DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

TWENTY-SIXTH ANNUAL REPORT

OF THE

DIRECTOR

OF THE

UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1904-5

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CONTENTS AND ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., August 21, 1905.

SIR: I have the honor to transmit herewith a report of the operations of the United States Geological Survey for the fiscal year 1904–5.

Thanking you for the active personal interest you have manifested in the work of the Survey, especially in the organization and operations of the Reclamation Service,

I am, with respect, your obedient servant,

Chas. D. Walcott,
Director.

Hon. E. A. HITCHCOCK,
Secretary of the Interior.

TWENTY-SIXTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

CHARLES D. WALCOTT, *Director*.

INTRODUCTION.

REMARKS ON THE WORK OF THE YEAR.

BRANCHES OF WORK.

The United States Geological Survey was created in 1879 for the purpose—as its name implies—of examining and reporting on the geologic structure and mineral resources and products of the national domain. To the adequate description of geologic formations and structure cartography is essential, and Congress early recognized this fact by making appropriations for the preparation of a geologic map of the United States. The topographic base map, in order to show with sufficient precision the relations of the geologic formations and the intricacies of the structure, must have a rather large scale and present considerable detail. No such map of this country existed in 1879, and its preparation was immediately begun. The waters of the country are of vast importance, and in a broad sense may be regarded as one of its greatest mineral resources. Hence, in the evolution of the work of the Survey, and especially in view of the great importance of the subject to the irrigation interests, Congress early began making appropriations for ascertaining the amount and quality of the surface and underground waters; and when, in 1902, the service for the reclamation of arid lands was organized, that work naturally was placed in the hands of the Secretary of the Interior and by him intrusted to the Director of the Survey.

The three great branches of work carried on by the Geological Survey are, therefore, the geologic, the topographic, and the hydrographic, and with these, more especially the latter, is conjoined the Reclamation Service; publication and administration constitute necessary auxiliary branches. Along these great lines the work of the Survey has progressed without essential variation for many years. The changes made have been due to normal expansion rather than to radical departure in object or plan.

STATE COOPERATION.

During the last fiscal year, State cooperation, as explained in previous reports, continued. Arrangements for cooperation in geologic work were made with five States, the total amount contributed by them being about $8,000, and arrangements for cooperative topographic surveys were made with eleven States, the amount available for such surveys being thus increased by more than $100,000.

RECLAMATION SERVICE.

The work of the Reclamation Service during the last fiscal year was advanced as rapidly as was thought consistent with thoroughness and accuracy. Actual construction is now in progress on eight projects, as follows: Salt River, Arizona; Truckee-Carson, Nevada; Hondo, New Mexico; Uncompahgre Valley, Colorado; Minidoka, Idaho; Belle Fourche, South Dakota; North Platte, Wyoming and Nebraska; and Shoshone, Wyoming. Proposals were received for work on the Laguna dam, Yuma project, California and Arizona; Huntley project, Montana, and the Fort Buford project, North Dakota and Montana. In several other States operations are at a point where advertisements for bids only await the removal of certain legal obstacles, the settlement of international difficulties, or the termination of delays on the part of local organizations or individuals.

The organization of the body of men constituting the personnel of the Reclamation Service, whose field of operations covers so large a territory, though necessarily difficult, has been satisfactorily accomplished, and precedents have been established along approved lines. The general allotment of funds has been made with a view to the greatest benefit to the greatest number, and from the broad standpoint of the welfare of the country as a whole.

One of the important features in the evolution of the irrigation work is the development of power, which the numerous dams and drops in canals make possible. Plans were made to transmit the power being developed in many sections of the arid regions, by means of electricity, to points more or less distant, there to be used for raising underground waters, pumping waters lying above the line of gravity canals, or for various other purposes, and attention was also given to the character of the soils and of the water to be used upon them, the materials used in the construction of the works, and numerous other details incident to reclamation by irrigation.

For more extended remarks on the work of the Reclamation Service see pages 249–299.

COAL-TESTING PLANT.

Under two special appropriations of $30,000 each, carried by the urgent deficiency bill approved February 18, 1904, and the general deficiency bill approved April 27, 1904, the Director of the Geological Survey was authorized to construct and operate at the Louisiana Purchase Exposition a plant for testing the coals and lignites of the United States, in order to determine their fuel values and the most economic method of their utilization for different purposes, it being provided that all testing machinery and all coals and lignites to be tested should be contributed free of charge to the Government. For carrying out the provisions of these acts the Director appointed a committee, consisting of Edward W. Parker, Joseph A. Holmes, and Marius R. Campbell, to direct the construction and operation of the plant. This committee received the heartiest cooperation from the manufacturers of such equipment as was needed for the installation of the plant, from the railroad companies in freight concessions and transportation for the experts and their assistants, and from the coal operators in the furnishing of coal in carload lots for testing purposes. Although the utmost expedition was used in the construction of the plant, it was not until the first of September that the testing work actually began. Between the first of September and the close of the exposition 65 carload samples of coal for testing purposes were received, and the results of the investigation were published in a preliminary report issued as Geological Survey Bulletin No. 261. The coals tested were received from 17 States and Territories, and much valuable information regarding the best uses to which the different coals may be put was obtained.

One of the most important facts developed during this investigation is the possibility of utilizing the vast lignite resources of the West in the manufacture of producer gas, it having been shown that a higher grade of this gas can be obtained from lignite than from ordinary bituminous and anthracite coal. The investigation also showed that the slack or fine coal produced at the dry, noncoking bituminous coal mines of the middle West, large quantities of which are now being wasted, can be profitably utilized by briquetting.

Detailed statements of the accomplishments of the various branches of the Survey are given in the following pages.

ORGANIZATION.

The following table exhibits the organization of the Survey at the close of the year:

Organization of the Geological Survey.

Branch.	Division.	Section.
Geologic	Geology and paleontology	Areal geology
		Physiographic and glacial geology.
		Pre-Cambrian and metamorphic geology.
		Petrology.
		Economic geology of metalliferous ores.
		Economic geology of nonmetalliferous minerals.
		Paleontology.
	Alaskan mineral resources.	
	Mining and mineral resources.	
	Chemical and physical researches.	Chemistry.
		Physics.
Topographic	Eastern topography, Western topography	Triangulation and computing.
		Inspection of surveying and mapping.
		Instruments and records.
	Geography.	
Hydrographic	Hydrography.	
	Hydrology	Eastern.
		Western.
	Hydro-economics.	
Publication	Editorial	Texts.
		Geologic maps.
		Topographic maps.
	Engraving and printing.	
Administrative	Executive	Correspondence, records, supplies, and shipments.
		Documents.
		Steam engineer, firemen, mechanics, and messenger, watch, and labor force.
	Disbursements and accounts.	
	Library.	
	Illustrations	Photography.
		Graphic illustrations.

NOTE.—Under authority of the Secretary of the Interior, the Director of the Geological Survey has charge of the work of the Reclamation Service.

OBITUARY.

Mention should here be made of the death, on June 29, 1905, of Mr. George H. Eldridge, who had been a prominent member of the Geological Survey for many years. An account of his life and work will be found on pages 300-303.

PLAN OF OPERATIONS.

The plan of operations for the fiscal year 1904–5 was laid before the Secretary of the Interior on May 17, 1904, and was approved by him on May 19, 1904. This detailed plan is on file in the Department. The work of the year, hereinafter reviewed, was executed in conformity with the plan submitted and approved.

APPROPRIATIONS.

There was appropriated for the work of the United States Geological Survey for the fiscal year 1904–5 the sum of $1,484,820. The acts making the appropriations set apart separate amounts for specific branches of work and for the salaries of persons connected with these branches. For convenience of reference these separate appropriations are here brought together and classified.

The legislative, executive, and judicial act contained the following item:

For rent		$31,400

The sundry civil act included the following items:

For salaries of Director, chief clerk, chief disbursing clerk, librarian, and photographer, together with clerks, messengers, watchmen, et al		32,740
For pay of skilled laborers, etc		20,000
For topographic surveys	$300,000	
For pay of 2 geographers and 2 topographers	9,200	
Total for topographic work		309,200
For geologic surveys	$175,000	
For pay of 4 geologists	13,700	
Total for geologic work		188,700
For paleontologic researches	$10,000	
For pay of 2 paleontologists	4,000	
Total for paleontologic work		14,000

For chemical and physical researches	$20,000	
For pay of 1 chemist	3,000	
Total for chemical work		$23,000
For gaging streams, etc		200,000
For preparation of illustrations		18,280
For preparation of report on mineral resources		50,000
For purchase of books for library		2,000
For engraving and printing maps		100,000
For survey of forest reserves		130,000

In the same act there was appropriated for engraving, printing, and binding publications of the Geological Survey $215,000, this sum to be disbursed not by the Geological Survey but by the Public Printer. The items are as follows:

For engraving illustrations for report of Director and for monographs, professional papers, bulletins, water-supply papers, and report on mineral resources	$65,000	
For printing and binding report of Director, monographs, professional papers, bulletins, water-supply papers, and report on mineral resources	150,000	
Total for printing and engraving reports		215,000

The deficiency bills approved February 18, 1904, and April 27, 1904, carried for the Geological Survey the following items:

For continuation of the investigation of the mineral resources of Alaska, to continue available until the close of the fiscal year 1905	80,000
For furnishing new addition to Geological Survey building, to continue available until the close of the fiscal year 1905	10,500
For testing of coals and other fuel substances at St. Louis, to continue available until expended	60,000
Grand total	1,484,820

The urgent deficiency bill approved January 5, 1905, made the following additional appropriation for the Geological Survey, but its use was not limited to the fiscal year ending June 30, 1905:

For testing of coals and other fuel substances at St. Louis	$25,000.00

The deficiency bill approved March 3, 1905, carried for the Geological Survey the following items:

For testing of structural materials of the United States	$5,000.00
For reimbursement to W. N. Brown, United States Geological Survey	62.30

ALLOTMENTS.

ALLOTMENTS TO GEOLOGIC WORK.

The total appropriation for geologic work for the fiscal year 1904–5 was $188,700, which was allotted as follows:

Allotments to geologic parties.

Party, etc.	Amount.
Executive office	$17,235.00
Purchase and repair of instruments	100.00
Ashley, G. H. (West Virginia)	4,025.00
Bain, H. F. (Mississippi Valley)	3,500.00
Bascom, F. (Pennsylvania, New Jersey)	650.00
Bassler, R. S. (New Jersey, Pennsylvania)	1,500.00
Bayley, W. S. (New Jersey, Pennsylvania, New York)	1,150.00
Becker, G. F. (supervision of division of chemistry and physics)	4,000.00
Boutwell, J. M. (Utah)	5,400.00
Butts, Charles (Alabama)	3,500.00
Campbell, M. R. (Pennsylvania, West Virginia, Ohio, Alabama)	8,400.00
Chamberlin, T. C. (United States in general)	7,500.00
Clark, W. B. (Maryland, Delaware, New Jersey)	1,000.00
Cross, Whitman (Colorado, and general scientific supervision)	9,840.00
Dale, T. N. (Vermont, West Virginia, Virginia, Maryland, Maine, New York)	2,700.00
Diller, J. S. (California)	4,100.00
Eckel, E. C. (United States in general)	3,000.00
Eldridge, G. H. (California, Florida.)	5,000.00
Emerson, B. K. (Massachusetts)	500.00
Emmons, S. F. (Colorado, and general scientific supervision)	6,000.00
Fenneman, N. M. (Louisiana, Texas, Colorado)	900.00
Fuller, M. L. (Michigan, eastern United States)	1,000.00
Gilbert, G. K. (California, and general scientific supervision)	4,700.00
Grant, U. S. (Wisconsin)	2,000.00
Hague, Arnold (Yellowstone National Park)	1,000.00
Hayes, C. W. (general administrative supervision)	6,000.00
Keith, Arthur (southern Appalachian region)	3,360.00
Kemp, J. F. (New York, Vermont)	150.00
La Forge, Laurence (Georgia)	2,000.00
Lindgren, Waldemar (Arizona, Colorado)	4,500.00
Newsom, J. F. (California)	350.00
Osborn, H. F. (monographs on Ceratopsia and Sauropoda)	2,500.00
Purdue, A. H. (Arkansas)	1,500.00
Ransome, F. L. (Colórado, Idaho)	6,030.00
Schrader, F. C. (Kansas)	3,550.00

Allotments to geologic parties—Continued.

Party, etc,	Amount.
Schuchert, Chas. (catalogue of Paleozoic fossils)	$100.00
Smith, G. O. (Maine, and scientific supervision in New England)	2,600.00
Smith, J. P. (monograph on the Triassic of North America)	500.00
Smith, W. S. T. (Kansas, Missouri)	585.00
Spencer, A. C. (New Jersey)	3,550.00
Spurr, J. E. (Colorado, Nevada)	8,550.00
Stanton, T. W. (general scientific supervision)	1,300.00
Stose, G. W. (West Virginia, Maryland, and editing geologic maps)	8,600.00
Taff, J. A. (Indian Territory)	4,340.00
Tarr, R. S. (New York)	1,000.00
Ulrich, E. O. (Northern Mississippi Valley, Indian Territory)	2,600.00
Van Hise, C. R. (Rocky Mountain and Lake Superior regions and general scientific supervision)	5,600.00
Walcott, C. D. (general scientific supervision)	1,500.00
Weed, W. H. (Montana, Appalachian region)	2,600.00
White, C. D. (United States in general)	3,000.00
Williams, H. S. (New York, and studies of Devonian paleontology and stratigraphy)	3,700.00
Willis, Bailey (general scientific supervision)	2,000.00
Contingent	7,125.00
Miscellaneous division for supplies	810.00
Total	188,700.00

ALLOTMENTS TO PALEONTOLOGIC WORK.

The total appropriation for paleontologic work for 1904–5 was $14,000, which was allotted as follows:

Allotments for paleontologic work.

Party, etc.	Amount.
Dall, William H	$4,360.00
Girty, G. H	2,175.00
Knowlton, F. H	2,500.00
Vaughan, T. W	2,500.00
Ward, Lester F	2,200.00
Contingent fund	215.00
Miscellaneous division for supplies	50.00
Total	14,000.00

CONTRIBUTIONS BY STATES FOR COOPERATIVE WORK IN GEOLOGY AND PALEONTOLOGY.

In addition to the sums appropriated for geology and paleontology ($188,700 and $14,000) there were available for the work of the division during the year the following sums appropriated by the various States for cooperation:

Appropriations by States for cooperative work in geology and paleontology.

State.	Amount.
Maine	$1,200.00
North Carolina	800.00
Pennsylvania	5,000.00
Maryland	1,000.00
Total	8,000.00

The conditions under which cooperation with the various States is undertaken have been fully explained in former reports.[a]

ALLOTMENTS TO TOPOGRAPHIC WORK.

The sum appropriated for topographic surveys was $300,000. Besides this general appropriation, certain stated salaries, aggregating $9,200, were appropriated for men engaged in topographic work, making the total appropriation for topography $309,200, which was allotted as follows:

Allotments to topographic work.

Section, etc.	Amount.
Eastern section	$179,600.00
Western section	79,300.00
Scientific salaries designated	9,200.00
Inspection of topography	4,400.00
Purchase and repair of instruments	10,250.00
Triangulation and computing section	1,400.00
Contingent expenses	25,050.00
Total	309,200.00

[a] See Twenty-second Ann. Rept. U. S. Geol. Survey, pt. 1, 1901, pp. 13-35.

ALLOTMENTS TO FORESTRY WORK.

The appropriation for the survey and investigation of forest reserves was $130,000, which was allotted as follows:

Allotments to forestry work.

Section, etc.	Amount.
Western section of topography	$94, 900. 00
Forest examination	20, 000. 00
Purchase and repair of instruments	3, 000. 00
Office and contingent expenses	12, 100. 00
Total	130, 000. 00

ALLOTMENTS TO HYDROGRAPHIC WORK.

For the gaging of streams, determination of the water supply of the United States, etc., there was appropriated the sum of $200,000, which was allotted as follows:

Allotments to hydrographic work.

Region, etc.	Amount.
Administration	$46, 000. 00
Arid and semiarid regions	50, 500. 00
Humid States	53, 500. 00
Eastern hydrology	15, 000. 00
Western hydrology	20, 000. 00
Hydro-economics	13, 000. 00
Contingent	2, 000. 00
Total	200, 000. 00

ALLOTMENTS TO ALASKAN WORK.

The appropriation of $80,000 for investigation of the mineral resources of Alaska was allotted as follows:

Allotments to work in Alaska.

Region, etc.	Amount.
Southeastern Alaska, geology—Fred E. Wright	$7,000.00
Kenai Peninsula, geology and topography—F. H. Moffit	9,800.00
Cook Inlet region, geology—G. C. Martin	7,500.00
Seward Peninsula, topography—T. G. Gerdine	14,600.00
Cape Lisburne and Seward Peninsula, geology—A. J. Collier	6,500.00
Yukon-Tanana region, topography—D. C. Witherspoon	11,300.00
Yukon-Tanana region, geology—L. M. Prindle	8,400.00
Paleontology, T. W. Stanton	1,700.00
Office of the Director	4,800.00
Administrative, A. H. Brooks	4,400.00
Clerical and stenographic work	2,040.00
Contingent	1,960.00
Total	80,000.00

MISCELLANEOUS ALLOTMENTS.

Chemistry and Physics.

The appropriation of $20,000 for chemical and physical researches was exclusive of the salary of the chief chemist, which was provided for in terms, and the entire amount was allotted for the pay of persons connected with the division and for the purchase of supplies, apparatus, etc.

Mineral Resources.

The appropriation of $50,000 for the preparation of the report on Mineral Resources was allotted to the gathering and compiling of statistical data for the calendar year 1904 and the preparation of the report thereon.

Engraving and Printing Maps, etc.

The appropriations for map engraving and printing, for the purchase of books and distribution of documents, for the preparation of illustrations, for the pay of skilled laborers, etc., and the special appropriations were all expended for the specific purposes named in the act.

WORK OF THE YEAR.

FIELD AND OFFICE WORK BY THE DIRECTOR.

During the fiscal year 1904–5 no field work was undertaken by the Director. He was obliged to spend most of the time in the office considering administrative matters, only a few days being available for research work.

GEOLOGIC BRANCH.

Division of Geology and Paleontology.

ADMINISTRATION.

The organization of the division of geology and paleontology remained essentially the same as described in the last annual report. The sections established for scientific supervision remain as enumerated in the last report, and are as follows: (1) Areal geology; (2) petrology; (3) paleontology; (4) economic geology of metalliferous ores; (5) economic geology of nonmetalliferous minerals; (6) physiographic and glacial geology; (7) pre-Cambrian and metamorphic geology.

An important function of the section chiefs is the examination and criticism of reports pertaining to their various fields of supervision. In order to give this criticism its highest value, section chiefs are instructed to keep in close touch with investigations during their progress in field and office, and, when necessary, to visit field parties. In the preparation of plans conferences are held with all the section chiefs, and in this way the various lines of work are kept in proper proportion.

Another division of supervisory responsibility has become necessary with the growing complexity of the work. Some of the men have developed capacity for handling large problems and for coordinating the work of others in such a manner as to give the results greater value than they would otherwise have. This capacity is now utilized, a certain amount of supervisory authority being given to others than section chiefs. Groups of parties, based on natural classification of the work, have been established. These are to a considerable extent determined by geographic location, although there is no intention to return to the strictly geographic subdivisions which prevailed up to 1893.

DETAILED STATEMENT OF GEOLOGIC AND PALEONTOLOGIC WORK.

WORK OF GEOLOGISTS IN CHARGE OF SECTIONS.

Section of areal geology.—Mr. Bailey Willis, geologist in charge, continued on leave of absence without pay for the greater part of the year. In his absence matters relating to areal geology were referred to various geologists, but chiefly to Mr. H. F. Bain, who continued in charge of the editing of geologic folio texts.

Section of physiographic and glacial geology.—Mr. G. K. Gilbert, geologist in charge, continued throughout the year to have general supervision of investigations coming under this section.

Section of pre-Cambrian and metamorphic geology.—Prof. C. R. Van Hise, geologist in charge, devoted considerable time to the work of this section, chiefly as a member of the special committee on the nomenclature and correlation of the geologic formations of the United States and Canada in the Lake Superior region. This committee, which consisted of C. R. Van Hise and C. K. Leith, of the United States Geological Survey; A. C. Lane, State geologist of Michigan; Robert Bell and Frank D. Adams, of the Canadian Geological Survey; and W. G. Miller, provincial geologist of Ontario, and was appointed by the general committee on the relations of the Canadian and United States geological surveys, spent six weeks in field work in the Marquette, Gogebic, Vermilion, Rainy Lake, Lake of the Woods, Animikie, and Original Huronian districts. The committee was augmented from time to time by other interested geologists, namely, C. W. Hayes, chairman of the general committee on relations between the two surveys, Prof. A. E. Seaman, and Messrs. J. U. Sebenius, W. N. Merriam, W. N. Smith, E. D. Ingall, and T. D. Denis. As a result of the committee's labors the following succession and nomenclature were recognized and adopted:[a]

Cambrian—Upper sandstone, etc., of Lake Superior.
- Unconformity.

Pre-Cambrian.
- Keweenawan (Nipigon).[b]
  - Unconformity.
- Huronian..
  - Upper (Animikie).
    - Unconformity.
  - Middle.
    - Unconformity.
  - Lower.
  - Unconformity.
- Keewatin.
  - Eruptive contact.
- Laurentian.

Section of petrology.—Mr. Whitman Cross, geologist in charge, devoted much time to the critical examination of manuscripts bearing upon petrologic matters. The petrographic reference collection was substantially increased during the year. In the care of this collection and in the preparation of the numerous reports on rock specimens submitted to the Survey Mr. Cross was assisted by Mr. Albert Johannsen.

The petrographic laboratory maintained its high record of efficiency. The work performed during the year consisted of 9,197 thin sections, 1,138 large or difficult sections, 1,642 saw cuts, and 86 surfaces polished. In June the laboratory was put in thorough repair and the facilities were somewhat enlarged.

Section of economic geology of metalliferous ores.—Mr. S. F. Emmons, geologist in charge, devoted the greater part of his time to the supervision of economic reports published during the year, embracing ten professional papers, four bulletins, and two geologic folios. Considerable time was also given to the preparation of the revised geologic maps of the Leadville, Colo., mining

[a] The report of the committee is published in full in Jour. Geol., vol. 13, pp. 89–104.

[b] Doctor Lane dissents as to the position of the Keweenawan as follows: "The use of pre-Cambrian above does not imply unanimity in the committee with regard to the pre-Cambrian correlation of the Keweenawan—a topic the committee as such did not investigate."

district, in which work Mr. Emmons was assisted from time to time by Prof. J. D. Irving, of Lehigh University.

The months of July, August, and September were spent in the mining regions of the West, chiefly in Colorado, Utah, Idaho, Oregon, California, Arizona, and New Mexico, in personal supervision of economic geologic work in progress and in determining the most favorable localities for beginning new work. During this journey Mr. Emmons attended the Mining Congress at Portland, Oreg., to which he was a delegate, and visited the Louisiana Purchase Exposition for the purpose of studying the remarkable collection of ores and minerals exhibited there.

In June, while on leave of absence without pay, Mr. Emmons attended the International Mining Congress at Liege, Belgium, to which he was a delegate from the United States.

Section of economic geology of nonmetalliferous minerals.—Mr. C. W. Hayes, in charge of this section, was so fully occupied with administrative duties as geologist in charge of geology that he was able to devote comparatively little time to the section. Considerable time was given to the annual bulletin, "Contributions to Economic Geology for 1904," which was prepared under the immediate supervision of Mr. Hayes.

Section of paleontology.—Mr. T. W. Stanton remained in charge of this section. In addition to administrative duties and the examination of collections of Mesozoic invertebrate fossils submitted for determination and report, Mr. Stanton spent several weeks in southwestern Alaska studying the stratigraphy and paleontology of the Mesozoic rocks of that region in connection with the party of Mr. George C. Martin engaged in an investigation of the coal and oil resources. The more important results of this work, a preliminary report of which has been published in the Bulletin of the Geological Society of America, are the recognition of the immense thickness of the conformable Middle and Upper Jurassic rocks, the determination of the statigraphic succession of the several distinct Mesozoic faunas, and the correlation of the results of previous reconnaissance work.

During the year the Upper Cretaceous section of eastern New Jersey was reviewed, in company with the State geologists of Maryland and New Jersey, and certain differences of interpretation which had arisen in the independent mapping of the area were adjusted. The month of June was spent in southeastern Colorado and adjacent parts of Oklahoma and New Mexico in a study of the relations of the fresh-water Morrison beds to the marine Comanche beds.

WORK OF GEOLOGIC AND PALEONTOLOGIC PARTIES.

Alden party.—Mr. W. C. Alden, under the direction of Prof. T. C. Chamberlin, continued work in quadrangles in southeastern Wisconsin, giving special attention to the glacial drift and associated phenomena, but also making studies of pre-Quaternary formations. The mapping of the areal geology of the Watertown, Oconomowoc, and Waukesha quadrangles was completed and that of the Hartford and West Bend quadrangles was begun. Office work included the final revision of two folios previously submitted, the preparation and submission of the manuscript for a bulletin on the drumlins of southeastern Wisconsin, the reading of the proof of Professional Paper No. 34, on the Delavan lobe of the Lake Michigan Glacier, and a short comparative study of the glacial drift series of eastern Iowa. The manuscript for the professional paper on the quartzite bowlder trains of the Waterloo, Wis., district, was also well advanced.

Ashley party.—Mr. George H. Ashley devoted the first part of the year to the completion of his report on the Cumberland Gap coal field of Kentucky and Tennessee, and then directed his attention to the investigation of the geology and economic resources of certain quadrangles in the central Appalachian region. Geologic surveys of the Houtzdale quadrangle, in Pennsylvania, and of the

Nicholas quadrangle, in West Virginia, were completed, and good progress was made in the preparation of the resulting maps and folio texts, and also in the preparation of the maps and text descriptive of the Curwensville quadrangle, Pennsylvania, which work was deferred until the completion of the survey of the adjoining Houtzdale quadrangle, in order to determine doubtful stratigraphic points. In addition, the areal and economic survey of the Kenova quadrangle, lying in Kentucky, Ohio, and West Virginia, was initiated and will be carried to completion during the coming fiscal year.

Mr. Ashley was assisted, in both the field and the office, by Messrs. W. C. Phalen, F. G. Clapp, and F. W. De Wolf.

During the absence of Mr. M. R. Campbell in connection with the investigations of the fuel resources of the United States Mr. Ashley performed the administrative duties connected with the cooperative surveys which are being made in Pennsylvania.

Atwood party.—Under the direction of Prof. R. D. Salisbury, Mr. W. W. Atwood spent several weeks of the field season in Utah, continuing his study of the glacial phenomena of the Uinta Mountains. Detailed mapping was done in the Gilbert Peak quadrangle and in the northwestern portion of the Ashley quadrangle. During the winter Mr. Atwood was engaged for only a portion of his time on work for the Survey, but good progress was made in the preparation of his report on the glaciation of the Uinta Mountains.

Bain party.—During the year Mr. H. Foster Bain continued his studies of the lead and zinc deposits of the Mississippi Valley, devoting special attention to the mines of Wisconsin, Iowa, and northwestern Illinois. In this work he had the cooperation of Prof. U. S. Grant and assistants, of the Wisconsin Geological and Natural History Survey, and of Messrs. E. O. Ulrich and E. E. Ellis, of the United States Geological Survey. A special study was also made of the copper deposits of Missouri, and, in conjunction with Mr. Ulrich, a bulletin discussing these deposits was prepared and submitted for publication. A brief general discussion of the lead and zinc deposits of the United States was also prepared and published in the annual economic bulletin of the Survey.

In April a study of the zinc deposits of southwestern Virginia and eastern Tennessee was made, in cooperation with Mr. Thomas L. Watson, State geologist of Virginia, and in May the areal and economic survey of the Lancaster quadrangle, in Wisconsin, was commenced, with the assistance of Messrs. E. F. Burchard and J. R. Bannister. The last month of the year was devoted to field work in southwestern Missouri, in a projected restudy, in cooperation with Mr. G. H. Girty, of the stratigraphy and paleontology of the Carboniferous rocks of that region.

Throughout the year Mr. Bain continued to perform the duties of editor of geologic folio texts, and also devoted considerable time to the work of various committees.

Bascom party.—Prof. Florence Bascom was engaged during the year in completing the areal mapping and descriptions of the pre-Paleozoic and Paleozoic formations of the four 15-minute quadrangles (Burlington, Lambertville, Bordentown, and Princeton) in New Jersey and Pennsylvania which are included in the Trenton folio.

During the spring Professor Bascom participated in a field conference with Messrs. George Otis Smith and Arthur Keith, of the Geological Survey, and Mr. E. B. Mathews, of the Maryland Geological Survey, for the purpose of determining the stratigraphic position of the Wissahickon mica-gneiss in the Coatesville, West Chester, and Norristown quadrangles of Pennsylvania, the result of which showed that detailed investigations in certain unmapped adjoining areas will be necessary before the stratigraphic limits of this formation can be satisfactorily defined. The publication of the Philadelphia Special folio will therefore be deferred until these investigations are completed.

Bassler party.—Mr. R. S. Bassler spent several weeks of the field season in an investigation of the stratigraphy and paleontology of the Ordovician limestones of the Lehigh Valley, Pennsylvania, in order to assist in determining certain doubtful stratigraphic points. He also devoted several weeks to stratigraphic and paleontologic work along the Mississippi River, from Hannibal, Mo., to Thebes, Ill., and in middle Tennessee and northern Alabama, in cooperation with Mr. E. O. Ulrich. In addition a study was made of the cement resources of the Valley of Virginia, a report on which was prepared and published in the annual economic bulletin.

Bayley party.—Prof. W. S. Bayley spent several weeks in revisionary work in the Highlands of New Jersey in clearing up certain doubtful points revealed by a study of the data gathered during the previous season in the Raritan quadrangle. For this purpose a careful examination was made of the western extension of the Highlands within the State of New Jersey, and the crystalline rocks in the region between the Raritan area and the Delaware River were surveyed. For a brief period Professor Bayley was assisted by Prof. F. B. Peck, who mapped in detail the interesting pre-Cambrian sedimentary beds near Phillipsburg.

In the office Professor Bayley devoted as much time as could be spared from his college duties at Waterville, Me., to microscopic studies of the thin sections of the crystalline rocks of the Raritan quadrangle, preparatory to the final detailed mapping of these rocks. As a result of this work it has been determined that the Highlands in the Raritan area comprise a series of highly metamorphosed pre-Cambrian sediments intruded by great masses of pyroxene rocks now changed to gneisses.

Boutwell party.—Mr. J. M. Boutwell devoted the field season to completing his study of the areal and economic geology of the Park City mining district, Utah, and to investigating various mineral deposits in that State. Upon the completion of field work in the Park City area reconnaissance work, for purposes of geologic correlation, was extended into the Wasatch Range; also to the mining camps of the Cottonwood region on the west and to areas on the north and south. A brief preliminary report on these investigations was prepared and published in the annual economic bulletin and the detailed report is in an advanced stage of preparation.

Mr. Boutwell was assisted by Mr. L. H. Woolsey. In addition to the assistance rendered Mr. Boutwell, Mr. Woolsey completed the manuscript for a bulletin on the economic resources of the Beaver quadrangle, Pennsylvania, the field work for which was done during the preceding season.

Before concluding his field work in Utah Mr. Boutwell visited the principal vanadium and radium properties in the southeastern part of the State, where a new mineral—a hydrous copper vanadate—and a new and highly arsenical variety of calcio-volborthite were found, and the occurrence of vanadium and uranium compounds was studied. Deposits of asphalt on the north shore of Great Salt Lake and various deep wells, drilled for oil or water, on the east and north shores of the lake were also visited. The results of these special studies have been published in Bulletin No. 210.

Butts party.—Mr. Charles Butts, acting under the supervision of Mr. M. R. Campbell, spent four months in the field in an areal and economic survey of the Brookwood quadrangle, Alabama, in which he was assisted by Mr. E. F. Burchard and, for a part of the time, by Mr. H. S. Gale. In the office he was occupied in the preparation of a preliminary report on the Warrior coal basin of Alabama, which was published in the annual economic bulletin, and in the completion of the maps and texts for the Ebensburg, Pa., geologic folio and for a bulletin on the economic geology of the Kittanning and Rural Valley quadrangles, Pennsylvania. Field work was resumed June 1, 1905, on the areal and economic survey of the Birmingham quadrangle, Alabama.

Campbell party.—Mr. M. R. Campbell, as a member of the committee to conduct coal tests at the Louisiana Purchase Exposition, provided for by act of Congress, devoted the summer to an inspection of the various coal fields of the United States. He personally visited mines in Alabama, Illinois, Missouri, Arkansas, Texas, New Mexico, Kansas, and North Dakota, and, through the reports of his assistants, Messrs. J. Shober Burrows, John W. Groves, and Frank W. De Wolf, became familiar with conditions in the other coal-producing States. The results of this work will be found in Bulletin No. 261, entitled "Preliminary Report of the Work of the United States Geological Survey Coal-Testing Plant at the Louisiana Purchase Exposition, St. Louis, 1904," and in Professional Paper No. 48, now in press, which comprises the final report.

Cooperative geologic work in Pennsylvania, conducted under Mr. Campbell's supervision, consisted of the survey of four 15-minute quadrangles and the completion of some areal work in quadrangles surveyed during the previous season. The Burgettstown quadrangle was surveyed with a great deal of care by Mr. W. T. Griswold, in a study of oil, gas, and coal problems of the region southwest of Pittsburg, made in connection with the topographic survey of the area. Although the geologic work is completed, the folio can not be published until the base map is engraved. The Amity and Rogersville quadrangles were surveyed by Mr. F. G. Clapp, assisted by Mr. Frank W. De Wolf, and the preparation of the resulting maps and texts is well advanced. The Houtzdale quadrangle was surveyed by Mr. George H. Ashley, assisted by Messrs. F. G. Clapp, W. C. Phalen, and F. W. De Wolf, and the preparation of the reports will be completed as soon as the base map is engraved.

Chamberlin party.—Prof. T. C. Chamberlin continued to direct and supervise the work of several parties working exclusively in Pleistocene geology, including those in charge of Messrs. Alden, Atwood, Leverett, Salisbury, and Taylor. He conducted field conferences on critical features of Pleistocene geology in Michigan with Messrs. Leverett and Taylor, and in Wisconsin with State Geologist Wiedman. He also held several office conferences at Chicago and Ann Arbor with the heads of the subordinate parties working under his immediate supervision. In both the field and the office he kept in close touch with the work of these parties and critically examined the resulting reports before transmitting them for publication.

Clark party.—Prof. W. B. Clark, assisted by Messrs. G. B. Shattuck, B. L. Miller, and A. Bibbins, continued geologic mapping in the Coastal Plain region. Field work included a reconnaissance survey of the Wilmington, Del., quadrangle and studies of the Pleistocene deposits of southern Maryland and adjacent portions of Virginia and of the deposits overlying the Potomac group, the latter representing a distinct formation, with a characteristic fauna and flora, which has hitherto been only partially recognized. In cooperation with the State of New Jersey a special study was also made of the Cretaceous and Tertiary formations of the area in New Jersey and Pennsylvania covered by the Philadelphia Special folio.

During the office season the manuscripts for the Dover (Del. and Md.) and the St. Mary and Patuxent (Md. and Va.) folios were completed and transmitted for publication.

Cross party.—Mr. Whitman Cross, assisted by Messrs. Ernest Howe and W. H. Emmons, continued detailed mapping in the San Juan Mountains of Colorado. During the field season the survey of the Ouray quadrangle was completed, a small amount of additional work was done in the Engineer Mountain quadrangle, and the newly established boundary between the Triassic and Permian formations was traced through the Rico and Durango quadrangles. A reconnaissance examination, designed to facilitate future detailed geologic work in the San Juan region, was also made by Mr. Albert Johannsen, in connection with the topographic party engaged in surveying the San Cristobal quadrangle.

In the office Mr. Cross's time was occupied with duties pertaining to the section of petrology, with problems connected with the correlation of the sedimentary formations in the San Juan Mountains with those of adjacent portions of Utah, Arizona, and New Mexico, and with matters relating to the publication of the Silverton, Needle Mountains, and Rico folios. Under his supervision the Ouray folio was prepared by Mr. Howe, assisted by Mr. Emmons, and submitted for publication.

The last month of the fiscal year was devoted to a reconnaissance from Mancos, Colo., to Moab, Utah, on the Grand River, about the La Sal Mountains, Utah, and across the Uncompahgre Plateau in Colorado, for the purpose of tracing several Mesozoic and Paleozoic formations from the western front of the Rocky Mountains into the plateau province of Utah, with a view to their correlation. In this reconnaissance Mr. Cross was assisted by Messrs. L. H. Woolsey, W. H. Emmons, and G. F. Kay.

Dale party.—Mr. T. Nelson Dale continued areal and economic surveys in Vermont, completing unfinished areas in Castleton, Whitehall, Ticonderoga, and Brandon quadrangles, and initiating work in the Middlebury and Port Henry quadrangles. A portion of the field season was also devoted to an inspection of the slate quarries at Northfield, Vt., and at Monson, Brownville, and North Blanchard, Me., for the purpose of obtaining data for the proposed bulletin on the slate resources and industry of the United States (Bulletin No. 275).

In the office Mr. Dale was chiefly occupied in the preparation of reports on the slates of Maine, Maryland, New York, Pennsylvania, Vermont, Virginia, and West Virginia, and in completing the illustrations and text for his proposed bulletin on Taconic physiography (Bulletin No. 272). He also completed the western portion of the geologic map for the Taconic folio.

Dall.—Mr. William H. Dall, assisted by Mr. Ralph Arnold, devoted his entire time throughout the year to office work, consisting of (1) the identification and classification of material submitted and the preparation of reports thereon for members of the Survey, various State officials, and private students, (2) original research, (3) proof reading, and (4) the preparation of manuscripts for publication.

Considerable time was spent in the classification of the Eocene material collected by Mr. T. Wayland Vaughan in Mississippi, Alabama, and northwestern Florida, the intention being, as soon as sufficient space is available in the National Museum, to establish two standard series of Tertiary fossils, one arranged biologically and showing the development of types from age to age, and the other arranged stratigraphically and showing the fauna of each special horizon. Cases, trays, tubes, labels, and other supplies required for the care of these collections were, as in former years, provided by the National Museum.

During the year proof was read of the volume on the Miocene of Maryland, prepared in cooperation with that State; of the paper on the fossils of the Bahamas, published by the Baltimore Geographic Society; and of the report on the land and fresh-water mollusks of Alaska, published by the Harriman Alaska expedition. The latter report is expected to serve as a manual for the study of the fauna of the fresh-water Pleistocene of the northern portion of the continent.

Although greatly retarded by routine office work, considerable progress was made in the study of the marine Tertiary fauna of the Pacific coast, which has hitherto been only imperfectly worked out.

A considerable portion of Mr. Arnold's time, both in the field and in the office, was devoted to studying the complex paleontologic data of the Santa Cruz quadrangle, California, in order to furnish a comprehensive key to the intricate stratigraphy of the area, a geologic folio of which is in preparation. Mr. Arnold also finished a paper on the species of *Pecten* in the Tertiary of the Pacific coast (Professional Paper No. 47), and spent some time in the selection and stratigraphic arrangement of Tertiary types for the proposed standard faunal collection.

Diller party.—Mr. J. S. Diller spent the greater part of the field season in completing the study of the stratigraphy of the Taylorsville region, in Plumas County, Cal., long noted for its Jurassic and Triassic fossils, and the opportunity which they afford for working out the detailed structure of a portion of the Sierra Nevada. The field work for this investigation, which was undertaken several years ago with the late Professor Hyatt, was completed, and during the office season good progress was made in the preparation of the resulting bulletin.

The reexamination of the igneous rocks of the Redding quadrangle, California, for the purpose of subdividing them on the geologic map of the area, was also completed, and the accumulated data were worked up and incorporated in the Redding folio, which was submitted for publication. In connection with this study a brief visit was made to the Klamath Mountains, in Trinity County, Cal., where a remarkably definite and important flora and fauna were found together in the same layers of the Knoxville beds, near Big Bar.

Eckel party.—Mr. E. C. Eckel spent the months of July, August, and a part of September in the office, engaged chiefly in administrative duties, in the absence of the geologist in charge. In October, accompanied by Mr. A. F. Crider, an examination was made of the clay resources of eastern Arkansas and of the brown iron ores of northeastern Texas, after which areal and economic work was resumed in Mississippi, with a view to the preparation of a bulletin on the geology and mineral resources of that State.

Field work was resumed in April, when an examination was made of the newly developed roofing-slate deposits of western Arkansas, followed by an economic study of the iron ores of Alleghany, Botetourt, Craig, Rockbridge, and Augusta counties, Va., these studies being in pursuance of the plan of the Survey to publish detailed reports on the slate and iron-ore deposits and industries of the United States.

Eldridge party.—Mr. George H. Eldridge devoted his time to work on the maps and detailed report of the oil fields of California. In addition, a brief visit was made by him to the phosphate fields of Florida for the purpose of acquiring information as to changes in conditions since the material was gathered for his detailed report, in course of preparation. Although Mr. Eldridge's work was greatly retarded by ill health, the report on the California oil fields, which involves a large amount of detail, was brought to an advanced stage, and he expected to have it ready for publication early next year. It is therefore with deep regret, personal, professional, and official, that Mr. Eldridge's death must here be recorded. It occurred June 29. A sketch of his life and work will be found on pages 300–303.

Emerson party.—During the year Prof. B. K. Emerson completed the folio map and text covering the geology of the eastern half of the Becket and Sandisfield quadrangles, Massachusetts, which form a part of the Housatonic folio. He also completed the map and text for a bulletin on the green schists and associated eruptive rocks of Rhode Island, which form the western border of the Narragansett coal basin. In addition, field and office work on the maps and texts for the Ware and Quinsigamond folios was greatly advanced, special facilities having been afforded by the extensive excavations made in the construction of the large reservoir at Clinton.

