The increase of $50,000 in the appropriation for investigations of water resources permitted a considerable extension of this work during the fiscal year. It was necessary, however, in order to perform important land-classification work in the West (see pp. 68–72) to allot 82 per cent of the total appropriation for work west of the one hundredth meridian.

ALLOTMENTS.

The allotments of the appropriation for the fiscal year were as follows:

Administrative expenses of the survey	$9,179
Clerical assistance and supervision of work	11,000
Purchase of supplies, telegrams, etc	800
Computations, reports, and technical studies	10,500
Stream gagings in—	
New England and New York	8,000
Virginia, South Carolina, North Carolina, Georgia, Alabama, Mississippi, and Tennessee	4,000
West Virginia, Kentucky, Ohio, Indiana, and Illinois	8,000
Minnesota	6,000
Texas	1,000
Arkansas	1,000
Stream gagings and water-power investigations in—	
Southern Wyoming, Colorado, and New Mexico	12,000
Northern Wyoming, Montana, and North Dakota	9,500
Idaho, Utah, and Nevada	11,000
Washington and Oregon	12,000
California	4,500
Nevada and Arizona	6,000
Stream gagings in Hawaii	5,000
Investigations of ground water, including quality of water	19,500
Land-classification board	4,000
Water-power investigations	6,200
Débris investigations	800
Contingent	21
	150,000

COOPERATION.

STATES.

Cooperation with several States has been maintained as described in previous reports. The States and the amounts allotted by them are as follows:

Amounts allotted by States for cooperative work with United States Geological Survey in investigations of water resources.

California	$9,000.00
Colorado	545.00
Hawaii	5,000.00
Idaho	5,000.00
Illinois	3,000.00
Maine	1,000.00
Massachusetts	825.00
New York	11,089.69
New Mexico	3,170.93
Oregon	2,500.00
Utah	2,000.00
Vermont	1,000.00
Washington	5,000.00
	49,130.62

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

California.—The determination of stream flow; the survey of reservoir, dam, and canal sites for the development of irrigation, water power, and municipal supply; the study of underground waters.

Colorado.—The determination of stream flow for use in the development of irrigation and water power.

Hawaii.—The determination of stream flow, the survey of reservoir sites, the measurement of precipitation, and the determination of the occurrence, quantity, and character of underground waters.

Idaho.—The determination of stream flow.

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

Maine.—The determination of stream flow and the survey of reservoir and dam sites.

Massachusetts.—The determination of stream flow.

New York.—There are two cooperative agreements in force in this State—one with the State engineer, in which $1,089.69 has been expended by each party for the determination of stream flow at points designated by the State engineer, and the other with the State water supply commission, in which the commission has allotted $10,000 and the survey $1,000, the money being devoted to the determination of stream flow for use in storage and the development of water power.

New Mexico.—The determination of stream flow for use in the development of water power and irrigation.

Oregon.—The determination of stream flow for use in the development of irrigation, municipal water supply, navigation, and water power.

Utah.—The determination of stream flow for use in irrigation and the development of water power.

Vermont.—The determination of the water resources of the State.

Washington.—The determination of stream flow for use in irrigation and the development of water power.

RECLAMATION SERVICE.

Cooperation has also been maintained with the United States Reclamation Service. The rivers supplying water to the reclamation projects under construction by that bureau must necessarily be investigated to determine the amounts of water that they will yield for irrigation. This work, being specifically applied to these projects, becomes a proper charge thereon, and the Reclamation Service has deemed it of advantage to utilize the Survey engineers for this purpose, paying to the Survey, through transfer of funds in the Treasury Department, the actual cost of the investigations. During the last year 96 stations have been maintained under this cooperative agreement.

OFFICE OF INDIAN AFFAIRS.

Cooperation has also been effected with the Office of Indian Affairs in connection with investigations of ground water. At the request of the Commissioner of Indian Affairs a study of ground-water supplies was undertaken in the Moqui and Navajo reservations of Ari-

zona, New Mexico, and southern Utah, $1,500 being set aside for this purpose by the Indian Office.

Investigations of stream flow on Indian reservations have also been placed under the direction of the Geological Survey. The number of stations maintained under this arrangement is as follows: Idaho, 2; New Mexico, 3; Washington, 6; Wisconsin, 2. The cost of this work has been paid by transfer in the United States Treasury from the Indian Office appropriation.

FOREST SERVICE.

The cooperation with the Forest Service during the year was merely a cooperation of services rendered in connection with the determination of stream flow in selected national forests. Stations were established by the United States Geological Survey, and their maintenance, operation, etc., was undertaken by the officials of the Forest Service, under the supervision of the Survey. The number of stations maintained under this arrangement is as follows:

Stream gaging stations in national forests.

California	51
Colorado	59
Idaho	7
Montana	14
New Mexico	7
Oregon	20
Utah	13
Washington	16
Wyoming	7

PUBLICATIONS.

The work of the water-resources branch is represented by the following publications issued during the year: Professional Paper 72; Water-Supply Papers 237, 240, 246, 251, 253 to 258, 260, 262 to 265, and 270. Titles and brief summaries of these publications are given on pages 31–33. Water-Supply Papers 261, 266, 267 to 269, 271, 272 to 278, 286, and 288, and Bulletin 479 were at the Government Printing Office at the close of the year. Nine manuscripts are in hand awaiting editorial work, and 16 other reports are in different stages of preparation. Reprints of the following water-supply papers, the original edition of which has been exhausted, were ordered and delivered during the year: 165, 167, 168, 174, 175, 177, 180, 238, 239, 253, 255, and 260.

ORGANIZATION.