Fenneman party.—Mr. N. M. Fenneman devoted twelve weeks of the summer of 1904 to an investigation of the oil fields of the Texas-Louisiana Gulf coastal plain. Several days were spent in each of the producing fields, namely, Spindletop, Sour Lake, Batson, Saratoga, and Matagorda, in Texas, and Jennings, Welsh, and Anse la Butte, in Louisiana, and visits were made to most of the localities where prospecting for oil was actively in progress; also to three of the Salt Islands and to Sulphur mine, Louisiana, for the purpose of comparing their geology with that of the oil fields. In September a few days were spent in a general examination of the Florence, Colo., oil field and in a brief visit to the Boulder, Colo., field. During the winter the report on the Gulf coastal plain oil fields was completed and submitted for publication as a bulletin, and the results of the observations on the Florence field were incorporated in a brief report published in the annual economic bulletin (No.260).

Fuller party.—Mr. M. L. Fuller devoted only a small portion of his time to work for the division of geology. About a month was spent in the preparation of a report on the Pleistocene geology of Long Island, New York, and the southeast coast of New England, based on field work of the previous year. A few weeks were also given to studies of the Pleistocene deposits of Rhode Island and southeastern Massachusetts, in which Mr. F. G. Clapp was associated with Mr. Fuller. As a result of these studies a series of four glacial and three interglacial stages has been recognized. Several substages, marking periods of deposition, folding, or erosion, have also been differentiated, and the persistency of most of the drift sheets has been established, several being traced as far as the end of Cape Cod.

Gilbert party.—Mr. G. K. Gilbert spent the first six weeks of the fiscal year in the Sierra Nevada, California, continuing studies of glacial erosion and of the terrace system of the higher parts of the range. In this work he traversed the upper basins of the San Joaquin and King rivers.

In connection with a project submitted to the Carnegie Institution for the investigation of modern earth movements in the Great Lakes region, he made summer and winter visits to various points on the shores of lakes Huron, Michigan, and Superior. The method of the proposed investigation included the use of water-level gages, and the immediate inquiry concerned the selection of gage stations and the determination of the most advantageous season for observation by means of gages. In the same connection a study was made of automatic gage records in the archives of the United States Lake Survey at Detroit, Mich.

In April it was arranged that Mr. Gilbert cooperate with the division of hydrography in the investigation of problems arising from the relation of hydraulic mining in the Sierra Nevada to agriculture in the Sacramento Valley, a subject to which the attention of the Geological Survey had been directed by the President of the United States. He took the field the following month for the purpose of studying the regimen of the Sacramento and its branches with respect to the transportation of débris, and continued in this work to the end of the year.

Girty party.—Mr. George H. Girty spent a part of the field season in an examination of the typical Mississippian sections of Iowa, Illinois, and Missouri, and the remainder in a continuation of his investigation of the Bradfordian series of Pennsylvania. In the office his time was devoted to (1) the identification and preparation of reports on collections of fossils sent in by Survey geologists; (2) a comparative study of American and Chinese Carboniferous faunas, based upon collections from the latter country made by the Carnegie expedition; (3) a continuance, almost to completion, of his descriptive work on the Permian faunas of the Guadalupe Mountains, Texas, and (4) a continuance of his investigation and report on the Bradfordian fauna and its relation to the faunas of the Chemung and Waverly.

The last month of the fiscal year was spent in the field, in a study of the Boone formation, its practical subdivisions, and its relations to adjacent formations above and below, in connection with the economic investigations of the lead and zinc deposits of Joplin and adjacent districts.

Grant party.—Prof. U. S. Grant devoted the field season to an areal and economic survey of the Mineral Point quadrangle in Wisconsin and Illinois. In this work he cooperated with the Wisconsin Geological and Natural

History Survey, and was assisted for three months by Mr. A. F. Crider. During the office season the manuscript and maps for the Mineral Point folio were completed and submitted for publication. A brief paper on the lead and zinc deposits of Wisconsin was also prepared for the annual economic bulletin, and one on the water resources of the Mineral Point quadrangle for the division of hydrography. A significant result of the detailed mapping in this area was the establishment of the fact that many of the lead and zinc deposits lie in synclinal basins.

The month of June was spent in Alaska in a study of the copper deposits and general geology of Prince William Sound.

Hague.—Mr. Arnold Hague undertook no field work during the last fiscal year. During the greater part of the time he was occupied in the preparation of the first volume of the monograph on the geology of the Yellowstone National Park and in work connected with the atlas accompanying that monograph.

Keith party.—Mr. Arthur Keith spent about five months of the fiscal year in the field, engaged in completing and initiating areal and economic surveys in North Carolina, South Carolina, and Georgia. The areal and economic survey of the Pisgah quadrangle was completed, and the folio maps and text have been finished and submitted for publication. The geologic map of the Cowee quadrangle was adjusted to the new topographic base map which had been prepared, and similar revisionary work was done on the Nantahala and Mount Guyot folios. The economic survey of the Highland Forest district in North Carolina, in cooperation with the State Geological Survey, was begun by Mr. Keith, assisted by Mr. D. B. Sterrett, in April, 1905, and field work was continued by Mr. Sterrett to the end of the fiscal year.

During the field season special studies were made of a metamorphic conglomerate belt in the Mount Mitchell quadrangle, of some newly developed kaolin and corundum deposits in the Nantahala quadrangle, and of recently discovered copper deposits in the Cowee quadrangle. Preliminary work was also done in the gold-mining district of Dahlonega, Ga., and, in cooperation with other geologists, several trips were made into the Piedmont region of Maryland and Pennsylvania for the purpose of assisting in the solution of certain intricate structural problems.

Kemp party.—Prof. J. F. Kemp was engaged for only a small portion of his time on work for the division of geology and paleontology. The maps and manuscript for his portion (the crystalline rocks) of the Fort Ticonderoga folio, New York-Vermont, were, however, completed, and considerable work was done on the maps and text for the folio covering the Lake Placid, Ausable, Mount Marcy, and Elizabethtown quadrangles, in the heart of the Adirondacks.

Knowlton.—Mr. F. H. Knowlton devoted the entire year to office work. In addition to the examination and preparation of reports on the extensive collections of fossil plants submitted for identification, the text for a monograph on the fossil flora of the Puget and allied formations was completed and now awaits the preparation of the illustrations.

La Forge party.—Mr. Laurence La Forge spent three and a half months of the field season in completing the detailed areal and structural mapping of the Cartersville Special quadrangle, Georgia, and in readjusting the geologic maps of adjacent portions of the Cartersville 30-minute quadrangle to the new topographic base map.

Early in June Mr. La Forge entered upon a reconnaissance of portions of the Suwanee and Dalton quadrangles, Georgia, a necessary preliminary to a complete detailed survey, for folio publication, of the Ellijay quadrangle in that State. In this work he was assisted by Mr. Lawrence A. Kolbe.

Leith party.—Prof. C. K. Leith, acting under the supervision of Professor Van Hise, devoted most of his time to the completion of the manuscript for the new correlation bulletin on the Archean and Algonkian. With the assistance of Messrs. A. E. Seaman and W. N. Smith some additional field work necessary for the completion of the final monograph on the Lake Superior region was also accomplished, and the illustrations for that monograph were practically completed. A few weeks in the fall were spent in a preliminary examination of the iron ores at Hartville, Wyo., at several localities in northeastern Washington, and on Vancouver and Texada islands, tributary to the Port Townsend, Wash., furnace, in pursuance of the plan to prepare a detailed economic report on the iron ores of western United States.

Leverett party.—Mr. Frank Leverett devoted only a portion of his time to the work of the division of geology and paleontology, the remainder being given to hydrologic investigations for the division of hydrology. The maps and manuscript for the Ann Arbor, Mich., folio were completed and considerable additional work was done on the monograph of the glacial formations and associated lacustrine features of the southern peninsula of Michigan and northern Indiana, in connection with which a special study was made of drumlins and interglacial clays in Michigan. A brief investigation was made of the amount of glaciation in the Salineville, Ohio, quadrangle, as a contribution to the geologic folio of that area.

Lindgren party.—Mr. Waldemar Lindgren was, during nearly the entire year, engaged in office work, including the completion of his portion of the report on the Cripple Creek mining district, Colorado, prepared in conjunction with Mr. F. L. Ransome, and the completion of the Clifton, Ariz., folio. A few days were spent in the examination of certain gold and tin deposits in Georgia and the Carolinas, and some progress was made in the preparation of a report on the gold mines of Dahlonega, Ga.

Mr. L. C. Graton made a petrographic study of the rocks of the Cripple Creek district and spent several weeks in the field in the investigation of the Carolina tin belt.

Newsom party.—Prof. J. F. Newsom spent the field season in completing the areal and economic survey of the Santa Cruz quadrangle, California. During the office season as much time as could be spared from his duties at Stanford University was devoted to the preparation of the geologic folio of the Santa Cruz area, which was well advanced. Field work was resumed the latter part of May in the San Jose and Mount Hamilton quadrangles, California, the areal, structural, and stratigraphic geology of which will be mapped during the present summer.

Osborn party.—Prof. Henry Fairfield Osborn continued the preparation of the titanothere monograph, being assisted by Mr. W. K. Gregory. This monograph is now approaching completion.

Substantial progress was made on the Sauropoda monograph, which is in preparation by Professor Osborn, assisted by Messrs. W. K. Gregory and A. E. Anderson. The subject, however, is constantly being enlarged by discoveries and contributions of other authors, especially Messrs. Hatcher and Riggs, who have added two entirely new types of Sauropoda to the forms known to the late Professor Marsh.

Purdue party.—During the field season Prof. A. H. Purdue completed the areal and economic survey of the Winslow quadrangle, Arkansas, which was begun by Mr. George I. Adams in the summer of 1903. During the office season as much time as could be spared from university duties was devoted to the preparation of the resulting folio maps and texts, which were carried to an advanced stage and will be completed during the early fall.

Ransome party.—Early in June the geologic mapping of the Coeur d'Alene mining district, Idaho, and the study of the stratigraphy and structure of that region were resumed by Mr. F. C. Calkins, under the direction of

Mr. F. L. Ransome. In July Mr. Ransome joined the party, devoting his attention chiefly to the study of the deposits of lead-silver ore, which give to the district its chief importance and interest.

In the office Mr. Ransome's time was occupied in the preparation of the preliminary and detailed reports on the Cripple Creek mining district, Colorado, prepared jointly with Mr. Waldemar Lindgren, the preliminary report being published as Bulletin No. 254 and the detailed report to appear as a professional paper. Mr. Ransome also prepared a preliminary report on the Coeur d'Alene district for the annual economic bulletin.

Reid party.—Prof. Harry Fielding Reid continued his work as special expert in charge of earthquake data. During the year a careful record, in the form of a card catalogue arranged chronologically, was kept of all earthquakes occurring in the United States about which any information could be obtained, from the newspapers, the reports of the Weather Bureau and the Light-House Board, or by correspondence.

Salisbury party.—Prof. R. D. Salisbury was in the field only sufficient time to supervise the detailed investigations of the glacial phenomena of certain selected areas in Colorado, especially in the vicinity of Leadville and Telluride, which were being conducted by assistants. Later in the year he prepared the maps and texts descriptive of the Pleistocene geology of the Dayton and Cloud Peak folios, Wyoming, and made considerable progress on the maps and text of the Pleistocene geology of the eastern part of the area included in the Philadelphia Special folio, Pennsylvania.

Schrader party.—Mr. F. C. Schrader spent three months in the field, engaged in an areal and economic survey, for folio publication, of the Independence quadrangle, Kansas, and of portions of the adjoining Fredonia and Parsons quadrangles. In this work he was associated with Prof. Erasmus Haworth.

The office season was devoted to the preparation of a report, to be published as a bulletin, under joint authorship with Professor Haworth, on the economic geology of the Independence quadrangle, and to the completion of the maps and text for the Independence folio.

George Otis Smith party.—Throughout the year Mr. George Otis Smith exercised general supervision over geologic surveys in New England and the crystalline belt of New Jersey, including field conferences with geologists from time to time, for the purpose of assisting in the solution of complicated geologic problems and in the critical examination of referred manuscripts, to which a large amount of time was devoted. In connection with this work the critical study of the intricate geology of certain portions of the Taconic and Green Mountain ranges in western Massachusetts was resumed by Mr. Smith, both alone and in field conferences with geologists engaged in detailed work in that area.

Under Mr. Smith's supervision cooperative work with the State of Maine was continued, the areal mapping of the Penobscot Bay quadrangle being completed by Messrs. E. S. Bastin and C. W. Brown, and a preliminary study of the geology of the Rockland quadrangle being made by Mr. Bastin, with the view to detailed mapping during the next season.

In the office the Snoqualmie, Wash., folio, prepared under the joint authorship of Mr. Smith and Mr. F. C. Calkins, was completed, and considerable progress was made in the compilation of the map and field notes for the Penobscot Bay folio.

Early in June field work in Maine was resumed, the detailed areal mapping of the Rockland quadrangle being undertaken by Mr. Bastin, and that of the Mount Desert quadrangle by Mr. Brown.

James Perrin Smith party.—Prof. James Perrin Smith spent a portion of July in southeastern Idaho, engaged in a study of Triassic stratigraphy, which resulted in the finding of three distinct faunal horizons in the Lower Triassic. In the spring a large portion of the material collected in Idaho, much of which represented new genera and species, was classified and descriptions were prepared.

Field work was resumed early in June, the first half of the month being spent in making collections of Triassic fossils in the Humboldt Range of Nevada and the remainder in continuing the study of Triassic stratigraphy in southeastern Idaho.

W. S. Tangier Smith party.—During the first half of the fiscal year Mr. W. S. Tangier Smith was engaged in the preparation of the maps and text for the Joplin, Mo., folio, the manuscript for a special report on the lead and zinc deposits of the Joplin district, and a brief report on the water resources of the same region. During the latter half of the year Mr. Smith was on leave.

Spencer party.—Mr. Arthur C. Spencer devoted the field season to a special investigation of the zinc deposits at Stirling Hill and Franklin Furnace, Sussex County, N. J., and a reexamination of the pre-Cambrian rocks of the Franklin Furnace quadrangle, with a view to the completion of the geologic folio of that area. A full consideration of these important ore deposits and their genetic relations will follow another season of field work, during which Mr. Spencer will make a study of the magnetic iron ores of the Highlands of New Jersey and New York. Analogies in the mineralogy and occurrence of the zinc and iron ores render this comparative study desirable before conclusions which have been outlined concerning the origin of the zinc ores are published. In conjunction with this study an extended investigation of the minerals occurring at these noted localities will be made by Mr. Charles Palache, who has already completed the necessary annotated bibliography pertaining to the subject.

In the office much of Mr. Spencer's time was given to the completion of an extended report on the general and economic geology of the Juneau gold belt of Alaska, which is now ready for the press.

Spurr party.—Mr. J. E. Spurr directed the work of two field parties engaged in the mapping of the areal and oconomic geology of the mining regions of Clear Creek and Gilpin counties, Colo. The detailed study of the mines and ores and the mapping on a large scale of districts of special economic importance were carried on by Mr. Spurr, assisted by Messrs. G. H. Garrey and H. F. Clark; and the areal mapping of the region adjacent to the mining belt was in charge of Mr. S. H. Ball, assisted by Mr. Oscar H. Hershey. During the field season the areal mapping of the Georgetown quadrangle and of a portion of the Central City quadrangle was completed, also the study of the mines of the Georgetown quadrangle and of the Empire district in the Central City quadrangle.

Before the close of the field season Mr. Spurr spent several weeks in the Tonopah, Nev., mining district, for the purpose of obtaining information regarding the latest developments there.

In view of the rapid development of the mining districts of Nevada during the last year, and the consequent demand for information, the Survey has undertaken the preparation of a reconnaissance topographic map of the entire region, including the Bullfrog, Kawich, Tokop, Lida, and other districts, and of a special topographic map of the Goldfield district, the principal center of activity. Mr. S. H. Ball accompanies the topographic party for the purpose of making a geologic reconnaissance map of the region.

Stose party.—Mr. George W. Stose was chiefly occupied with the duties pertaining to the editing of geologic maps and associated lines of committee work. In the fall of 1904, however, two months were devoted to mapping the West Virginia portion of the Pawpaw and Hancock quadrangles, in association with Mr. G. C. Martin, who surveyed the Maryland portion. Some progress was also made in the preparation of the Mercersburg-Chambersburg folio (Pennsylvania), but inasmuch as a careful paleontologic study of the correlation of the Ordovician and Silurian formations in the area is being made by Messrs. Ulrich and Bassler, the completion of this folio was deferred.

Taff party.—Mr. J. A. Taff spent the first month of the field season in reviewing, in association with Mr. E. O. Ulrich, the geology of certain portions of the Tahlequah and Muscogee quadrangles in Indian Territory, with the result that paleontologic evidence was obtained which made possible a more accurate classification and correlation of formations that heretofore had yielded very meager faunas. This work was afterwards extended into the southern portions of the McAlester, Tuskahoma, and Windingstair quadrangles in the Ouachita Mountains.

Upon the conclusion of this review work Mr. Ulrich proceeded to other duties and Mr. Taff entered upon the areal survey of the Antlers quadrangle and the remaining part of the Sansbois quadrangle, in which he was assisted by Messrs. Carl D. Smith and Millard K. Shaler.

Tarr party.—Prof. R. S. Tarr devoted only a portion of his time to work for the Survey. He spent the field season in the Catatonk 30-minute quadrangle, New York, the survey of the Pleistocene geology and physiography of which was nearly completed. During the winter the maps and text of the Quaternary geology and physiography of the area included in the Watkins Glen folio were completed and submitted for publication, and some work was done in the preparation of the Catatonk folio.

Taylor party.—Mr. F. B. Taylor, under the direction of Professor Chamberlin, continued his studies of the old shore lines of the glacial lakes in southeastern Michigan, chiefly in the region of The Thumb and the Saginaw Valley.

The months of May and June were devoted to a study of the relations of the moraines to the Maumee beaches and the Imlay outlet and to an investigation of the Ohio and Pennsylvania extension of the Arkona beaches.

Ulrich party.—Mr. E. O. Ulrich spent the first half of July in reviewing, in company with Mr. N. H. Darton, the Paleozoic stratigraphy of the Bighorn Mountains, Wyoming.

In company with Prof. A. H. Purdue a brief review was then made of the rocks in the Winslow quadrangle, Arkansas, and in company with Mr. J. A. Taff similar studies were carried on in the Tahlequah and Muscogee quadrangles, Indian Territory.

The month of August was spent with Mr. Taff and party in stratigraphic and paleontologic studies in the Ouachita Mountains, Indian Territory, where certain intricate geologic problems were satisfactorily solved. A part of September was devoted to an investigation of the stratigraphy and structure of the Huntsville, Ala., region, with special reference to the occurrence of oil and gas. Several weeks were then given to a study, made in company with Mr. H. F. Bain and Prof. E. M. Shepard, of stratigraphic problems bearing on the occurrence and distribution of metallic deposits in the Ozark region of Missouri.

During the office season Mr. Ulrich was engaged (1) in the preparation of reports on the problems investigated in the field for geologists engaged in the detailed mapping of the districts visited; (2) in the careful revision of the manuscript and maps for the Fayetteville and Yellville, Ark., folios, to conform to the new stratigraphic and paleontologic evidence obtained by Mr. Ulrich during the last field season; and (3) in the identification and preparation of reports on Ordovician and Silurian fossils sent in by geologists of the Survey.

Early in June Mr. Ulrich entered upon field work in the Appalachian Valley for the purpose of working out certain complicated stratigraphic problems in that region.

Vaughan party.—Mr. T. Wayland Vaughan devoted most of the year to office work, consisting of the identification and preparation of reports on collections of fossils submitted, the continuance of work on his monograph on the later Tertiary corals of North America, and the study, for the United States Bureau of Fisheries, of the additional collections of recent corals obtained from the Hawaiian Islands during the year.

About the middle of May Mr. Vaughan entered upon field work in Texas, where he completed the survey of the Brackett quadrangle. Subsequently a visit was made to Forrest, Ark., for the purpose of making collections of fossils at Crowleys Ridge, St. Francis County, in order, if possible, to determine the geologic horizon of the beds there exposed.

Weed party.—Mr. Walter H. Weed devoted the major portion of his time to the preparation of the maps and manuscript for the report on the Butte, Mont., copper district. Owing to the great mass of material to be digested, the preparation of this report has consumed more time than was expected. In September a week was spent in a study of the recent developments in the Leonard mine, which threw new light upon certain complicated problems.

At intervals throughout the year, as required, Mr. Weed assisted in the preparation of the maps to accompany the Yellowstone Park monograph. In connection with this work considerable time was devoted to a general study of hot springs and hot-spring phenomena, and in December a visit was made to the warm springs of Georgia, for the purpose of determining, if possible, whether monthly gagings of the hot waters would throw any light on the genesis of the heat.

The investigation of the Appalachian copper deposits was also pursued at intervals throughout the year, visits being made to a number of localities in Virginia, New Jersey, Pennsylvania, North Carolina, Georgia, and Alabama.

White party.—Mr. David White spent several weeks in the field, engaged in the solution of special correlation problems in the Appalachian region.

Besides the study of the material personally acquired by Mr. White, many collections of fossils transmitted by various geologists of the Survey and of State surveys were during the year examined and reported upon, and proof of Professional Paper No. 35 was read.

Williams party.—Prof. H. S. Williams, assisted by Mr. Edward M. Kindle, devoted the field season to mapping the areal geology of the Catatonk 30-minute quadrangle, New York, which adjoins the Watkins Glen quadrangle on the east.

During the office season, with Mr. Kindle's assistance, the preparation of the maps and text covering the areal geology of the Catatonk folio was carried to an advanced stage. The illustrations for the proposed monograph on the Chapman fauna of Maine were also completed, and some progress was made on the text.

Division of Alaskan Mineral Resources.

INTRODUCTION.

An appropriation of $80,000 was made for the fiscal year 1904–5 for continuing the investigation of the mineral resources of Alaska. In accordance with the wording of the clause of the bill making this appropriation, the endeavor has been to make surveys which promised to be of immediate service to the mining interests rather than to enter upon minute studies which should have for their purpose the ultimate determination of the laws of occurrence of mineral deposits. This policy is furthermore justified by the fact that in but few instances have developments reached the stage making it possible to gather the detailed facts necessary for the exhaustive study of any given area. As a result much of the work has been of a preliminary character, but if this fact is specifically stated in the publication of results, intelligent mining men will not give undue weight to the conclusions presented. Though it is self-evident that final statements concerning the mineral wealth of a region must be based on a comprehensive knowledge of the geology, it is equally true that many of the data collected and even the tentative conclusions reached while the study of the geology is being carried on may be of very great value to the miner and prospector. If, however, the geologic studies do not progress beyond this preliminary stage, their value is soon lost, for the knowledge attained by the miner will soon be more complete than that of the geologist. It has, therefore, been the policy in the Alaskan work to supplement the exploratory and reconnaissance surveys by detailed examinations as fast as demanded by mining developments or permitted by the available funds.

The Alaska surveys were continued in charge of Mr. Alfred H. Brooks throughout the year. The field force included nine geologists, three topographers, six temporary assistants, and a larger number of camp hands. Besides these, Mr. T. W. Stanton, in charge of the section of paleontology, gave the whole of the field season and a part of the winter to Alaskan work.

WORK IN 1904.

SUMMARY OF FIELD INVESTIGATIONS.

Nine parties were dispatched to Alaska during the summer of 1904. Of these five were engaged in geologic investigations, two in topographic surveys, one was a combined geologic and topographic party, and one studied the methods and costs of placer mining. As several of the expeditions were subdivided after reaching the field, there were in all fourteen parties engaged in these surveys during most of the summer.

The geologic work included a reconnaissance of parts of southeastern Alaska, a study of the gold, coal, and oil fields of the Cook Inlet region, a continuation of the investigation of the Fairbanks and Rampart districts, a survey of the Cape Lisburne coal field, and a continuation of the work in Seward Peninsula. Topographic reconnaissance surveys (scale 1:250,000) were made of about 4,500 square miles in the Yukon-Tanana region and of about 1,500 square miles in the Cook Inlet placer district, and a detailed map (scale 1:45,000) was made of about 600 square miles near Nome. A special study of methods and costs of placer mining was made in the Juneau, Eagle, and Birch Creek regions and in Seward Peninsula, and an examination of some of the Canadian placer districts was made for comparative purposes.

INVESTIGATION OF COSTS AND METHODS OF PLACER MINING.

The remoteness of many points in Alaska from a base of supplies, the exceptional difficulties in travel, and the hardships of the winter climate combine to make the mining industry both costly and difficult. Because of many demands for information and of the general lack of exact knowledge regarding economical methods of mining, it was determined to make an investigation of the costs and methods of placer mining in the Territory in 1904. To increase the value of the data to be obtained, it was planned to make a comparative study of the neighboring Klondike field, in Yukon Territory, and Atlin, in British Columbia.

Mr. Chester Wells Purington was engaged to carry out this work. He was assisted by Mr. Sidney Paige. The party left Seattle the 26th of May, and arrived in Juneau the 30th of that month, where a stop of five days was made in order to visit all the accessible placers.

At Skagway an unavoidable delay was caused by soft ice in Lake Atlin, preventing the passage of steamers to the Atlin district. By June 11, however, the party reached that locality with the first steamer, and spent five days in visiting the more important creeks of the district. Much valuable information was obtained regarding the hydraulic operations.

From Atlin the party proceeded to Dawson, Yukon Territory, arriving on the 25th of July, where three weeks were employed in visiting all the important creeks of the famous camp, and studying the various methods employed in extracting gravel. Owing to the varied character of the operations and the universal courtesy, both of the Canadian officials and of the miners, numerous valuable comparative data were secured.

Eagle, 100 miles below Dawson, on Yukon River, was the first Alaskan camp to be visited. Three days in this vicinity were ample for visiting and studying all the work being carried on at the time, and on July 20 the party proceeded by steamer to Circle, where a pack train was engaged. Four days were spent in visiting the important creeks of the Birch Creek mining district. Another week was devoted to the creeks of the Fairbanks mining district. In cooperation with Mr. Prindle's party, much information was secured, and all the methods employed were carefully examined.

Nome, on Seward Peninsula, was reached August 20. The remainder of the season until September 24 was spent in visiting the more important creeks of the Nome and Council districts. In the vicinity of Nome, Anvil, Dexter, and Glacier creeks were studied in detail; in the vicinity of Council, Ophir, Crooked, and Warm creeks were given special attention. The party also visited a portion of the Casadepaga region and investigated the operations on Solomon River.

In addition to the information personally collected by the party, many data were obtained by the return to Washington of blank schedules sent out early in the season to all portions of the Territory, requesting information respecting individual claims. At the close of the season Mr. Purington also made a brief visit to Oroville, Cal., to study the methods of gold dredging in that district. Special efforts were made to obtain costs of mining, freight, transportation, and supplies at all the camps visited.

In the Atlin and Klondike districts exceptionally good roads were found. In Alaska, however, where natural conditions are essentially the same, but where money has not been spent on roads, the entire lack of adequate means of transportation was apparent. Much can be done to increase the output and lower the cost of mining in Alaska by the judicious building of good roads.

Mining of placer gold in Alaska is carried on, for the most part, during June, July, August, and September. Gold mining by drifting in winter is on the increase, but at present the winter product does not exceed 15 per cent of the total amount of gold extracted.

It was found that operations requiring the installation of expensive plants are frequently undertaken before adequate sampling of the ground has been done; that methods of mining and conveying the auriferous material, while often leaving much to be desired from the standpoint of economy, are in the main developing along favorable lines; and that the gold-washing and gold-saving appliances in use are in numerous cases inexcusably crude and inefficient.

The South Coast Province is characterized by heavy grades, abundant water supply, and good timber. Gold-bearing gravels are, however, distributed in small quantity, and however good the conditions for the installation of hydraulic plants, the province remains an unimportant producer of alluvial gold.

The Interior Province promises to continue to be an important producer for many years. Geographically considered, the phenomenal Canadian deposits of the Klondike come within this province. No gravels approaching the Klondike deposits in richness have been found on the American side of the international boundary, but a large area yet remains to be prospected.

The largest known auriferous gravel deposits in Alaska occur in Seward Peninsula, where greater rainfall and the comparatively low cost of ditch construction have led to the investment of much capital in long water conduits. It is not always evident that this procedure is the most economical method of exploitation.

SOUTHEASTERN ALASKA.

The field work in this part of Alaska for last season was arranged and carried out in harmony with the general plan to make a geologic map of the area and to prepare a report on its mineral resources. Further work in those parts of the archipelago which had already been studied in greater or less detail by Survey geologists was postponed, and those parts which had not yet been studied were visited and examined, the purpose being to collect accurate economic data from the entire region and to accomplish as much geologic mapping as possible.

Mr. Fred E. Wright, assisted by Mr. Charles W. Wright, was assigned to this field. Together they studied from May 19 to July 1 the geologic cross section from Taku Inlet to Sitka, the observations being confined chiefly to the shore exposures. During July Mr. F. E. Wright made a somewhat detailed investigation of the Sitka mining district, while Mr. C. W. Wright examined the coal and metalliferous deposits of Admiralty Island. August was devoted to the mapping of the shore exposures from Sitka to Wrangell and to Cleveland Peninsula. From August 26 to September 6, Mr. F. E. Wright ascended Stikine River as far as Tahltan River and studied the geologic section across the Coast Range, while Mr. C. W. Wright mapped the geology from Wrangell to Windham Bay, thus completing the map of the mainland strip from Skagway to the Ketchikan district. The last three weeks of September were devoted to an examination of some of the important copper and gold deposits of the Ketchikan district.

The facts of economic interest ascertained during the progress of this work may be summarized as follows: The coal deposits which have been prospected at several points on Admiralty Island and along the north end of Kuiu and Kupreanof islands do not appear to be of sufficient extent to become commercially valuable. The seams are narrow and irregular, and the coal itself is, in general, of poor quality. In the Sitka mining district gold is distributed in the slates and graywackes and occurs either in mineralized zones or in quartz ledges, often near or along the contacts of intrusives. None of the deposits, however, have yet been found to be of sufficient extent to demonstrate the possibility of developing large mines in this region. The Wrangell district contains no mines which are producing at the present time. On the mainland silver-lead veins having favorable surface indications have recently been discovered, and these may prove to be of value in the future. In the Ketchikan district several copper mines and gold properties are being exploited and may yield a moderate production in 1905.

Of the scientific facts observed the most important is perhaps the discovery of Mesozoic fossil-bearing strata on Admiralty Island, the first proof of the presence of rocks of this age in southeastern Alaska. The beds are exposed along the north shore of Pybus Bay and consist chiefly of folded and metamorphosed slates, graywackes and conglomerates. They rest unconformably on highly altered Carboniferous limestones, outcropping on the southeastern side of the bay. Northward similar beds have been found. It is possible that the graywacke belt of the Sitka district is equivalent to these beds, although no paleontologic evidence was obtained to support this conclusion.

The occurrence of coal beds on Admiralty Island containing Eocene plants and of similar coal beds on Kupreanof Island, assigned to the Upper Cretaceous, indicates a continuous period of deposition from Upper Cretaceous to Eocene, a condition which has also been observed in the Yukon district.

The coal seams which have been prospected at Murder Cove, on the south end of Admiralty Island, occur in basaltic tuffs and between lava flows, in a manner similar to that of certain coal beds of Yukon River. As no fossils were found in these seams, their stratigraphic position, whether Upper Cretaceous or Eocene, could not be definitely determined.

GOLD PLACERS OF THE KENAI PENINSULA.

The combined geologic and topographic party detailed for work on Kenai Peninsula was in charge of Mr. Fred H. Moffit, assistant geologist, with whom was associated Mr. E. G. Hamilton, assistant topographer. This party, including a total of seven members, sailed from Seattle May 22 and reached Seward, on Resurrection Bay, May 29. It was provided with ten pack animals and provisions for four months.

The principal object in view was to investigate and map the placer gold field adjacent to Turnagain Arm and on Kenai River, but it was further intended to extend the mapping over as much of the northern and western portions of the peninsula as time would permit.

Work was begun at Seward, the southern terminal of the Alaska Central Railroad, now building. Topographic mapping was carried on with the plane table on a scale of 1: 180,000 and a 200-foot contour interval. An attempt was also made to establish a system of triangulation to be carried to the north side of the peninsula, by which the mapping could be tied with previous or future work in the Sushitna River region or on the west side of Cook Inlet, but this work had to be given up later because of continued bad weather and consequent delay in reaching the more important field of work.

The party proceeded northward across the peninsula, stopping for a number of days in the vicinity of Lake Kenai, whose shores were mapped by boat, and finally reached the forks of Sixmile Creek, 10 miles south of Sunrise, about the 1st of July. Moving southward, the placers of Canyon Creek and Mills Creek were visited, after which the party crossed the divide between Canyon Creek Valley and the head of Resurrection Creek and descended this stream to Palmer and Bear creeks, the principal gold producers of this part of the field. From Hope it moved to Sunrise about August 1. Here a boat was secured and the streams flowing into the upper part of Turnagain Arm were visited. The only important gold producer north of Turnagain Arm is Crow Creek, tributary to Glacier Creek. Work in this part of the field was seriously interfered with by rainy weather, and the party did not reach Sunrise again until August 31. After a day of preparation, the pack train was again started southward and four days later reached the lower end of Lake Kenai. From this point Kenai River was followed to Lake Skilak, thence across the lowlands to Kenai, on Cook Inlet. This journey was difficult because, for the greater part of the distance, there are no trails and the marshy lands between Lake Skilak and Kenai are almost impassable for pack animals in summer. From Kenai Seldovia was reached by steamer, and the labors of the season were completed by ten days' work along the southern shore of Kachemak Bay.

The topographer mapped an area of about 1,600 square miles, of which 50 square miles are in the Kachemak Bay region.

The geologic reconnaissance was extended over the area mapped, special attention being given to the placer deposits. The placers on the streams are derived in part by the reconcentration of the gold in the high gravels, in part by decomposition of auriferous veins in the country rock, which has taken place since the deep gravels were deposited. Fewer men are now engaged in mining operations than during the first few years of exploitation, but the introduction of hydraulic mining machinery has made it possible to handle with profit some gravels which were not formerly worked, and it is probable that hydraulic methods will be still further extended.

OIL AND COAL FIELDS OF THE COOK INLET REGION.

Mr. G. C. Martin, assisted by Mr. R. W. Stone and accompanied by Mr. T. W. Stanton, made a reconnaissance of the Kachemak Bay region, the southern half of the shores of Cook Inlet, and the south coast of the Alaska Peninsula as far west as Cold Bay. The purpose was to study the stratigraphic sequence of the Mesozoic and Tertiary beds, to determine the possible extension of the known coal fields and of the areas within which there are indications of petroleum, and incidentally to gather topographic data.

This work was begun at Seldovia on May 30. After a brief study of the rocks exposed on the south shore of Kachemak Bay, the party went across to Homer, on the north shore of Kachemak Bay, where a study of the Kenai formation with its contained coal beds was begun.

This work was continued for three weeks by Mr. Stone, while the rest of the party left for Snug Harbor, on the west shore of Cook Inlet. The coast from Snug Harbor to the mouth of Cook Inlet was approximately mapped with a traverse plane table checked by a rough triangulation, and geologic boundaries for the region contiguous to the shore were placed upon the map thus made. From this point to Cold Bay the plane-table work was discontinued and the geology was sketched on the existing maps.

Several weeks were spent at Cold Bay in studying the stratigraphy with special reference to the possibility of there being deposits of petroleum of commercial importance. Messrs. Stanton and Stone went from Cold Bay to Chignik, where a few days were spent in study of the coal-bearing rocks, which are probably of Upper Cretaceous age. In the meanwhile Mr. Martin had gone to Unga to endeavor to determine the age of the ore deposits on that island. Messrs. Martin and Stone afterwards went to Controller Bay and spent about two weeks on a supplemental reconnaissance of the coal and petroleum fields there.

The salient geologic features of this region are as follows: In Alaska Peninsula a core of coarsely crystalline granitic rocks is flanked on the eastern side by Mesozoic sediments and on the western side by late Tertiary or post-Tertiary beds. The Mesozoic beds are in places overlain by early Tertiary formations. Both the Mesozoic and the Tertiary beds are cut by andesite and basalt. The intrusion and volcanic outflow has continued from late Jurassic time until the present, the region containing several active volcanoes.

The Cook Inlet and Alaska Peninsula region contains a very thick and well-exposed section of Mesozoic rocks, in which the Upper Triassic, Lower, Middle, and Upper Jurassic, and Upper Cretaceous are represented. The greatest development is in the Jurassic, which is here probably better represented, both stratigraphically and faunally, than in any other part of North America.

The economic side of the work involved a close study of the Kenai coals and an investigation of the structural conditions in the neighborhood of the oil wells which were being drilled at Oil City and near Cold Bay. Close watch was kept for facts which might point to an extension of the coal and oil fields or to the discovery of new ones.

The ore body of the Apollo Consolidated mine, on Unga Island, was described in 1898 by Becker, who concluded that the country rock is of Miocene age from its lithologic similarity to andesites which are supposed to overlie the Miocene at the north end of the island. He assigned the mineralization to late Tertiary or post-Tertiary age.

CONTROLLER BAY REGION.

The brief supplementary reconnaissance of the Controller Bay coal and oil fields established the following facts:

The rocks include a series of complex semimetamorphosed beds, a series of Eocene oil-bearing shales, a series of Oligocene coal measures, a series of Miocene conglomerates, sandstones, and shales, a few igneous rocks, and a large area of alluvial and glacial deposits.

Most of the important seepages occur along straight lines, each having a general northeast-southwest direction. These lines are nearly parallel to the strike in their vicinity and are undoubtedly influenced in position and direction by the structure. They probably represent the outcrops of oil-bearing strata. It seems probable that in this, as in most other fields, the occurrence of oil is controlled by the structure. The location of the anticlines and the structural position of the strata outcropping at the lines of seepages will probably prove to be the safest guide in the location of the wells.

Fifteen wells have been drilled or are drilling in this region. Of these, three were abandoned before reaching bed rock, four are still drilling, and one is now furnishing oil which is used as fuel at the other wells of the same company.

The coal area, which is now known to be at least 120 square miles in extent, is situated nearly within the valley of Bering River and on the northern tributaries of that stream. The southern or coastward boundary of the coal area coincides with the position of Bering River and Bering Lake. The western boundary probably lies along a north-south line extending through the north arm of Bering Lake.

In spite of such serious questions as those of local pockets, faults, and steep dips, there is little doubt that there are many seams which will prove to be workable over large areas, and several seams which will have average thicknesses of from 10 to 20 feet. The amount of coal even above drainage level is very great. The shipping problems are serious, but the amount and quality of the coal would seem to be sufficient to justify large initial expenditures.

TOPOGRAPHIC SURVEYS IN SEWARD PENINSULA.

The party organized for work in Seward Peninsula consisted of Thomas G. Gerdine, topographer in charge, with two field assistants and eight camp hands.

On June 12 the party landed at Nome, where three days were spent procuring supplies, erecting signals, and doing other necessary work preparatory to the actual surveys.

Surveys were begun on June 15 and were carried on continuously, except when prevented by bad weather, until September 30, when the party returned to Nome.

The results of the season's work were the completion of two maps, called the Nome Special and the Grand Central Special sheets. These two sheets embrace an area of about 600 square miles, lying between 64° 25′ and 64° 55′ north latitude and 165° and 165° 30′ west longitude. The field scale of the work was 1: 45,000, with contour interval of 25 feet, horizontal and vertical control for the same being dependent on determinations made by the United States Coast and Geodetic Survey in 1900. Within the limits of the sheets nineteen permanent bench marks were set, all referring to a common datum. In addition, numerous secondary bench marks were determined and marked along the line of levels.

CAPE LISBURNE COAL FIELDS.

Mr. Arthur J. Collier, assistant geologist, was detailed to spend a part of the season in a reconnaissance of the Cape Lisburne coal fields and to make supplementary observations on the developments of the gold placers and tin deposits of Seward Peninsula.

Accompanied by one assistant, Mr. Collier arrived at Nome July 4, and during the sixteen days following visited the mining camps at Lost River, Deering, and Kewalik, as well as several near Nome.

At Nome final preparations were made for the expedition to the Cape Lisburne region, which lies 200 miles north of Seward Peninsula and is accessible by sea only during July, August, and the early part of September. For this work a second field assistant and a boatman were employed, and the equipment consisted of a dory of the type used by the surfmen at Nome, a camping outfit, and provisions for six weeks.

The party arrived in the field July 22 and remained thirty-one days. Frequent and long-continued northeast gales interfered seriously with the work during this time, since the only means of moving camp was by dory along the coast. Geologic and topographic reconnaissance mapping was carried along the coast from Cape Beaufort to Cape Thompson, a distance of 140 miles, and inland for several miles.

On the 22d of August the party sailed from Point Hope on the United States revenue cutter *Thetis* for Cape Prince of Wales, where several stormy days were spent investigating the development of the tin deposits both there and at Lost River. The *Thetis* then brought the party to Seattle, stopping en route at Nome, St. Lawrence Island, Plover Bay, St. Matthew Island, and Unalaska.

The rocks of the Cape Lisburne region are all of sedimentary origin and are readily separated into a Paleozoic group, a Mesozoic group, and a Quaternary group. Calcareous sandstones and slates, having a total thickness of not less than 1,000 feet, comprise the oldest formation, which is probably of Devonian age. This is overlain conformably by a Mississippian series having a total thickness of not less than 4,500 feet, in which three formations can be differentiated as follows: (1) A lower formation consisting of slates, shales, limestones, and coal beds; (2) overlying the coal-bearing formation, black cherts, slates, shales, and cherty limestones containing bivalves and corals; (3) above these beds a great thickness of massive limestones composed largely of fossil corals. The Mesozoic rocks, which rest unconformably on the Mississippian, include two shale and sandstone formations, the lower of which is coal bearing and highly fossiliferous, while the upper does not contain either coal beds or fossils. On paleobotanic evidence the age of the coal-bearing member, which has been called the Corwin formation, is determined as Jurassic, while the upper formation, which is conformable with the Corwin, is regarded as probably Lower Cretaceous. The total thickness of the Corwin formation is approximately 15,000 feet, while that of the Upper Mesozoic formation is not less than 5,000 feet, making the total thickness of Mesozoic rocks not less than 20,000 feet.

Two coal-bearing formations, one of which is of Jurassic age and the other of Lower Carboniferous, were examined. The Jurassic Corwin formation contains over forty coal beds, aggregating about 150 feet of coal. At least ten of these beds are 4 feet or more in thickness and are of economic value. The coals of this formation are bituminous and of low grade, but considerably better than average lignites.

Owing to the complicated structure of the Carboniferous coal fields, it was impossible to determine the number of beds. At two localities, several miles apart, a coal bed over 40 inches thick was measured and several smaller beds were seen. The coal is a high grade of bituminous or semibituminous and seems to be remarkably free from impurities. These two occurrences are unique, since the Jurassic coal is the first of that age to be found in Alaska, and the Carboniferous coal is the only Paleozoic coal of economic value known in America west of the Rocky Mountains.

YUKON-TANANA COUNTRY.

Geologic work.—That part of Alaska which is bounded by Yukon and Tanana rivers and the international boundary, with an area of 40,000 square miles, contains four widely separated gold-placer regions, namely, Fortymile, Birch Creek, Fairbanks, and Rampart. Two of these, the Fortymile and Birch Creek regions, were studied in some detail during the field season of 1903, and a more hasty examination was made of the Fairbanks region.

Mr. L. M. Prindle was detailed in 1904 to continue the work of the previous year in the Yukon-Tanana country by making a geologic reconnaissance trip overland from Eagle by way of Fairbanks to Rampart, with the object of mapping, so far as possible, the formations in the little-known areas between Yukon and Tanana rivers and studying in detail the mining developments in the Fairbanks and Rampart gold-placer regions.

Mr. Prindle was assisted by Mr. Frank L. Hess, and his party included a packer, a cook, and 7 horses. The party left Eagle the 17th of June and on the 20th of September started from Rampart by steamer up the Yukon, reaching Seattle the 5th of October.

The time from the 17th of June to the 28th of July was spent in the area between Eagle, on Yukon River, and Fairbanks, 200 miles nearly west of Eagle, on the Tanana. After studying the recent developments in the Fairbanks region, the party spent the greater part of August in the area between Fairbanks and Rampart, 80 miles northwest of Fairbanks, on the Yukon, and the remainder of the season in the placers of the Rampart region.

Though the topographic map made in 1903 was available for the greater portion of the area from Eagle to Fairbanks, there was no map of the area northwest from the Fairbanks region to the vicinity of Rampart. Rough sketch maps were made of this area, based upon the estimation of distances by pacing, directions by pocket compass, and altitudes by aneroid barometer.

The schists which form the source of the placers of the Fortymile, Birch Creek, and Fairbanks regions were found to have a wide distribution to the south of the Fortymile basin and westward toward Fairbanks. Auriferous gravels were observed on streams which showed no evidence of having been prospected, indicating that there is here a large field worthy of attention. These investigations determined another important fact, namely, that even in small areas, where the geologic conditions are apparently uniform, the occurrence of gold in workable placers may be limited to but a few creeks. Therefore the schists of the Yukon-Tanana country are a favorable field for prospecting, but there is no reason for expecting a uniform distribution of the commercial placers.

Topographic work.—The topographic party organized for work in the Yukon-Tanana region consisted of Mr. D. C. Witherspoon, topographer in charge, one field assistant, and 6 camp men. The party sailed from Seattle on the 28th of May, with the necessary camp equipment, supplies, and 13 horses. Skagway was reached on June 1, where six days were spent waiting for navigation to open on the Yukon, and the party reached Eagle June 12. The interval between June 12 and 15 was spent in repacking outfits and supplies.

The actual surveys were begun at the western margin of the Fortymile quadrangle on June 22. The horizontal control was by a reconnaissance triangulation extended westward from points established by the Geological Survey in 1898 and 1903. The necessary triangulation stations were occupied by the topographer while carrying on the plane-table work. The plane-table surveys were made on a scale of 1:180,000, with contour interval of 200 feet. This work has been reduced to the platted positions of the triangulation points and will be published on a scale of 1:250,000. The vertical control was established by means of vertical angles supplemented by aneroid readings.

The area surveyed is bounded in a general way by Birch Creek, parallel 65° 41′ N., and Yukon River on the north; meridian 142° W. on the east; parallel 64° 40′ N. on the south; and meridian 146° W. on the west. This region includes a portion of the headwaters of Birch Creek, Fortymile, Seventymile, Salt Jacket, Chena, and Charley rivers, and comprises an area of 4,500 square miles.

During the operations the movement of the pack train carrying the main bulk of supplies was directed in a general westerly direction through the center of the field. From this base of supplies side trips were made to the north and south, Mr. Witherspoon covering the southern and his assistant the northern portion of the area.

The season, taken as a whole, was very unfavorable for topographic surveys. Of the eighty days spent in the field, twenty-one were fair; on twenty-two the work was to a great extent interrupted; and the remaining thirty-seven were rainy, foggy, or snowy to such an extent as to prevent all instrumental work.

On the 6th of September, after several days of freezing weather, it was found necessary to abandon further surveys and hasten to Fairbanks, the nearest point from which transportation could be secured. The cold, rainy weather had proved injurious to Mr. Witherspoon's health and it was with great difficulty that the latter part of the work and the return trip to Fairbanks were accomplished. At Fairbanks those pack animals which had not dropped by the wayside were disposed of at public auction. The camp equipment, etc., suitable for further use was packed for shipment, and the 19th of September the party, with the exception of three members who had decided to remain in Alaska, began its return trip to the States, reaching Seattle on October 19.

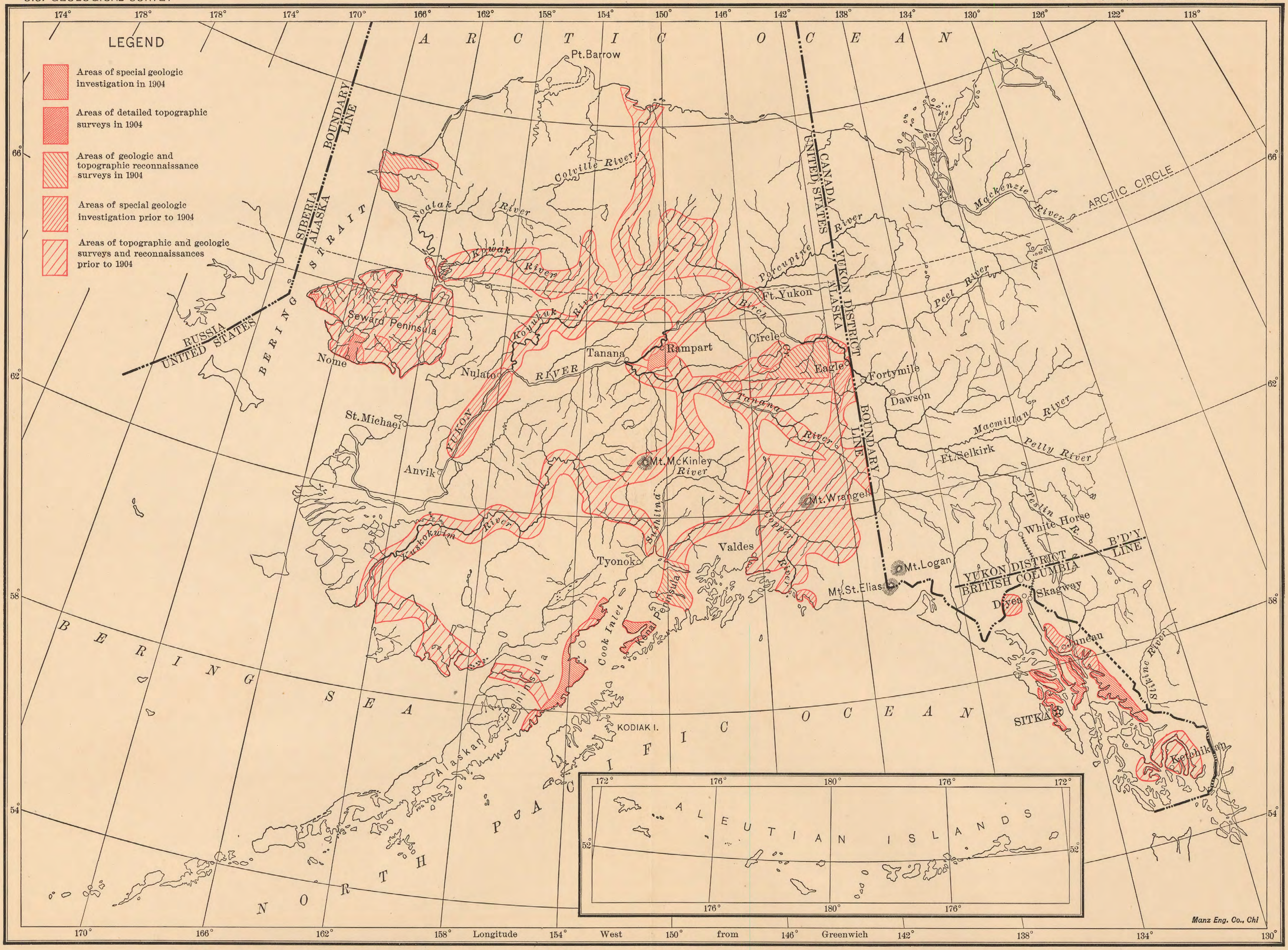
ADMINISTRATIVE AND OFFICE WORK.

Mr. Brooks's time was taken up largely with the administration of the division. He was detained in Washington by various matters until August, when he took the field. His route led him through southeastern Alaska and down the Yukon to Nome, and thence back to Seattle. He visited several parties, but the purpose of his journey was more especially to study the mining developments with a view of planning future work. The journey included about three weeks of field work in Seward Peninsula.

Besides the administrative and routine work, Mr. Brooks did considerable work on the compilation of a report on "The Geology and Geography of Alaska." The manuscript for this report was transmitted in July, but its publication was delayed because of shortage of funds for illustrations. It was sent to the printer recently, as Professional Paper No. 45.

Mr. Brooks also prepared a paper on "The pre-Cambrian Rocks of Alaska," to be incorporated in the "Pre-Cambrian Correlation Paper" in preparation by Messrs. Van Hise and Leith. An article was written for the International Geographic Congress, entitled "The Geography of Alaska, with a Sketch of the Geomorphology." In response to a demand for information relative to fuel in Alaska, an article was published in the Transactions of the American Institute of Mining Engineers entitled "The Outlook for Coal Mining in Alaska." A contribution was also made to the Progress Report (Bulletin No. 259), under the title of "Placer Mining in Alaska in 1904."

Mr. Brooks left Washington late in May, 1905, and proceeded direct to Controller Bay, where he spent about two weeks in the coal and oil fields in company with Mr.



MAP OF ALASKA, SHOWING PROGRESS OF TOPOGRAPHIC AND GEOLOGIC SURVEYS

Scale
100 0 100 200 300 400 miles

Martin. Later, with Mr. Fred E. Wright, he made a geologic reconnaissance of Portland Canal, in southeastern Alaska, which occupied him until about the first of July.

In the administrative work Mr. Brooks had the efficient aid of Mr. Gerdine, who supervised the topographic work of the division and prepared all the topographic field plans. Mr. Cleveland Abbe, jr., rendered invaluable services in the critical reading and revision of the manuscripts which were submitted for publication, and in the absence of the authors looked after the text and map proofs. In addition to this, he kept record of instruments and other property, and continued the cataloguing of the maps of the division, and during Mr. Brooks's absence in the field he had charge of the office force.

Mr. C. W. Purington proceeded to Washington at the close of the field season, prepared a preliminary report for the "Report on Progress of Investigations of Mineral Resources of Alaska" (Bulletin No. 259), and also completed his final report on "Methods and Costs of Gravel and Placer Mining in Alaska" (Bulletin No. 263).

Messrs. F. E. and C. W. Wright contributed a paper on "Economic Developments in Southeastern Alaska" to Bulletin No. 259. Mr. F. E. Wright described petrographically and arranged the rock collection from southeastern Alaska, preparatory to writing a general report on that region. A part of his time he also devoted to map work.

There was an unfortunate delay in the publication of the results of the investigations of the Juneau district, made by Mr. Arthur C. Spencer, assisted by Mr. C. W. Wright, in 1903. This delay, caused chiefly by Mr. Spencer's assignment to another field, made it possible to incorporate in his report a chapter on the geology and resources of Admiralty Island by Mr. C. W. Wright, based on the results of his field work in 1904. The completed report was submitted for publication soon after the close of the fiscal year.

There was a similar delay in the publication of a report on "The Geology of the Central Copper River Region" (Professional Paper No. 41), by Mr. Walter C. Mendenhall. The manuscript of this report was completed by Mr. Mendenhall early in July, 1904, and transmitted for publication. Later it was recalled because of shortage in funds for illustration, but it is now in press.

Mr. Moffit contributed to Bulletin No. 259 a paper on the "Gold Placers of Turnagain Arm, Cook Inlet," and also prepared a bulletin on "The Cook Inlet Gold Placers." His last year's work, entitled "The Fairhaven Gold Placers of Seward Peninsula, Alaska," is in press as Bulletin No. 247.

Mr. Martin completed a bulletin (No. 250) on "The Petroleum Fields of the Pacific Coast of Alaska and the Bering River Coal Field," and contributed several short abstracts to the Report on Progress (Bulletin No. 259). He has in preparation a paper on "The Geology of Alaska Peninsula."

Mr. R. W. Stone contributed to Bulletin No. 259 a paper on the "Coal Resources of Southwestern Alaska," and prepared a report on "The Kachemak Bay Coal Fields" to accompany Mr. Moffit's bulletin on "The Cook Inlet Gold Placers." He gave about two months of the year to the work of the division of geology.

Mr. Collier prepared a bulletin on "The Geology of the Cape Lisburne Coal Fields" and an abstract of the same for the Report on Progress (Bulletin No. 259). He also contributed to the latter bulletin short reports on "Recent Development of Alaskan Tin Deposits" and on "Auriferous Quartz Veins on Unalaska Island," and did considerable work on a report on the "Placer Mines of Seward Peninsula."

Mr. Prindle and Mr. Hess together prepared a preliminary report on "The Rampart Placer Region" for publication in Bulletin No. 259, and finished a more detailed report on the same field to appear as a bulletin. Mr. Prindle also completed a report on "The Gold Placers of the Fortymile, Birch Creek, and Fairbanks Regions," which is in press as Bulletin No. 251. Mr. Prindle during the year made a petrographic study of and a report on the specimens collected on the Mount McKinley expedition, and the results will appear in the report on that expedition now in preparation. Mr. Hess also collaborated with Mr. L. C. Graton in preparing an article entitled "The Occurrence and Distribution of Tin," which was published in Bulletin No. 260.

Besides the administrative work already mentioned, Mr. Gerdine completed the drawings of the Nome Special and the Grand Central maps, which were submitted for engraving. He also revised the reconnaissance map of the southern part of Seward Peninsula, of which a new edition is to be issued.

Mr. Witherspoon was continuously engaged in assembling the results of the surveys of the previous season in the Yukon-Tanana region. This work was completed before he took the field in June.

Mr. Hamilton completed the drawing of a reconnaissance map of the northern part of Kenai Peninsula, which was submitted as an illustration to Mr. Moffit's report. He also compiled various maps for different members of the division and began the drawings for several Alaskan sheets on a scale of 1:1,000,000.

SURVEYS IN 1905.

WORK IN SOUTHEASTERN ALASKA.

During the season of 1905 Mr. F. E. Wright, assisted by Mr. C. W. Wright, will conduct an investigation of the Ketchikan district preparatory to a report which will supplement that already published on this region. It is also proposed to spend as much time as is feasible in the Coast Range area in order to gain new facts bearing on its structure. During the first six weeks of the field season Mr. E. M. Kindle, accompanied by Mr. C. W. Wright, will study the fossil fauna and statigraphic relations in southeastern Alaska. Mr. Wright's party began work on May 15.

YAKUTAT BAY REGION.

Mr. R. S. Tarr, assisted by Mr. B. S. Butler, will make a reconnaissance of the Yakutat Bay region, which he reached on June 25. The purpose of this party will be to study the general geology and also to determine whether the coals reported to occur here are of the same horizon as those in the Controller Bay region.

CONTROLLER BAY COAL FIELD.

The important coal and petroleum deposits about Controller Bay have been found to justify much more detailed work than has been done there previously. During the field season of 1905 both topographic and geologic surveys are to be carried out under the direction of Mr. G. C. Martin, who began work May 22. The topographic map will be made by Mr. E. G. Hamilton, assisted by Mr. W. R. Hill, on a scale of 1:45,000, with 50-foot contours. It will cover an area of about 300 square miles, and its vertical control will rest on a series of primary levels.

The geologic survey, which will be performed by Mr. G. C. Martin, assisted by Mr. A. G. Maddren, will be made as detailed as the topographic base will permit. An attempt will be made to determine the areal geology, the outcrop of the more important coal seams, and the boundaries of the field.

Mr. Martin will also make a reconnaissance in the Matanuska coal field, north of Cook Inlet, for the purpose of determining its extent, thickness of coal seams, quality of the coal, and the commercial possibilities of the field.

PRINCE WILLIAM SOUND.

Mr. U. S. Grant, assisted by Mr. Sidney Paige, will make an investigation of the copper deposits of Prince William Sound, and, time permitting, will make detailed stratigraphic studies along the coast line. Mr. Paige will also make a reconnaissance survey of the Herendeen Bay coal field in the early part of the season. Mr. Paige began work on May 24, and joined Mr. Grant at Valdez in June.

SEWARD PENINSULA.

The region adjacent to Nome, which was topographically surveyed in 1904, will this year be the subject of detailed geologic surveys of Mr. F. H. Moffit, assisted by Mr. F. L. Hess. Special attention will be given to the high bench gravels, and an attempt will be made to determine the old topography which they represent. The solution of this problem may prove of great economic value. Mr. Hess will also devote some time to a supplementary study of the tin deposits near York. Mr. Moffit's party began work in June.

The topographic work in Seward Peninsula will again be in charge of Mr. T. G. Gerdine. It is planned to map the country lying between 164° and 164° 30′ west longitude and 64° and 65° north latitude. This work will be executed on a scale of 1:45,000, with 25-foot contours. In the course of the survey lines of primary level will be run and benches established throughout the area. The Gerdine party began work about the middle of June.

YUKON-TANANA REGION.

Surveys in the Yukon-Tanana region will be divided between two parties. One party, in charge of Mr. D. C. Witherspoon, will do both geologic and topographic work. Mr. Witherspoon, assisted by Mr. R. B. Oliver, will map the country between Circle and Fort Hamlin lying south of the Yukon Flats. The topographic map will be of a reconnaissance character for publication on a scale of 1:250,000, with 200-foot contours.

Mr. R. W. Stone will be attached to the Witherspoon party for geologic work. He will study and map the geology of the region traversed as far as circumstances will permit, paying especial attention to the occurrence of placer gold. Mr. Stone will also visit and investigate any new placers which may have been discovered on Beaver Creek.

The other party will be under the direction of Mr. L. M. Prindle, with an assistant. This party will proceed from Dawson westward to Fairbanks, on the Tanana, making a foot traverse and geologic-geographic reconnaissance of this heretofore unmapped country. Special attention will be given to the geology of the gold-producing districts, and before closing the season's work recent developments in the Fairbanks district will be studied.

The Witherspoon and Prindle parties sailed from Seattle June 2, going inland by way of Skagway and Lewes River.

PROPOSED EXPLORATIONS FOR RAILWAY ROUTES.

The full development of the resources of Alaska is dependent on the improvement of transportation facilities. There are known to be large areas of placer ground, workable lode deposits, and high-grade coal fields which can not be exploited until they are made accessible by railways and roads. That this fact has in a measure been recognized by Congress is indicated in the recent enactment of a road law which appropriates a certain percentage of the revenues received from licenses outside of incorporated towns for highway construction. Another measure bearing on the same subject was an appropriation for the survey of a wagon road from the coast at Valdez to Eagle, on the Yukon. Though the construction of wagon roads is of the utmost importance to the Territory, economical transportation for long distances can be achieved only through the construction of railways. This fact has been recognized by capitalists, and several corporations have been formed for the purpose of constructing railways from the coast inland, but with one exception the plans have not matured beyond the preliminary stage. Some attempt has been made to secure Government aid for the construction of railways in Alaska. It has been argued that the Government could well afford to foster commercial development of this field by insuring the bonds of the proposed railway, as it has in the case of the Philippine Island railways. Whether or not financial aid is a wise policy, certainly it appears that the Government could well afford to explore the routes of the proposed railways and by this means assure the selection of the best location, both for economical construction and for the best development of the resources.

The settled parts of Alaska fall naturally into four geographic provinces—the Pacific coast, Seward Peninsula, the Copper River and Cook Inlet region, and the Yukon basin. The whole of the Pacific coast is accessible to tide water throughout the year, and its numerous fine harbors give it cheap freight rates. In this province the construction of wagon roads and railways is not a serious problem, for the distances from tide water are not great. The coast of Seward Peninsula can be reached by ocean steamer from June to October, though the absence of harbors makes freight rates high. Several short railways have been built inland, following routes based on the maps of the Geological Survey, which has completed the survey of the entire peninsula. The extension of these railways, together with the construction of some wagon roads, will provide the necessary transportation facilities.

There remain, then, the two inland provinces, both difficult of access. To be sure, there are trails into the Copper River basin, but the present charges for transportation, which vary from 25 cents to a dollar a pound, are almost prohibitive to mining enterprises. In the Yukon basin the conditions are not much better. Though Yukon River with its tributaries forms a great artery of summer travel, but few of the placer districts are near navigable waters, and in winter the great interior region is almost entirely cut off from the outside world.

These two interior provinces could be opened up by the construction of a trunk line from some port on Pacific tide water to Yukon River. The choice of routes is limited on the east by the international boundary and on the west by Cook Inlet, and is furthermore confined to two general zones within this belt. The first zone embraces the Copper River Valley and the passes which connect it with Port Valdez, a part of Prince William Sound; the second, the broad depression at the head of

Cook Inlet. As the upper half of Cook Inlet is ice bound during winter, a port would have to be chosen on the east coast of Kenai Peninsula.

There are known to be at least three routes feasible for a railway at and near where Copper River breaks through the Coast Range barrier, but these all converge about 100 miles inland, whence the route would follow the Copper for 150 miles to the base of the Alaska Range. These mountains can be traversed either along the Delta River Valley or through Mentasta Pass. In either case Tanana River will be reached, and thence there are many routes, the best one depending on the terminal point on the Yukon which is selected.

The second zone of practicable railway routes lies in the Cook Inlet and Sushitna River region; and Resurrection Bay, on the east side of Kenai Peninsula, probably affords the best coastal terminal. Here some 20 miles of railway have already been constructed. The natural route thence stretches northward over a low divide and, skirting the eastern and northern shore of Turnagain Arm, will reach the lowlands at the mouth of the Sushitna Valley. From here on there are two principal routes inland. The one ascends the Matanuska Valley and enters the Copper River basin, where it will merge with the routes previously described, while the other follows the main Sushitna Valley, traverses the Alaska Range through the broad gap known as Caribou Pass, and emerges in the Tanana Valley near where Cantwell River leaves the mountains. By this route the railway would reach navigable waters on the Tanana, about 50 miles below the town of Fairbanks, and there would thence be a choice of routes to the Yukon.

There is a third possible route into the interior, which, however, does not commend itself either from the standpoint of economical construction or from its utility in opening up known resources. This leaves the coast at some embayment on the west side of Cook Inlet and, skirting the shore of the inlet for a hundred miles, turns northwest and traverses the Alaska Range through one of the low passes near the head of Skwentna River, thus reaching the Kuskokwim Valley. Thence there would be a choice of routes to the Yukon, but a direct one to the mouth of the Tanana would probably be preferable.

Another route which has been proposed leaves tide water from one of the harbors on the west coast of Cook Inlet, passes north of Lake Iliamna, and, after traversing the Kuskokwim, reaches the Yukon about 100 miles above the head of the delta. This route, though the most direct to Seward Peninsula, would be of little use in developing the Yukon-Tanana gold fields.

Though the routes outlined are, without question, the only feasible railway routes into the interior of Alaska, they admit of almost infinite minor variation. As the proper location of a railway is highly important, it will be economical to study the field exhaustively before the final choice is made. There is no quicker or more economical method of making this inquiry than by carrying on surveys and investigations of mineral resources such as the Geological Survey has been doing. Such surveys have already been made of the Copper River basin, where it will be possible to make the preliminary location of a railway from the existing contoured maps. As the location must be determined not only by the topography but also by the distribution of the mineral resources, the investigation of the latter becomes one of the governing factors in railway location.

It appears, therefore, that railway-construction enterprises can best be served by reconnaissance surveys of the entire area which would be tributary to any of the routes chosen. That this is a legitimate function of the Government there can be no doubt, for it accords with the policy established long ago when a transcontinental route was sought. It is equally clear that this exploration falls within the field already occupied by the Geological Survey. These proposed explorations, if they are to serve the public, must be begun at once, and as the present appropriation for the investigation of Alaska's mineral resources is hardly adequate for necessary work in the producing mining districts, a special appropriation should be made for this purpose. The areas to be surveyed embrace about 50,000 square miles, and the field work can be accomplished in two seasons. The estimated cost is about $200,000—not large, considering the important results which will be attained.

Division of Mining and Mineral Resources.

The principal work of this division is the preparation of the annual report on the mineral resources of the United States, although considerable time is devoted to answering technical inquiries. During the year the report on the mineral resources for 1903 was issued, and considerable progress was made on the report for 1904. In addition to the usual work of the division, Congress directed by act approved March 3, 1905, that it should take up "the investigation of methods of extraction of the mineral values of the black sands of the placer mines of the United States," upon which work the division is now engaged.

In addition to the regular agents and field assistants who aided in the work, Mr. David T. Day, geologist in charge, was assisted by Mr. Edward W. Parker and Mr. Jefferson Middleton, statisticians, and a number of statistical experts.

In 1904, for the fifth time, the total value of our mineral production exceeded the enormous sum of $1,000,000,000.

The exact figures for 1904 were $1,289,045,586, as compared with $1,419,280,617 in 1903, with $1,260,501,898 in 1902, with $1,086,550,871 in 1901, and with $1,063,678,053 in 1900; a loss in 1904 from 1903 of $130,235,031, or 9.17 per cent; a gain in 1904 over 1902 of $28,543,688, or 2.26 per cent; a gain in 1904 over 1901 of $202,494,715, or 18.64 per cent, and a gain in 1904 over 1900 of $225,367,533, or 21.19 per cent.

As heretofore, iron and coal are the most important of our mineral products. The value of the iron in 1904 was $233,025,000; the value of the coal, $444,816,288. The fuels decreased from $634,226,291 in 1903 to $584,483,514 in 1904, a loss of $49,742,777, or 7.84 per cent. Anthracite coal showed a decrease in value of $13,062,428 from $152,036,448 in 1903 to $138,974,020 in 1904. The average price of anthracite coal per long ton at the mine was $2.35, as against $2.50 in 1903, $2.35 in 1902, $2.05 in 1901, $1.85 in 1900, and $1.80 in 1899; and the average price per short ton for bituminous coal at the mine was $1.10, as compared with $1.24 in 1903 and with $1.12 in 1902. The decrease in value of the bituminous coal output from 1903 was $45,845,665, a combined decrease in value of coal of $58,908,093 in 1904.

The loss of $130,235,031 in the total value of our mineral production is due to losses in both metallic and nonmetallic products, the metallic products showing a decrease from $624,318,008 in 1903 to $541,465,236 in 1904, a loss of $82,852,772, and the nonmetallic products showing a decrease from $793,962,609 in 1903 to $747,180,350 in 1904, a loss of $46,782,259. To these products should be added estimated unspecified products, including molybdenum, bismuth, tungsten, and other mineral products, valued at $400,000 (as against $1,000,000 of unspecified products in 1903), making the total mineral production for 1904 $1,289,045,586.

The manufacture of arsenious oxide, noted for the first time in the United States in the report for 1901, was continued in 1904, but again in decreased proportions as compared with 1902 and 1903.

Statistics of the production of sand for molding, building, engines, and furnace use, and for other purposes, were collected for the first time in 1904.

Included in the volume for 1904 is a brief report calling attention to peat in the United States and to its possibilities as a source of fuel.

Tin was produced commercially, though in small quantities, in South Carolina, South Dakota, and Alaska, and the mines were actively exploited during the year 1904.

METALS.

Iron and steel.—Twenty States produced pig iron in 1904, as against 22 in 1903, 22 in 1902, 20 in 1901, and 21 in 1900 and 1899. The total production of pig iron in 1904 was 16,497,033 long tons, as against 18,009,252 long tons in 1903, 17,821,307 tons in 1902, 15,878,354 tons in 1901, 13,789,242 tons in 1900, 13,620,703 tons in 1899, 11,773,934 tons in 1898, and 9,652,680 tons in 1897. The production of 1904 shows a decrease in quantity of 1,512,219 long tons, or over 8 per cent from the production of 1903, and a decrease in value from $344,350,000 to $233,025,000, amounting to $111,325,000, or over 32 per cent. The average price per long ton of pig iron decreased from $19.12 in 1903 to $14.13 in 1904. The average prices per long ton in recent years have been as follows: 1902, $20.92; 1901, $15.25; 1900, $18.85; 1899, $18; 1897, $9.85; 1896, $10.47; 1895, $11.14; 1894, $9.75.

Iron ores.—The production of iron ores in 1904 amounted to 27,644,330 long tons, as compared with 35,019,308 long tons in 1903 and with 35,554,135 long tons in 1902, a loss in 1904 from 1903 of 7,374,978 long tons. The value at the mines of the ore mined in 1904 was $43,186,741, a loss as compared with the 1903 value, $66,328,415, of $23,141,674. As in the five preceding years, the production of iron ores in the United States in 1904 has never been equaled by that of any other country.

Manganese ores.—The production of manganese ores decreased from 11,995 long tons, valued at $116,722, in 1901, to 7,477 long tons, valued at $60,911, in 1902, and to 2,825 long tons, valued at $25,335, in 1903, and increased in quantity to 3,146 long tons, valued at $29,466, in 1904. The average price per ton in 1904 was $9.37, as compared with $8.97 in 1903, with $8.15 in 1902, with $9.73 in 1901, and with $8.52 in 1900.

Gold.—The production of gold in 1904, as reported to the Survey, amounted to 3,910,729 fine ounces, as compared with 3,560,000 fine ounces in 1903, with 3,870,000 fine ounces in 1902, with 3,805,500 fine ounces in 1901, with 3,829,897 fine ounces in 1900, and with 3,437,210 fine ounces in 1899. The value was $80,835,648, as compared with $73,591,700 in 1903, with $80,000,000 in 1902, with $78,666,700 in 1901, with $79,171,000 in 1900, and with $71,053,400 in 1899.

Silver.—The coining value of the silver produced in 1904 was $72,402,224, as compared with $70,206,060 in 1903, with $71,757,575 in 1902, with $71,387,800 in 1901, and with $74,533,495 in 1900. The production in 1904 was 55,999,864 fine ounces, as compared with 54,300,000 fine ounces in 1903, with 55,500,000 fine ounces in 1902, with 55,214,000 fine ounces in 1901, and with 57,647,000 fine ounces in 1900. The commercial value of the production in 1904 was $32,035,378, as compared with $29,322,000 in 1903, with $29,415,000 in 1902, with $33,128,400 in 1901, and with $35,741,140 in 1900.

Copper.—The production of domestic copper increased from 698,044,517 pounds in 1903 to 812,537,267 pounds in 1904, an increase of 114,492,750 pounds, or about 16 per cent, in quantity, and it increased in value from $91,506,006 in 1903 to $105,629,845 in 1904, an increase of $14,123,839, or about 15 per cent.

Lead.—The production of lead increased to 307,000 short tons in 1904 from 282,000 short tons in 1903. It was 270,000 short tons in 1902, 270,700 short tons in 1901, and 270,824 short tons in 1900. The value of the production in 1904 was $26,402,000, as compared with $23,520,000 in 1903, with $22,140,000 in 1902, with $23,280,200 in 1901, and with $23,561,688 in 1900.

Zinc.—The production of zinc in 1904 showed an increase in quantity as compared with 1903, 1902, and 1901, the production being 186,702 short tons, as compared with 159,219 short tons in 1903, with 156,927 short tons in 1902, with 140,822 short tons in 1901, and with 123,886 short tons in 1900. The value of the zinc production in 1904 was $18,670,200, as compared with $16,717,995 in 1903, with $14,625,596 in 1902, with $11,265,760 in 1901, and with $10,654,196 in 1900.

Aluminum.—The production of aluminum during 1904 was 8,600,000 pounds, valued at $2,477,000, as compared with 7,500,000 pounds, valued at $2,284,900, in 1903; with 7,300,000 pounds, valued at $2,284,590, in 1902; with 7,150,000 pounds, valued at $2,238,000, in 1901, and with 7,150,000 pounds, valued at $1,920,000, in 1900.

Quicksilver.—The production of quicksilver during 1904 amounted to 34,570 flasks (of 76½ avoirdupois pounds net, 75 pounds net after June, 1904), as compared with 35,620 flasks in 1903, with 34,291 flasks in 1902, with 29,727 flasks in 1901, and with 28,317 flasks in 1900. The value of the quicksilver produced in 1904 was $1,503,795, as compared with $1,544,934 in 1903, with $1,467,848 in 1902, with $1,382,305 in 1901, and with $1,302,586 in 1900. California, including Nevada, reported 29,234 flasks, as compared with 30,591 flasks in 1903, with 28,972 flasks in 1902, and with 26,720 flasks in 1901; and Texas reported 5,336 flasks, as against 5,029 flasks in 1903, 5,319 flasks in 1902, and 2,932 flasks in 1901.

Nickel.—The production of metallic nickel reported in 1904 was 24,000 pounds, as against a production of 114,200 pounds in 1903, of 5,748 pounds in 1902, of 6,700 pounds in 1901, of 9,715 pounds in 1900, and of 22,541 pounds in 1899. The value in 1904 was $11,400, as against $45,900 in 1903, $2,701 in 1902, $3,551 in 1901, $3,886 in 1900, and $8,566 in 1899. The imports of nickel in 1904 were valued at $1,121,491, as compared with $1,493,889 in 1903, with $1,437,649 in 1902, with $1,849,620 in 1901, and with $1,183,884 in 1900.

Platinum.—The production of platinum from domestic ores in 1904 was 200 ounces, valued at $2,600, as compared with 110 ounces, valued at $2,080 (not including $6,000 worth of platinum reported as contained in slimes obtained from the treatment of copper ores from the Rambler mine, Wyoming), produced in 1903; with 94 ounces, valued at $1,814, in 1902; with 1,408 ounces, valued at $27,526, in 1901; with 400 ounces, valued at $2,500, in 1900, and with 300 ounces, valued at $1,800, in 1899.

Antimony.—The total quantity of antimony obtained from all sources in 1904 was 3,057 short tons, valued at $505,524, as compared with a total production for 1903 of 3,128 short tons, valued at $548,433. No antimony was obtained from domestic ores during 1903. The antimony obtained from the smelting of foreign imported ores in 1904 amounted to 486 short tons, valued at $61,926, and the antimony obtained from hard lead produced from foreign and domestic lead ores was 2,571 short tons, valued at $443,598, a total production for 1904 of 3,057 short tons, valued at $505,524, as compared with 3,128 short tons, valued at $548,433, in 1903, with 3,561 short tons, valued at $634,506, in 1902, and with 2,639 short tons, valued at $539,902, in 1901.

Bismuth.—The marketed production of bismuth ore in 1904 was 5,184 pounds, valued at $314. There was no marketed production of bismuth ores in the United States during 1903 or 1902. The marketed output in 1901 was 318.6 short tons. The ore contained gold and silver, for which the producers were paid. As nearly as can be ascertained, the value of the output in 1901 was $80 per ton, not including charges for transportation or treatment. The price of the refined metal is kept so low by the combination controlling the business that profitable mining of domestic ores is practically out of the question.

Tin.—There was no production of metallic tin in 1904; but about 159 short tons of concentrates were shipped from South Carolina, South Dakota, and Alaska to England, as against 20 short tons of concentrates shipped from South Carolina in 1903; value not given either in 1903 or in 1904.

FUELS.

Coal.—For the third time in the history of the United States the production of coal in 1904 reached a total of over 300,000,000 short tons, showing an actual output of 352,310,427 tons of 2,000 pounds, valued at $444,816,288. Of this total the output of anthracite coal amounted to

65,318,490 long tons (equivalent to 73,156,709 short tons), which, as compared with the production of 66,613,454 long tons in 1903, was a decrease of 1,294,964 long tons, or almost 2 per cent. The value of anthracite coal at the mines in 1904 was $138,974,020, as against $152,036,448 in 1903, $76,173,586 in 1902, and $112,504,020 in 1901. The average value of the marketed coal sold during the year at the mines was $2.35 per long ton, the value in 1903 having been $2.50, in 1902, $2.35, and in 1901, $2.05.

The output of bituminous coal (which includes semi-anthracite and all semibituminous and lignite coals) amounted in 1904 to 279,153,718 short tons, valued at $305,842,268, as compared with 282,749,348 short tons, valued at $351,687,933, in 1903, with 260,216,844 short tons, valued at $290,858,483, in 1902, and with 225,828,149 short tons, valued at $236,422,049, in 1901. The decrease in the production of bituminous coal in 1904 from 1903 was therefore 3,595,630 short tons in quantity and $45,845,665 in value. The average price per ton at the mines during 1904 was $1.10, as against $1.24 per ton in 1903, the highest price recorded by the Survey.

Coke.—The coke production of the United States in 1904, which included the output from 2,610 retort or by-product ovens, amounted to 23,621,520 short tons, as compared with 25,274,281 short tons in 1903, with 25,401,730 short tons in 1902, with 21,795,883 short tons in 1901, and with 20,533,348 short tons in 1900. The decrease in quantity in 1904 from 1903 was 1,652,761 short tons, or about 6.5 per cent. The total value was $46,026,183, a loss from the 1903 value, $66,498,664, of $20,472,481. It should be borne in mind that the value for 1903 was in part the abnormal result of the coal strike in 1902.

Gas, coke, tar, and ammonia.—The aggregate value of all the products obtained from the distillation of coal in gas works and retort ovens in 1904 was $51,157,736, as compared with $47,830,600 in 1903 and with $43,842,895 in 1902.

Petroleum.—The total production of crude petroleum in the United States in 1904 was 117,063,421 barrels, as against 100,461,337 barrels in 1903, 88,766,916 barrels in 1902, and 69,389,194 barrels in 1901, an increase of 16,602,084 barrels, or 16.53 per cent, over the production of 1903, and of 31.88 per cent over that of 1902. The increase in 1904 came from California, Kansas and Indian Territory and Oklahoma, Texas, Indiana, Louisiana, and Kentucky and Tennessee, in the order named. In round numbers, the gains in 1904 over 1903 were as follows: California, 5,300,000 barrels; Kansas and Indian Territory and Oklahoma, 4,500,000 barrels; Texas, 4,300,000 barrels; Indiana, 2,200,000 barrels; Louisiana, 2,000,000 barrels; Kentucky and Tennessee, 500,000 barrels. The largest decrease in production in 1904, as compared with 1903, was in Ohio, which showed a decrease of about 1,600,000 barrels, Pennsylvania and New York 280,000 barrels, and West Virginia 260,000 barrels. It will be observed that the greatest gains were in the South and West and in the Lima-Indiana field, and that, relatively, the Appalachian field lost heavily. The value of crude petroleum produced during 1904 was $101,170,466, or 86.42 cents per barrel, as against $94,694,050, or 94.26 cents per barrel, in 1903, and $71,178,910, or 80.19 cents per barrel, in 1902.

Natural gas.—The value of the natural gas produced in 1904 was $38,496,760, as compared with $35,807,860 in 1903, with $30,867,863 in 1902, with $27,066,077 in 1901, with $23,698,674 in 1900, and with $20,074,873 in 1899—a gain of 7.51 per cent in 1904 over 1903.

STRUCTURAL MATERIALS.

Stone.—The value of all kinds of stone produced in the United States during 1904 amounted to $74,200,361, as compared with $72,945,908 in 1903, with $69,830,351 in 1902, with $60,275,762 in 1901, with $48,008,739 in 1900, and with $48,785,875 in 1899.

Clay products.—The activity in all branches of the clay-working industries noted in the reports as true of 1899, 1900, 1901, 1902, and 1903 diminished very slightly during 1904. The value of all clay products, as reported to this office, in 1904 was $131,023,248, as against $131,062,421 in 1903, $122,169,531 in 1902, $110,211,587 in 1901, and $96,212,345 in 1900. The brick and tile products in 1904 were valued at $105,864,978, as against $105,626,369 in 1903, $98,042,078 in 1902, $87,747,727 in 1901, and $76,413,775 in 1900. The pottery products were valued in 1904 at $25,158,270, as against $25,436,052 in 1903, $24,127,453 in 1902, $22,463,860 in 1901, and $19,798,570 in 1900.

The commercial production of clay mined and sold by those not manufacturing the product themselves in 1904 was valued at $2,320,162, as compared with $2,594,042 in 1903, with $2,061,072 in 1902, with $2,576,932 in 1901, and with $1,840,377 in 1900. The crude brick clay was valued at $13,000,000.

Cement.—The total production of hydraulic cement in the United States in 1904 was 31,675,257 barrels, valued at $26,031,920, as compared with 29,899,140 barrels, valued at $31,931,341, in 1903; with 25,753,504 barrels, valued at $25,366,380, in 1902; with 20,068,737 barrels, valued at $15,786,789, in 1901, and with 17,231,150 barrels, valued at $13,283,581, in 1900. The Portland cement production in 1904 was 26,505,881 barrels, valued at $23,355,119, as compared with 22,342,973 barrels, valued at $27,713,319, in 1903; with 17,230,644 barrels, valued at $20,864,078, in 1902; with 12,711,225 barrels, valued at $12,532,360, in 1901, and with 8,482,020 barrels, valued at $9,280,525, in 1900—an increase in quantity in 1904 as compared with 1903 of 4,162,908 barrels, and a decrease in value of $4,358,200. The production of natural-rock cement in 1904 was 4,866,331 barrels, valued at $2,450,150, as compared with 7,030,271 barrels, valued at $3,675,520, in 1903; with 8,044,305 barrels, valued at $4,076,630, in 1902; with 7,084,823 barrels, valued at $3,056,278, in 1901, and with 8,383,519 barrels, valued at $3,728,848, in 1900—a decrease in quantity in 1904 of 2,163,940 barrels, and in value of $1,225,370. The production of slag cement in 1904 amounted to 303,045 barrels, valued at $226,651, as against 525,896 barrels, valued at $542,502, in 1903.