The organization of the water-resources branch has been changed during the year to conform to the new conditions and objects of work. The investigation of water-power sites, rights of way, etc.,

was first performed by the engineers of the division of surface waters in connection with their measurements of stream flow. This plan, however, resulted in a division of interest in both kinds of work, so that neither received the attention that it required, even to the extent of the small allotments available for the purpose. A new division was therefore organized, the members of which give their entire time to the land-classification work. The organization is now as follows:

M. O. Leighton, chief hydrographer.
Division of surface waters: John C. Hoyt, engineer in charge.
Division of underground waters: W. C. Mendenhall, geologist in charge.
Division of water utilization: M. O. Leighton, engineer in charge.

DIVISION OF SURFACE WATERS.

MEASUREMENTS OF STREAM FLOW.

The work assigned to the division of surface waters consists of the measurement of the flow of rivers in the United States, which is divided into 14 districts, as follows:

Maine district, covering only the State of Maine: C. C. Babb, district engineer, State capitol, Augusta, Me.

New England district: New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York. C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district and computing section: Maryland, Virginia, and New Jersey. R. H. Bolster, district engineer, Washington, D. C.

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

Ohio Valley district: Illinois, Indiana, Iowa, Kentucky, Michigan, North Carolina, Ohio, Tennessee, Virginia, West Virginia, and Wisconsin. A. H. Horton, district engineer, Federal Building, Newport, Ky.

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

Upper Missouri district: Montana, North Dakota, and Wyoming. W. A. Lamb, district engineer, Montana National Bank Building, Helena, Mont.

Denver district: Colorado, Nebraska, New Mexico, South Dakota, and Wyoming. W. B. Freeman, district engineer, Chamber of Commerce Building, Denver, Colo.

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

Columbia River district: Oregon, Washington, and Idaho. F. F. Henshaw, district engineer, Tilford Building, Portland, Oreg.

California district: California, Nevada, and Arizona. W. B. Clapp, district engineer, Federal Building, Los Angeles, Cal.

Texas district, covering only the State of Texas: T. U. Taylor, resident engineer, Austin, Tex.

Hawaiian district, covering the Territory of Hawaii: F. W. Martin, district engineer, Honolulu, Hawaii.

Alaskan district, covering the Territory of Alaska: C. E. Ellsworth, engineer in charge.

The results of the work performed in these districts are compiled and computed for publication by the computing section in the Washington office, under the charge of R. H. Bolster, assistant engineer. The distribution of the gaging stations by States is shown in the accompanying table, together with the number of stations established and discontinued and the number of measurements made. As a large part of the work is carried on in cooperation with other Federal bureaus, State organizations, and private parties, the table has been arranged to show the extent of such cooperation in each State.

At the end of the year the total number of stations maintained (exclusive of those in Hawaii and Alaska) was 1,105. During the year 107 stations were discontinued and 420 stations were established; 4,975 measurements were made at regular stations and 596 miscellaneous measurements were made. In addition to the foregoing, records ready for publication were received at the end of the year from private parties for about 100 stations.

Gaging stations and cooperating parties for the fiscal year 1910.

State.	Geological Survey alone.	Reclamation Service.	Forest Service.	Indian Office.	Army Engineers.	Weather Bureau.	Other Federal bureaus.	States.	Municipalities.	Private parties.	Counted more than once.	Maintained June 30, 1911.	Established during year.	Discontinued during year.	Regular measurements during year.	Miscellaneous measurements during year.
Alabama	....	....	....	....	1	2	....	5	....	....	....	8	....	....	7	....
Arizona	10	....	....	....	....	....	....	....	....	....	....	10	10	....	42	22
California	....	8	51	....	....	....	....	43	24	7	....	133	71	6	542	164
Colorado	4	1	59	....	....	....	....	18	....	6	3	85	59	14	1,102	55
Connecticut	....	....	....	....	....	2	....	....	....	....	....	2	....	....	1	....
Georgia	3	....	....	....	....	9	....	....	....	5	....	17	1	....	50	....
Idaho	....	4	7	2	....	1	....	63	....	10	12	75	44	11	378	31
Illinois	....	....	....	....	....	2	....	22	....	....	....	24	1	....	118	1
Indiana	....	....	....	....	....	1	....	....	....	....	....	1	....	....	1	1
Iowa	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....
Kentucky	....	....	....	....	....	2	....	....	....	1	....	3	3	....	20	4
Maine	....	....	....	....	....	....	....	21	....	12	5	28	1	1	60	1
Maryland	2	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....
Massachusetts	....	....	....	....	....	....	....	12	4	4	4	16	4	4	48	3
Michigan	....	....	....	....	....	....	....	1	1	6	....	8	....	....	....	....
Minnesota	....	....	....	....	....	2	....	42	....	3	5	42	3	5	116	5
Mississippi	1	....	....	....	....	1	....	7	....	....	....	9	....	....	....	....
Montana	35	51	14	....	....	1	....	16	....	4	1	120	41	10	564	12
Nebraska	....	....	....	....	....	....	....	7	....	....	....	7	1	1	43	....
Nevada	7	1	....	....	....	1	....	1	....	3	....	13	10	....	30	12
New Hampshire	2	....	....	....	....	....	....	....	....	7	....	9	2	....	11	....
New Jersey	1	....	....	....	....	2	....	....	....	....	....	3	....	....	....	....
New Mexico	....	....	7	3	....	....	....	40	....	3	13	40	15	3	225	35
New York	....	....	....	....	1	3	....	36	3	1	6	38	22	15	173	33
North Carolina	5	....	....	....	....	1	....	....	....	....	....	6	....	2	18	9
North Dakota	8	....	....	....	....	....	....	....	....	....	....	8	....	....	18	2
Ohio	1	....	....	....	....	4	....	1	....	....	....	6	2	....	16	3
Oregon	....	7	20	....	....	4	....	126	1	43	75	126	49	7	275	43
Rhode Island	....	....	....	....	....	....	....	3	....	....	....	3	....	1	....	....
South Carolina	....	....	....	....	....	1	....	....	....	....	....	1	....	3	....	....
Tennessee	2	....	....	....	....	8	....	....	....	....	....	10	3	....	17	....
Texas	1	....	....	....	....	3	....	....	....	....	....	4	4	....	22	19
Utah	....	....	13	....	....	1	....	21	1	2	1	37	3	11	327	5
Vermont	....	....	....	....	....	....	....	8	....	7	7	8	8	9	20	30
Virginia	9	....	....	....	....	1	....	....	....	3	....	13	....	....	19	....
Washington	....	21	16	6	....	....	1	138	3	16	63	138	43	4	588	96
West Virginia	18	....	....	....	2	4	....	....	....	1	....	25	4	....	42	5
Wisconsin	....	....	....	2	....	1	....	....	....	5	....	8	2	....	5	1
Wyoming	8	3	7	....	....	....	....	....	....	....	....	18	14	....	77	4
	117	96	194	13	4	57	1	631	37	150	195	1,105	420	107	4,975	596