ABRASIVE MATERIALS.

Carborundum.—The production of carborundum in 1904 was 7,060,380 pounds, as compared with 4,759,890 pounds in 1903, with 3,741,500 pounds in 1902, and with 3,838,175 pounds in 1901. The value of the carborundum varies from 8 to 10 cents a pound.

Corundum and emery.—The combined production of corundum and emery in 1904 amounted to 1,932 short tons, valued at $57,235, as against 2,542 short tons, valued at $64,102, in 1903; 4,251 short tons, valued at $104,605, in 1902, and 4,305 short tons, valued at $146,040, in 1901.

Crushed steel.—The production of crushed steel in 1904 was 790,000 pounds, as against 755,000 pounds in 1903, 735,000 pounds in 1902, and 690,000 pounds in 1901.

Crystalline quartz.—In 1904 the production of crystalline quartz included under abrasives amounted to 31,924 short tons, valued at $74,600, as against 8,938 short tons, valued at $76,908, in 1903; 15,104 short tons, valued at $84,335, in 1902, and 14,050 short tons, valued at $41,500, in 1901.

Garnet.—The production of abrasive garnet in the United States during 1904 amounted to 3,854 short tons, valued at $117,581, as against 3,950 short tons, valued at $132,500, in 1903; 3,926 short tons, valued at $132,820, in 1902, and 4,444 short tons, valued at $158,100, in 1901. The average price for the 1904 production is reported as $30.51 per ton.

Grindstones.—The total value of all kinds of grindstones produced during 1904 was $881,527, as against $721,446 in 1903, $667,431 in 1902, and $580,703 in 1901. The production of 1904 was the largest on record for any year. It should be remembered, however, that the price, which was from $15 to $18 per ton, has decreased to from $8 to $11 per ton, and that therefore the tonnage of grindstones used has correspondingly increased within the last few years. The imports for 1904 amounted in value to $93,152, as against $85,705 in 1903, $76,906 in 1902, and $88,871 in 1901.

Infusorial earth and tripoli.—In 1904 the production of infusorial earth and tripoli amounted to 6,274 short tons, valued at $44,164, as against 9,219 short tons, valued at $76,273, in 1903; 5,665 short tons, valued at $53,244, in 1902, and 4,020 short tons, valued at $52,950, in 1901.

Millstones and buhrstones.—The value of the production of millstones and buhrstones in 1904 was $37,338, as against $52,552 in 1903, $59,808 in 1902, and $57,179 in 1901. From 1886 to 1894 there was a very large decrease—from $140,000 to $13,887—in the production of buhrstones. From 1894 to 1902 there was a gradual increase in the production, but there was a decrease in both 1903 and 1904.

Oilstones and whetstones.—There was a decided decrease in the commercial domestic production of oilstones and whetstones during 1904, the value falling from $366,857 in 1903 to $188,985 in 1904. The production was valued at $221,762 in 1902 and 158,300 in 1901.

CHEMICAL MATERIALS.

Arsenious oxide.—The domestic production of arsenious oxide (white arsenic) in 1904 was 36 short tons, valued at $2,185, as compared with 611 short tons, valued at $36,691, in 1903; with 1,353 short tons, valued at $81,180, in 1902, and with 300 short tons, valued at $18,000, in 1901.

Borax.—The reported returns for 1904 gave an aggregate production of crude borax of 45,647 short tons, valued at $698,810, as compared with 34,430 short tons, valued at $661,400, in 1903, and with 17,404 short tons of refined and 2,600 short tons of crude, valued at $2,538,614, in 1902. The production during 1901 was 17,887 short tons of crude borax and 5,344 short tons of refined borax, with a total value of $1,012,118.

Bromine.—The production of bromine in 1904, including the amount of bromine contained in potassium bromide, amounted to 897,100 pounds, valued at $269,130, as compared with 598,500 pounds, valued at $167,580, in 1903; with 513,893 pounds, valued at $128,472, in 1902, and with 552,043 pounds, valued at $154,572, in 1901.

Fluorspar.—The total commercial production of fluorspar in 1904 was 36,452 short tons, valued at $234,755, as compared with 42,523 short tons, valued at $213,617, in 1903; with 48,018 short tons, valued at $271,832, in 1902, and with 19,586 short tons, valued at $113,803, in 1901—a decrease in quantity in 1904 of 6,071 short tons, but an increase of $21,138 in value over 1903. The average price of crude fluorspar in 1904 was reported as $4.97, or 69 cents per ton more than the 1903 price, $4.28, but 22 cents less than the 1902 price, $5.19; and the average price of ground fluorspar in 1904 was $8.44 per ton, a decrease of $1.55 from the 1903 price, $9.99, and of $1.54 from the 1902 price, $9.98.

Gypsum.—The output of crude gypsum in 1904 was 940,917 short tons, valued in its first marketable condition at $2,784,325, as compared with 1,041,704 short tons, valued in its first marketable condition at $3,792,943, in 1903; with 816,478 short tons, valued at $2,089,341, in 1902; with 633,791 short tons, valued at $1,506,641, in 1901, and with 594,462 short tons, valued at $1,627,203, in 1900. The production in 1899 was 486,235 short tons, and in 1898 it was 291,638 short tons. The greatly increased production of late years is attributable to the largely increased use of wall plaster and of plaster of Paris in large modern buildings and in the manufacture of staff for temporary buildings.

Marls.—The production of marls in the United States in 1904 was 18,989 short tons, valued at $13,145; in 1903 it was 34,211 short tons, valued at $22,521, and in 1902 it was 12,439 short tons, valued at $12,741.

Phosphate rock.—The total commercial production of phosphate rock reported to the Survey in 1904 amounted to 1,874,428 long tons, valued at $6,873,625, as compared with 1,581,576 long tons, valued at $5,319,294, in 1903; with 1,490,314 long tons, valued at $4,693,444, in 1902, and with 1,483,723 long tons, valued at $5,316,403, in

1901—an increase in quantity in 1904 over 1903 of 292,852 tons, and in value of $1,554,331. The total quantity of phosphate rock reported as mined during 1904 was 1,991,169 long tons, as against 1,618,799 long tons in 1903 and 1,499,617 long tons in 1902.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda, and other sodium salts. The domestic production of salt in 1904 amounted to 22,030,002 barrels of 280 pounds, valued at $6,021,222, as compared with 18,968,089 barrels, valued at $5,286,988, in 1903; with 23,849,231 barrels, valued at $5,668,636, in 1902; with 20,566,661 barrels, valued at $6,617,449, in 1901, and with 20,869,342 barrels, valued at $6,944,603, in 1900.

Sulphur and pyrite.—The combined domestic production in 1904 of sulphur and of pyrite for the manufacture of sulphuric acid amounted to 333,542 long tons, valued at $3,460,863, a considerable increase as compared with 233,127 long tons, valued at $1,109,818, produced in 1903; with 207,874 long tons, valued at $947,089, in 1902, and with 241,691 long tons, valued at $1,257,879, in 1901.

PIGMENTS.

Barytes.—The production of crude barytes in 1904 was 65,727 short tons, valued at $174,958, as compared with 50,397 short tons, valued at $152,150, in 1903; with 61,668 short tons, valued at $203,154, in 1902, and with 49,070 short tons, valued at $157,844, in 1901.

Cobalt oxide.—The production of cobalt oxide reported in 1904 was 22,000 pounds, valued at $42,600; in 1903 it was 120,000 pounds, valued at $228,000 (not including the value of 60 short tons of cobalt ore); in 1902 it was 3,730 pounds, valued at $6,714; and in 1901 it was 13,360 pounds, valued at $24,048. All the cobalt oxide was obtained as a by-product in smelting lead ores at Mine La Motte, Missouri.

Mineral paints.—The commercial production of mineral paints in 1904 amounted to 59,785 short tons, valued at

$631,171, as compared with 63,687 short tons, valued at $635,557, in 1903; with 73,049 short tons, valued at $944,332, in 1902, and with 61,460 short tons, valued at $789,962, in 1901.

Zinc white.—The production of zinc white in 1904 amounted to 63,363 short tons, valued at $4,808,482, as compared with 62,962 short tons, valued at $4,801,718, in 1903; with 52,645 short tons, valued at $4,016,499, in 1902, and with 46,500 short tons, valued at $3,720,000, in 1901.

MISCELLANEOUS.

Asbestos.—The asbestos commercially produced in the United States in 1904 was obtained chiefly from deposits in Georgia and Virginia, with a small quantity from Massachusetts. The total commercial production was 1,480 short tons, valued at $25,740, as against 887 short tons, valued at $16,760, in 1903, and 1,005 short tons, valued at $16,200, in 1902.

Asphaltum.—Under this title are included the various bitumens or hydrocarbons not discussed under the heading "petroleum" in the volume on mineral resources. The commercial production in 1904 was 81,572 short tons, valued at $903,741, as against 101,255 short tons, valued at $1,005,446, in 1903, 105,458 short tons, valued at $765,048, in 1902, and 63,134 short tons, valued at $555,335, in 1901.

Bauxite.—In 1904 the production of bauxite was 47,661 long tons, valued at $235,704, as compared with 48,087 long tons, valued at $171,306, in 1903; with 27,322 long tons, valued at $120,366, in 1902, and with 18,905 long tons, valued at $79,914, in 1901.

Chromic iron ore.—California was the only State producing chromite during 1904, the quantity being 123 long tons, valued at $1,845, as compared with 150 long tons, valued at $2,250, in 1903; with 315 long tons, valued at $4,567, in 1902, and with 368 long tons, valued at $5,790, in 1901.

Feldspar.—The production of feldspar in 1904 was 45,188 short tons, valued at $266,326, as against 41,891 short tons, valued at $256,733, in 1903; 45,287 short tons, valued at $250,424, in 1902, and 34,741 short tons, valued at $220,422, in 1901—an increase in 1904 over 1903 of 3,297 tons in quantity and of $9,593 in value.

Fibrous talc.—This variety of talc or soapstone occurs in but one locality in the United States—Gouverneur, St. Lawrence County, N. Y. It is used principally as make-weight in the manufacture of paper. In 1904 the production was 64,005 short tons, valued at $507,400, as against 60,230 short tons, valued at $421,600, in 1903; 71,100 short tons, valued at $615,350, in 1902, and 69,200 short tons, valued at $483,600, in 1901.

Flint.—The production of flint in 1904 was 52,270 short tons, valued at $100,590, as against 55,233 short tons, valued at $156,947, in 1903; 36,365 short tons, valued at $144,209, in 1902, and 34,420 short tons, valued at $149,297, in 1901.

Fuller's earth.—As reported to the Survey, the production of fuller's earth in 1904 was 29,480 short tons, valued at $168,500, as compared with 20,693 short tons, valued at $190,277, in 1903; with 11,492 short tons, valued at $98,144, in 1902, and with 14,112 short tons, valued at $96,835, in 1901.

Glass sand.—The production of glass sand in 1904 was 858,719 short tons, valued at $796,492, as against 823,044 short tons, valued at $855,828, in 1903, and 943,135 short tons, valued at $807,797, in 1902.

Graphite.—The commercial production of crystalline graphite during 1904 amounted to 5,681,177 pounds, valued at $238,447, as compared with 4,538,155 pounds, valued at $154,170, in 1903; with 3,936,824 pounds, valued at $126,144, in 1902; with 3,967,612 pounds, valued at $135,914, in 1901, and with 5,507,855 pounds, valued at $178,761, in 1900. The production of amorphous graphite in 1904 was 19,115 short tons, valued at $102,925, as compared with 16,591 short tons, valued at $71,384, in 1903; with 4,739 short tons, valued at $55,964, in 1902; with 809 short tons, valued at $31,800, in 1901, and with 611 short tons, valued at $18,818, in 1900. The production of artificial graphite in 1904 was 3,248,000 pounds, valued at $217,790, the average price being 6.71 cents per pound, as compared with 2,620,000 pounds, valued at $178,670, in 1903, when the average price was 6.82 cents per pound, and with 2,358,828 pounds, valued at $110,700, in 1902, when the average price was 4.70 cents per pound.

Limestone for iron flux.—The quantity of limestone used for fluxing in blast furnaces in 1904 was 10,657,038 long tons, valued at $4,702,768, as compared with 12,029,719 long tons, valued at $5,423,732, in 1903; with 12,139,248 long tons, valued at $5,271,252, in 1902, and with 8,540,168 long tons, valued at $4,659,836, in 1901, the decrease in 1904 being due to idleness of furnaces during the year.

Lithium.—The production of lithium minerals in 1904 was 577 short tons, valued at $5,155, a decrease of 578 short tons in quantity and of $18,270 in value from the 1903 production of 1,155 short tons, valued at $23,425. Of this 1904 production the greater part was spodumene from South Dakota.

Magnesite.—The production of magnesite in the United States continues to be limited to California. During the year 1904 the commercial production reported was 2,850 short tons, valued at $9,298, as compared with 3,744 short tons, valued at $10,595, in 1903, and with 2,830 short tons, valued at $8,490, in 1902.

Mica.—The total production of mica in 1904 was 668,358 pounds of sheet mica, valued at $109,462, and 1,096 short tons of scrap mica, valued at $10,854, as against 619,600 pounds of sheet mica, valued at $118,088, and 1,659 short tons of scrap mica, valued at $25,040, produced in 1903, and against a total value of $118,849 for the production of 1902.

Mineral waters.—The total production of mineral waters in 1904 was 67,718,500 gallons, valued at $10,398,450, as compared with 51,242,757 gallons, valued at $9,041,078, in 1903; with 64,859,451 gallons, valued at $8,793,761, in 1902, and with 55,771,188 gallons, valued at $7,586,962, in 1901.

Molybdenum.—The commercial production of molybdenum in 1904 was 14.5 short tons of concentrates, valued at $2,175, as against 795 short tons of concentrates, valued at $60,865, in 1903. The value of molybdenum ores fluctuates very greatly.

Monazite and zircon.—The production of monazite is confined exclusively to North Carolina and South Carolina, by far the larger quantity being obtained from the former State. In 1904 the production amounted to 745,999 pounds (including small quantities of zircon, columbite, and gadolinite), valued at $85,038, as compared with 865,000 pounds, valued at $65,200 (including 3,000 pounds of zircon, valued at $570), produced in 1903; with 802,000 pounds of monazite, valued at $64,160, in 1902, and with 748,736 pounds, valued at $59,262, in 1901—a decrease in 1904 of 119,001 pounds in quantity, but an increase in value of $19,838 as compared with 1903.

Peat.—The production of peat in 1904 is estimated as amounting to about 1,200 short tons, valued at $4,200.

Potassium salts.—There was no production of potassium salts in the United States in 1904; the imports amounted to 216,182,603 pounds, valued at $3,651,808.

Precious stones.—The value of the gems and precious stones found in the United States in 1904 was $324,300, as against $307,900 in 1903, $328,450 in 1902, and $289,050 in 1901. There has been a great advance in the lapidary industry in the United States since 1894. The fact that larger establishments have been formed, which are able to purchase the rough diamonds in greater quantities, has placed our American diamond cutters in a position equal to that held by the cutters of Amsterdam, Antwerp, and Paris. The cutting of our native gems has also grown to the proportions of an industry, notably in the case of the beryls and the amethysts found in North Carolina and Connecticut; the turquoises from New Mexico, Arizona, Nevada, and California; the fine-colored and deep-blue sapphires found in Montana; the colored tourmalines of San Joaquin County, Cal.; the chrysoprases from Visalia, Tulare County, Cal.; the garnets of Arizona and New Mexico, and the pale-purple garnets of North Carolina.

Pumice stone.—The production of pumice amounted in 1904 to 1,530 short tons, valued at $5,421, as against 885 short tons, valued at $2,665, in 1903, and 700 short tons, valued at $2,750, in 1902.

Rutile.—Rutile to the value of $7,000 was reported in 1904.

Sands, molding, building, engine, etc.—The production of sands for molding, building, engine, furnace, and other purposes reported in 1904 was 9,821,009 short tons, valued at $4,951,607.

Talc and soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of talc and soapstone in 1904 amounted to 27,184 short tons, valued at $433,331, as compared with 26,671 short tons, valued at $418,460, in 1903; with 26,854 short tons, valued at $525,157, in 1902; with 28,643 short tons, valued at $424,888, in 1901, and with 27,943 short tons, valued at $383,541, in 1900.

Tungsten.—The commercial production of concentrated tungsten ores during 1904 amounted to 740 short tons, valued at $184,000, as against 292 short tons, valued at $43,639, in 1903, and 184 short tons in 1902, of which not more than a few tons were sold. In 1901 the production amounted to 179 tons of concentrated ore, valued at $27,720.

Uranium and vanadium.—The production of uranium and vanadium minerals in 1904, as reported to the Survey, amounted to about 45 short tons of crude and concentrated ore, valued at $10,600, as against 30 short tons of concentrates, equivalent to about 19 short tons of metal, valued at $5,625, in 1903, and 3,810 short tons of crude ore, valued at $48,125, in 1902.

Division of Chemical and Physical Research.

During the fiscal year 1904–5 no changes were made in the personnel of the division of chemical and physical research, in charge of Mr. G. F. Becker. The routine work in the laboratory was essentially the same as in former years. In all, 140 analyses were reported and 194 qualitative determinations of minerals were made. Apart from this routine work, the chemists conducted various researches and did individual work as follows:

Mr. F. W. Clarke compiled Bulletin No. 262, "Contributions to Mineralogy," a collection of researches carried out partly in the Survey laboratory and partly in cooperation with geologists. He also carried on, through assistants, researches on the constitution of certain silicates. A large part of his time was occupied in continuing the preparation of a monograph on "Chemical Geology."

Messrs. W. F. Hillebrand and E. T. Allen published Bulletin No. 253, on the fire assay of the telluride ores. Mr. Hillebrand also acted as adviser in the investigation of coals undertaken in connection with the St. Louis Exposition by Mr. N. W. Lord, and, in the same connection, undertook an investigation of the condition of moisture in coals, a very important and complex question.

Mr. E. C. Sullivan continued the researches on the secondary enrichment of copper ores and the effect of natural precipitants upon their solution.

Mr. George Steiger prepared interesting artificial zeolites containing silver and thallium in place of the monad and dyad bases, a research bearing immediately upon the rational constitution of this group of minerals.

Mr. W. T. Schaller made crystallographic studies of natural minerals and artificial crystals for several geologists, and determined the index of refraction of artificial feldspar glasses prepared in the physical laboratory. He also published an important paper on dumortierite (Bulletin No. 262), and with Mr. L. C. Graton described a new mineral, purpurite. He is at present engaged in the field study of lithium minerals in California.

Messrs. A. L. Day and E. T. Allen extended their researches on the thermal properties of rock-forming minerals and the ferromagnesian silicates, and are preparing to make investigations in which artificial minerals will be dealt with under high pressure as well as high temperature. Their memoir on "The Thermal Properties of Feldspar," abstracts of which have appeared elsewhere, was published in extenso by the Carnegie Institution as Publication No. 31, and forms one of the most important contributions to geologic physics ever printed. Mr. Day is also joint author with Mr. Becker of two papers mentioned below.

Mr. C. E. Van Orstrand spent the year on experimental work in connection with the theory of elasticity and the mathematical discussion of the results. This investigation is under the special direction of Mr. Becker, who has given most of his time to it.

Mr. Becker published Bulletin No. 241, "Experiments on Schistosity and Slaty Cleavage;" also a paper on "Present Problems of Geophysics," read before the International Scientific Congress at St. Louis in September, 1904; "Simultaneous Joints," printed by the Washington Academy of Sciences, and "A Feature of Mayón Volcano," printed by the same society, which also issued "The Linear Force of Growing Crystals," by Messrs. Becker and Day, and "An Interesting Pseudosolid," by the same authors.

TOPOGRAPHIC BRANCH.

Organization.

The organization of the topographic branch remained during the year practically as given in last year's report.

Cooperative arrangements for topographic surveys were made with eleven States. The State geologist of Alabama allotted $1,000; the legislature of California allotted $10,000; the director of the Kentucky Geological Survey allotted $5,000; the State Survey Commission of Maine allotted $2,500; the State geologist of Maryland allotted $6,300; the State geologist of Michigan allotted $1,000;

the State engineer and surveyor of New York allotted $19,000; the governor of Ohio allotted $23,800; the State Survey Commission of Pennsylvania allotted $15,000; the director of the University of Texas Mineral Survey allotted $2,500; the State geologist of West Virginia allotted $15,000. Thus, $101,100 was allotted by the States mentioned, in addition to the Federal appropriation, for topographic work.

Summary of Results.

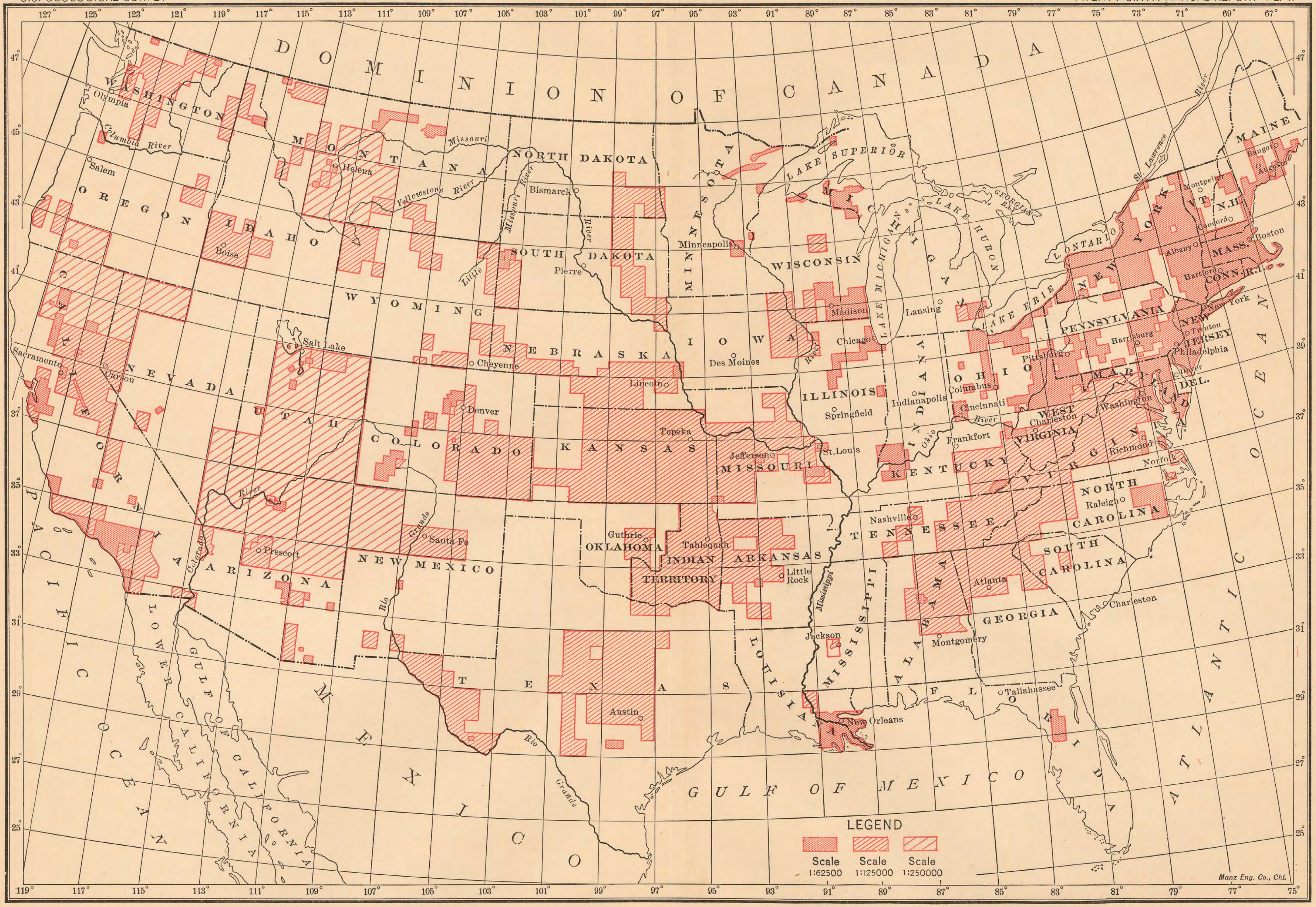
The following summary includes all small-scale topographic surveys made by the divisions of topography, including those of forest reserves, and by the Reclamation Service and the division of Alaskan mineral resources:

One base line was measured; primary azimuth observations were made at 2 triangulation stations; 360 triangulation stations were occupied or located; 3,776 miles of primary traverse were run.

The condition of topographic surveys to June 30, 1905, distinguished as to scale, etc., is shown on a general map of the United States, Pl. II, and the detailed distribution of this work in the various States and Territories is shown on the accompanying maps, Pls. III–XXIV. On the latter are indicated by proper symbols the sheets published to June 30, 1905, the sheets in course of publication, and the areas surveyed during the field season of 1904 and drawn in map form in the office season of 1904–5. By appropriate symbols these maps also show areas in which precise or primary spirit levels have been run and unmapped areas which are controlled by primary triangulation or traverse or by astronomic positions.

As shown in the following table giving the details of topographic mapping and spirit leveling for the fiscal year, the total area of new surveys was 21,296 square miles. The total area surveyed in the United States to date is 955,996 square miles, or about 32 per cent.

In addition (as shown in tables on pages 104, 130), 5,250 square miles of revision or resurvey were completed by final topographic mapping in the eastern division and 304



MAP OF UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE SCALE EMPLOYED FOR EACH AREA

Scale

100 0 100 200 300 miles

1905

square miles in the western division, over which preliminary reconnaissance surveying had been previously carried, thus making the total area of actual surveys for the season 26,850 square miles.

In connection with these topographic surveys there were run 27,186 linear miles of spirit levels, which amount includes 252 miles of precise levels, thus making the total mileage of spirit levels since the first authorization of this class of work by Congress, in 1896, amount to 158,064 miles. In addition, 18,920 miles of levels were run by stadia angulation.

The total area covered by topographic surveys made by the members of the topographic branch in Alaska during the fiscal year 1904–5, as reported in detail on pages 54–76, was about 6,600 square miles.

Present condition of topographic surveys of the United States, showing new areas surveyed in 1904–5.

State or Territory.	Total area.	New area surveyed in 1904–5.	Total area surveyed to Apr. 30, 1905.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*
Alabama	52,250	....	17,534
Arizona	113,020	787	61,600
Arkansas	53,850	154	20,469
California	158,360	1,387	68,535
Colorado	103,925	389	35,490
Connecticut	a 5,047	....	5,047
Delaware	2,050	190	1,008
District of Columbia	70	....	70
Florida	58,680	....	1,821
Georgia	59,475	567	15,519
Idaho	84,800	....	14,933
Illinois	56,650	....	4,915
Indian Territory	30,962	....	30,620
Indiana	36,350	....	2,311
Iowa	56,025	....	9,395
Kansas	82,080	....	64,159
Kentucky	40,400	517	13,244
Louisiana	48,720	624	7,627
Maine	33,040	183	6,305
Maryland	12,210	459	10,294

Present condition of topographic surveys of the United States, showing new areas surveyed in 1904–5—Continued.

State or Territory.	Total area.	New area surveyed in 1904–5.	Total area surveyed to Apr. 30, 1905.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*
Massachusetts	[a] 8,332	....	8,332
Michigan	58,915	252	3,266
Minnesota	83,365	....	2,640
Mississippi	46,810	....	249
Missouri	69,415	....	32,564
Montana	146,080	1,346	43,974
Nebraska	77,510	....	25,774
Nevada	110,700	....	28,953
New Hampshire	9,305	219	2,823
New Jersey	[a] 7,886	....	7,756
New Mexico	122,580	247	28,022
New York	49,170	2,644	36,515
North Carolina	52,250	166	16,038
North Dakota	70,795	827	7,837
Ohio	41,060	3,067	12,596
Oklahoma	39,030	....	4,154
Oregon	96,030	201	13,041
Pennsylvania	45,215	1,536	16,959
Rhode Island	[a] 1,131	....	1,131
South Carolina	30,570	....	5,016
South Dakota	77,650	382	17,485
Tennessee	42,050	....	19,849
Texas	265,780	1,030	64,218
Utah	84,970	599	63,227
Vermont	9,565	214	3,463
Virginia	42,450	334	29,397
Washington	69,180	607	16,466
West Virginia	24,780	918	21,863
Wisconsin	56,040	....	10,909
Wyoming	97,890	1,450	20,583
Total	[a] 3,024,880	21,296	955,996

[a] The total area here given is from reports of Twelfth Census, and is not a summation of column.

The total areas of the States marked with a superior letter and the areas given in the last column of the foregoing table include land areas only. They are the result of careful measurement on the topographic maps of the

Geological Survey. They do not include large bodies of water bordering on the national boundary or the open ocean, but do include all rivers and the smaller lakes. The measurement closely follows the shore line, jumping from headland to headland only across necks and straits less than 1,000 feet in width. For example, the area of Long Island Sound is excluded, though the State boundary between Connecticut and New York is near the middle of its channel, and legally the two States jointly control its waters.

Eastern Division of Topography.

FIELD WORK.

SUMMARY.

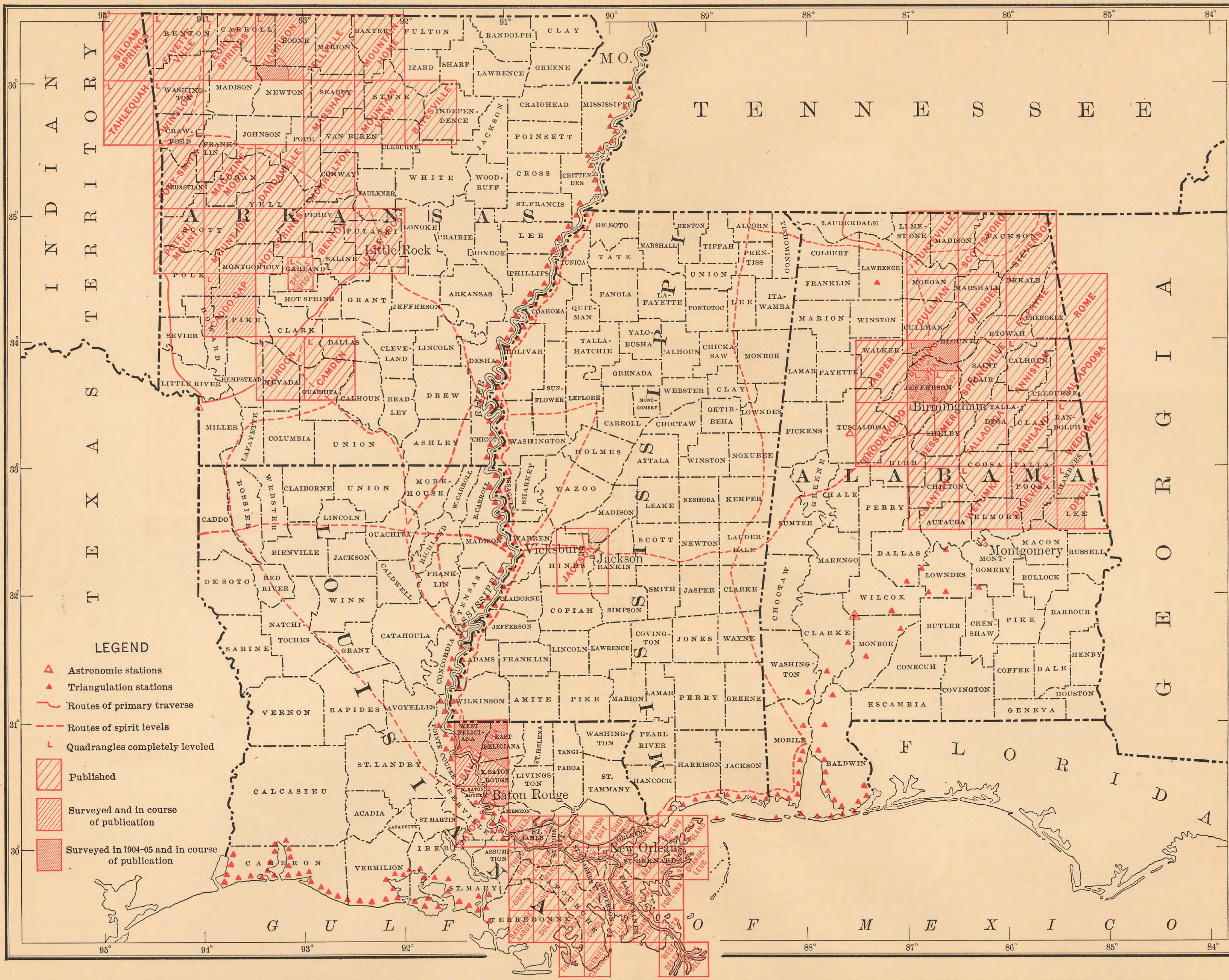
Mr. H. M. Wilson, geographer, continued in charge of the eastern division of topography. During the season topographic work was carried on by parties working in twenty-two States, namely, Alabama, Arkansas, Delaware, Georgia, Kentucky, Louisiana, Maine, Maryland, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Carolina, Vermont, Virginia, West Virginia, and Wisconsin. The survey of sixty-five new quadrangles was completed, and of the quadrangles in which earlier reconnaissance surveys had been made forty-one were completely resurveyed or revised; in addition, forty-six new quadrangles were partly surveyed and fourteen old ones were partly resurveyed or revised. The total new area mapped was 12,871 square miles, of which 2,172 were for publication on the scale of 1:125,000, and 10,699 for publication on the scale of 1:62,500. There were resurveyed or revised 1,188 square miles on the publication scale of 1:125,000, and 4,062 square miles on the publication scale of 1:62,500. In connection with this work 22,654 linear miles of spirit levels were run, and 775 permanent bench marks established along the routes run by primary methods. Along the remainder—of secondary order—temporary bench marks were set at least every mile run. Primary control was carried on during the season by seven parties working in portions of eighteen States. They controlled 18,600 square miles, lying within fifty-six quadrangles.

Topographic surveys in the eastern division from May 1, 1904, to April 30, 1905.

State or Territory.	Contour interval.	Scale of publication. 1:125,000. New.	Scale of publication. 1:125,000. Resurvey or revision.	Scale of publication. 1:62,500. New.	Scale of publication. 1:62,500. Resurvey or revision.	Total area surveyed.	Levels. Distance run.	Levels. Bench mark.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	20	......	522	......	[a] 481	1,003	1,222	75
Arkansas	50	154	8	......	......	162	91	6
Delaware	20	......	......	190	5	195	240	10
Georgia	50	567	......	......	......	567	316	......
Kentucky	20	......	......	517	20	537	1,214	33
Louisiana	20	624	......	......	......	624	345	10
Maine	20	......	......	183	......	183	179	15
Maryland	10, 20	......	......	459	899	1,358	1,909	39
Michigan	20	......	......	[b] 252	35	287	320	2
Missouri	20	......	......	......	472	472	899	42
New Hampshire	20	......	......	219	......	219	307	27
New Jersey	20	......	......	......	764	764	......	......
New York	20	......	......	2,644	368	3,012	1,718	65
North Carolina	10, 100	......	424	166	......	590	868	69
North Dakota	20	827	......	......	......	827	884	38
Ohio	10, 20	......	......	3,067	......	3,067	6,032	158
Pennsylvania	20	......	......	1,536	141	1,677	2,148	39
South Carolina	50, 100	......	234	......	......	234	312	15
Vermont	20	......	......	214	......	214	284	13
Virginia	10	......	......	334	......	334	938	12
West Virginia	20	......	......	918	......	918	1,523	78
Wisconsin	20	......	......	......	877	877	905	29
Total	......	2,172	1,188	10,699	4,062	18,121	22,654	775

[a] Of this, 52 square miles were mapped on the publication scale of 1:24,000, with a contour interval of 20 feet.

[b] Of this, 45 square miles were mapped on the publication scale of 1:24,000, with a contour interval of 20 feet.



MAP OF ALABAMA, MISSISSIPPI, ARKANSAS, AND LOUISIANA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

DETAILS OF FIELD WORK, BY STATES.

Alabama.—The State geologist of Alabama allotted $1,000 for cooperative work in that State, which was met by a like sum from the Federal organization; the latter allotted, also, $12,000 additional in its own interests. The terms of the agreement of 1899 were continued to cover this cooperation. Under the general supervision of Mr. H. B. Blair, topographer in charge of section, two parties were engaged in work in six quadrangles. The mapping of the Opelika (Alabama-Georgia) quadrangle, for publication on the scale of 1:125,000, with a contour interval of 50 feet, was continued under the cooperation. The resurvey of the Birmingham Special was completed, and that of the Bessemer Special and Leeds quadrangles was in progress, all for publication on the scale of 1:62,500, with a contour interval of 20 feet. Incidentally a portion of the area was surveyed for publication on the scale of 1:24,000 as the Birmingham-Bessemer City map. The resurvey of the north half of the Birmingham quadrangle, for publication on the scale of 1:125,000 with a contour interval of 50 feet, was completed, and the Birmingham Special and Leeds will be reduced to complete this sheet. The revision of the Dadeville sheet, for publication on the original scale and with the same contour interval, was completed. In addition to the areas reported in the following tabular statement, 28 square miles were mapped as overrun on edges of adjacent quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Alabama.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Chambers Lee	Opelika (unfinished).	H. B. Blair			89	23	335	617
Jefferson	Birmingham Special (resurvey completed).	H. B. Blair, in charge; C. D. S. Clarkson; O. Jones.	248		329	4	2,342	1,201
Jefferson Shelby	Bessemer Special.	H. B. Blair						199
Jefferson Shelby St. Clair	Leeds	H. B. Blair, in charge; C. D. S. Clarkson; J. F. Webb.	133		308	25	1,911	994
Blount Cullman Jefferson Shelby St. Clair Walker	Birmingham	O. Jones, in charge; C. Caldwell.	495		496	23	2,702	2,191
Jefferson	Birmingham-Bessemer City.	H. B. Blair, in charge; C. D. S. Clarkson.	(52) included in above sheets.					
Total[a]			628		804	48	4,613	3,384
Chambers Coosa Elmore Lee Macon Tallapoosa	Dadeville (revision).	H. B. Blair, in charge; J. F. Webb.	27					50

[a] Resurveys unfinished in the field.

Arkansas.—Under the supervision of Mr. Van H. Manning, topographer in charge of section, two parties were engaged in completing the topographic mapping of the Harrison (Arkansas-Missouri) quadrangle for publication on the scale of 1:125,000, with a contour interval of 50 feet. In addition to the areas reported in the following tabular statement, 6 square miles were mapped as overrun on edges of adjoining sheets.

Topographic surveys in Arkansas, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Carroll, Boone, Madison, Newton	Harrison (completed).	C. L. Sadler, in charge; E. K. Duck.	154	10	91	6	310	119
Boone, Baxter, Marion, Newton, Searcy	Yellville (revision completed).	C. L. Sadler, C. G. Anderson.	18	....	....	....	....	70

Delaware.—Four parties were engaged in the topographic mapping of portions of six quadrangles. Mapping of the Coatesville (Pennsylvania-Delaware) and the Wilmington (Delaware-New Jersey) quadrangles was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Barclay and Dover (Maryland-Delaware) quadrangles was completed for publication on the above scale and with the same contour interval.

Topographic surveys in Delaware, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Newcastle	Coatesville	R. D. Cummin, in charge; A. C. Roberts.	0.5	....	....	....	....	....
Do	Wilmington	W. C. Hall, W. M. Beaman, J. S. B. Daingerfield.	190.0	....	228	10	942	449
Total [a]			190.5	....	228	10	942	449
Kent	Barclay	R. Coe	1.0	....	12	....	51	49
Dover	Dover	....do	4.0	....	....	....	....	....
Total [b]			5.0	....	12	....	51	49

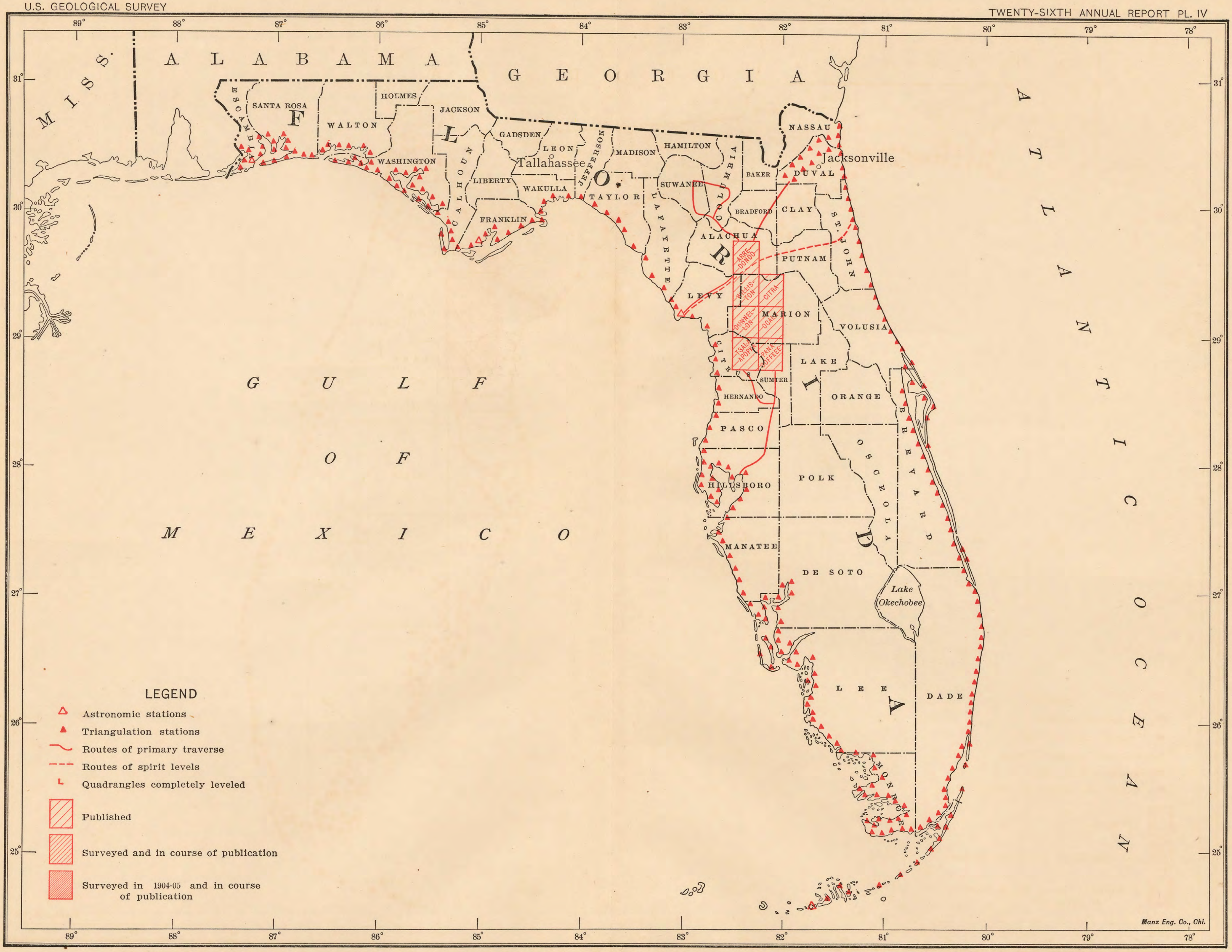
[a] Completed in the field. [b] Resurvey completed in the field.