In Alaska 54 gaging stations were maintained in the Yukon-Tanana region for an average period of 143 weeks, furnishing data on the water resources of about 4,700 square miles; 15 gaging stations were also maintained for about 170 weeks in Seward Peninsula, yielding data on the run-off of approximately 1,800 square miles.

The data in connection with the investigation in the Territory of Hawaii have not yet been assembled for publication. Excellent progress, however, has been made in this Territory in spite of local difficulties.

The standard of the progress reports on stream measurements has been materially improved. The installation of a number of automatic gages of different patterns, each adapted to peculiar conditions, is also expected to make the records more accurate and to give a clearer insight into the laws governing stream flow.

Old-time records of stations maintained by the War Department and by the United States Weather Bureau are being carefully investigated and by means of discharge measurements made during previous years and complete studies and adjustments of the discharge data it will be possible to obtain for a large number of stations long-time records of daily discharge. The longest record thus far obtained is for Ohio River at Wheeling, W. Va., from 1838 to date. It is expected that these investigations will throw light on the much-discussed problems of the relation of run-off to precipitation and the effect of deforestation on river discharge.

To facilitate the use of Government reports relating to water supply, climate, and related subjects, the United States has, by agreement between the Geological Survey and the Weather Bureau, been divided into 12 areas and the progress report of stream gaging has been divided into 12 parts, each part covering one of these areas. The areas and the numbers of the corresponding reports giving the results for 1909 and 1910 are shown in the table below. The reports for 1910 have not yet been published.

Reports on surface-water supply of the United States.

	Water-Supply Paper No.	
	1909	1910
North Atlantic coast	261	281
South Atlantic coast and eastern Gulf of Mexico	262	282
Ohio River basin	263	283
St. Lawrence River basin	264	284
Upper Mississippi River and Hudson Bay basins	265	285
Missouri River basin	266	286
Lower Mississippi River basin	267	287
Western Gulf of Mexico	268	288
Colorado River basin	269	289
Great Basin	270	290
California	271	291
North Pacific coast	272	292

RIVER-PROFILE SURVEYS.

During the year all river-profile surveys were performed by the topographic branch, except certain incidental surveying in the upper Mississippi district by Robert Follansbee in St. Louis, Ottertail, Cloquet, and Vermilion rivers, and on certain rivers draining into Lake Superior.

DÉBRIS INVESTIGATION.

A report on the investigation of the natural laws governing the transportation of material of rivers has been in preparation by G. K. Gilbert. This is based on the results of nearly four years' laboratory experimentation in California, and the laws discovered by the studies will undoubtedly be extremely valuable to the engineering profession.

DIVISION OF GROUND WATERS.

At the beginning of the fiscal year 1910–11 an allotment of $19,500 was made from the appropriation for gaging streams, to be used by the division of underground waters for investigating ground-water problems in the United States. In addition to this direct allotment, $1,500 was set aside by the Office of Indian Affairs for a special study of conditions on the Moqui-Navajo Reservations in Arizona and New Mexico.

Of the direct allotment, $2,000 was transferred to the geologic branch for use in the cooperative work carried on under the supervision of that branch in the States included in the Atlantic and Gulf Coastal Plain. The results of this work are summarized in the report of the geologic branch.

A small sum was set aside at the beginning of the year for completing the field work involved in the preparation of a report on California springs by G. A. Waring, who, as indicated in the last annual report, severed his connection with the Survey early in September, 1910. Previous to his departure, but during the present fiscal year, he spent a month in field work in California, completed the first draft of his manuscript, and delivered it for editorial revision and review. Some progress has been made in the work necessary to prepare it for publication.

R. B. Dole, assistant chemist, was assigned to the San Joaquin Valley, in California, where he spent three months in a study of the composition of the underground waters. Several hundred field assays and a smaller number of complete analyses were made and are now being assembled in the form of a report, which it is expected will be completed early in the next fiscal year.

In August the division of underground waters was strengthened by the transfer to it from the Reclamation Service of Herman Stabler,

qualified as a chemist and engineer. Mr. Stabler was assigned to the San Joaquin and San Jacinto valleys, in California, to study the results of experience in irrigation by the use of pumping plants, to determine especially the cost of pumped water under various conditions and the relative value of the different pumping devices in use. About 60 pumping plants were tested, and a report on the experiments in the San Jacinto Valley has been prepared. The report on the San Joaquin Valley work is as yet incomplete.

These two researches in the San Joaquin Valley are intended to supplement geologic and statistical studies of the development of the underground waters in this great valley, and their results will eventually be combined with the results of those studies in a general report on the area.

By cooperation with the city of Los Angeles, Cal., an investigation of the relation of ground-water supplies to run-off, on the one hand, and to loss through evaporation and other forms of drainage, on the other, has been undertaken in Owens Valley by Charles H. Lee. Careful measurements of all streams tributary to this valley and of evaporation from soil surfaces under various conditions of ground-water level have been made. It is expected that the report embodying the results of this work will constitute a contribution to our knowledge of certain fundamental facts involved in all ground-water problems—facts which heretofore it has not proved feasible to investigate, although their importance has long been recognized.

One of the most important single researches undertaken during the year is that of Sulphur Spring Valley, Ariz., extending from Douglas, on the Mexican line, northward beyond Willcox. This work has been undertaken as a result of a cooperative agreement with the Arizona Experiment Station, R. H. Forbes, director, and has been in charge of O. E. Meinzer, of the Geological Survey. It involves reconnaissance topographic work and careful studies of ground-water levels, of the costs of recovery by pumping, of the chemical character of the ground waters and of the soils, and of other facts bearing generally on the problems of irrigation by means of underground waters. The preparation of a report embodying the results of this research is well advanced toward completion at the close of the fiscal year.

At the beginning of the year a small allotment was made through the geologic branch to N. H. Darton to enable him to procure results that can be embodied in a water-supply paper on the area about Deming, N. Mex. This work was extended southward from Deming to a point within 15 or 20 miles of the Mexican border, but was not completed during the fiscal year. An additional small allotment will be made during the year 1911–12 to permit the completion of this work.

The report on the underground waters of Iowa, the preparation of which, in cooperation with the State Survey, has been under way for some time, was received in rough draft late in the fiscal year, and at its close is undergoing revision. Direct supervision over this report has been exercised by Prof. W. H. Norton, of Mount Vernon, Iowa, and the document will be issued as the joint product of the State and Federal surveys.

A similar report on the geology and water resources of Minnesota, submitted for publication during the previous fiscal year, has been advanced through the various stages of editorial revision and publication, and was issued just before the close of the present fiscal year.

C. H. Gordon, of Knoxville, Tenn., completed the rough draft of his report on the geology and underground waters of the Wichita region of north-central Texas during the year, and submitted it for revision and comment. This completes the series of reports that have been prepared for the Survey by Prof. Gordon.

The special investigations undertaken for the Office of Indian Affairs in the Moqui and Navajo reservations in Arizona have been carried out by Prof. H. E. Gregory, of the Survey staff and of Yale University. The results of these studies are not prepared for publication, but are presented in the form of manuscript reports intended to serve as practical guides to engineers and agents of the Indian Office. These manuscripts are transmitted directly to the Commissioner of Indian Affairs for his information.

A study of the quality of the surface waters of Washington, commenced in 1909, has been completed in cooperation with the Washington State Board of Health as one of a series of reports dealing specifically with the quality of the surface waters of the United States. The chemical laboratory for which quarters were courteously furnished by the University of Washington has been discontinued and a report on the work, to be published as a water-supply paper, is being prepared by Walton Van Winkle, who was in direct charge of the investigations for the Survey. Samples of water were collected daily for a year from the principal rivers of Washington at 17 stations and were united in sets of convenient number; the composites thus obtained were subjected to mineral analysis. In addition, determinations of turbidity, color, and alkalinity were made daily on several streams, and samples were also collected daily for six months at Albany, Oreg., from Willamette River, one of the largest tributaries of the Columbia. The results of these examinations as presented in Mr. Van Winkle's report furnish definite, reliable information regarding the chemical composition of the surface waters of Washington, the changes to which they are subject, and their availability as domestic and industrial supplies and for irrigation. Coupled with

other observations that have been made they supply means for estimating the rate of chemical denudation in the State and the conditioning effect of the geologic structure of the region.

In addition to the investigations outlined above, a large amount of miscellaneous work has been performed by the division during the year. R. B. Dole, for example, in addition to the California work for which he is directly responsible, has maintained general supervision over investigations of the quality of water in different parts of the United States and has revised chapters on the chemistry of water in all reports that have been submitted for publication. More or less of the energy of the division has been absorbed in making enlarged-homestead designations under the authority of the act of February 3, 1909, and in preparing reports on lists presented by the public-land States for segregation under the Carey Act. The results of work of this type have been presented through the land-classification board in the geologic branch.

DIVISION OF WATER UTILIZATION.

SCOPE OF THE WORK.

The work of the water-resources branch includes the investigation of power sites and other matters on the public lands; the investigation of water powers, floods, and river profiles, and the preparation of reports thereon for publication; the investigation of the run-off of rivers that drain lands proposed by the Secretary of Agriculture for purchase as national forests, and the interpretation of the data obtained to determine whether or not the control of such lands would promote or protect navigation.

WATER-POWER SITES.

A statement of the lands recommended either for withdrawal or for restoration for water-power sites, with all similar matters in connection therewith, such as reports on applications for right of way, enlarged-homestead designations, and Carey Act segregations, is given in detail in the report of the land-classification board.

During 1910 areas aggregating over 650,000 acres not previously examined were investigated by engineers of the water-resources branch in connection with water-power withdrawals.

The work of preparing reports on water-power sites and collateral matters is done in conformity with that portion of the sundry civil appropriation act providing for the preparation of "reports on the best methods of utilizing the water resources."

ACQUISITION OF LANDS.

Just before the close of the fiscal year investigations of stream flow were made in the White Mountain region of New Hampshire

to determine the relation of forest cover to stream flow. This region has been designated by the Secretary of Agriculture for purchase as a national forest, and the examination is being made in accordance with the requirements of the Weeks Act.

PUBLICATION BRANCH.