Georgia.—One party completed the topographic mapping of the Wilkes (Georgia-South Carolina) quadrangle for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Topographic surveys in Georgia, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Elbert, Lincoln, McDuffie, Taliaferro, Oglethorpe, Warren, Wilkes	Crawfordsville (completed).	A. Pike in charge; R. L. Harrison, A. P. Meade.	567	....	316	....	....	1,955

Kentucky.—The State geologist of Kentucky allotted $5,000 for cooperative topographic surveys in the State for the fiscal year ending June 30, 1905, and this was met by a like sum from the funds of the United States Geological Survey. The work was prosecuted under an agreement signed March 15, 1904. Under the general supervision of Mr. C. E. Cooke, topographer in charge of section, three parties were at work in thirteen quadrangles. The mapping of the Sebree and Sutherland quadrangles was completed, and progress was made on the Frankfort and Georgetown quadrangles, all for publication on the scale of 1:62,500, with a contour interval of 20 feet. Corrections were made of the Calhoun, Newburg, and Owensboro sheets, publication scale 1:62,500, contour interval 20 feet; and of the Harrodsburg sheet, publication scale 1:125,000, contour interval 50 feet. Some revision was done of the work of the previous season on the Hagan, Harlan, Log Mountain, Middlesboro, and Pineville sheets, scale 1: 62,500, contour interval 20 feet. In addition to the areas reported below, 35 square miles were mapped as overrun on edges of adjacent quadrangles.



MAP OF FLORIDA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Topographic surveys made in 1904–5 in cooperation with the State of Kentucky.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Henderson Union Webster	Sebree	W. L. Miller in charge; R. W. Berry.	236	....	618	23	5,681	889
Daviess McLain Ohio	Sutherland	....do	236	....	373	2	2,983	683
Total [a]			472	....	991	25	8,664	1,572
Anderson Franklin Shelby Woodford	Frankfort	W. L. Miller, C. E. Cooke, R. W. Berry.	25	....	163	1	1,010	458
Fayette Franklin Scott Woodford	Georgetown	W. L. Miller, C. E. Cooke.	20	....	45	....	442	193
Total [b]			45	....	208	1	1,452	651
Daviess Henderson Hopkins McLain Webster	Calhoun	W. L. Miller	....	....	15	....	....	....
Anderson Boyle Casey Fayette Garrard Jessamine Lincoln Madison Mercer Woodford	Harrodsburg	C. E. Cooke	....	....	....	....	....	53
Daviess Henderson	Newburg	W. L. Miller	....	....	....	7	....	....
Daviess	Owensboro	R. W. Berry	2	....	....	....	....	19
Total [c]			2	....	15	7	....	72
Harlan Bell	Hagan	R. W. Berry	2	....	....	....	....	....
Harlan Knox Leslie	Harlan	....do	4	....	....	....	....	4
Bell Knox Whitley	Log Mountain	....do	2	....	....	....	....	4
Bell Harlan	Middlesboro	....do	9	....	....	....	....	5
Bell Clay Harlan Knox Leslie	Pineville	....do	1	....	....	....	....	3
Total [d]			18	....	....	....	....	16

[a] Completed in field. [b] Unfinished in field. [c] Addition to sheets. [d] Revision unfinished in field.

Louisiana.—Under the general supervision of Mr. H. B. Blair, topographer in charge of section, one party was engaged in the completion of the mapping of the Bayou Sara quadrangle, for publication on the scale of 1 : 125,000, with a contour interval of 20 feet. In addition to the area reported below, 45 square miles were mapped as overrun on edges of adjoining sheets.

Topographic surveys in Louisiana, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
East Baton Rouge. West Baton Rouge. East Feliciana..... West Feliciana....	Bayou Sara (completed).	D. Hannegan...	624	....	345	10	1,189	....

Maine.—Under an agreement dated April 14, 1903, and a supplemental agreement signed the same date, arrangement was made for the expenditure of $2,500 each by the State Survey Commission of Maine and the United States Geological Survey during the year 1904–5. Under the general supervision of Mr. Hersey Munroe, topographer in charge of section, one party was engaged in work in five quadrangles. The Matinicus Island, Muscongus, Rockland, and Tenants Harbor sheets were completed in the field, and some work was accomplished on The Forks, all for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In addition to the above, primary levels were run along Kennebec River from Hallowell to Caratunk Plantations; and in cooperation with the hydrographic branch of this Survey the topographic branch ran a line of primary levels from the northernmost bench mark on Penobscot River along the railroad to Mattawamkeag and thence over the highways to Norcross. In addition to the areas reported below, 14 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Maine.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Knox	Matinicus Island.	T. F. Slaughter	2					
Knox, Lincoln	Muscongus	do	12		16		68	128
Knox, Waldo	Rockland	do	144	56	163	15	693	402
Knox	Tenants Harbor	do	25					35
Total [a]			183	56	179	15	761	565
Somerset, Piscataquis	The Forks (unfinished).	T. F. Slaughter		64			48	75

[a] Completed in field.

River surveys in Maine.

River.	Topographer.	Spirit levels.	Bench marks.	Elevations.
Kennebec	T. F. Slaughter, in charge; F. J. McMaugh	98	45	285
Penobscot	do	74	20	219

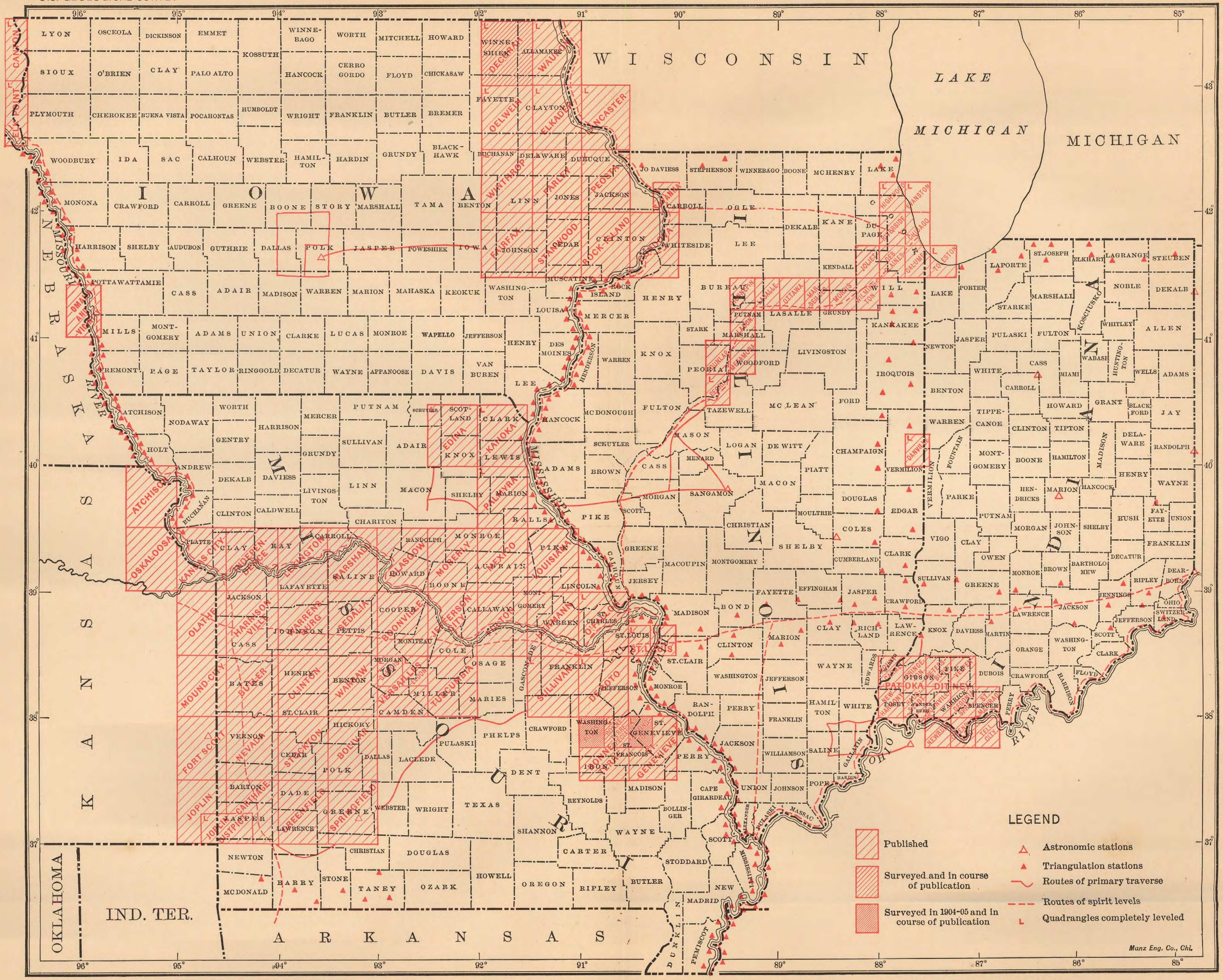
Maryland.—In May, 1904, the State geologist of Maryland allotted $6,300 toward the cooperative topographic survey of Maryland, and the Director of the United States Geological Survey met this by a like sum, the expenditures to be made under the terms of an agreement signed May 5, 1902. Four parties were at work in fourteen quadrangles. The Denton and Hurlock sheets were completed in the field, and progress was made on the Harrington and Seaford. The resurvey of the Barclay, Crapo, Drum Point, and Ellicott quadrangles was completed in the field, good progress was made in the resurvey of the Laurel and Relay quadrangles, and some leveling was done in the Rockville and Seneca quadrangles. The Owensville and Prince Frederick sheets were revised for culture, the Owensville being completed in the field. All of the above work is on the publication scale of 1:62,500, with contour intervals of 10 and 20 feet. In addition to the areas reported in the following table, 21 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Maryland.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Caroline, Talbot	Denton	R. Coe, L. S. Leopold.	189	....	445	10	1,449	724
Caroline, Dorchester, Talbot	Hurlock	R. Coe, H. L. Johnston.	219	....	420	1	976	689
Total[a]			408	....	865	11	2,425	1,413
Caroline	Harrington	R. Coe	21	....	......	......	......	31
Caroline, Dorchester	Seaford	R. Coe, H. L. Johnston.	30	....	38	1	152	22
Total[b]			51	....	38	1	152	53
Queen Anne	Barclay	R. Coe	230	....	471	2	1,836	701
Dorchester	Crapo	W. C. Hall, in charge; J. R. Eakin.	178	....	101	5	......	303
Chesapeake, St. Mary	Drum Point	J. R. Eakin	169	....	16	1	......	29
Baltimore, Carroll, Howard	Ellicott	W. H. Beaman	......	....	194	....	1,023	623
Total[c]			706	....	782	8	2,859	1,656
Anne Arundel, Howard, Montgomery, Prince George	Laurel	W. M. Beaman	......	....	16	4	68	71
Anne Arundel, Baltimore, Howard, Prince George	Relay	do	3	....	190	9	766	501
Howard, Montgomery	Rockville	do	......	....	16	6	101	......
Frederick, Montgomery	Seneca	do	......	....	2	....	8	......
Total[d]			3	....	224	19	943	572
Anne Arundel, Calvert, Prince George	Owensville (revision completed).	W. M. Beaman, in charge; F. T. Fitch.	180	....	......	......	......	110
Anne Arundel, Calvert, Prince George	Prince Frederick (revision unfinished).	do	10	....	......	......	......	......

[a] Completed in field.
[b] Unfinished in field.
[c] Resurvey completed in field.
[d] Resurvey unfinished in field.

Michigan.—Under the terms of an agreement signed May 27, 1903, for the cooperative topographic survey of the State, $1,000 was allotted by the State geologist of Michigan and $2,400 by the Director of the United States



MAP OF INDIANA, ILLINOIS, IOWA, AND MISSOURI, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Geological Survey, and arrangements were made for the expenditure of the funds and the prosecution of this work. One party was engaged in work in three quadrangles. The Detroit and Grosse Point sheets were completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. Incidentally a portion of the area was surveyed on a scale of 1:24,000, for publication as the Detroit City map. The Wyandotte sheet, covering the southeast quarter of the Detroit River 2-mile quadrangle, was revised for publication on the above scale. In addition to the areas entered in the following table, 10 square miles were mapped as overrun on edges of adjacent quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Michigan.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Macomb, Oakland, Wayne	Detroit	C. E. Cooke, in charge; R. W. Berry, J. N. Williamson.	193	....	238	....	554	633
Macomb, Wayne	Grosse Point	C. E. Cooke, in charge; J. N. Williamson.	59	....	64	2	170	144
Do	Detroit City	do	(45) included in above sheets.					
Total[a]			252	....	302	2	724	777
Monroe, Wayne	Wyandotte (revision completed).	C. E. Cooke, in charge; J. N. Williamson.	35	....	18	....	....	48

[a] Completed in field.

Missouri.—One party was engaged in work in three quadrangles. The resurvey of the Farmington and Potosi quadrangles, for publication on the scale of 1:62,500, and with a contour interval of 20 feet, was completed in the field. Secondary control was in progress in the Forsyth quadrangle, for publication on the scale of 1:125,000, with a contour interval of 50 feet. In addition to the areas reported in the following table, 35 square miles were mapped as overrun on edges of adjacent quadrangles.

Topographic surveys in Missouri, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Christian ...... Stone .... Taney	Forsyth (unfinished).	V. H. Manning......	....	....	152	24	215	236
Ste. Genevieve.	Farmington ..	V. H. Manning, in charge; W. J. Lloyd, C. G. Anderson, D. F. Higgins.	236	90	225	....	1,468	811
Washington ...	Potosi	V. H. Manning, in charge; C. G. Anderson, D. F. Higgins.	236	....	522	18	2,731	1,009
Total *a* ...	....	....	472	90	747	18	4,199	1,820

a Resurveys completed in field.

New Hampshire.—One party completed the mapping of the Milford quadrangle for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition a level line was run from Manchester to Lake Sunapee for the control of the Lake Sunapee quadrangle. In addition to the area reported in the following table, 8 square miles were mapped as an overrun on edges of adjoining quadrangles.

Topographic surveys in New Hampshire, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Hillsboro	Milford (completed).	H. Munroe, in charge; C. Hartman.	219	116	237	9	869	642
Level line from Manchester to Lake Sunapee			....	....	70	18	91	....

New Jersey.—Two parties were engaged in work in six quadrangles. Revision surveys in the Bordentown, Burlington (New Jersey-Pennsylvania), Morristown, and Princeton quadrangles was completed, but similar work in the Lambertville (New Jersey-Pennsylvania) quadrangle was unfinished in the field. The above work is for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. Revision of the coast-survey work in the Wilmington (Delaware-New Jersey) quadrangle was completed; scale 1:62,500, contour interval 20 feet.

Topographic surveys in New Jersey, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Burlington, Mercer, Monmouth, Ocean	Bordentown	J. M. Whitman, in charge; J. I. Treidel, F. J. McMaugh.	225	....	....	....	....	....
Burlington, Mercer	Burlington	J. M. Whitman, in charge; J. I. Treidel, F. J. McMaugh, F. A. Dykeman.	90	....	....	....	....	....
Essex, Morris, Passaic	Morristown	J. M. Whitman, in charge; T. H. Moncure, J. I. Treidel.	3	....	....	....	....	....
Mercer, Middlesex, Somerset	Princeton	J. M. Whitman, in charge; J. I. Treidel, F. A. Dykeman.	228	....	....	....	....	....
Total[a].	....	....	546	....	....	....	....	....
Hunterdon, Mercer, Somerset	Lambertville (revision unfinished).	J. M. Whitman, in charge; R. M. Sutton, T. H. Moncure.	178	....	....	....	....	....
Salem	Wilmington (revision of coast-survey work completed).	W. C. Hall, in charge; R. M. Sutton.	40	....	....	....	....	....

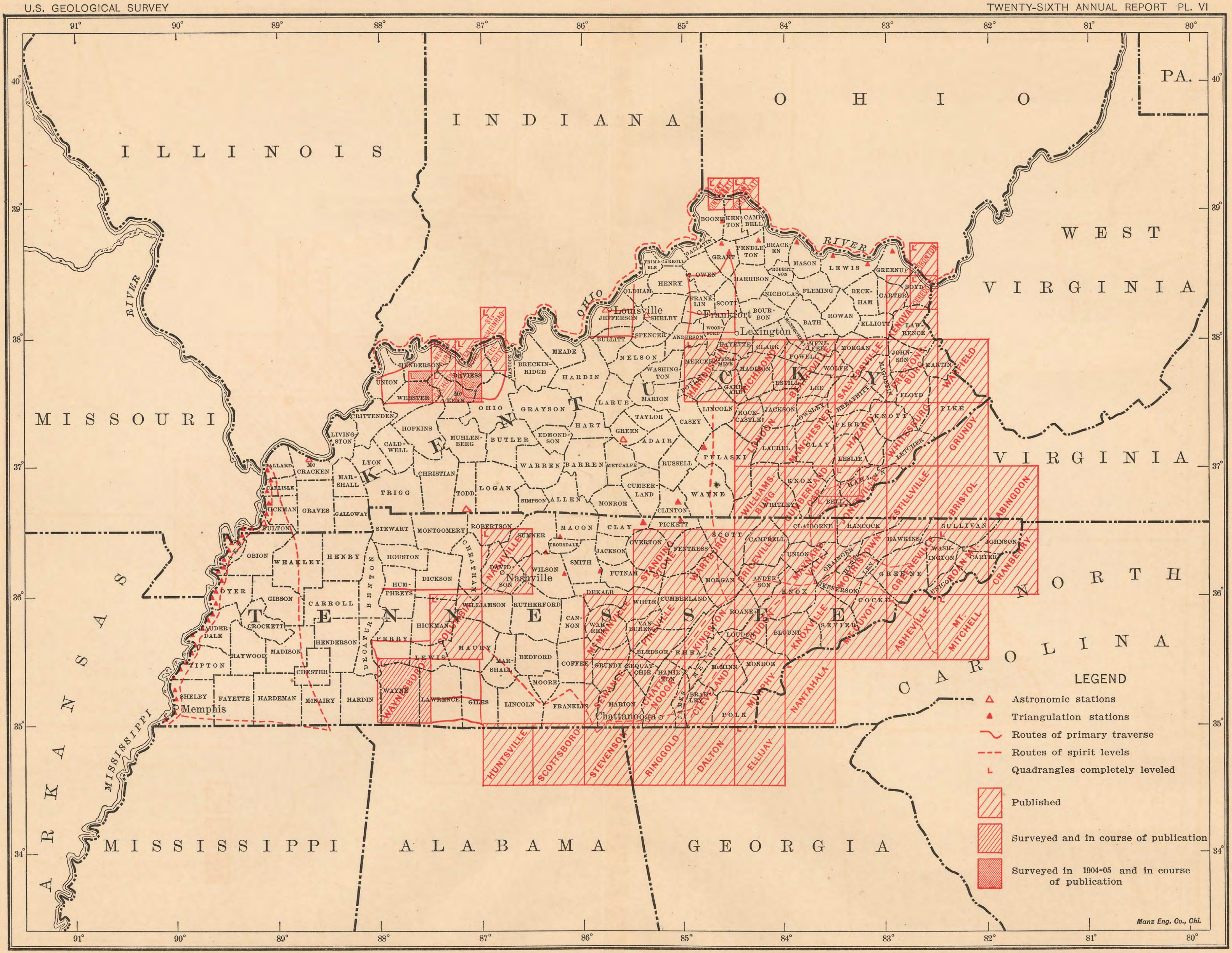
[a] Revision completed in field.

New York.—In May, 1904, an agreement was signed by the State engineer of New York and the Director of the United States Geological Survey, in which $19,000 was allotted by each for the cooperative topographic survey of the State, and arrangements were made for its expenditure and the prosecution of the work. Under the general supervision of Mr. J. H. Jennings, topographer in charge of section, seven parties were engaged in work in twenty-five quadrangles. The field mapping of fifteen was completed and that of seven remained unfinished, and revision surveys of three others were completed. The above work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to the areas reported in the following tabular statement, 69 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in 1904–5 in cooperation with the State of New York.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Allegany	Angelica	J. M. Whitman	221		135		532	336
Erie Genesee Wyoming	Attica	J. H. Jennings, in charge; G. Young.	219		25		98	473
St. Lawrence	Brier Hill	C. C. Bassett	100		98	5	193	217
Erie	Depew	J. H. Jennings, in charge; J. M. Whitman, G. Young.	219					808
Orange Sullivan Ulster	Ellenville	C. C. Bassett, W. O. Tufts.	223					172
Lewis	Highmarket	J. H. Jennings, in charge; J. I. Gayetty.	210		44		80	353
Oneida Oswego	Kasoag	J. H. Jennings, in charge; G. Young.	217		185	1	609	541
Hamilton	Lake Pleasant	G. S. Smith, in charge; O. C. Merrill, F. Graff, J. R. Eakin, A. P. Meade.	217	18	103	1	354	879
St. Lawrence	Massena	C. C. Bassett	209		245	12	241	588
Onondaga Oswego	Mexico	J. H. Jennings, in charge; G. Young.	217					75
St. Lawrence	Ogdensburg	C. C. Bassett	206		224	9	522	489
Fulton Hamilton Herkimer	Piseco Lake	G. S. Smith, in charge; F. Graff, J. R. Eakin, A. P. Meade, O. C. Merrill.	158					817
St. Lawrence	Red Mills	C. C. Bassett	36		28	1	60	78
Franklin Hamilton St. Lawrence	Tupper Lake	W. O. Tufts	46	5			3	210
St. Lawrence	Waddington	C. C. Bassett	136		114	4	258	198
Total [a]			2,634	23	1,201	33	2,950	6,234
Cattaraugus Erie	Eden	J. H. Jennings			29	5	53	760
Orange	Goshen	W. O. Tufts		124	234	8	632	670
Orange	Port Jarvis	J. H. Jennings, in charge; W. O. Tufts, J. A. Close.		105	46	5	176	90
Lewis Oneida	Port Leyden	G. S. Smith, in charge; J. M. Whitman, G. Young.			78		381	588
Madison Oneida	Sangerfield	J. H. Jennings, in charge; G. Young.		155	29	6	57	430
Hamilton Saratoga Warren	Stony Creek	G. S. Smith	10	107	36	3	231	141

[a] Completed in field.



MAP OF KENTUCKY AND TENNESSEE, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Topographic surveys in 1904-5 in cooperation with the State of New York—Continued.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Herkimer, Oneida, Otsego	Winfield	J. H. Jennings, in charge; J. A. Whitman, J. M. Close.	....	134	25	5	52	314
Total *a*	....	....	10	625	477	32	1,582	2,993
Chautauqua	Clymer	J. H. Jennings	203	....	40	....	168	92
Cattaraugus, Chautauqua	Jamestown	do	80	....	....	....	....	....
Sullivan, Ulster	Slide Mountain.	W. O. Tufts	85	....	....	....	....	....
Total *b*	....	....	368	....	40	....	168	92

a Unfinished in field. *b* Revision completed in field.

North Carolina.—Topographic mapping was in progress in three quadrangles by three parties. The mapping of the Hertford quadrangle was completed for publication on the scale of 1:62,500, with a contour interval of 10 feet. The resurvey of the Saluda (North Carolina-South Carolina) quadrangle was in progress, as was the control of the Charlotte (North Carolina-South Carolina) quadrangle, both for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet.

Topographic surveys in North Carolina, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Pasquotank, Perquimans	Hertford (completed).	A. Pike, in charge; B. Duke.	166	....	258	11	5	538
Cabarrus, Gaston, Lincoln, Mecklenburg, Union	Charlotte (unfinished).	W. C. Hall	....	....	189	38	675	168
Buncombe, Henderson, McDowell, Polk, Rutherford	Saluda (resurvey unfinished).	W. M. Beaman, W. C. Hall, in charge; L. S. Leopold, J. R. Eakin.	424	101	421	20	1,767	1,814

North Dakota.—One party, under the supervision of Mr. Robert Muldrow, topographer in charge of section, was engaged in completing the mapping of the Wyndmere quadrangle for publication on the scale of 1:125,000, with a contour interval of 20 feet. In addition to the area reported in the following table, 51 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in North Dakota, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Ransom, Richland, Sargent	Wyndmere (completed).	B. Duke, in charge; J. G. Staack.	827	....	884	38	1,717	....

Ohio.—In an agreement signed May, 1904, by the governor of the State of Ohio and the Director of the United States Geological Survey $23,800 was allotted on behalf of the State for the year ending May 6, 1905, toward the cooperative topographic map of Ohio, and the same amount on behalf of the Federal Survey for the fiscal year ending June 30, 1905. In this agreement arrangements were made for the method of survey and the manner of expenditure. Under the general supervision of Mr. Frank Sutton, topographer in charge of section, nine parties were at work in thirty-three quadrangles, the mapping of fifteen of which was completed. Sixteen were partly surveyed. Additions were made to two previously mapped. This work is for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. In addition to the areas reported in the following tabular statement, 196 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Ohio.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Ashtabula Geauga Lake	Chardon	W. N. Morrill	227		405	7	2,052	764
Athens Morgan Washington	Chester Hill	D. C. Harrison, in charge; A. O. Burkland.	231	30	333		2,663	26
Ashtabula	Conneaut	W. N. Morrill	162		272	12	2,054	363
Clark Greene Miami Montgomery	Dayton	F. Sutton, W. H. Griffin, R. W. Berry, C. L. Sadler.	229		500		319	
Portage Summit	Kent	C. W. Goodlove, in charge; W. H. S. Morey.	75		32		280	36
Allen Auglaize Logan	Lima	M. Hackett	227		790		1,235	132
Butler Hamilton Warren	Mason	W. H. Griffin, in charge; C. L. Sadler.	231					23
Medina Lorain	Medina	W. N. Morrill	225		370	8	2,845	728
Fayette Madison Pickaway Ross	Mount Sterling.	C. W. Goodlove	230		362		2,432	275
Clark Greene	Springfield	W. H. Griffin, in charge; C. L. Sadler, R. W. Berry.	229		417		243	60
Washington	St. Marys	A. M. Walker	43		73	2	116	194
Crawford Seneca Wyandot	Sycamore	M. Hackett	121					90
Seneca	Tiffin	M. Hackett, in charge; R. C. McKinney.	225		235		726	16
Ashland Lorain Medina	Wellington	W. N. Morrill	225		436	11	2,446	700
Athens Hocking Vinton	Zaleski	W. H. Lovell, C. W. Goodlove, W. H. S. Morey.	231	80	487	15	3,850	763
Total [a]			2,911	110	4,712	55	21,261	4,170
Ashtabula	Andover	W. N. Morrill						395
Hancock Hardin Wyandot	Arlington	M. Hackett			55	7	274	570
Gallia Lawrence	Athalia	W. H. Lovell		192	64	15	312	684
Gallia Jackson Lawrence	Bidwell	do.						73

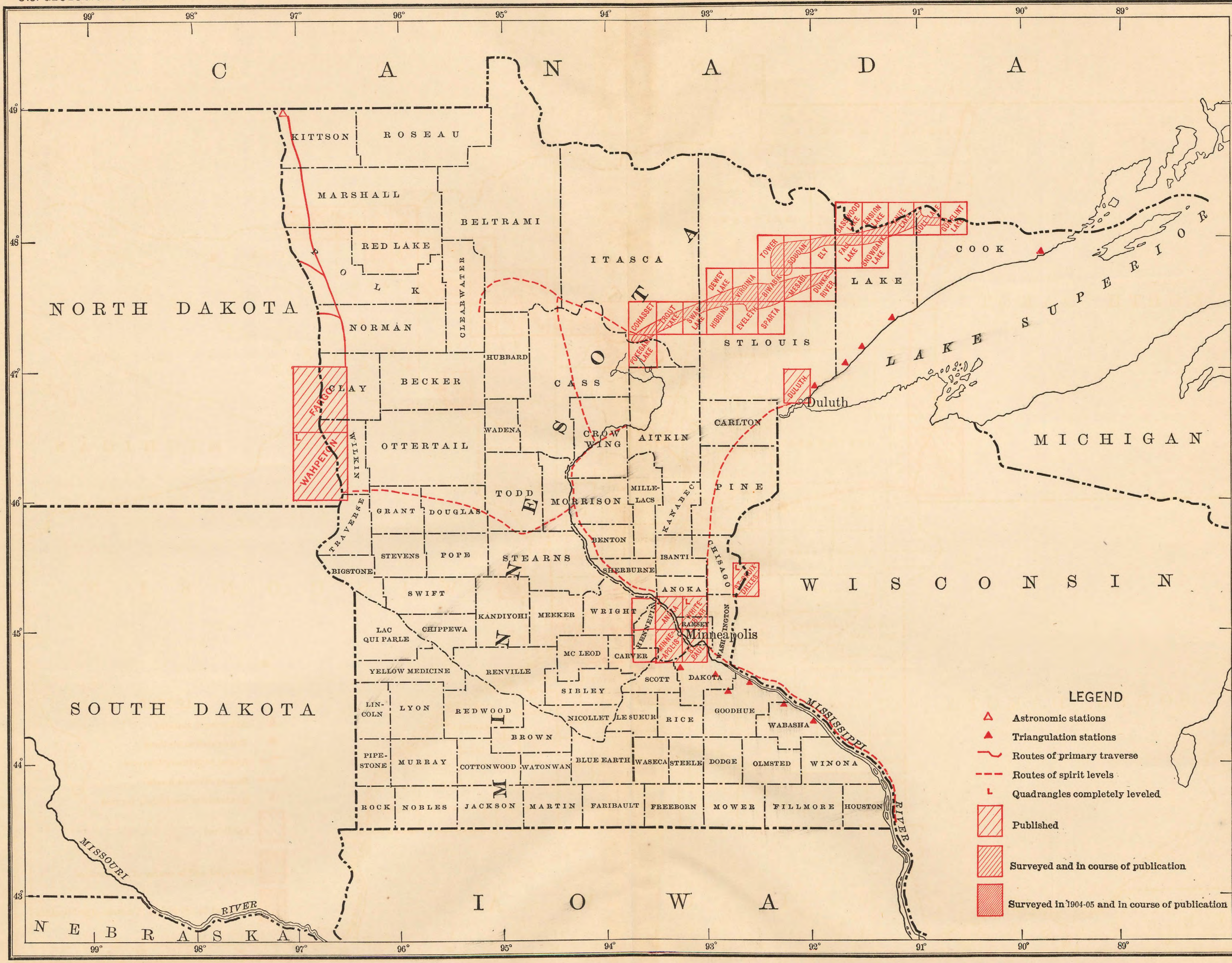
[a] Completed in field.

Topographic surveys made in 1904–5 in cooperation with the State of Ohio—Continued.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Clinton, Warren	Blanchester	W. H. Griffin						597
Allen, Hancock, Hardin, Putnam	Bluffton	M. Hackett			80	11	374	691
Darke, Miami, Montgomery	Brookville	W. H. Griffin						718
Cuyahoga, Geauga, Portage, Summit	Chagrin Falls	W. N. Morrill						485
Ashtabula	Jefferson	do			54	12	349	448
Athens, Meigs	Keno	W. H. Lovell, W. J. Lloyd.		320	171	8	829	754
Madison	London	W. H. Griffin			43	7	23	407
Athens, Gallia, Meigs	Pomeroy	W. H. Lovell, W. J. Lloyd, R. C. McKinney, A. O. Burkland.	156	426	350	17	2,592	713
Clark, Greene, Madison	South Charleston.	W. H. Griffin			77	13	40	573
Hancock, Seneca, Wyandot	Upper Sandusky	M. Hackett			384	4	97	603
Darke, Preble	West Manchester.	W. H. Griffin						621
Gallia, Jackson, Meigs, Vinton	Wilkesville	W. H. Lovell, D. C. Harrison.		191	42	9	21	653
Total[a]			156	1,129	1,320	103	4,911	8,985
Delaware, Marion, Morrow, Union	Delaware	M. Hackett						19
Jefferson	Steubenville	C. L. Sadler						8
Total[b]								27

[a] Unfinished in field. [b] Additions to completed sheets.

Pennsylvania.—In cooperation with Pennsylvania the topographic mapping of the State was conducted under an agreement signed July 12, 1899, by the members of the State Survey Commission and the Director of the United States Geological Survey; and by correspondence



MAP OF MINNESOTA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL in June, 1903, arrangements were made for the expenditure of $15,000 on behalf of the State and the same amount on behalf of the Federal Survey. Under the general supervision of Mr. R. D. Cummin, topographer in charge of section, six parties were engaged in work in seventeen quadrangles. In nine of these field work was completed and in five it was left uncompleted; revision was completed in two others and begun in a third. All the original mapping is for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to the areas reported in the following tabular statement, 66 square miles were mapped as overrun on edges of adjacent quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of Pennsylvania.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		Miles.			Miles.
Allegheny, Beaver, Washington	Burgettstown	W. T. Griswold, in charge; M. J. Munn, E. W. McCrary, J. H. Wilke.	228	51	699	13	4,230	583
Allegheny, Washington	Carnegie	E. B. Clark, in charge; J. S. B. Daingerfield.	111					25
Chester, Lancaster	Coatesville	R. D. Cummin, in charge; A. C. Roberts.	229		163		579	430
Allegheny, Westmoreland	Greensburg	E. B. Clark, in charge; J. S. B. Daingerfield.	228					27
Cambria, Indiana, Somerset, Westmoreland	Johnstown	A. C. Roberts, in charge; B. B. Alexander.	101					69
Allegheny, Washington, Westmoreland	McKeesport	E. B. Clark, in charge; B. B. Alexander.	71					18
Cumberland, Dauphin, Perry	New Bloomfield	R. D. Cummin, in charge; R. Coe, H. L. Johnston, B. B. Alexander, I. M. Flocker.	227	60	402	9	1,352	646
Berks, Chester, Montgomery	Phoenixville	R. D. Cummin, in charge; J. M. Whitman, J. D. Forster, H. L. McDonald, B. B. Alexander.	228		478		2,030	696
Clearfield, Indiana, Jefferson	Punxsutawney	A. C. Roberts	113					10
Total[a]			1,536	111	1,742	22	8,191	2,504

[a] Completed in field.

Topographic surveys made in 1904–5 in cooperation with the State of Pennsylvania—Continued.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Crawford	Andover	W. N. Morrill						46
Greene, Washington	Claysville	W. T. Griswold, in charge; B. J. Greene, M. J. Munn, E. M. McCrary.	2	124	54	7	97	740
Juniata, Perry, Snyder	Millerstown	R. D. Cummin, in charge; J. D. Forster.		68	75	10	283	897
Allegheny, Butler, Westmoreland	Sharpsburg	R. D. Cummin						400
Berks, Chester, Lancaster	Suplee	do			198		556	786
Total [a]			2	192	327	17	936	2,869
Bucks	Bordentown	J. M. Whitman	3					
Bucks, Philadelphia	Burlington	J. M. Whitman, in charge; C. Hartman, F. J. McMaugh, J. I. Treidel.	138					
Total [b]			141					
Bucks	Lambertville (revision unfinished).	J. M. Whitman			79		283	244

[a] Unfinished in field. [b] Revision completed in field.

South Carolina.—One party was engaged in the mapping of two quadrangles. The survey of the Charlotte (North Carolina-South Carolina) and the resurvey of the Saluda (North Carolina-South Carolina) quadrangles were in progress for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet. In addition to the area reported in the following table, 12 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in South Carolina, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
York	Charlotte (unfinished).	W. C. Hall			42	4	148	
Greenville, Spartanburg	Saluda (resurvey unfinished).	W. C. Hall, in charge; W. M. Beaman, L. S. Leopold, J. E. Eakin.	234	36	270	11	954	1,085

Vermont.—One party was engaged in work in three quadrangles. The survey of the Burlington quadrangle was completed in the field, and additions were made to the Plattsburg and Rouse Point (Vermont-New York) sheets; all for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to the area reported in the following table, 22 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in Vermont, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Addison; Chittenden	Burlington (completed).	H. Munroe, C. Hartman.	214	123	284	13	1,156	853
Grand Isle; Chittenden; Grand Isle (addition).	Plattsburg and Rouse Point.	H. Munroe	....	....	....	....	....	40

Virginia.—One party was engaged in the survey of two quadrangles. The mapping of the Williamsburg quadrangle was completed in the field, and considerable progress was made in mapping the Yorktown quadrangle, for publication on the scale of 1: 62,500, with a contour interval of 10 feet. In addition to areas reported in the following table, 24 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in Virginia, 1904–5.

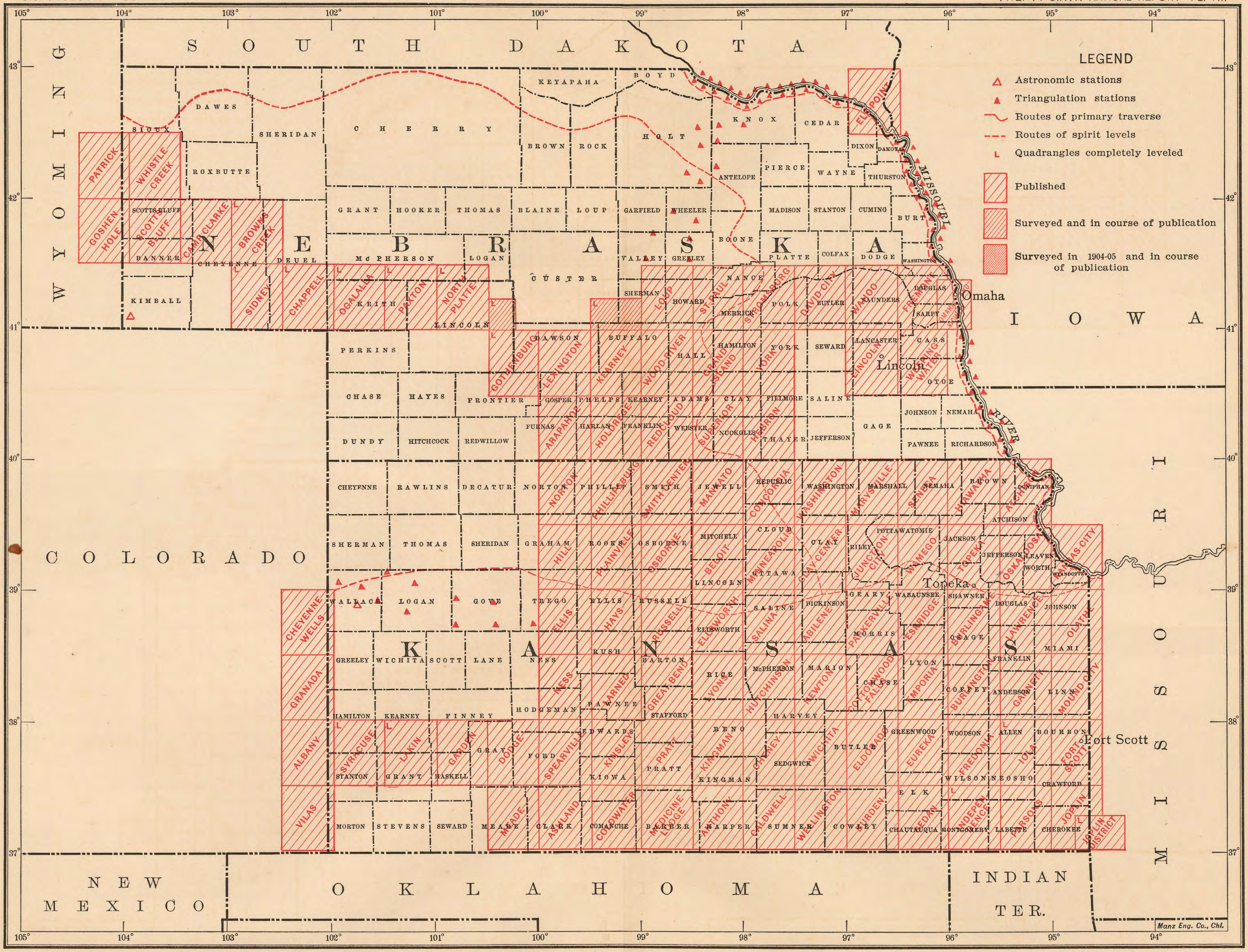
County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels. Spirit levels.	Levels. Bench marks.	Levels. Elevations.	Traverse.
			Sq. miles.		*Miles.*			*Miles.*
Gloucester; James City; York	Williamsburg (completed).	A. Pike, in charge; R. L. Harrison.	237	....	709	12	72	974
James City; Surrey; Warwick	Yorktown (unfinished).	A. Pike	97	....	229	....	....	475

West Virginia.—Topographic mapping in the State of West Virginia was in progress under the terms of an agreement signed by the State geologist of West Virginia and the Director of the United States Geological Survey in March, 1901. Out of the total appropriation by the legislature for the years 1903–4 and 1904–5, $10,000 was set aside for the work of the year 1904, and $15,000 of Federal funds were available. Under the general supervision of Mr. A. M. Walker, topographer in charge of section, six parties were at work in twelve quadrangles, the surveys of four of which were completed in the field, and considerable progress was made in six others. Additions were also made to two sheets of other quadrangles previously completed. The original work is all for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to areas reported in the following table, 22 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys made in 1904–5 in cooperation with the State of West Virginia.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		Miles.			Miles.
Ritchie, Wirt, Wood	Elizabeth	E. I. Ireland, in charge; J. H. Sinclair, D. B. Reger.	232	47	367	21	1,247	825
Calhoun, Ritchie, Wirt	Harrisville	W. N. Brown, in charge; J. R. McMillan, J. H. Sinclair.	232	123	361	15	1,547	1,457
Doddridge, Gilmer, Ritchie	Holbrook	E. I. Ireland, in charge; D. B. Reger.	119	....	53	....	149	....
Pleasants, Ritchie, Tyler	St. Marys	A. M. Walker, in charge; H. L. McDonald.	188	10	225	4	977	760
Total [a]			771	180	1,006	40	3,920	3,042
Calhoun, Gilmer, Roane, Wirt	Arnoldsburg	A. M. Walker	....	70	90	20	395	65
Cabell	Athalia	W. H. Lovell	....	10	....	....	....	53
Jackson, Mason	Keno	W. J. Lloyd	....	47	....	2	....	23
Mason	Pomeroy	W. H. Lovell	....	10	8	....	40	30
Calhoun, Roane, Wirt	Spencer	A. M. Walker	....	179	....	....	....	....
Barbour, Marion, Monongalia, Preston, Taylor	Thornton	A. M. Walker, in charge; W. N. Brown, J. H. Sinclair.	147	54	419	16	1,904	1,082
Total [b]			147	370	517	38	2,339	1,253

[a] Completed in field. [b] Unfinished in field.



MAP OF NEBRASKA AND KANSAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Topographic surveys made in 1904–5 in cooperation with the State of West Virginia—Cont'd.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Barbour, Harrison, Taylor, Upshur	Philippi	A. M. Walker						11
Hancock, Brooke	Steubenville	C. L. Sadler						7
Total [a]								18

[a] Additions.

Wisconsin.—Three parties under the general supervision of Mr. Robert Muldrow, topographer in charge of section, were engaged in work in four quadrangles. The resurvey of the Evansville and Madison quadrangles for publication on the scale of 1:62,500, with a contour interval of 20 feet, was completed in the field. The revision of the Lake Geneva and Silver Lake quadrangles for culture only was completed in the field; scale 1:62,500, contour interval 20 feet. In addition to the areas reported in the following table, 51 square miles were mapped as overrun on edges of adjoining quadrangles.

Topographic surveys in Wisconsin, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Trigonometric locations.	Levels.			Traverse.
					Spirit levels.	Bench marks.	Elevations.	
			Sq. miles.		*Miles.*			*Miles.*
Dane, Green, Rock	Evansville	R. Muldrow, in charge; A. T. Fowler, J. G. Staack.	219	243	368	10	1,721	527
Dane	Madison	R. Muldrow	218	263	537	19	2,136	580
Total [a]			437	506	905	29	3,857	1,107
Kenosha, Racine, Walworth	Lake Geneva	B. Duke	220					25
Kenosha, Racine	Silver Lake	L. S. Smith	220					
Total [b]			440					25

[a] Resurvey completed in field. [b] Revision for culture.

OFFICE WORK.

The field work of surveying was discontinued by the various parties of the eastern division of topography from time to time during November and December. Upon completion of field work the party chiefs reported for office work in Washington.

Mr. A. H. Thompson acted as geographer in charge of office work during Mr. Wilson's absence on field inspection.

Mr. J. H. Wheat, topographer in charge of map work for the eastern division of topography, inspected all drafting, edited the completed atlas sheets, had charge of and transmitted all manuscript maps for photography and engraving, and attended to all other technical matters concerning maps.

The chiefs of the various sections had entire supervision of all office drafting done in the areas constituting the eastern division, including the examination of manuscript maps, as well as of printed proofs received from the division of engraving and printing.

During the office season the drafting of 80 sheets was completed. Photolithographic copies of all were made on the scale of 1:48,000 (4,000 feet to 1 inch) or 1:96,000, for immediate distribution, and the originals were then transmitted for engraving. The Detroit City, Mich., and Madison City, Wis., sheets were photolithographed on the scale of 1:24,000, but will not be engraved.

Atlas sheets on which drafting was completed in office by eastern division of topography.

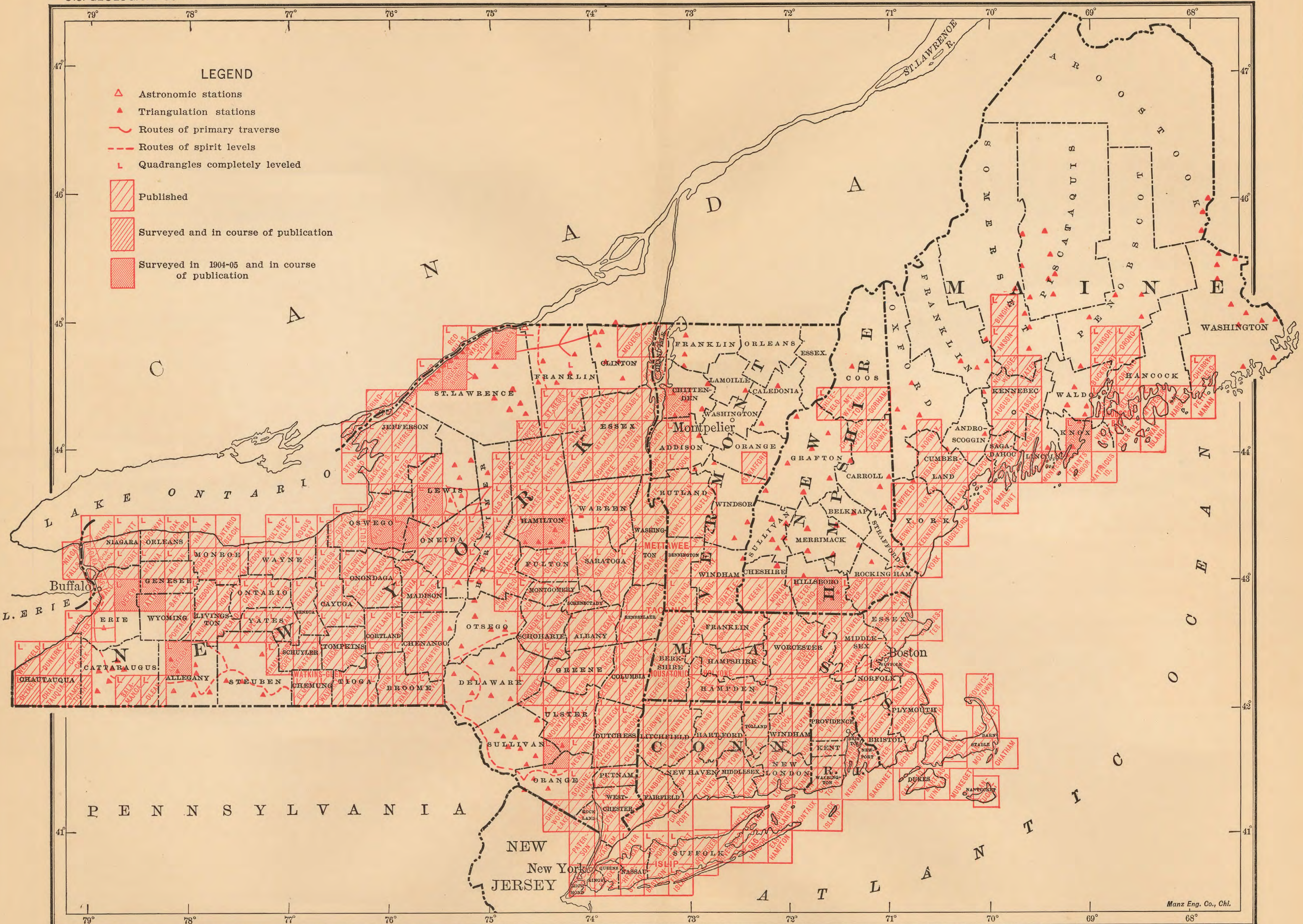
State.	Sheet.	Scale.	Contour interval.
			Feet.
Alabama	Birmingham Special	1:62,500	20
Arkansas	Harrison (Ark.-Mo.)	1:125,000	50
Delaware	Wilmington (Del.-N. J.)	1:62,500	20
Georgia	Crawfordsville (Ga.-S. C.)	1:125,000	50
Kentucky	Sebree	1:62,500	20
	Sutherland	1:62,500	20
Louisiana	Bayou Sara	1:125,000	20

Atlas sheets on which drafting was conpleted in office by eastern division of topography—Continued.

State.	Sheet.	Scale.	Contour interval.
			Feet.
Maine	Matinicus Island	1:62, 500	20
	Monhegan	1:62, 500	20
	Rockland	1:62, 500	20
	Tenants Harbor	1:62, 500	20
Maryland	Barclay (Md.-Del.)	1:62, 500	10
	Crapo	1:62, 500	10
	Denton	1:62, 500	10
	Drum Point	1:62, 500	10
	Ellicott	1:62, 500	20
	Hurlock	1:62, 500	10
	Owensville	1:62, 500	20
Michigan	Detroit	1:62, 500	20
	Detroit City	1:24, 000	20
	Dexter	1:62, 500	20
	Grosse Point	1:62, 500	20
	Saline	1:62, 500	20
	South Lyon	1:62, 500	20
	Ypsilanti	1:62, 500	20
Missouri	Farmington	1:62, 500	20
	Potosi	1:62, 500	20
New Hampshire	Milford	1:62, 500	20
New Jersey	Bordentown (N. J.-Pa.)	1:62, 500	20
	Burlington (N. J.-Pa.)	1:62, 500	20
	Princeton	1:62, 500	20
New York	Attica	1:62, 500	20
	Angelica	1:62, 500	20
	Brier Hill	1:62, 500	20
	Depew	1:62, 500	20
	Ellenville	1:62, 500	20
	Highmarket	1:62, 500	20
	Kasoag	1:62, 500	20
	Lake Pleasant	1:62, 500	20
	Red Mills	1:62, 500	20
	Massena	1:62, 500	20
	Mexico	1:62, 500	20
	Ogdensburg	1:62, 500	20
	Piseco Lake	1:62, 500	20
	Tupper Lake	1:62, 500	20
	Waddington	1:62, 500	20

Atlas sheets on which drafting was completed in office by eastern division of topography—Continued.

State.	Sheet.	Scale.	Contour interval.
			Feet.
North Carolina	Hertford	1:62,500	10
North Dakota	Wyndmere	1:125,000	20
Ohio	Chardon	1:62,500	20
	Chester Hill	1:62,500	20
	Conneaut (Ohio-Pa.)	1:62,500	20
	Dayton	1:62,500	20
	Kent	1:62,500	20
	Lima	1:62,500	10
	Mason	1:62,500	20
	Medina	1:62,500	20
	Mount Sterling	1:62,500	20
	Springfield	1:62,500	20
	Sycamore	1:62,500	10
	Tiffin	1:62,500	10
	Wellington	1:62,500	20
	Zaleski	1:62,500	20
Pennsylvania	Burgettstown	1:62,500	20
	Carnegie	1:62,500	20
	Coatesville (Pa.-Del.)	1:62,500	20
	Greensburg	1:62,500	20
	Johnstown	1:62,500	20
	McKeesport	1:62,500	20
	New Bloomfield	1:62,500	20
	Phoenixville	1:62,500	20
	Punxsutawney	1:62,500	20
Vermont	Burlington	1:62,500	20
Virginia	Williamsburg	1:62,500	10
West Virginia	Elizabeth	1:62,500	20
	Harrisville	1:62,500	20
	Holbrook	1:62,500	20
	St. Marys (W. Va.-Ohio)	1:62,500	20
Wisconsin	Evansville	1:62,500	20
	Lake Geneva	1:62,500	20
	Madison	1:62,500	20
	Silver Lake	1:62,500	20



MAP OF MAINE, NEW HAMPSHIRE, VERMONT, MASSACHUSETTS, RHODE ISLAND, CONNECTICUT, AND NEW YORK
SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Western Division of Topography

FIELD WORK.

SUMMARY OF ALL SURVEYS.

Mr. E. M. Douglas, geographer, continued in charge of the western division of topography. During the season topographic work was carried on in eleven States—Arizona, California, Colorado, Montana, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming, and in addition, forest-reserve boundary surveys were carried on in nine forest reserves in six States, as follows: Chiricahua Reserve, Arizona; Santa Barbara and San Jacinto reserves, California; Pocatello Reserve, Idaho; Lewis and Clark Reserve, Montana; Wichita Reserve, Oklahoma; and Aquarius, Logan, and Payson reserves, Utah. The survey of twenty quadrangles and six special quadrangles was completed and most of one quadrangle was revised, in addition to which thirteen quadrangles, one reservoir site, and one special quadrangle were partially surveyed. The total new area mapped was 8,425 square miles, of which 4,539 square miles were for publication on the scale of 1:125,000; 3,847 square miles were for publication on the scale of 1:62,500; 30 square miles were for publication on the scale of 1:24,000, and 9 square miles were for publication on the scale of 1:12,000. Resurveys or revision surveys covered 304 square miles, 266 of which were for publication on the scale of 1:62,500, 20 for publication on the scale of 1:24,000, and 18 for publication on the scale of 1:12,000. In connection with this work 4,531 linear miles of primary spirit levels were run and 1,086 permanent bench marks were established. There were run, also, 18,930 miles of secondary levels by stadia methods. Of forest-reserve boundary lines 753 miles were surveyed and marked by special iron posts.

Topographic surveys in the western divison from May 1, 1904, to April 30, 1905.

State or Territory.	Contour intervals.	Scale of publication.				Total area surveyed.	Levels.	
		1:125,000.		1:62,500.				
		New.	Resurvey or revision.	New.	Resurvey or revision.		Distance run.	Bench marks.
	Feet.	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Sq. mi.*	*Miles.*	
Arizona	50			757	57	[a] 844	463	127
California	5–10–20–50	310		1,068		[ab] 1,407	1,049	234
Colorado	10–100	160		229		[b] 407	296	93
Idaho							20	6
Montana	5–20–100	306		1,040		1,346	735	123
New Mexico	10–50			247		247	136	30
Oregon	100	201			209	410	191	50
South Dakota	20			382		382	393	73
Texas	50	1,030				1,030	372	118
Utah	50–100	515		84		599	103	8
Washington	100	607				607	72	6
Wyoming	100	1,450				1,450	701	218
Total		4,579		3,807	266	8,729	4,531	1,086

[a] Of this, 30 square miles in Arizona and 20 square miles resurvey in California on scale of 1:24,000.
[b] Of this, 9 square miles in California and 18 square miles resurvey in Colorado on scale of 1:12,000.

SUMMARY OF TOPOGRAPHIC SURVEYS.

Topographic work, exclusive of the forest-reserve boundary surveys, was carried on during the season by various parties in Arizona, California, Colorado, Montana, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming, which resulted in the completion of the survey of fourteen quadrangles and six special quadrangles, and the partial survey of ten quadrangles, one special quadrangle, a reservoir site, and the Belle Fourche dam project. The total new area surveyed was 5,397 square miles, of which 1,511 square miles were for publication on the scale of 1:125,000; 3,847 square miles were for publication on the scale of 1:62,500, and 39 square miles were for publication on special scales. In addition, 209 square miles on the scale of 1:62,500 were revised for culture. Eighteen square miles on the scale of 1:12,000 and 20 square miles on the scale of 1:24,000 were resurveyed. In connection with this work 3,209 miles of levels were run and 734 permanent bench marks were established.

TOPOGRAPHIC SURVEYS, BY STATES.

Arizona.—One party was engaged in topographic work on the Desert Well, Fort McDowell, Camels Back, and part of the Sacaton quadrangles, for publication on the scale of 1:62,500, with a contour interval of 50 feet; and one party on the Tombstone Special quadrangle for publication on the scale 1:24,000, with a contour interval of 50 feet.

In order to bring the leveling of the Geological Survey to a higher standard of accuracy, it was decided in the fall of 1904 to adopt the Coast and Geodetic Survey methods and instruments for the most important lines of levels. With this purpose in view, a precise-level outfit was purchased, including two velocipede cars for use along the Southern Pacific Railroad, and Mr. M. S. Bright, levelman, ran the first line from Yuma to Tucson.

Topographic surveys in Arizona, 1904–5.

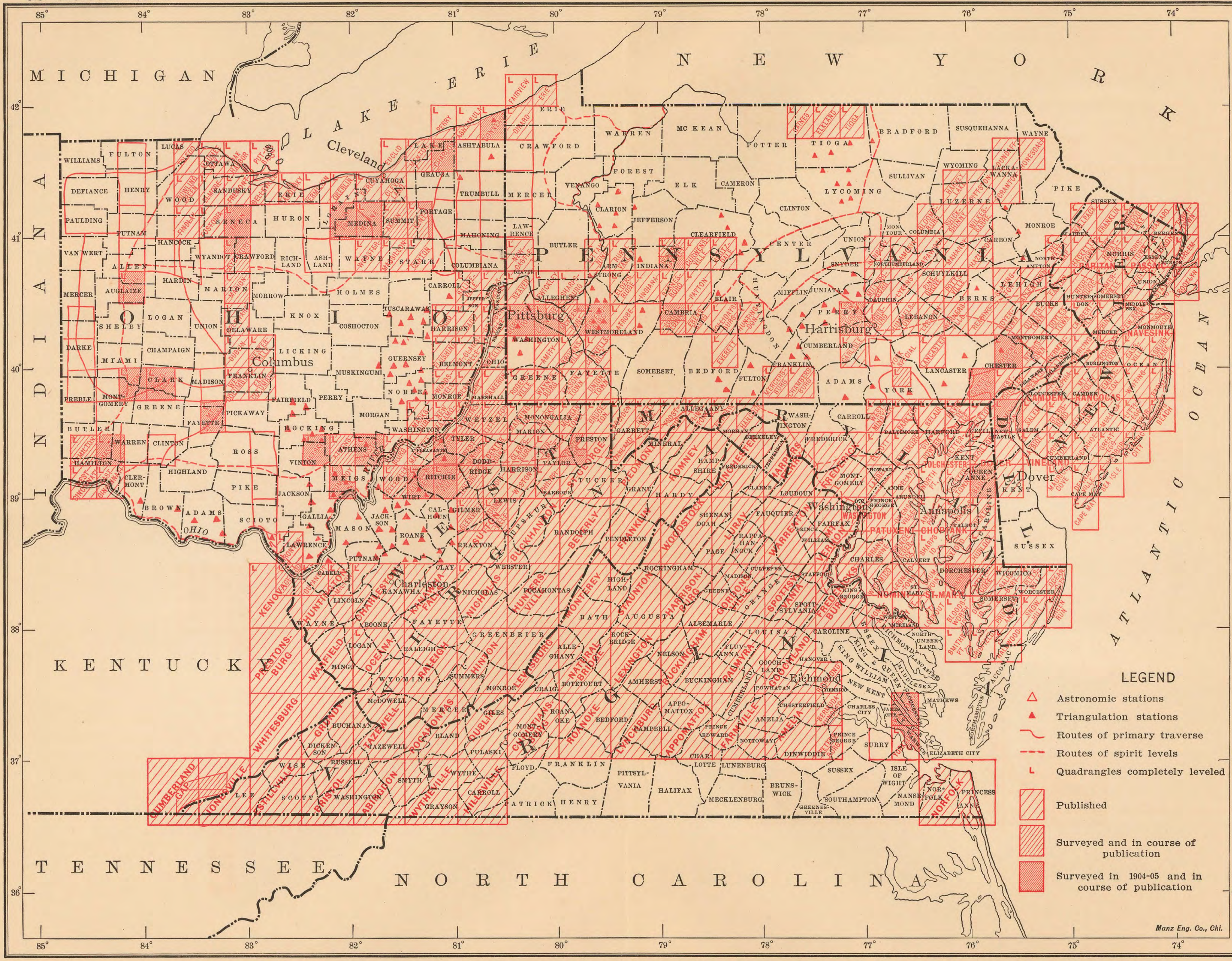
County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*	*No.*	*Miles.*
Pinal, Maricopa	Desert Well	T. M. Bannon, C. H. Birdseye, S. S. Stahl.	195			581
Do	Fort McDowell	T. M. Bannon, C. H. Birdseye	227			278
Do	Camels Back	T. M. Bannon, C. H. Birdseye, S. S. Stahl.	205			334
Do, Pinal	Sacaton	T. M. Bannon, S. S. Stahl	130			134
Cochise	Tombstone Special	R. H. Sargent	30	31	6	
Yuma, Maricopa	Yuma to Tucson	M. S. Bright		252	85	274
Total			787	283	91	1,601

California.—Part of the topographic work in California was carried on under a continuation of the agreement of the previous year between the Director of the United States Geological Survey and the State Board of Examiners of California, whereby $10,000 appropriated by the State was to be met by a like sum from the Geological

Survey, making a total of $20,000 for cooperative work. The cooperative work was confined entirely to the Sacramento Valley, and was carried on by three parties in the Willows, Maxwell, and part of the Colusa quadrangles for publication on the scale of 1:62,500, with a contour interval of 5 feet, the field surveys being on a scale of 2 inches to 1 mile. Topographic surveys were carried on in five other localities in California, viz: One party was engaged in completing the survey of the Bakersfield and Oil Center Special quadrangles, one in the completion of the Iron Mountain Special, and three parties in the survey of the Pleasanton, Holtville, and Tesla quadrangles. The work in the Bakersfield, Tesla, and Pleasanton quadrangles is for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet; that in the Iron Mountain Special on the scale of 1:24,000, with a contour interval of 50 feet; that in the Oil Center Special on the scale of 1:12,000, with a contour interval of 10 feet; that in the Holtville on the scale of 1:125,000, with a contour interval of 50 feet. In addition, one party was engaged in running a line of levels from Merced to the Yosemite Valley for the control of the Yosemite Special quadrangle.

Topographic surveys made in 1904–5 in cooperation with the State of California.

County.	Sheet.	Topographer.	Area.	Levels.	Bench marks.	Traverse.
			Sq. mi.	*Miles.*		*Miles.*
Shasta	Iron Mountain Special.	R. B. Marshall, in charge; A. I. Oliver, E. R. Bartlett.	20			
Kern	Bakersfield	R. B. Marshall, in charge; S. N. Stoner, H. R. Ferriss, W. N. Vance.	159	21	5	28
Do	Oil Center Special	R. B. Marshall, in charge; H. R. Ferriss.	9			
Alameda Contra Costa	Pleasanton	R. B. Marshall, in charge; S. N. Stoner, A. H. Sylvester.	236	18	5	511
Colusa Glenn	Sacramento Valley	R. B. Marshall, in charge; C. L. Nelson, Geo. R. Davis, J. P. Harrison, E. Percy Davis, H. R. Ferriss, W. N. Vance, E. R. Bartlett.	673	365	87	265
San Diego	Holtville	R. B. Marshall, in charge; S. N. Stoner, J. P. Harrison.	270	169	40	683
Alameda	Tesla	A. I. Oliver	40			
Merced Mariposa		R. B. Marshall, in charge; C. H. Semper.		180	41	
Total			1,407	753	178	1,487



MAP OF PENNSYLVANIA, NEW JERSEY, DELAWARE, MARYLAND, VIRGINIA, WEST VIRGINIA, AND OHIO SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Colorado.—Two parties were engaged in topographic work in the Black Hawk quadrangle and in the Idaho Springs, Silver Plume, and Central City Special quadrangles. The Black Hawk work was for publication on the scale of 1:62,500, with a contour interval of 100 feet, and the work in the special quadrangles was for publication on the scale of 1:12,000, with a contour interval of 10 feet.

Topographic surveys in Colorado, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Jefferson, Boulder, Gilpin	Black Hawk	Frank Tweedy	229	94	17	608
Clear Creek, Teller, Gilpin	Idaho Springs Special.	Pearson Chapman	8	17	7	60
Clear Creek	Silver Plume Special.	do	2	13	4	2
Gilpin	Central City Special.	Pearson Chapman, Dan F. Moore.	8	22	7	105
Total			247	146	35	775

Montana.—In cooperation with the Reclamation Service, three parties were engaged in topographic surveys in the Kremlin, Box Elder, and Lonesome Special quadrangles, and in parts of the Big Sandy, Virgelle, Laredo, Vandalia, and Glasgow quadrangles, and completed work in the Hinsdale Special quadrangle. The field work was done on the scales of 1:45,000 and 1:24,000, for publication on the scale of 1:62,500, with contour intervals of 20 and 5 feet. Lonesome Lake was also surveyed for a reservoir site, on the scale of 1:24,000. In addition to this topographic work two parties were engaged in running independent lines of levels, one to ascertain the subsidence of the surface of the earth in the vicinity of Butte, and the other to check old work in the vicinity of Garrison, the latter work being chargeable partly to forestry.

Topographic surveys in Montana, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Trav-erse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Chouteau	Kremlin	H. L. Baldwin, jr., in charge; Wm. Stranahan, Werner Lutz, A. J. Mather.	198	16	5	588
Do	Box Elder	H. L. Baldwin, jr., in charge; Wm. Stranahan, H. H. Hodgeson, A. J. Mather, W. Lutz.	199	45	14	851
Do	Lonesome Special.	H. L. Baldwin, jr., in charge; Wm. Stranahan, H. H. Hodgeson, S. P. Floore, Werner Lutz, A. J. Mather.	199	74	19	642
Do	Big Sandy	H. L. Baldwin, jr., in charge; Wm. Stranahan, A. J. Mather, Werner Lutz, S. P. Floore, H. H. Hodgeson.	116	34	7	294
Do	Laredo	Wm. Stranahan	70	19	4	309
Do	Virgelle	do	22	13	3	44
Valley	Vandalia	H. L. Baldwin, jr., in charge; A. B. Searle, H. H. Hodgeson, S. P. Floore, John Gussenhoven, Lee Morrison.	92	60	6	125
Do	Glasgow	H. L. Baldwin, jr., in charge; H. H. Hodgeson, S. P. Floore, F. Appleby.	42	28	4	
Do	Hinsdale	H. L. Baldwin, jr., in charge; A. B. Searle, Werner Lutz, H. H. Hodgeson, S. P. Floore, Lee Morrison, John Gussenhoven.	80	18	5	432
Chouteau	Lonesome Reservoir.	H. L. Baldwin, jr., A. B. Searle, H. H. Hodgeson, Lee Morrison.	22	35	4	634
Silver Bow / Flathead / Teton	Butte	F. E. Fellows, L. H. Brady, R. H. Chapman, G. H. Kendall.		92 / 9 / 44 / 84	17 / 2 / 3 /	
Total			1,040	571	93	3,919

New Mexico.—One party was engaged in topographic work on the Socorro quadrangle, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

Topographic surveys in New Mexico, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Trav-erse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Socorro	Socorro	R. H. Chapman, in charge; A. B. Searle, H. H. Hodgeson, B. D. Stewart.	247	136	30	479

Oregon.—In cooperation with the Reclamation Service the level line from Huntington to Biggs, commenced the previous season, was completed by Mr. C. H. Semper, levelman, 149 miles of line being run and 43 permanent bench marks established. One party was engaged in the revision of the culture of the Portland quadrangle, for publication on the scale of 1:62,500, with a contour interval of 25 feet, in order that copies might be ready for distribution at the Lewis and Clark Exposition. The area covered was 209 square miles.

South Dakota.—In cooperation with the Reclamation Service two parties were engaged in topographic work in an irregular area which is the site of the Belle Fourche reclamation project, and also in the Vale and Belle Fourche quadrangles. The area was surveyed on the scale of 1,000 feet to the inch, with a contour interval of 5 feet, all the work being for publication by large-scale photolithographs, and also by engraved sheets on the scale of 1:62,500, with a contour interval of 20 feet.

Topographic surveys in North Dakota, 1904–5.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Butte	Belle Fourche project.	W. H. Herron, in charge; C. H. Birdseye, J. E. Blackburn, Chester Irvine, J. E. Tichenor, R. M. Lafollette, H. D. Johnson; Homer Hadley, levelman.	235	231	42	1,739
Do	Belle Fourche	do	50			180
Do	Vale	do	97	162	31	331
Total			382	393	73	2,250

Texas.—Under a cooperative agreement with the University of Texas Mineral Survey, one party was engaged in topographic work in the Van Horn quadrangle, the resulting map being for publication on the scale of 1:125,000, with a contour interval of 50 feet. The amount allotted by the Mineral Survey was $2,500. A party was also engaged in running a level line for the control of the Texarkana 30-minute and adjoining quadrangles, to connect with Coast and Geodetic Survey bench marks at Greenville and Pittsburg.

Topographic surveys made in 1904-5 in cooperation with the University of Texas Mineral Survey.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
El Paso	Van Horn	Arthur Stiles, in charge; Stuart Penick, J. E. Blackburn.	1,030	79	29	2,096
Union	Texarkana	Chester Irvine		293	89	
Total			1,030	372	118	2,096

Utah.—One party was engaged in topographic work in the Frisco Special quadrangle, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

Topographic surveys in Utah, 1904-5.

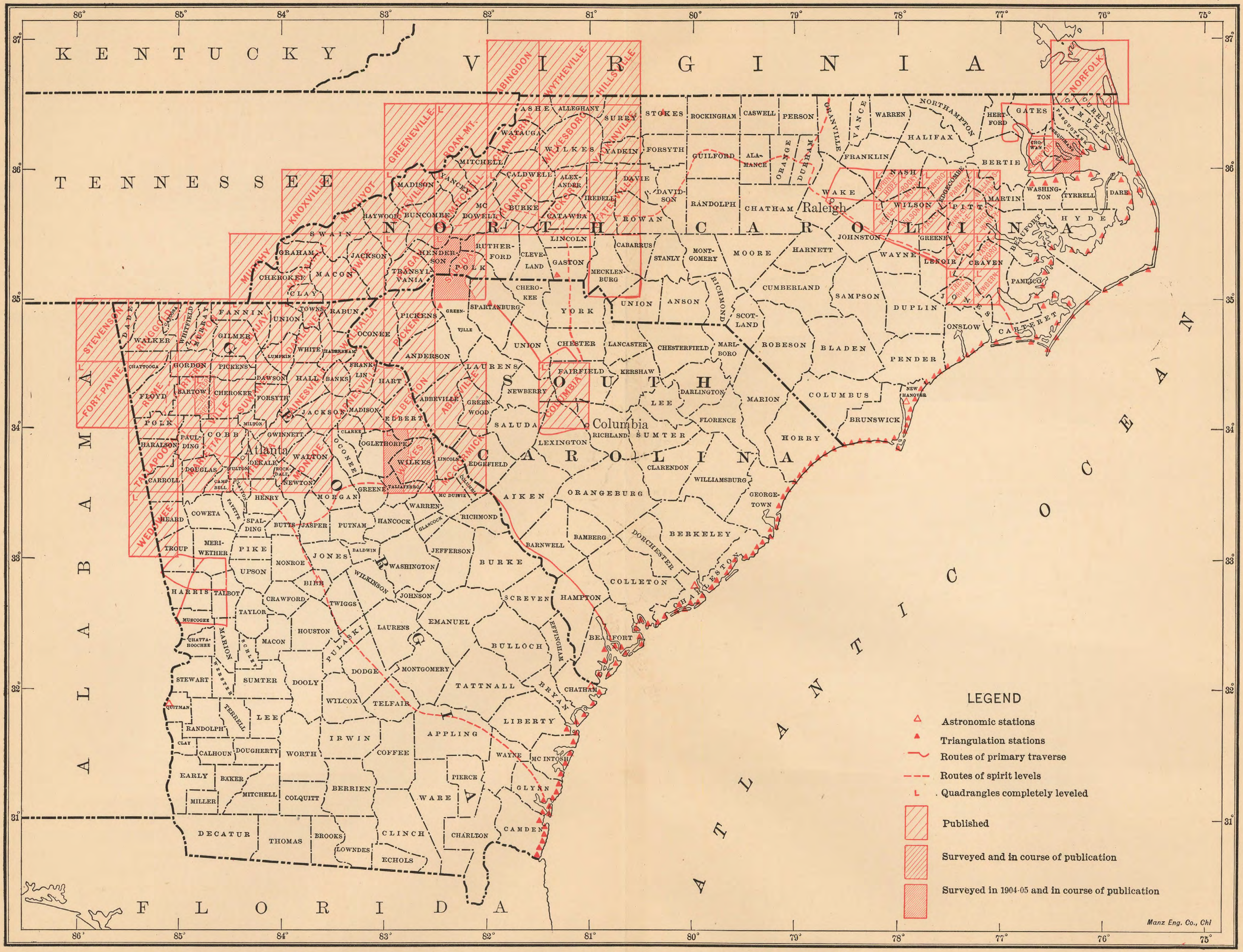
County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Beaver	Frisco Special	F. McLaughlin, R. A. Farmer	84	103	8	322

Washington.—One party was engaged in topographic work in the Pullman quadrangle, commenced last season, for publication on the scale of 1:125,000, with a contour interval of 50 feet. In addition, during the latter part of the season, one party ran a check line of levels over a small portion of the Okanogan quadrangle.

Topographic surveys in Washington, 1904-5.

County.	Sheet.	Topographer.	Area mapped.	Levels.		Traverse.
				Spirit levels.	Bench marks.	
			Sq. miles.	*Miles.*		*Miles.*
Whitman, Latah	Pullman	L. C. Fletcher	211			275
Okanogan	Okanogan	G. H. Kendall		72	6	
Total			211	72	6	275

Wyoming.—Mr. M. S. Bright, levelman, completed a circuit of levels begun the season previous and continued the line down Platte River via Casper and Orin Junction, at which place it was connected with the precise-level line of the Coast and Geodetic Survey. This line was



MAP OF NORTH CAROLINA, SOUTH CAROLINA, AND GEORGIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

231 miles in length, and in connection with it 59 permanent bench marks were established. This work was in Natrona, Converse, and Carbon counties.

SUMMARY OF SURVEYS OF FOREST RESERVES.

The topographic survey of forest reserves was continued under the direction of Mr. E. M. Douglas, geographer, and the forest examinations under the direction of Mr. Henry Gannett, geographer.

Topographic surveys were conducted in the following reserves: Grand Canyon, Sierra, San Juan (proposed), Lewis and Clark, Wallowa (proposed), Uinta, Mount Rainier, Medicine Bow, and Yellowstone. The boundaries of the Aquarius, Pocatello, Logan, Wichita, and Chiricahua reserves were completely surveyed and marked with iron posts, and portions of the boundaries of the Payson, Lewis and Clark, San Jacinto, and Santa Barbara reserves were surveyed and marked with iron posts. Five quadrangles were completely and four were partly surveyed. The total new area surveyed was 3,028 square miles, all for publication on the scale of 1: 125,000. In addition, 57 square miles were resurveyed, for publication on the scale of 1: 62,500. In connection with the above, 1,322 miles of levels were run and 352 permanent bench marks established; 753 miles of boundary lines were surveyed and marked, in connection with which 82½ miles of public-land lines were run, and 112 miles of the Lewis and Clark boundary were retraced for the purpose of marking with iron posts.

TOPOGRAPHIC SURVEYS OF FOREST RESERVES, BY STATES.

Arizona.—On April 30 topographic work was in progress by one party in the Shinumo quadrangle, for publication on the scale of 1: 62,500, with a contour interval of 50 feet. To secure additional control for this quadrangle and adjacent areas a line of levels was run from Apex Siding to Williams along the Grand Canyon Railroad and via Ash Fork to Jerome Junction along the Santa Fe Railroad. Between Williams and Jerome

Junction the precise level was used. The work in Arizona was greatly delayed by the exceptionally bad weather of the winter.

Forest-reserve surveys in Arizona, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Traverse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Coconino	Shinumo	Grand Canyon	R. T. Evans	57			181
			M. S. Bright		180	36	
Total				57	180	36	181

California.—Two parties were engaged in running level lines. One was a check line in the Sierras over the Tehipite quadrangle. Another, starting from a sea-level datum at Mohave, ran via Keeler to Independence in the Owens Valley, the intention being to connect with former work west of that place. This work was in progress at the close of this report. For the line from Mohave to Independence the precise methods and instruments (previously referred to in this report) were adopted.

Forest-reserve surveys in California, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Traverse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Fresno, Tulare	Tehipite	Sierra	R. A. Farmer		88		
Kern			do		208	56	
Total					296	56	

Colorado.—One party was engaged in topographic work in the San Cristobal quadrangle, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Forest-reserve surveys in Colorado, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Traverse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Hinsdale, Mineral	San Cristobal	San Juan	J. F. McBeth, J. E. Chapson.	160	150	58	120

Idaho.—A party under Mr. M. S. Bright, levelman, in the early part of the season ran a line of levels from Elmira to Bonners Ferry, placing temporary bench marks. This line, consisting of 20 miles, was checked later in the year by Mr. G. H. Kendall, levelman, who established six permanent bench marks in connection with it.

Oregon.—One party was engaged in completing the topographic survey of the Telocaset quadrangle, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Forest-reserve surveys in Oregon, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Traverse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Union	Telocaset	Wallowa	W. C. Guerin, C. H. Semper.	201	42	7	121

Montana.—One party was engaged in completing the topographic survey of the Kintla Lakes quadrangle and beginning that of the Marston quadrangle, both for publication on the scale of 1:125,000, with a contour interval of 100 feet. In addition, for the control of this and adjoining areas, one level party was maintained.

Forest-reserve surveys in Montana, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Traverse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Flathead	Kintla Lakes	Lewis and Clark	R. H. Chapman	216			205
Do	Marston		do	90			205
Flathead, Missoula			G. H. Kendall		164	30	
Total				306	164	30	410

Utah.—One party was engaged in completing topographic work in the Gilbert Peak quadrangle, for publication on the scale of 1: 125,000, with a contour interval of 100 feet.

Forest-reserve surveys in Utah, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area. mapped.	Levels.		Trav- erse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Summit, Wasatch, Uinta, Sweetwater	Gilbert Peak	Uinta	A. E. Murlin	515	....	....	238

Washington.—One party was engaged in completing topographic work in the Mount Adams quadrangle, for publication on the scale of 1: 125,000, with a contour interval of 100 feet.

Forest-reserve surveys in Washington, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Trav- erse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Yakima, Klickitat	Mount Adams	Mount Rainier	A. H. Sylvester	396	....	....	1,433

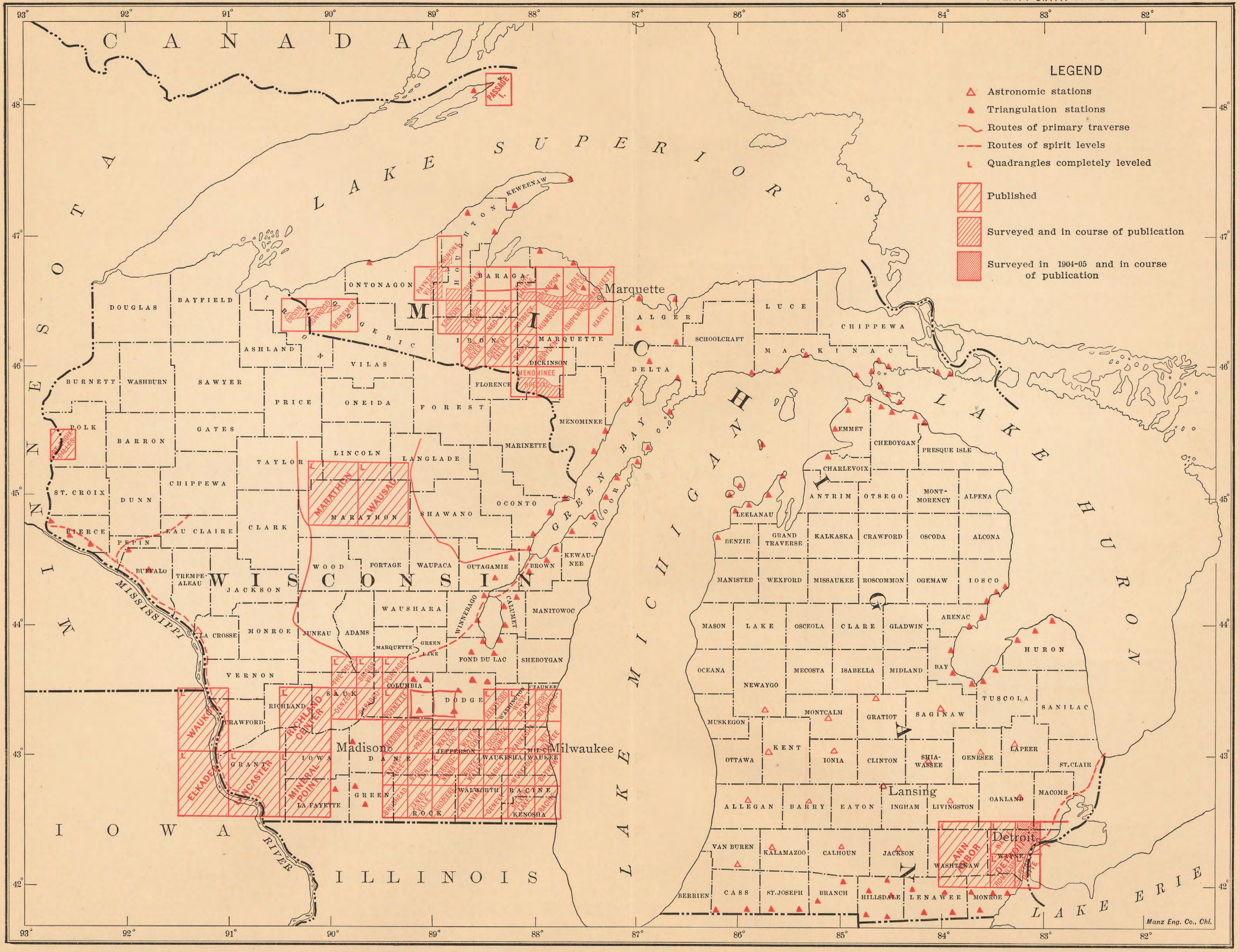
Wyoming.—Two parties were engaged in topographic work in two quadrangles, the Kirwin and the Medicine Bow, both for publication on the scale of 1: 125,000, with a contour interval of 100 feet.