BOOK PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 2 professional papers, 33 bulletins, 23 advance chapters from 5 bulletins, 16 water-supply papers, 54 advance chapters from the annual report on mineral resources for 1909, 7 advance chapters from the annual report on mineral resources for 1910, 5 geologic folios, 43 press bulletins, and a number of pamphlets. These publications were the Thirty-first Annual Report; Professional Papers 68 and 72; Bulletins 381 (published also in 4 advance chapters), 425 to 427, inclusive, 429, 430 (published also in 10 advance chapters), 431 (published also in 2 advance chapters), 432 to 447, inclusive, 449, 452, 453, 457, 459 to 463, inclusive, 465, and 7 separates from 470; Water-Supply Papers 237, 240, 246, 251, 253 to 258, inclusive, 260, 262 to 265, inclusive, and 270; 54 (all) advance chapters from Mineral Resources for 1909; 7 advance chapters from Mineral Resources for 1910; 5 geologic folios (published in folio and octavo form); a list of publications; a list of topographic maps and folios and geologic folios; "Regulations and instructions of the United States Geological Survey;" a chart showing mineral products of the United States, 1900–1909; a chart showing production of coal in the United States from 1814; and Press Bulletins 428 to 458, inclusive, and new series 1 to 7, inclusive (also 5 special issues). Titles and summaries of the publications of the regular series are given on pages 22–35.

The total number of printed pages in these publications was 13,566; the publications of the previous year comprised 12,855 pages.

During the year 40,648 pages of manuscript were edited and prepared for printing, and proof sheets for 17,417 final printed pages were read and corrected, this work involving the handling of 5,787 galley proofs and 32,706 page proofs. The corresponding figures for 1909–10 were 29,057 pages of manuscript, 12,517 final printed pages, 4,893 galley proofs, and 28,005 page proofs. Indexes were prepared for 74 publications, covering 14,400 pages; the figures for the previous year were 56 publications and 10,782 pages.

The press bulletin was prepared in this section until April 1, 1911.

The copy and proofs of all account and record books and blanks, circulars, office cards, etc., are examined in this section. This work consumes a large part of the time of one person, but it is not practicable to report the amount statistically.

The division of mineral resources, the water-resources branch, and the library rendered special assistance in copy preparing and proof reading.

At the close of the year the personnel of the section consisted of the editor, the assistant editor, 4 editorial clerks, and 1 stenographer and typewriter.

SECTION OF ILLUSTRATIONS.

During the year 3,990 illustrations were prepared and most of them were transmitted, to accompany 39 bulletins, 24 water-supply papers, 5 professional papers, 1 annual report, and 1 report on mineral resources. These illustrations included 267 maps, 1,119 diagrams, 1,720 paleontologic drawings, 4 landscape drawings, 587 photographs retouched, and 234 miscellaneous pieces.

The section received and compared critically 2,379 proofs, as well as all contract-printed inserts delivered at the Government Printing Office.

The number of electrotypes furnished to outside applicants was 157.

At the close of the year material for the illustration of 29 reports was on hand, 17 being from 50 to 90 per cent completed.

The personnel of the section consisted of 10 draftsmen (including the draftsman in charge) and 1 copyist clerk.

SECTION OF GEOLOGIC MAPS.

Twenty-two folios have been in hand in various stages during the year. Five folios (Nos. 172 and 174 to 177, inclusive), which are listed and described on pages 34–35, were published. The Foxburg-Clarion, Pawpaw-Hancock, Claysville, and Bismarck folios were completed with the exception of the printing of the descriptive text, and the maps of the Raritan, Choptank, and Llano-Burnet folios were nearly finished. The engraving of the Ellijay, Murphysboro-Herrin, and Kenova folios was begun. The Springfield-Tallula, Apishapa, and Colorado Springs folios were received for publication and the maps were in part prepared for engraving. Some editorial revision has been done on the San Francisco, Galatia, and other folio maps. The list of folios in course of publication and in preparation for publication, arranged in the order of progress, is as follows:

Foxburg-Clarion, Pa. (No. 178).
Pawpaw-Hancock, W. Va.-Md.-Pa. (No. 179).
Claysville, Pa.
Bismarck, N. Dak.
Llano-Burnet, Tex.
Choptank, Md.
Raritan, N. J.
Murphysboro-Herrin, Ill.
Kenova, Ky.-Ohio-W. Va.
Apishapa, Colo.
Philipsburg, Mont.
Ellijay, Ga.-N. C.-Tenn.
Belleville-Breese, Ill.
Springfield-Tallula, Ill.
Barnesboro-Patton, Pa.
Eureka Springs-Harrison, Ark.
Colorado Springs, Colo.

The geologic map of North America was edited and proof read, and three of the four sheets comprising it were printed. The sheet for the southeast quarter is in press and the edition will soon be completed. This is the largest map ever issued by the Geological Survey. Twelve colors are used to represent the geology, in addition to the two colors of the base, and the map is an effective piece of lithographic work. It also supplies a long-existing demand for a geologic wall map of the United States that is accurate as to detail within the scale of the map and that represents the true state of geologic knowledge.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 97 atlas sheets and special maps were on hand for publication, and the accessions during the year were 140—a total of 237 maps, of which 23 are fractional atlas sheets that average about 50 per cent completed. The following statement shows the status of these 237 maps on June 30, 1911, and the similar record on June 30, 1910:

Status of work on maps, June 30, 1910, and June 30, 1911.

	1911	1910
Published during the year	86	93
In process of engraving	56	57
Not taken up	95	40

The manuscripts edited during the year comprise 88 new topographic atlas sheets and special maps prepared for engraving and 3 maps prepared for photolithography; corrections for 205 sheets heretofore published; 6 maps published under contract; parts of sheets K 15, I 17, J 17, K 16, and K 17 of the millionth scale map; and 199 map illustrations which are or will be included in 39 survey reports. The proof read comprises 76 new atlas sheets and special maps, corrections to 55 old ones, and 16 maps published under contract.