Forest-reserve surveys in Wyoming, 1904–5.

County.	Sheet.	Reserve.	Topographer.	Area mapped.	Levels.		Trav- erse.
					Spirit levels.	Bench marks.	
				Sq. miles.	*Miles.*		*Miles.*
Bighorn	Kirwin	Yellowstone	T. M. Bannon, S. S. Stahl, W. J. Forster, H. M. Huntington.	857	358	119	291
Albany, Carbon	Medicine Bow	Medicine Bow	R. T. Evans	593	112	40	849
Total				1,450	470	159	1,140

BOUNDARY SURVEYS OF FOREST RESERVES.

Arizona, Chiricahua Reserve.—Mr. John P. Walker, U. S. surveyor, early in January, 1905, began the survey of this boundary and continued the work until the early part of May, when the entire line, consisting of 92½ miles,



MAP OF MICHIGAN AND WISCONSIN, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL was completed and marked with iron posts. In connection with the establishment of the boundary, 10½ miles of public-land lines were run.

California, Santa Barbara Reserve.—Mr. W. H. Thorn, U. S. surveyor, began the survey of the boundary of this reserve about the middle of October, and the work was in progress at the close of this report, when about half of the boundary, consisting of 145 miles, was completely surveyed and marked with iron posts. In connection with the boundary survey 6 miles of public-land lines were run.

California, San Jacinto Reserve.—The north and east boundaries of this reserve were surveyed and marked with iron posts by Mr. F. E. Joy, U. S. surveyor, who began work the latter part of November and continued until the middle of May, when 80 miles were completed. In connection with this boundary survey 19½ miles of public-land lines were run. Work was discontinued owing to proposed changes in the boundary.

Idaho, Pocatello Reserve.—Mr. F. E. Joy, U. S. surveyor, commenced work on the boundary of this reserve the 1st of June and had completely surveyed and marked the same with iron posts by the last of July. This boundary comprises 48 miles, and in connection with its survey 1 mile of public-land lines was run.

Montana, Lewis and Clark Reserve.—Mr. W. H. Thorn, U. S. surveyor, continued the survey of this reserve, beginning work about June 1 and continuing until November 7, when work was discontinued on account of winter weather. During the season Mr. Thorn surveyed and marked with iron posts 61½ miles of new line, and retraced 112 miles previously surveyed, for the purpose of setting iron posts, which were omitted the year before. In connection with this boundary survey 5½ miles of public-land lines were run.

Oklahoma, Wichita Reserve.—The entire boundary of this reserve, consisting of 53½ miles, was surveyed and marked with iron posts by Mr. John P. Walker, U. S. surveyor, who commenced work about the 1st of December and continued through January. In connection with this work 2½ miles of public-land lines were run.

Utah, Aquarius Reserve.—The entire boundary of this reserve, consisting of 154 miles, was completely surveyed and marked with iron posts by Mr. John P. Walker, U. S. surveyor, who commenced work about June 1 and continued through September. In connection with this boundary survey 11 miles of public-land lines were established.

Utah, Logan Reserve.—The boundary of this reserve, comprising 74 miles, was completely surveyed and marked with iron posts by Mr. F. E. Joy, U. S. surveyor, who commenced work the 1st of August and continued until the 11th of November. In connection with this boundary survey 7 miles of public-land lines were run. It was necessary for Mr. Joy to return to this reserve early in the spring of 1905 to make some minor corrections, which were required to perfect the survey.

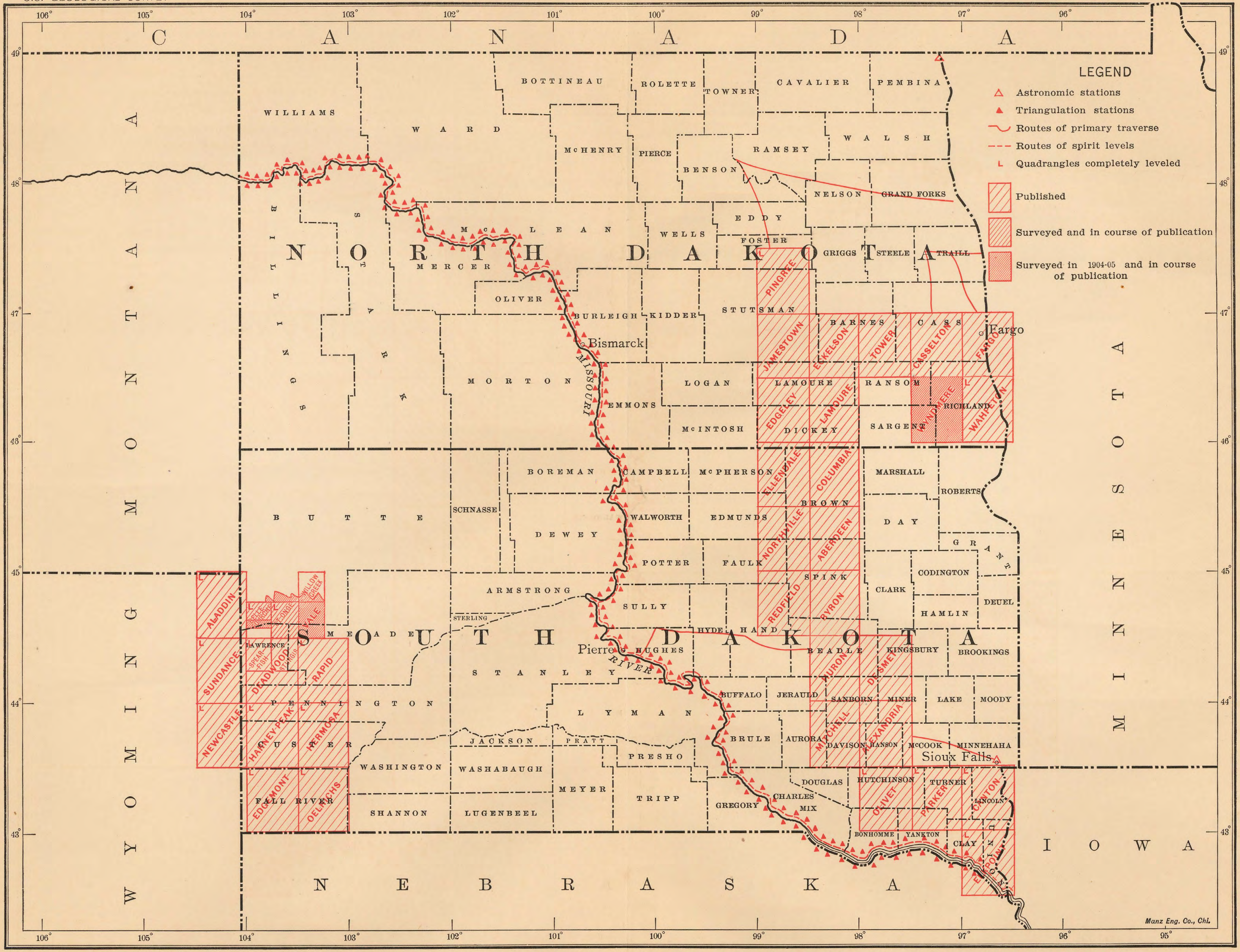
Utah, Payson Reserve.—Mr. John P. Walker, U. S. surveyor, commenced the survey of this boundary on the first of October and continued until the latter part of November, when work was discontinued on account of unfavorable weather, 44 miles having been completed. In connection with this boundary survey 19½ miles of public-land lines were run.

OFFICE WORK.

During Mr. Douglas's absence on field inspection Mr. A. H. Thompson acted as geographer in charge of office work.

During the office season the drafting of 30 sheets was completed and photographic copies of the same, on both field and publication scales, were made for advance distribution.

In the following table, arranged alphabetically by States, are enumerated the sheets drawn.



MAP OF NORTH DAKOTA AND SOUTH DAKOTA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Atlas sheets on which drafting was completed in office during 1904–5 by western division of topography.

State and sheet.	Scale.	Contour interval.
ARIZONA:		*Feet.*
Camels Back	1:62,500	50
Desert Well	1:62,500	50
Fort McDowell	1:62,500	50
Jerome	1:125,000	100
Tombstone Special	1:24,000	50
Vishnu	1:48,000	50
CALIFORNIA:		
Bakersfield	1:62,500	20
Iron Mountain Special	1:24,000	50
Maxwell	1:62,500	5
Oil Center Special	1:12,000	10
Pleasanton	1:62,500	50
Willows	1:62,500	5
COLORADO:		
Black Hawk	1:62,500	100
Central City Special	1:12,000	10
Idaho Springs Special	1:12,000	10
Silver Plume Special	1:12,000	10
MONTANA:		
Box Elder	1:62,500	20
Kremlin	1:62,500	20
Lonesome Special	1:62,500	20
Hinsdale	1:62,500	20
Kintla Lakes	1:125,000	100
NEW MEXICO:		
Socorro	1:62,500	50
OREGON:		
Portland revision	1:62,500	25
Telocaset	1:125,000	100
SOUTH DAKOTA:		
Vale	1:62,500	20
TEXAS:		
Van Horn	1:125,000	50
UTAH:		
Gilbert Peak	1:125,000	100
WASHINGTON:		
Mount Adams	1:125,000	100
Oakesdale	1:125,000	50
WYOMING:		
Kirwin	1:125,000	100

Triangulation and Computing Section.

FIELD WORK.

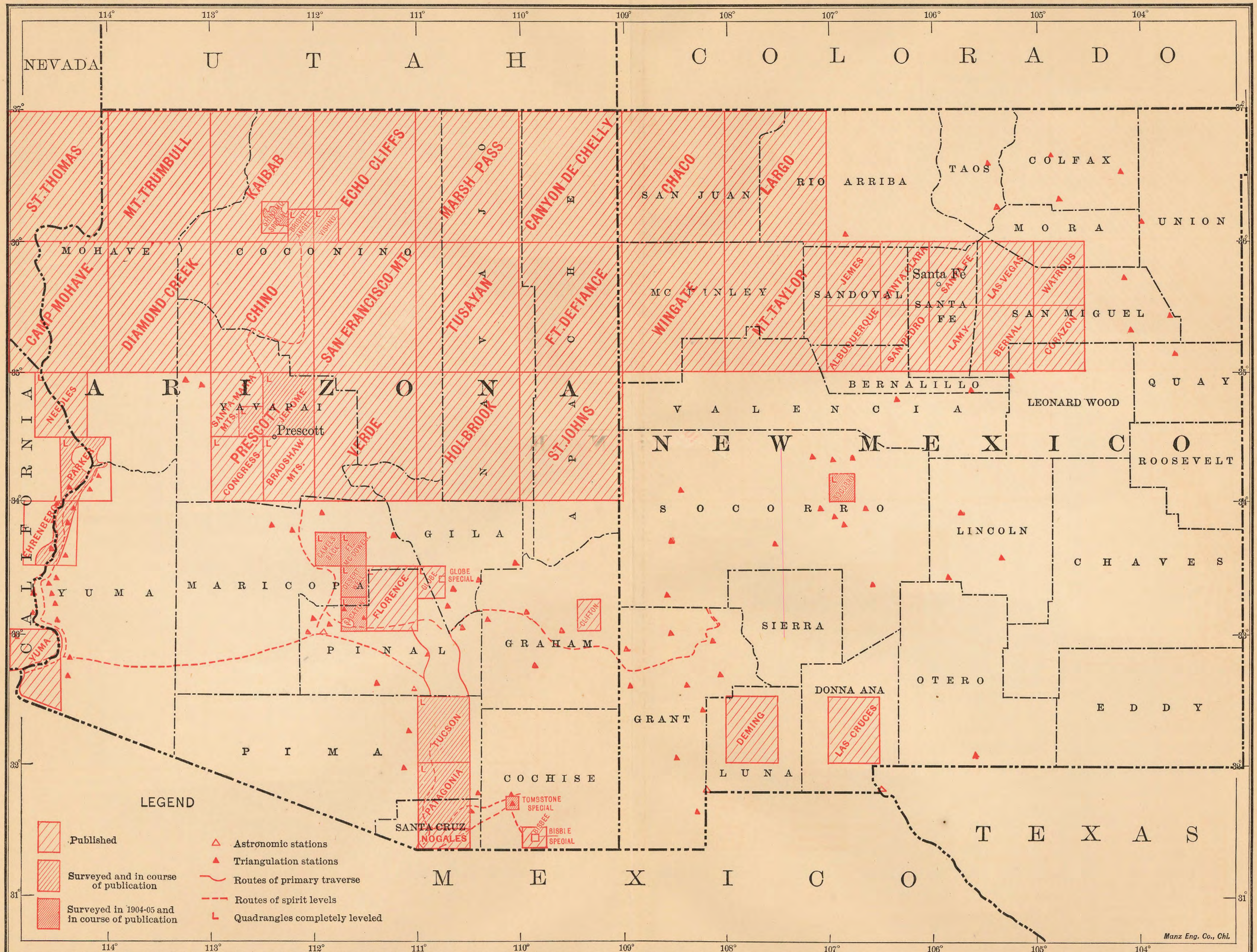
EASTERN DIVISION.

Mr. S. S. Gannett, geographer, continued to have general supervision of the primary control executed during the season in this division, under the general direction of Mr. H. M. Wilson, geographer in charge.

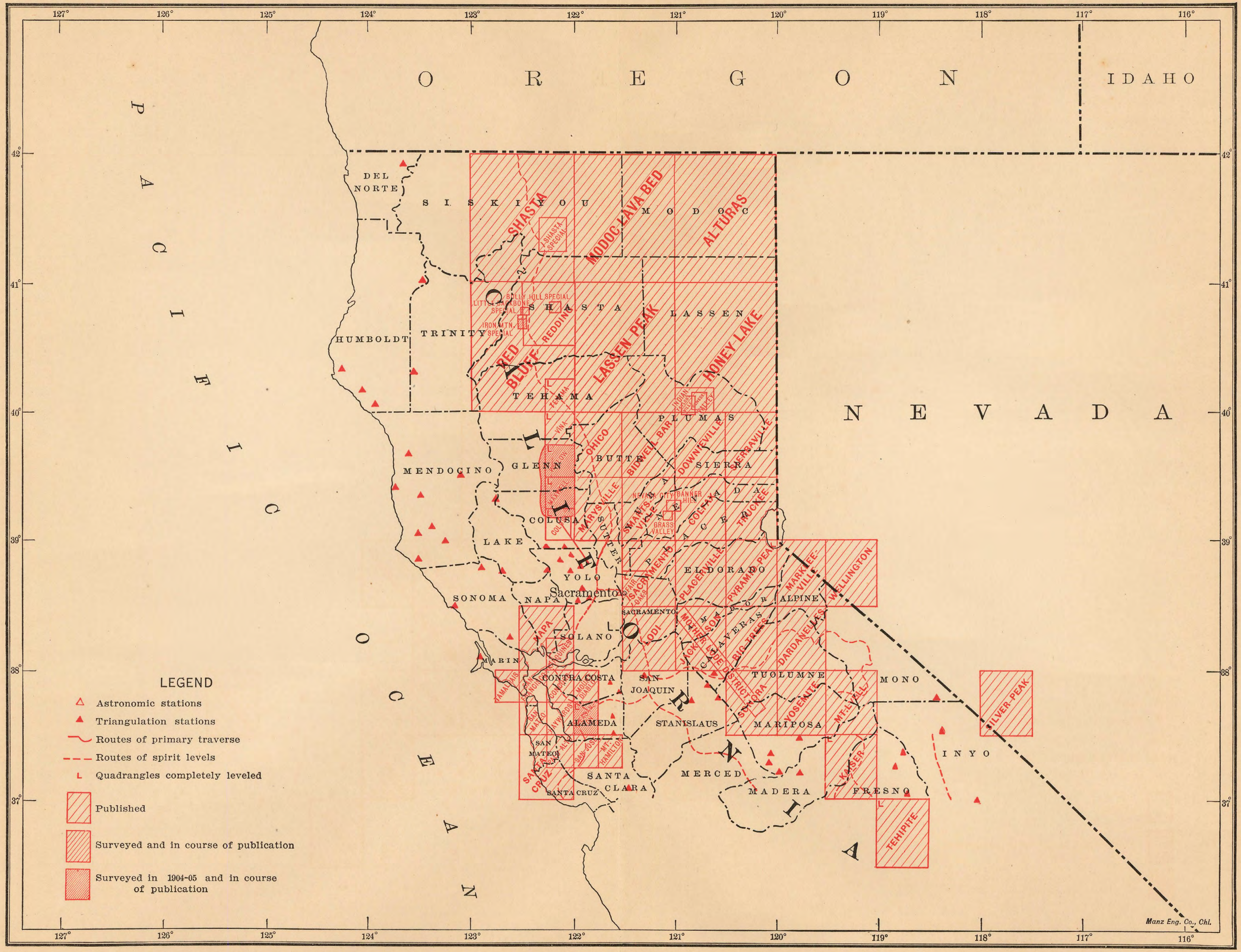
Primary triangulation and primary traverse were carried on at various times by seven parties. This work was distributed over portions of eighteen States: Alabama, Arkansas, Iowa, Kentucky, Maine, Maryland, Minnesota, Missouri, New Hampshire, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. The total area covered by this primary control was 18,600 square miles, of which 16,275 square miles were controlled by primary traverse. The result of this control was to make available forty-eight 15-minute quadrangles and eight 30-minute quadrangles in which to prosecute future topographic surveys. In the progress of this work fifty-five triangulation stations were permanently marked and their geodetic positions determined, and 3,179 miles of primary traverse were run.

Alabama.—The Birmingham 30-minute quadrangle, including the Birmingham and Leeds Special 15-minute quadrangles, was controlled by Mr. Oscar Jones, topographer, in the spring of 1904, by 189 miles of primary traverse. The Bessemer 30-minute quadrangle was controlled in a similar manner by Mr. C. B. Kendall, field assistant, in the fall of the same season by 195 miles of traverse. These two adjoining quadrangles cover portions of the counties of Bibb, Blount, Chilton, Jefferson, St. Clair, and Shelby.

Arkansas.—In order to preserve the identity of triangulation stations located during the seasons of 1887 to 1891 in the northwest portion of this State, Mr. E. L. McNair, topographer, visited 57 of these stations, of which he identified and permanently marked 48.



MAP OF ARIZONA AND NEW MEXICO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL



MAP OF NORTHERN CALIFORNIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Iowa.—The Des Moines 30-minute quadrangle, including the Des Moines 15-minute special quadrangle, was controlled by 164 miles of primary traverse run by Mr. J. R. Ellis, topographic aid, in the fall of 1904.

Kentucky.—Control for the Morganfield, Sebree, and Sutherland 15-minute quadrangles, in the counties of Daviess, Ohio, Union, and Webster; for the Frankfort 30-minute quadrangle, in the counties of Anderson, Fayette, Franklin, Grant, Henry, Owen, Scott, and Woodward, and for the Louisville quadrangle, covering portions of Bullitt, Jefferson, and Oldham counties, was obtained by 301 miles of primary traverse run by Mr. J. R. Ellis.

Maine.—The Belfast 15-minute quadrangle in Waldo County was controlled by Mr. E. L. McNair, topographer, who located 6 points by triangulation for this purpose.

Maryland.—Mr. C. B. Kendall, field assistant, ran 187 miles of primary traverse for the control of the Monocacy, Owensville, Ridgeville, Rockville, and Seneca 15-minute quadrangles, covering portions of the counties of Anne Arundel, Carroll, Frederick, Howard, Montgomery, and Prince George.

Minnesota.—Two 15-minute quadrangles in the counties of Carver, Hennepin, and Wright were controlled by 118 miles of traverse run by Mr. George T. Hawkins, topographer.

Missouri.—Additional control for the Farmington and Potosi 15-minute quadrangles, in St. Francois, Ste. Genevieve, and Washington counties, was obtained by Mr. Sledge Tatum by means of 63 miles of traverse.

New Hampshire.—During the summer of 1904 control for the Sunapee Lake quadrangle, in the counties of Merrimac and Sullivan, was obtained by triangulation by Mr. E. L. McNair, topographer. Four new stations were occupied and six secondary points cut in.

New York.—Additional control for the Waterville and Winfield quadrangles, in Herkimer and Oneida counties, was obtained by Mr. McNair, who located 5 triangulation points for this purpose; control for the Eden quadrangle, in Erie County, for the McKeever and Port Leyden quadrangles, in Lewis County, and for the Brier Hill, Canton, Massena, Morristown, and Ogdensburg quadrangles, in St. Lawrence County, was obtained by means of 336 miles of primary traverse run by Mr. McNair.

North Carolina.—The Charlotte 30-minute quadrangle, in Cabarrus, Iredell, Mecklenburg, Rowan, and Union counties, was controlled by 195 miles of primary traverse run by Mr. C. B. Kendall.

North Dakota.—Mr. Sledge Tatum, topographer, completed control for the Wyndmere 30-minute quadrangle, in Ransom, Richland, and Sargent counties, by running 97 miles of traverse.

Ohio.—During the field season of 1904 primary-traverse control was completed for fifteen quadrangles situated in the counties of Columbiana, Cuyahoga, Geauga, Lake, Mahoning, Medina, Pike, Putnam, Ross, Scioto, Summit, and Trumbull. A total distance of 591 miles was run, of which Mr. Kendall ran 101 miles and Mr. Ellis 490 miles.

Pennsylvania.—The Phoenixville and Suplee 15-minute quadrangles, in Berks, Chester, and Lancaster counties, were controlled by 116 miles of primary traverse by Mr. E. L. McNair. The Neshannock and Stoneboro quadrangles, in Mercer County, were controlled by 69 miles of traverse run by Mr. J. R. Ellis. The Honeygrove, Loysville, and Shippensburg quadrangles, in Franklin, Juniata, Perry, and Snyder counties, were controlled by 9 triangulation stations located by Mr. George T. Hawkins, topographer.

Tennessee.—Mr. C. B. Kendall ran 120 miles of primary traverse for the control of the Lawrenceburg 30-minute quadrangle, in Giles, Lawrence, and Maury counties.

Virginia.—The Jamestown, Williamsburg, and Yorktown quadrangles, in Gloucester, Isle of Wight, King and Queen, and Surry counties, were controlled by 91 miles of traverse run by Mr. C. B. Kendall in the spring of 1904.

West Virginia.—Five quadrangles, covering portions of the counties of Braxton, Calhoun, Jackson, and Roane, were triangulated by Mr. C. A. Clunet, field assistant; 22 new stations were occupied and 3 points were located by intersections.

Wisconsin.—For the resurvey of ten 15-minute quadrangles in the counties of Jefferson, Kenosha, Racine, Walworth, and Waukesha, 222 miles of traverse were run by Mr. George T. Hawkins in the fall of 1904.

WESTERN DIVISION.

Triangulation was carried on at various times during the year by nine parties and primary traverse by one of the same parties. This work was distributed over portions of eleven States and Territories: Arizona, California, Colorado, Montana, New Mexico, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. The total area covered by this primary control was 21,850 square miles, of which 5,000 square miles were controlled by primary traverse. The result of this control was to make available fifteen 15-minute quadrangles and twenty 30-minute quadrangles in which to prosecute future surveys. In the progress of this work 254 new triangulation stations were selected, permanently marked, and their geodetic positions determined, and 597 miles of primary traverse were run.

Arizona.—Secondary triangulation was extended over three 15-minute quadrangles in Maricopa County by Mr. T. M. Bannon, topographer, in the winter of 1904–5. Six secondary and three point stations were located by intersections.

California.—In order to control six special 10-minute quadrangles in the Sacramento Valley, Mr. C. F. Urquhart occupied 18 triangulation stations and located 18 points by intersections. These stations are situated in the counties of Butte, Colusa, Sutter, and Yolo, and are developed from the Yolo base, United States Coast and Geodetic Survey.

Montana.—During the season of 1904, Mr. Fred McLaughlin connected the triangulation which had been extended eastward from the Burnham base with the Missouri River Commission triangulation near the junction of Missouri and Milk rivers, in Valley County.

Later in the season an area of about 1,000 square miles in Chouteau County was controlled, extending from a little north of the Burnham base, in Chouteau County, south of the Burnham base to connect with the line Recess-Ridge of the Missouri River triangulation, and thence west to beyond Marias River. The work was done under the supervision of Mr. H. L. Baldwin, jr. Eight old stations were reoccupied, including those of the Missouri River Commission, and 18 new ones were selected and occupied.

South Dakota.—Mr. R. B. Robertson occupied 3 primary triangulation stations, 13 secondary stations, and located 15 other points for the control of the special maps of the Belle Fourche project, in Butte County.

Texas.—The Vanhorn 30-minute quadrangle in El Paso County was controlled by Arthur Stiles, who occupied 4 primary stations and located 9 secondary points.

An area of about 5,000 square miles in the northeastern part of the State was controlled during the winter and spring of 1904–5 by Mr. Sledge Tatum, topographer, who ran a primary-traverse line 597 miles in length through the counties of Bowie, Cass, Fannin, Gregg, Harrison, Lamar, Marion, Red River, Titus, and Upshur. This line was run approximately along the parallels and meridians bordering 30-minute quadrangles.

Utah.—The area of the Frisco Special map, in Beaver County, was controlled by Mr. Fred McLaughlin in the late fall of 1904. Seven stations were occupied and 6 were located by intersections.

SURVEYS OF FOREST RESERVES, WESTERN TOPOGRAPHY.

California, Sierra Reserve.—The control for an area of 5,000 square miles in the counties of Fresno, Inyo, Mono, and Tulare was partly completed by Mr. C. F. Urquhart, topographer, in the summer of 1904. Mr. Urquhart reoccupied 4 old stations, selected and permanently marked 15 new stations, obtained final observations at most of the latter, and located 15 points by intersections.

Colorado, proposed reserve.—One 30-minute quadrangle (including the Creede Special), in Hinsdale and Mineral counties, was controlled by Mr. J. F. McBeth, topographer, who occupied 9 new stations and located 2 points by intersections.

New Mexico, Gila River and proposed reserve.—In the winter of 1904–5, Mr. R. H. Chapman, topographer, measured and expanded a base at San Antonio, a few miles south of Socorro, for the control of the Gila River and proposed reserve. From this base triangulation was extended northward so as to connect with the astronomic pier at Albuquerque and with points located in 1886–87 from the Wingate base and astronomic station. Sixteen stations were occupied and 15 points were located by intersections, but owing to extremely unfavorable conditions final observations could not be obtained. Azimuth observations were made at the North base and a check azimuth was observed at Socorro Peak.

Oregon, proposed reserve.—The Grants Pass 30-minute quadrangle, covering portions of the counties of Jackson and Josephine, was triangulated in the fall of 1904 by Mr. A. I. Oliver, who occupied 9 stations.

Wyoming, Yellowstone Reserve.—An area of 4,000 square miles in the counties of Bighorn and Fremont was triangulated during the season of 1904 by Mr. R. B. Robertson. Besides reoccupying 6 old stations, 24 new stations were selected, permanently marked and occupied, and 17 points were located by intersections.

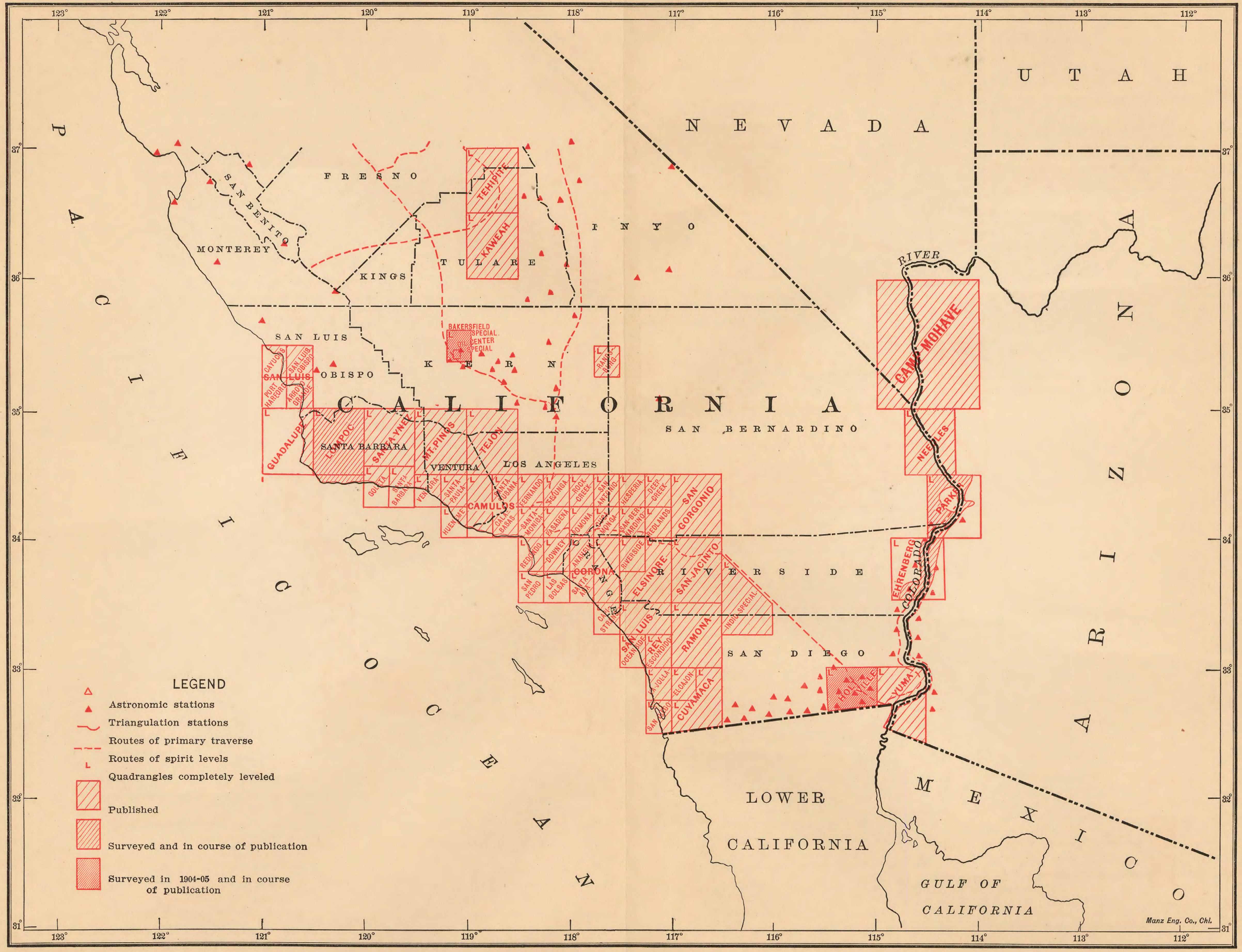
OFFICE WORK.

The office computations of triangulation, primary traverse, and adjustment of level circuits were continued in charge of Mr. S. S. Gannett, geographer. The results of primary triangulation and primary traverse were summarized in form for publication as a bulletin. The triangulation plats for many of the States were brought up to date, and the card catalogue of triangulation and primary-traverse stations was extended so as to include several thousand additional stations.

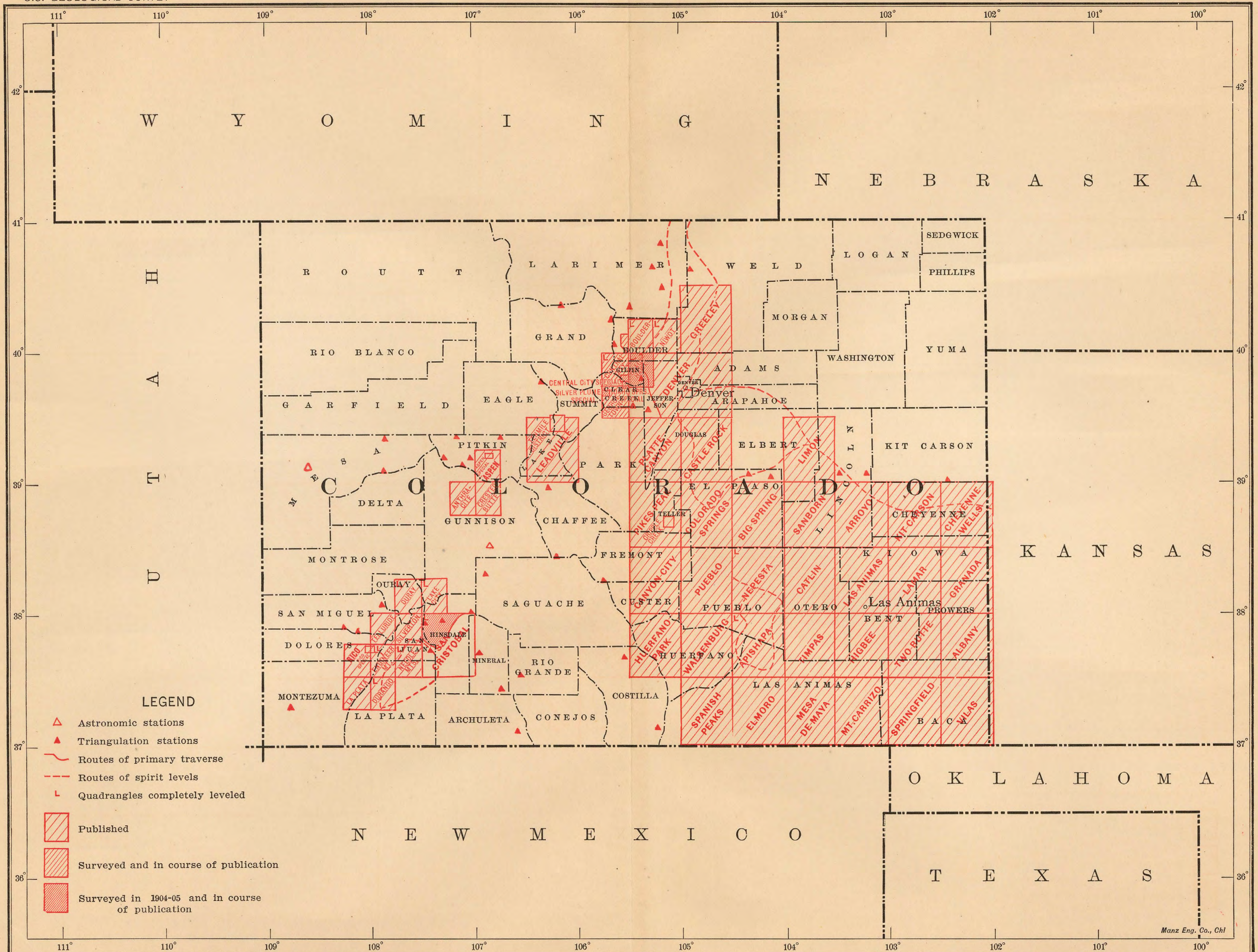
United States standard geodetic datum.—The primary triangulation in the United States was commenced at various points and existed at first as a number of detached portions, in each of which the geodetic datum was dependent only upon the astronomic stations connected with that particular portion. The completion of the transcontinental belt of triangulation between the Atlantic and Pacific oceans in 1899, as well as the computation of an oblique arc between Maine and Louisiana in the following year, joined all of the detached portions and made them one continuous triangulation. Upon the completion of this work by the United States Coast and Geodetic Survey, that Office undertook to discard the old geodetic data heretofore used and to substitute one datum for the whole country. This involved much preliminary study to determine the best datum to be adopted, and on March 13, 1901, that Bureau adopted what is now known as the United States standard datum, to which all geodetic positions in the United States have been reduced. The United States Geological Survey at once accepted this standard datum of the United States, the result being to introduce changes of considerable magnitude in nearly all portions of the United States except New England and the Middle Atlantic States. All positions are now computed and published on the United States standard datum, unless otherwise stated.

A considerable portion of the office duties consisted of the preparation of triangulation and leveling data for chiefs of field parties and of replies to requests of persons not connected with the Survey.

A summary of the office computing during the year follows:



MAP OF SOUTHERN CALIFORNIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL



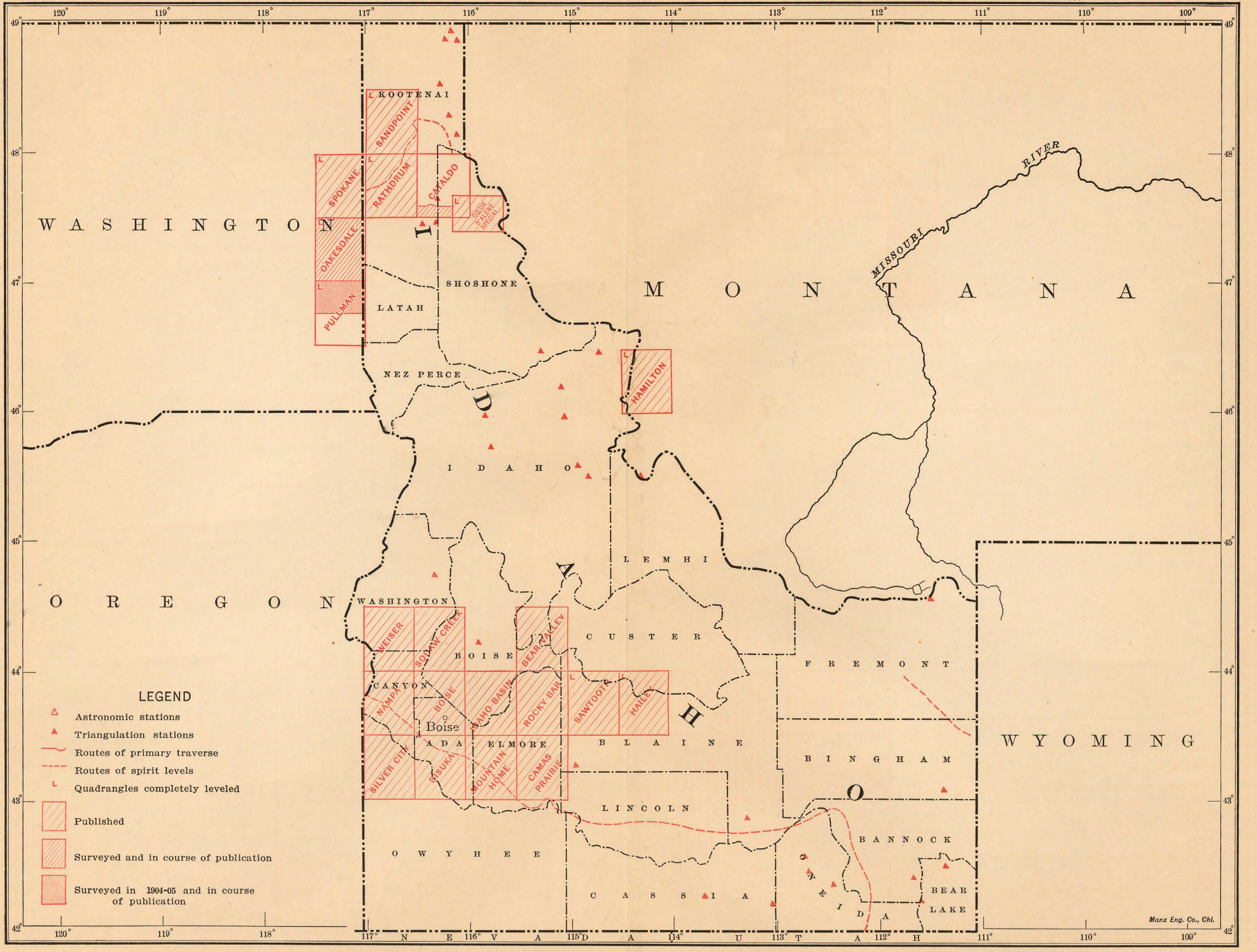
MAP OF COLORADO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Summary of office work in computing, May 1, 1904, to April 30, 1905.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
EASTERN.				
Alabama:				
Blount Jefferson St. Clair		Computation of 2,253 latitudes and departures and 167 geographic positions.		S. S. Gannett. G. T. Hawkins. L. Scott Smith. C. A. Clunet.
Bibb Chilton Shelby		Computation of 1,764 latitudes and departures and 170 geographic positions.		G. T. Hawkins. C. B. Kendall. C. A. Clunet. J. R. Ellis. L. Scott Smith.
Chambers			Birmingham	D. H. Baldwin.
Jefferson			Leeds	
Lee			Opelika	Fred Graff.
Arkansas:				
Calhoun Dallas Garland Hempstead Hot Springs Howard Montgomery Nevada Pulaski Saline Sharp Washington			Arkadelphia Benton Camden Caddo Gap Eureka Springs Fayetteville Gurdon Harrison Winslow	D. H. Baldwin.
Delaware:				
Newcastle			Wilmington	Fred Graff.
Illinois:				
Peoria			Peoria	D. H. Baldwin.
Wabash			Mount Carmel	
Indiana:				
Gibson Posey Vanderburg Warrick			Degonia Huntingburg Rockport St. Meinard Velpen Washington	D. H. Baldwin.
Iowa:				
Allamakee Clayton Dubuque Fayette Winneshiek			Decorah Elkader Farley Oelwein Peosta Waukon	D. H. Baldwin.
Boone Dallas Polk Story		Computation of 550 latitudes and departures and 150 geographic positions.		Geo. T. Hawkins. W. H. Lovell. J. R. Ellis. L. Scott Smith.
Kansas:				
Allen Bourbon Crawford Neosho			Independence Iola	D. H. Baldwin.