A new edition of the topographic and geologic index map of the United States was prepared, proof read, and published. All but one of the 21 circulars of the series 9–323 were revised and reprinted during the year. The conventional signs adopted by the committee on unification representing the map-making bureaus of the Government were arranged and prepared for publication on one sheet. The lists of topographic maps were revised to date and proof read for a new edition of the pamphlet "Topographic maps and folios and geologic folios."

Five men were engaged in the work of this section during the year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 136 new books, 5 folios, 80 new maps, 11 revised maps (4 of which were the results

of resurveys), 3 photolithographs, and 135 reprints of maps, a total of 370 publications. The total of all editions received was 498,886 books, 20,490 geologic folios, and 698,878 maps, a grand total of 1,218,254.

Reprints of the following publications were delivered to the Survey during the fiscal year: Bulletins 398, 406, 421, 424, and 431–A; Water-Supply Papers 165, 167, 168, 175, 177, 180, 238, 239, 253, 255 (two reprints), and 260; Mineral Resources of the United States, calendar year 1908, Parts I and II; and two advance chapters from Mineral Resources for 1909, namely, "The production of gold and silver in 1909" and "Petroleum operators' statistics of petroleum production."

During the year 488,930 books, 34,117 geologic and topographic folios, and 684,129 maps (including 517,777 sold), a total of 1,208,176, were distributed.

The total amount received and turned into the Treasury as the result of sales of publications was $21,583.55 ($19,230.20 of which was derived from the sale of topographic and geologic maps), an increase of $381 over the amount received in the fiscal year 1909–10.

Fifteen persons were engaged in the work of this section.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

During the year ending June 30, 1911, 86 topographic atlas sheets and special maps were published, and at the end of the year 56 sheets were in various stages of progress toward publication. Besides the engraved maps, sheets Nos. 1, 2, and 3 of Willamette Valley, Oreg., were photolithographed and published.

Corrections were engraved on the plates of 192 maps hitherto published. Editions of 231 maps were printed and delivered to the map room. This includes new sheets (engraved and lithographed) and reprints.

Five geologic folios were published, three of them in two forms, and 20,490 copies of seven different folios were printed and delivered. Six geologic folios were in press at the close of the year and four others had been partly completed.

Under contracts with the Government Printing Office, awarded on competitive bids, illustrations were printed for the following survey publications: Monograph LII; Bulletins 91, 108, 234, 239, 381, 398, 406, 430, 431, 435, 438, 440, 443, 445, 447, 448, 450, 452, 454, 456; Professional Papers 70, 71, 75; Water-Supply Papers 240, 275; Mineral Resources, 1909; Thirty-first Annual Report of Director.

For the Government Printing Office also the following items were printed and delivered: Illustrations for the American Ephem-

eris and Nautical Almanac, Annual Report Chief of Engineers United States Army, Annual Report Commissioner of Indian Affairs, Annual Report Superintendent of Coast and Geodetic Survey, Annual Report Isthmian Canal Commission, Annual Report Superintendent Yosemite National Park, Twenty-second Annual Report on the Statistics of Railways, eight Senate and House documents, Annual Report Superintendent Crater Lake National Park, Annual Report Governor of Alaska, Annual Report Governor of Arizona, Annual Report Commissioner of Corporations, Annual Report Board of Regents Smithsonian Institution, Third Annual Report Superintendent Block and Train Signal Board.

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 13 national forests, index map of the national forests of the United States, and map of North America showing natural forest regions; for the General Land Office, 964 township plats; for the Department of the Interior, maps of 2 national parks, 2 national monuments, 1 bird reservation, and 10 homestead maps of States and Territories; for the Reclamation Service, a large amount of miscellaneous work; for the Biological Survey, 3 maps of North America. Work was also done for the War Department, Navy Department, Department of State, Department of Justice, Department of Agriculture, Department of Commerce and Labor, Office of Indian Affairs, Isthmian Canal Commission, Bureau of Mines, Hydrographic Office, International Boundary Commission, Weather Bureau, Interstate Commerce Commission, Treasury Department, Army Service Schools, Tariff Board, and the District of Columbia. This work for other branches of the Government amounted to about $48,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was nearly 2,000,000 and required more than 4,500,000 printings. The total number of copies printed, including topographic maps and geologic folios, was 2,555,230, requiring nearly 8,000,000 impressions. On requisition of the Government Printing Office 351 transfer impressions were made and shipped to contracting printers.

INSTRUMENT SHOP.

The work of the instrument shop consisted of repairing surveying, drafting, engraving, stream-gaging, and other instruments and making copper plates and electrotypes. More than 1,200 repairs and overhauls were made, 79,755 square inches of new copper plates were made and 954 square inches were resurfaced, and 10,710 square inches of electrotypes were made.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 16,004 negatives, of which 11,603 were dry, 3,342 were wet, and 1,059 were paper; and 40,748 prints, of which 16,331 were maps and diagrams and 24,417 were photographs for illustrations.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

The work in the executive division was of the same scope as in other years, except for the transfer of the administrative bookkeeper to the division of disbursements and accounts. Considerable time was given by the chief of the division and two clerks to reports on various subjects for the use of the President's Commission on Economy and Efficiency. A special file of these reports and of the correspondence relating to them is maintained.

In many items the work performed by the division shows increase, in spite of the separation of the Bureau of Mines from the Geological Survey. The decreases mentioned below are due in large part to that separation.

Mails, files, and records.—During the year 134,386 pieces of incoming mail were handled in this division, an increase of 1 per cent over the number handled in the preceding fiscal year. Of this number 2,590 were registered, which is an increase of slightly more than 10 per cent over the preceding year. This number does not include the pieces of mail distributed unopened to the several branches, divisions, sections, and individuals in the Survey. Since March 1 a record of mail distributed unopened has been kept, and the number of pieces of such mail handled during the four months was 99,158.

Of the letters opened in this division, 26,076 contained remittances for Survey publications, a slight increase over the number of similar letters received during the last fiscal year, but the amount of money received, $23,790.18, is $68.68 less than last year.

The recording, referring, and filing of correspondence required the services of 5 clerks throughout the year. The number of letters mailed through the division was 92,126, an increase of about 8 per cent. Of this number 20,951 were registered, which is an increase of 73 per cent.

Personnel.—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 862 persons, compared with 958 at the close of the fiscal year 1909–10. The total number of changes in the personnel for the year was 1,119, which included original appointments, separations, promotions, extensions, and changes of status of every description. Of these, 275 were new appointments, 370 were separations (including 53 transfers to the

Bureau of Standards and 140 transfers to the Bureau of Mines, organized July 1, 1910), 375 were promotions, and 6 were reductions.

During the year 12,794 days of annual leave and 3,396 days of sick leave were granted, being about 68 per cent of the amount of annual leave and 18 per cent of the amount of sick leave which it is permissible to grant under the law; also 3,239 days of leave without pay. In addition to the above there were 203 transfers to State pay rolls in cooperative work.

Property.—An inventory of nonexpendable property in Washington was submitted to the department at the close of the calendar year 1910.

Express and freight.—During the year 4,009 pieces of freight and express were handled, of which 1,427 were outgoing and 2,582 were incoming. This was a decrease of 10 per cent in the number of pieces handled. There were 451 transportation accounts checked, a decrease of about 20 per cent.

A change was made in the method of recording express and freight shipments so as to segregate the outstanding transportation accounts in the card record. Except for the rearrangement of the cards, which has been completed, this involved no additional clerical work, and it facilitates the checking of transportation accounts.

Purchase and distribution of supplies.—The purchase and distribution of supplies, which includes the work of procuring bids, issuing orders, and preparing vouchers covering all purchases in open market, required the services of 3 persons. The number of requisitions handled was 2,157, an increase of more than 7 per cent.

Stationery.—There were 7,148 requisitions filled from stock in the stationery room. The requisitions drawn on the department numbered 330 for miscellaneous supplies, 184 for stationery, and 430 for printing. These figures show an increase over those for 1910, except in requisitions for stationery and printing drawn on the department, and the decrease in those items is accounted for by the fact that the requisitions called for larger quantities than those drawn in previous years.

During the last half of the year the work of the stationery room has been reorganized. A simple but effective system of records has been established, including a stock record which shows at all times the condition of stock on hand and a file of requisitions by branches and divisions. Several new forms have also been issued, including invoices to accompany shipments of stationery supplies to the field and orders to indicate shortage of supplies which are out of stock. On account of assignments to other work, illness, and other causes the force in the stationery room has varied during the year, but it normally consists of 4 men, including the clerk in charge of the property records.

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below:

Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1911.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director	$34,860.00	.....	$34,860.00	$34,591.98	$268.02
Salaries, scientific assistants	29,900.00	.....	29,900.00	29,899.90	.10
Skilled laborers, etc	20,000.00	.....	20,000.00	19,988.64	11.36
Topographic surveys	350,000.00	$5,735.14	355,735.14	354,211.13	1,524.01
Geologic surveys	300,000.00	53,818.73	353,818.73	348,694.85	5,123.88
Mineral resources of Alaska	90,000.00	33,021.88	123,021.88	122,801.91	219.97
Chemical and physical researches	20,000.00	18.20	20,018.20	19,911.28	106.92
Preparation of illustrations	18,280.00	.....	18,280.00	18,250.67	29.33
Mineral resources of the United States	75,000.00	65.60	75,065.60	74,235.26	830.34
Gaging streams, etc	150,000.00	23,944.69	173,944.69	172,853.95	1,090.74
Books for the library	2,000.00	.....	2,000.00	991.29	1,008.71
Geologic maps of the United States	100,000.00	54,166.75	154,166.75	144,294.03	9,872.72
Surveying national forests	75,000.00	89.55	75,089.55	73,560.35	1,529.20
	1,265,040.00	170,860.54	1,435,900.54	1,414,285.24	21,615.30

The following table gives the classified net expenditures by the Survey for the fiscal year, the repayments shown in the preceding table having been deducted:

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1911.

Appropriation.	Total.	Salaries and wages.	Traveling expenses.	Subsistence.	Stable service.	Freight and expressage.	Telegraph and telephone service.	Printing and engraving.	Heat, light, and power.	Special and miscellaneous service.	Materials.	Stationery and photographic supplies.
Salaries, office of the Director	$34,591.98	$34,591.98										
Salaries, scientific assistants	29,899.90	29,899.90										
Skilled laborers, etc	19,988.64	19,988.64										
Topographic surveys	348,475.99	224,787.02	$19,741.32	$28,378.38	$10,823.05	$6,109.43	$578.46	$4,272.65	$22.66	$1,098.44	$1,851.44	$4,311.01
Geologic surveys	294,876.12	225,475.74	23,071.89	6,475.90	3,595.97	2,005.73	395.97	5,076.79	120.00	930.45	540.32	3,684.62
Mineral resources of Alaska	89,780.03	52,375.41	11,481.11	4,450.28	882.90	5,710.62	116.22	562.64	.....	198.75	303.01	966.34
Chemical and physical researches	19,893.08	17,493.47	16.35	16.85	.....	3.80	9.18	82.83	351.05	1.80	29.96	146.80
Preparation of illustrations	18,250.67	17,172.27	.....	.....	.....	4.50	14.46	826.63	.....	.....	18.27	107.04
Mineral resources of the United States	74,169.66	63,893.51	3,668.22	2,475.59	26.70	356.48	756.32	290.26	9.19	214.00	47.21	342.93
Gaging streams, etc	148,909.26	105,129.98	13,674.82	7,874.70	523.50	2,421.91	682.74	2,238.79	.....	775.12	2,186.53	1,568.53
Books for the library	991.29	.....	.....	.....	.....	17.37	.....	.....	.....	.....	.....	.....
Geologic maps of the United States	90,127.28	65,369.64	74.66	70.35	.....	94.72	58.10	2,146.46	966.70	64.68	2,070.75	14,470.52
Surveying national forests	73,470.80	43,570.94	4,514.97	3,887.85	3,403.16	1,807.44	42.06	188.20	.....	212.44	501.25	356.14
	1,243,424.70	899,748.50	76,243.34	53,629.90	19,255.28	18,532.00	2,653.51	15,685.25	1,469.60	3,495.68	7,548.74	25,953.98

Appropriation.	Fuel.	Mechanics' supplies.	Laboratory supplies.	Wearing apparel.	Forage.	Provisions.	Special and miscellaneous supplies.	Equipment.	Live stock.	Rents.	Losses.	Repairs and replacements.
Salaries, office of the Director	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Salaries, scientific assistants	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Skilled laborers, etc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Topographic surveys	$394.89	$23.75	$187.32	$106.25	$9,060.70	$13,094.15	$126.99	$7,610.70	$1,890.50	$11,214.67	.....	$2,792.21
Geologic surveys	181.93	24.19	427.93	107.60	2,060.71	3,068.88	48.32	10,656.71	3,377.50	2,404.96	.....	1,144.01
Mineral resources of Alaska	9.35	3.20	49.15	88.00	1,833.06	2,089.29	23.43	4,341.41	3,275.00	233.50	$415.00	372.36
Chemical and physical researches	.75	.63	1,061.30	.....	.....	.....	.....	412.88	.....	193.85	.....	71.58
Preparation of illustrations	.....	.....	.....	.....	.....	.....	.....	94.44	.....	.....	.....	13.06
Mineral resources of the United States	.....	.....	12.95	.....	1.70	7.50	23.28	1,288.62	.....	739.70	.....	15.50
Gaging streams, etc	45.40	12.55	100.88	205.85	242.45	189.83	65.71	2,436.45	.....	6,794.94	.....	1,738.58
Books for the library	.....	.....	.....	.....	.....	.....	.....	973.92	.....	.....	.....	.....
Geologic maps of the United States	2.40	213.13	717.30	10.20	.....	.....	7.92	3,199.97	.....	.....	.....	589.78
Surveying national forests	69.89	5.05	40.00	71.25	2,493.46	5,453.06	48.13	3,192.19	1,260.00	1,794.19	.....	559.13
	704.61	282.50	2,596.83	589.15	15,692.08	23,902.71	343.78	34,207.29	9,803.00	23,375.81	415.00	7,296.21

LIBRARY.

The library has received during the year, by purchase and exchange, 11,388 books and pamphlets and 875 maps, some of which are of temporary value only and will not be recorded as accessions to the permanent collection. The exchanges received during the year were notably valuable. A careful estimate shows that the library now contains 86,000 books, 100,000 pamphlets, and about 100,000 maps. Accessions are restricted as closely as possible to publications that consider subjects within the scope of the Survey's work and that will probably be of permanent value. Publications on other scientific subjects are transferred to the Library of Congress. Notwithstanding the efforts to confine the increase to the narrowest limits consistent with usefulness, the need of additional shelf room is now urgent.

The number of persons consulting the library during the year was 7,873, and 10,326 books and 521 maps were loaned for use outside.

Of the current receipts all material which is unquestionably of permanent value to the library is promptly recorded by full titles in the author and subject catalogues. Other material is recorded in briefer manner, classed, and shelved where it is available for use. During the year 5,812 volumes and 631 maps were catalogued.

Additions to the card catalogue during the year numbered 6,976. The Survey continues to furnish to the Library of Congress for printing on its cards the catalogue entries of geologic publications; of these entries 733 were supplied during the year.

The correspondence consisted of 4,528 letters received and 3,495 letters written and related largely to the exchange of publications. The demand for the publications of the survey is very active in the educational and scientific institutions throughout the world which have departments of geology or are interested in the subjects covered by the reports. The list of institutions to which full sets are distributed now numbers 355 in the United States and 582 in foreign countries, a total of 937. Publications that are of value to the library are received in exchange from most of the institutions on this list. The authorized distribution of the Survey publications from the office of the superintendent of documents, Government Printing Office, supplies public and school libraries and other institutions which have no exchange agreements with the Survey, and duplication of distribution is carefully avoided. To an additional list of 508 persons and institutions, domestic and foreign, selected publications are furnished in return for certain of their own publications supplied to the library. The gratuitous distribution of the topographic sheets to libraries is now practically up to the authorized number—500. The geologic folios are furnished to 375 libraries, in addition to the

depository libraries, which receive the folios from the superintendent of documents, Government Printing Office.

The bibliography of North American geology for 1909 was completed and issued as Bulletin 444. It contained 1,305 author entries, an increase of 90 over the volume for 1908. The bibliography for 1910, with 1,410 author entries, will be ready for the printer in July, and will be published as Bulletin 495. A part of the time of the assistant librarian has been devoted to the preparation of indexes and of data to be incorporated in Professional Paper 71 ("Index to the stratigraphy of North America").

The personnel of the library consisted of the librarian, the assistant librarian, 2 cataloguers, and 3 other persons.

A fire in the store directly under the Survey library on Sunday afternoon, July 31, 1910, greatly endangered the library. Fortunately no books were destroyed, but the bindings of 200 or more were seriously damaged.

INDEX.

V.

W.

○