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
EASTERN—cont'd.				
Kentucky:				
Anderson		Computation of 1,863 latitudes and departures and 163 geographic positions.		Geo. T. Hawkins C. A. Clunet. L. Scott Smith
Fayette				
Franklin				
Grant				
Henry				
Owen				
Scott				
Woodford				
Bullitt		Computation of 758 latitudes and departures and 95 geographic positions.		Geo. T. Hawkins. J. R. Ellis. C. A. Clunet.
Jefferson				
Oldham				
Anderson			Calhoun	D. H. Baldwin.
McLean			Frankfort	
Fayette			Lexington	A. P. Meade.
Woodford				
Louisiana:				
East Feliciana			Bayou Sara	Fred Graff.
West Feliciana				
Maine:				
Knox			Belfast	Fred Graff.
Waldo			Bucksport	
			Castine	
			Rockland	
Waldo	Reduction to center, station and figure adjustments, final computation of distances, and geodetic positions.			E. L. McNair.
Maryland:				
Anne Arundel		Computation of 1,376 latitudes and departures and 170 geographic positions.		C. L. Kendall. Geo. T. Hawkins. C. A. Clunet.
Carroll				
Frederick				
Howard				
Montgomery				
Prince George				
Caroline			Crapo	D. H. Baldwin. Fred Graff.
Dorchester			Denton	
Montgomery			Drum Point	
			Hurlock	
			Laurel	
			Relay	
			Rockville	
			Seneca	
Michigan:				
Macomb			Detroit	D. H. Baldwin.
Minnesota:				
Carver		Computation of 356 latitudes and departures and 84 geographic positions.		Geo. T. Hawkins. C. A. Clunet.
Hennepin				
Wright				
Missouri:				
St. Francois		Computation of 540 latitudes and departures and 54 geographic positions.		Geo. T. Hawkins. C. A. Clunet. L. Scott Smith.
Ste. Genevieve				



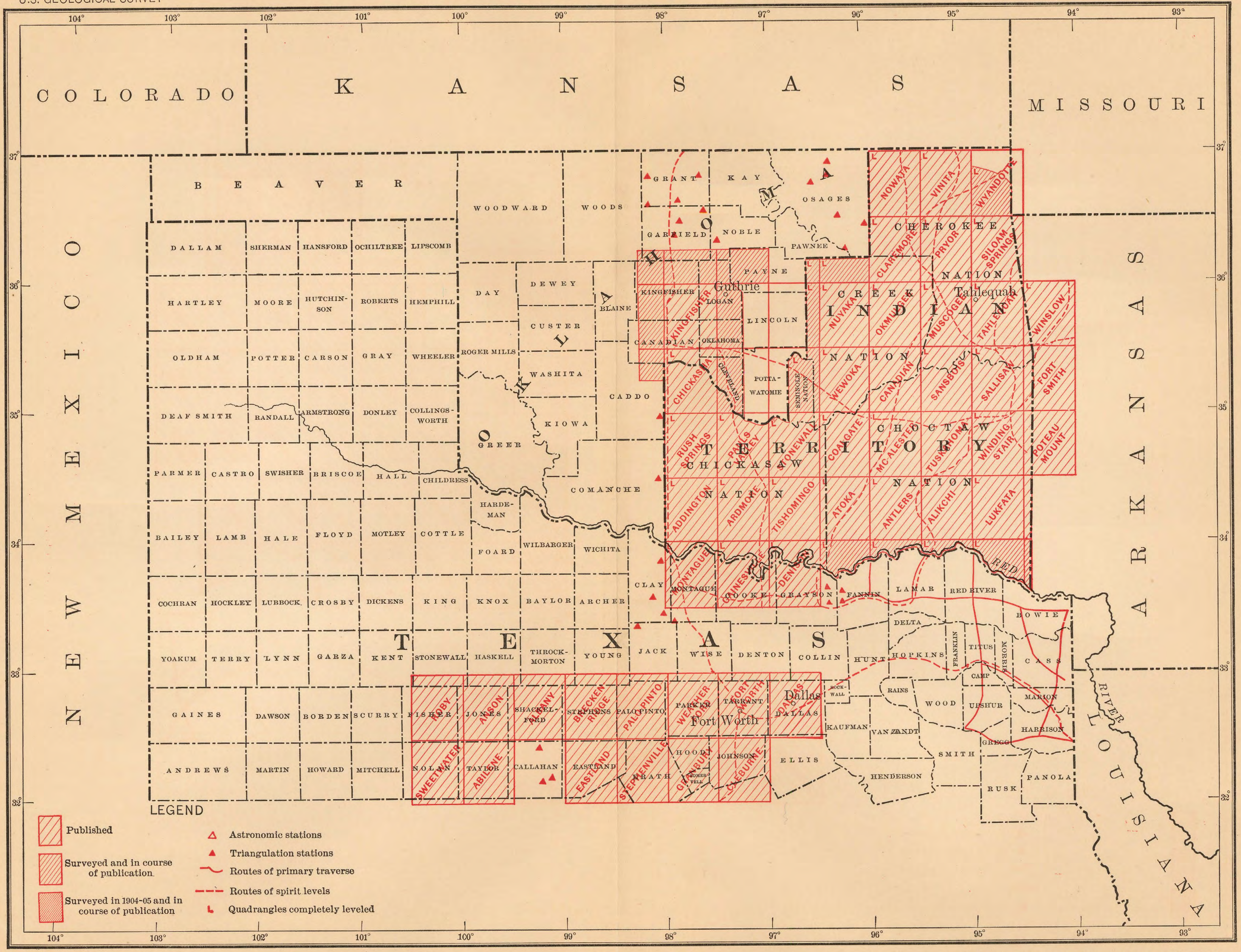
MAP OF IDAHO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
EASTERN—cont'd.				
Missouri—Cont'd.				
Franklin	....	....	De Soto	D. H. Baldwin. Fred Graff.
Jefferson			Forsyth	
Marion			Palmyra	
Stone			Potosi	
Taney			Sullivan	
New Hampshire:				
Hillsboro	Reduction to center, station and figure adjustments, final computation of distances, and geodetic positions.	....	....	E. L. McNair.
Merrimac				
Sullivan				
			Boscawen	A. P. Meade.
			Concord	
			Milford	
			Suncook	
			Sunapee	
New York:				
Erie	....	Computation of 2,251 latitudes and departures and 258 geographic positions.	....	S. S. Gannett. D. H. Baldwin. C. A. Clunet. E. L. McNair.
Lewis				
St. Lawrence				
Herkimer	Reduction to center, station and figure adjustments, final computation of distances, and geodetic positions.	....	....	E. L. McNair.
Oneida				
Orange	....	....	Goshen Port Jervis	D. H. Baldwin.
North Carolina:				
Cabarrus	....	Computation of 1,533 latitudes and departures and 169 geographic positions.	....	Geo. T. Hawkins. C. B. Kendall. C. A. Clunet.
Iredell				
Mecklenburg				
Rowan				
Union				
			Charlotte	D. H. Baldwin.
North Dakota:				
Ransom	....	Computation of 208 latitudes and departures and 45 geographic positions.	....	Sledge Tatum.
Richland				
Sargent				
			Wyndmere	S. S. Gannett.
Ohio:				
Allen	....	Computation of 2,793 latitudes and departures and 485 geographic positions.	....	S. S. Gannett. D. H. Baldwin. Geo. T. Hawkins. J. R. Ellis. W. H. Lovell. C. A. Clunet.
Columbiana				
Cuyahoga				
Geauga				
Lake				
Medina				
Mahoning				
Putnam				
Ross				
Scioto				
Summit				
Trumbull				

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
EASTERN—cont'd.				
Ohio—Continued.				
Allen Ashtabula Clark Clinton Hancock Meigs	.....	.....	Arlington Bluffton Chardon Conneaut Jefferson King London Medina South Charleston Upper Sandusky	D. H. Baldwin. A. P. Meade. Fred Graff.
Pennsylvania:				
Berks Chester Lancaster Mercer	.....	Computation of 1,228 latitudes and departures and 161 geographic positions.	.....	Geo. T. Hawkins. W. H. Lovell. L. Scott Smith. C. A. Clunet. J. R. Ellis.
Franklin Perry Juniata Snyder	Reduction to center, station and figure adjustments, final computation of distances and geodetic positions.	.....	.....	Geo. T. Hawkins.
Allegheny Mercer Perry Washington	.....	.....	Burgettstown Claysville Millerstown New Bloomfield Neshannock Shenango	D. H. Baldwin.
South Carolina:				
Greenville Spartanburg	.....	.....	Saluda	D. H. Baldwin.
Tennessee:				
Giles Lawrence Maury	.....	Computation of 1,168 latitudes and departures and 110 geographic positions.	.....	D. H. Baldwin. C. B. Kendall. Geo. T. Hawkins. C. A. Clunet.
Wayne	.....	.....	Waynesboro	D. H. Baldwin.
Vermont:				
Chittenden	.....	.....	Burlington	Fred Graff.
Virginia:				
Isle of Wight Gloucester King and Queen Surry	.....	Computation of 679 latitudes and departures and 78 geographic positions.	.....	Geo. T. Hawk ns. L. Scott Smith.
			Jamestown Yorktown	D. H. Baldwin.
West Virginia:				
Braxton Calhoun Jackson Roane	Reduction to center, station and figure adjustment, final computation of distances and geodetic positions.	.....	.....	S. S. Gannett. Geo. T. Hawkins. C. A. Clunet.
Gilmer Ritchie Taylor Vadis	.....	.....	Arnoldsburg Burnsville Glenville Harrisville Holbrook Thornton	D. H. Baldwin. A. P. Meade.



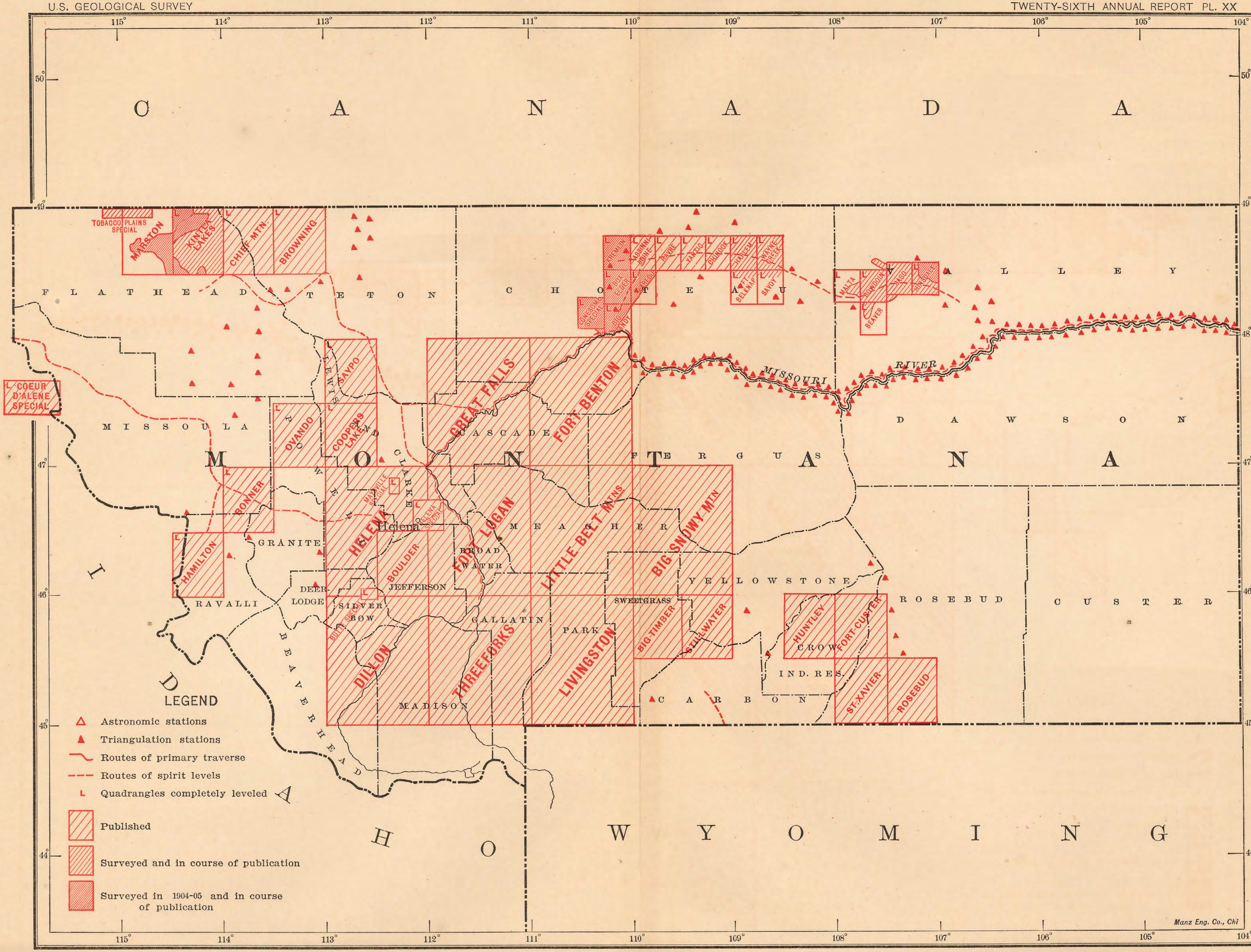
MAP OF INDIAN TERRITORY, OKLAHOMA, AND NORTHERN TEXAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
EASTERN—cont'd.				
Wisconsin:				
Jefferson, Kenosha, Racine, Walworth, Waukesha	....	Computation of 600 latitudes and departures and 161 geographic positions.	....	Geo. T. Hawkins. C. A. Clunet.
Dane, Green, Rock	....	....	Dells, Evansville, Lancaster, Madison, Mineral Point, Richland	D. H. Baldwin. Fred Graff.
WESTERN.				
Arizona:				
Cochise, Coconino, Maricopa	....	....	Computation of precise-level line, Yuma to Tucson.	D. H. Baldwin. L. C. Fletcher.
Yuma	Reduction to center, figure adjustment, computation of distances and geodetic positions.	....	....	J. F. McBeth. T. M. Bannon.
			Bisbee, Bright Angel	L. C. Fletcher.
California:				
Butte, Colusa, Fresno, Inyo, Mono, Sutter, Tulare, Yolo	Reduction to center, station adjustment, computation of distances and geodetic positions.	....	....	C. F. Urquhart.
Kern, San Diego, Shasta, Tulare, Yolo	....	....	Copay, Colusa, Bakersfield, Kaweah, Redding, Dunnigan, Elmira, Tehipite, Tesla	L. C. Fletcher. D. H. Baldwin.
			Imperial Valley, Sacramento, Computation of precise-level line, Mohave-Keeler.	S. S. Gannett.
Colorado:				
Hinsdale, Mineral	Reduction to center, station and figure adjustment, computation of distances and geodetic positions.	....	....	J. F. McBeth.

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
WESTERN—cont'd.				
Colorado—Cont'd. Arapahoe Boulder Clear Creek Gilpin Weld			Central City Denver Greeley Idaho Springs Longmont Silver Plume San Cristobal	S. S. Gannett. L. C. Fletcher.
Idaho: Kootenai			Bonners Ferry	L. C. Fletcher.
Montana: Chouteau Silverton Valley			Big Sandy Bowdoin Box Elder Butte Glasgow Hinsdale Loppard Saco Kintla Lakes	D. H. Baldwin.
Valley			Tampico Vandalia	S. S. Gannett.
	Station and figure adjustment, final computation of distances and geodetic positions.			J. F. McBeth. Fred McLaughlin.
New Mexico: Bernalillo Socorro Valencia	Computation of azimuth observations, reduction to center, station and figure adjustments.			R. H. Chapman. H. H. Hodgeson.
Oregon: Jackson Josephine	Reduction to center, station and figure adjustment, final computation of distances and geodetic positions.			A. I. Oliver.
Baker Grant Union			Grant Pass Baker Sumpter Telocaset	S. S. Gannett. L. C. Fletcher.
South Dakota: Butte	Reduction to center, station adjustment, computation of distances and geodetic positions.			D. H. Baldwin.
			Belle Fourche	L. C. Fletcher.
Texas: Bowie Cass Fannin Gregg Harrison Lamar Marion Red River Titus Upshur		Computation of 2,971 latitudes and departures and 500 geographic positions.		Sledge Tatum. H. L. Baldwin, jr. H. H. Hodgeson. J. F. McBeth. A. E. Murlin. Fred McLaughlin.



MAP OF MONTANA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Summary of office work in computing, May 1, 1904, to April 30, 1905—Continued.

Topographic division, State, and county.	Triangulation.	Primary traverse.	Level adjustment: Quadrangle.	Computer.
WESTERN—cont'd.				
Texas—Continued.				
Bastrop, Burnett, Bexar, Caldwell, Gonzales, Lampasas, Travis, Williamson			Austin, Bastrop, Blanco, Burnett, Fredericksburg, Llano	S. S. Gannett. D. H. Baldwin.
Utah:				
Beaver	Computation of geodetic distances and positions.			J. F. McBeth.
			Frisco	D. H. Baldwin.
Washington:				
King, Kittitas, Pierce, Yakima			Readjustment of line along Northern Pacific Railroad, Seattle to Pasco.	
Wyoming:				
Bighorn	Reduction to center, station and figure adjustment, final computation of geodetic distances and positions.			S. S. Gannett. J. F. McBeth. Fred McLaughlin.
			Kirwin and adjacent quadrangles.	L. C. Fletcher.

Section of Inspection of Topographic Surveying and Mapping.

Mr. John H. Renshawe, geographer, continued in charge of the inspection of topographic surveying and mapping. On the 1st of July he proceeded to Colfax, Wash., for the purpose of examining and reporting on field work in progress in that vicinity. Later he visited field parties in western and northern Montana, in the Uinta Mountains of northeastern Utah, in the vicinity of Golden and in the San Juan Mountains of Colorado, and in the vicinity of Van Horn, Tex. This work occupied him until the end of August, when he proceeded eastward and visited field parties in the vicinity of Baton Rouge, La., Potosi, Mo., Sebree and Lawrenceburg, Ky., Grafton, W. Va., Pomeroy, Nelsonville, Lima, and Painesville, Ohio, Sherman and Ellenville, N. Y., Pottstown and Coatesville, Pa., and Gloucester, Va., returning to the office early in November.

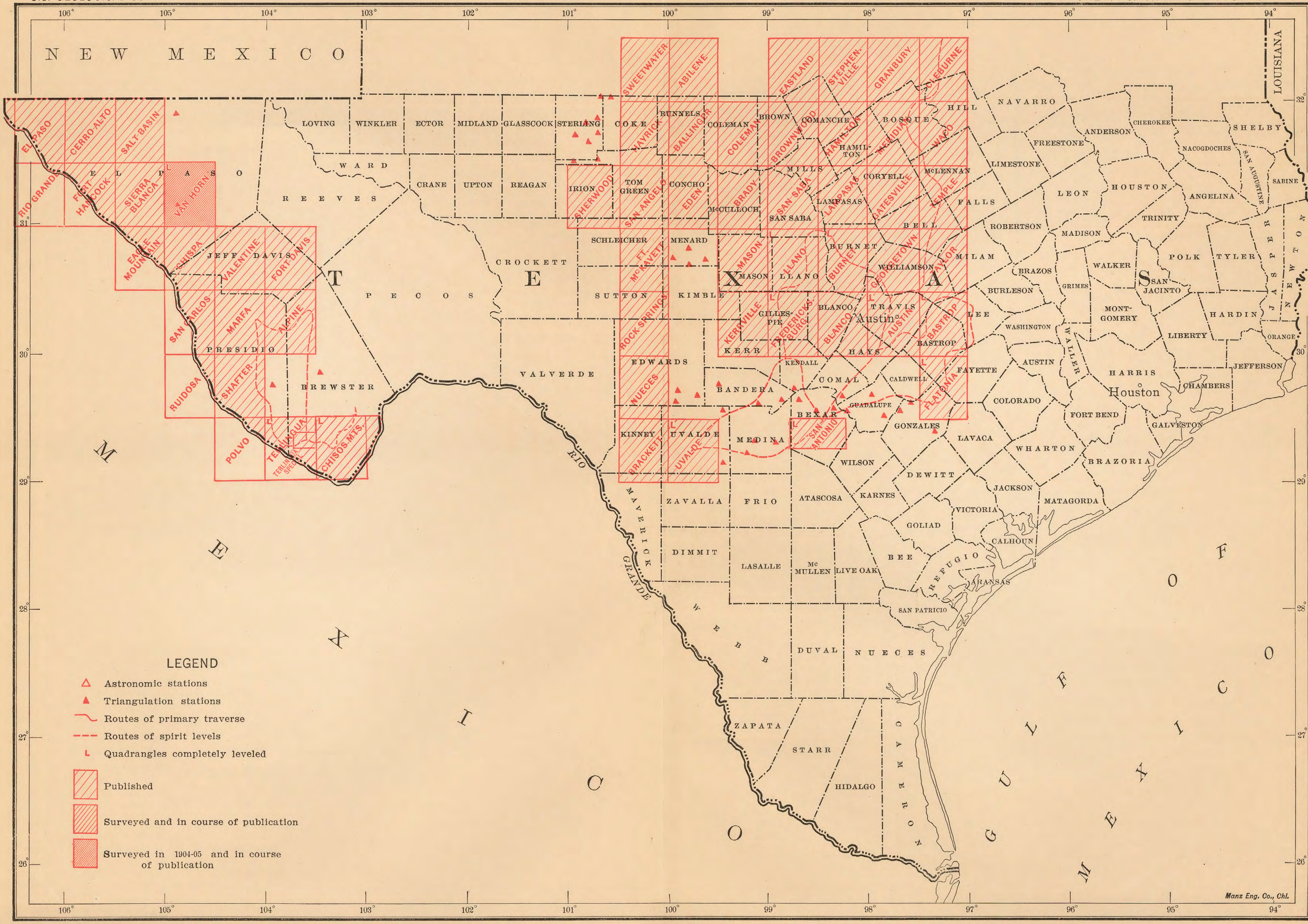
Mr. Renshawe also remained in charge of the revision of the base map of the United States, work on which proceeded during his absence in the field and was continued during the winter season. At the end of the fiscal year the work was completed for all surveyed areas in the eastern portion of the United States and the drawings submitted for engraving.

During the office season, in addition to the preparation of new material for the revision of the base map, Mr. Renshawe had supervision of the final drawing of map sheets in the eastern and western divisions of topography, giving special attention to the elimination of individual styles among the draftsmen, and regulating the amount and character of detail in the expression of the various topographic forms throughout the United States.

Section of Instruments and Topographic Records.

Mr. S. A. Aplin, topographer, continued in charge of instruments and topographic records. The overhauling of all the instruments was continued. The purchase of instruments during the year was confined largely to regular types to provide for loss by wear and tear. Several new precise levels and rods of the Coast Survey type have been purchased, and they have been found so satisfactory that more may be procured to replace primary levels. Some improved designs have been experimented with. Among these are an adaptation of the solar compass to plane-table work, a new form of sight alidade, an attachment for taking the telescopic alidade apart so that it will pack in smaller compass, and an attachment to alidades for stadia work.

The filing of the original records under the existing card system was continued. The number of pieces filed was about 1,100, comprising triangulation, level, and topographic notebooks and plane-table sheets, and about 200 pieces of miscellaneous material. Other material relating strictly to the individual quadrangles was separately filed.



MAP OF SOUTHERN TEXAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

Division of Geography and Forestry.

The work of this division remained during the year in charge of Mr. Henry Gannett, geographer. Field work was carried on by two parties, one in charge of Mr. F. G. Plummer, with Mr. M. G. Gowsell as chief assistant, and the other in charge of Mr. Theodore F. Rixon.

Mr. Plummer's party examined the western portion of the Santa Barbara Forest Reserve and two areas proposed for reservation, one in the neighborhood of San Luis Obispo and the other in the neighborhood of Monterey, all in California. Reports on these areas have been prepared.

Mr. Rixon's party examined two areas proposed for reservation, one including the mountains southeast of Albuquerque and the other north of and adjoining the Pecos River Reserve, both of these areas being in New Mexico. Reports on them have been prepared.

Office work consisted of the compilation of maps of portions of the United States on a manuscript scale of 12 miles to the inch, with the purpose of publishing them in sheets on a scale of 1:1,000,000, and the preparation of a revised edition of the Dictionary of Altitudes (Bulletin No. 274), the former edition being completely exhausted. The extensive changes which have been made in the alignment and elevation of railroads all over the country in the last few years have rendered it necessary to obtain new profiles from railroad companies and to make a new adjustment of them. In the new edition the heights of about 60,000 points are given. In addition, a Gazetteer of Indian Territory was prepared and several hundred land-classification maps were transferred and colored.

During the spring the work of examining forest reserves, etc., together with the men employed upon it, was transferred to the Bureau of Forestry of the Department of Agriculture.

As this closes the work of the Geological Survey in the examination of forest lands, it may be well to make a brief résumé of the results accomplished. The work was committed to this office by act of Congress in 1897, and has therefore been carried on for eight years. During this time the following reserves have been examined and reported on:

Arizona:
- Black Mesa.
- San Francisco Mtn.

California:
- Lake Tahoe.
- Plumas.
- San Bernardino.
- San Gabriel.
- San Jacinto.
- Santa Barbara.
- Sierra.
- Stanislaus.
- Yosemite Park.

Colorado:
- Battlement Mesa.
- Pikes Peak.

Colorado—Continued.
- Plum Creek.
- South Platte.
- White River.

Idaho:
- Priest River.

Idaho and Montana:
- Bitterroot.

Montana:
- Flathead.
- Lewis and Clark.
- Little Belt.
- Yellowstone (part).

New Mexico:
- Gila River.
- Lincoln.

Oklahoma:
- Wichita.

Oregon:
- Ashland.
- Cascade Range.

South Dakota:
- Black Hills.

Washington:
- Mount Rainier.
- Olympic.
- Washington.

Wyoming:
- Bighorn.
- Teton.
- Yellowstone (part).

The names given above are in most cases those which were in use at the time of the examinations. Many of them have since been changed through consolidation.

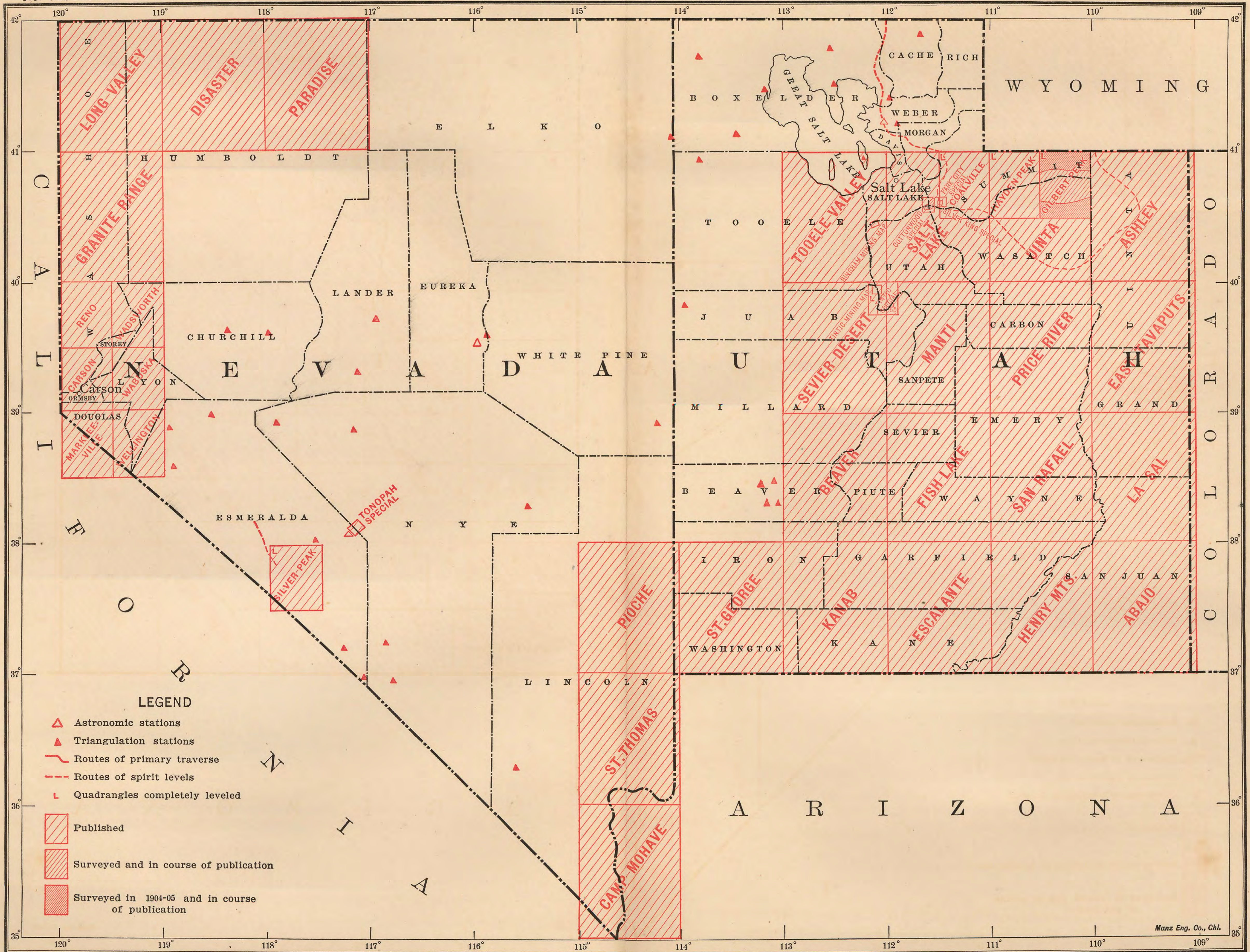
Besides these reserves, large areas were examined with a view to the formation of new reserves or their inclusion in existing reserves.

The total area examined during the eight years amounts to 110,000 square miles.

HYDROGRAPHIC BRANCH.

Organization.

The hydrographic branch continued its investigations during the year on lines previously followed and described. The work was under the immediate charge of Mr. Frederick H. Newell, and was divided into three parts—hydrography, hydrology, and hydro-economics, each composing a division. The division of hydrography has to do with the distribution of the surface waters of the United States; it determines the quantity and fluctuations of flow of rivers, mainly those having importance for water power, irrigation, municipal supplies, or other



MAP OF NEVADA AND UTAH, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL industrial purposes. The division of hydrology investigates the currents of water under ground, particularly those reached by deep wells. It is studying the geology of the earth's surface in so far as it concerns the distribution and amount of underground water, especially that having industrial importance. The division of hydroeconomics studies the qualities of water as affecting its industrial and municipal uses.

Cooperative arrangements for hydrographic work were made with eight States. The State Survey Commission of Maine allotted $3,500; the Forestry Commission of New Hampshire, $300; the State engineer and surveyor of New York, $1,500; the State of California, $10,000; the State of Oregon, $2,500; the State geologist of Maryland a sum sufficient to pay all gage readers in that State, and the State engineers of Nevada and Nebraska each a sum sufficient for the services of a hydrographer who devoted his time to stream gaging.

Division of Hydrography.

The work of the division of hydrography was continued during the fiscal year 1904–5 along the lines previously developed, and under the immediate charge of Mr. Frederick H. Newell, assisted by various men in field and office. The field work was divided into two sections—the eastern, which includes the humid States, most of which lie east of Mississippi River, and the western, which is made up of the arid and semiarid States west of the Mississippi. For convenience in organization, these sections have been divided into hydrographic districts, each of which is in charge of a district hydrographer, to whom all the employees in the district report, and who is responsible to the chief hydrographer for the work in his district.

The inspection of stations and methods was carried on by Mr. E. C. Murphy, who spent the larger part of his time in inspecting the work in the various districts in company with the district hydrographers or their assistants.

Mr. John C. Hoyt was in charge of computations and the preparation of the data for publication.

Complete descriptions of the river stations, together with the data and the results obtained by discussion of these data, will be published in Water-Supply Papers Nos. 124 to 135, inclusive. The data for the various sections of the country are divided in these papers as follows: No. 124, Atlantic Coast of New England drainages; No. 125, Hudson, Passaic, Raritan, and Delaware River drainages; No. 126, Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages; No. 127, Santee, Savannah, Ogeechee, and Altamaha River and Eastern Gulf of Mexico drainages; No. 128, Eastern Mississippi River drainages; No. 129, Great Lakes and St. Lawrence River drainages; No. 130, Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages; No. 131, Platte, Kansas, Meramec, Arkansas, and Red River drainages; No. 132, Western Gulf of Mexico drainages; No. 133, Colorado River and the Great Basin drainages; No. 134, the Great Basin and Pacific Ocean drainages in California; and No. 135, Columbia River and Puget Sound drainages.

EASTERN SECTION.

The eastern section of hydrography is divided into five hydrographic districts, as follows:

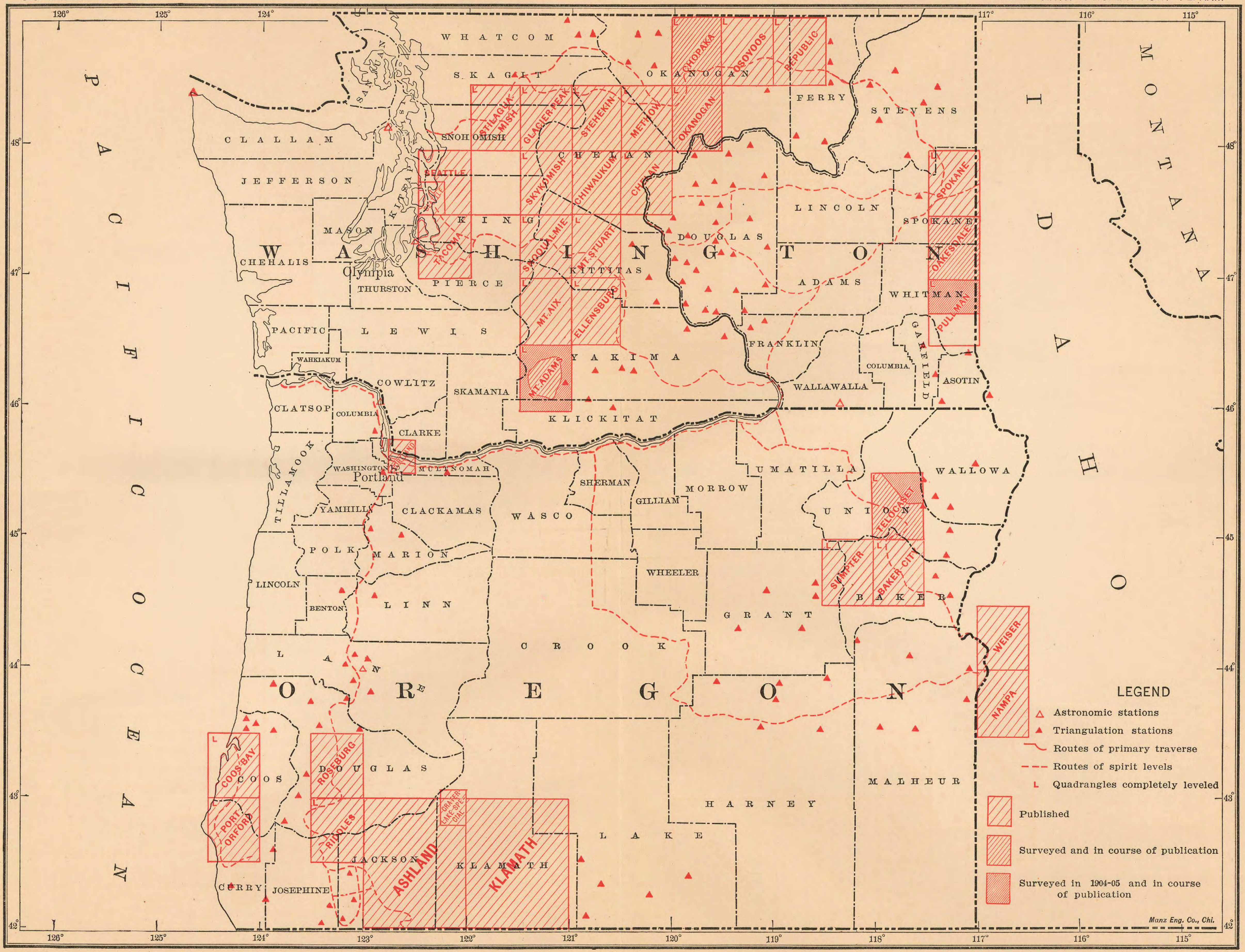
New England: Resident hydrographer, Mr. H. K. Barrows, with headquarters at Boston, Mass.

New York and the lower peninsula of Michigan: Resident hydrographer, Mr. R. E. Horton, with headquarters at Utica, N. Y.

Middle Atlantic States (including New Jersey, Pennsylvania, Maryland, West Virginia, and Virginia): Resident hydrographer, Mr. N. C. Grover, with headquarters at Washington, D. C.

Southern Atlantic and Eastern Gulf States: Resident hydrographer, Mr. M. R. Hall, with headquarters at Atlanta, Ga.

Mississippi Valley: Resident hydrographer, Mr. F. W. Hanna, with headquarters at Chicago, Ill. This district includes the northern peninsula of Michigan, Wisconsin, Illinois, Indiana, Ohio, Kentucky, Missouri, Iowa, Minnesota, and North Dakota.



MAP OF WASHINGTON AND OREGON, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL

The following paragraphs give, in geographic order, descriptions of the operations in the various States included in the eastern section of hydrography, and also the names of parties who have cooperated in the work.

Maine.—Measurements of the amount of water flowing in the rivers at various stages were continued during the year in cooperation with the State. Surveys of Kennebec River from Skowhegan, Me., to Moosehead Lake and of Penobscot River from tide water to Norcross, Me., were made during the year.

New Hampshire.—Stream-gaging work in this State was continued and extended in cooperation with the State.

Vermont.—Stream gaging was continued on the principal rivers of the State.

Massachusetts.—Measurements of the amount of water flowing in rivers of the State were continued and extended to include the principal rivers. As in former years, the Metropolitan Water and Sewerage Board supplied the measurements of the flow of streams in the drainage areas which furnish the Boston water supply.

Rhode Island.—A limited amount of river gaging was continued throughout the year.

Connecticut.—Measurements were continued on several rivers in the State.

New York.—The river stations previously established were continued throughout the year in cooperation with the State.

New Jersey.—Investigations were continued in this State, more particularly on the rivers in the northern part.

Pennsylvania.—The river stations in the Delaware and Susquehanna drainage basins were continued and the work was extended to the Ohio River drainage in the western part of the State.

Maryland.—The river stations previously established were maintained and several new ones were established, in cooperation with Prof. William B. Clark, director of the Maryland Geological Survey.

Virginia.—The stream gaging was continued and extended to include all of the important rivers of the State. A survey of Roanoke River is in progress.

West Virginia.—Measurements of the more important rivers in this State were continued.

North Carolina, South Carolina, and Georgia.—Stream-gaging work in these States was continued during the year.

Florida.—Systematic measurements of the flow of several of the more important rivers of this State were started.

Alabama.—Measurements of the amount of water flowing in the more important streams were continued. A survey of Tallapoosa River from Tallapoosa, Ga., to Matilda, Ala., was made during the year.

Mississippi.—Stream gaging was continued and extended to several of the important rivers in the State.

Tennessee.—Measurements of the amount of water flowing in the important rivers were continued.

Kentucky.—Stream-gaging work was extended to include the important rivers of the State.

Ohio, Indiana, and Illinois.—Stream-gaging work in these States was continued and largely increased during the year.

Michigan.—Measurements were continued on the important streams in the State.

Wisconsin, Minnesota, Iowa, and Missouri.—Stream gaging was continued and was extended to cover the important streams in each of these States.

WESTERN SECTION.

The western section of hydrography is divided into nine hydrographic districts. With two exceptions these districts are coextensive with State boundaries. The two exceptions are: (1) A district which includes the States of Colorado, Kansas, Nebraska, South Dakota, Wyoming, and portions of New Mexico, Oklahoma, and Indian Territory; district hydrographer, Mr. M. C. Hinderlider, with headquarters at Denver, Colo. (2) A district including parts of New Mexico, Oklahoma, and Indian Territory; district hydrographer, J. M. Giles, with headquarters at Carlsbad, N. Mex.

The following paragraphs give, in alphabetic order, descriptions of the operations in various States and Territories included in the western section of hydrography, and also the names of the engineers and others who have charge or assist in the prosecution of the work.

Arizona.—Measurements in this Territory were confined to localities investigated for irrigation purposes. Mr. W. A. Farish was in charge of hydrographic investigations, with headquarters at Phoenix, Ariz.

California.—On account of the great commercial value of water in this State, measurements have been very widely distributed and cover practically all sections of the State. The stream gaging was in charge of Mr. S. G. Bennett, under the general supervision of Mr. J. B. Lippincott, with headquarters at San Francisco. The State cooperated in this work.

Colorado.—A large number of river stations were maintained in this State, a few of these in connection with definite reclamation projects, but generally pertaining to the broad questions of water supply within the State. Resident hydrographer, Mr. M. C. Hinderlider, with headquarters at Denver.

Idaho.—Stream measurements were continued under the general direction of Mr. D. W. Ross, with headquarters at Boise.

Kansas.—Stream measurements were extended in this State to include the important rivers. Mr. M. C. Hinderlider was in general charge.

Montana.—River measurements in this State were increased during the year, under the general direction of Mr. C. C. Babb.

Nebraska.—Stream gagings in this State were continued, in cooperation with the State, through the State engineer, Mr. Adna Dobson, with headquarters at Lincoln.

Nevada.—Work in Nevada was continued, in cooperation with the State, through the State engineer, Mr.

Henry Thurtell, who had charge of the work under the general direction of Mr. L. H. Taylor.

New Mexico.—Several stations on the Rio Grande were maintained by Mr. W. W. Follett, consulting engineer of the International (Water) Boundary Commission, and the results were furnished to the Survey for publication. Stream gaging in other parts of the Territory was continued and was extended to include the important rivers. Mr. M. C. Hinderlider was in charge of the work in the northern part of the Territory, with headquarters at Denver, Colo., and Mr. J. M. Giles was in charge of the work in the southern part of the Territory, with headquarters at Carlsbad, N. Mex.

North Dakota.—River measurements were continued under the general direction of Mr. F. W. Hanna.

Oklahoma.—River measurements were continued by Mr. W. G. Russell and Mr. J. M. Giles.

Oregon.—The river stations previously established in this State were maintained under the general direction of Mr. J. T. Whistler.

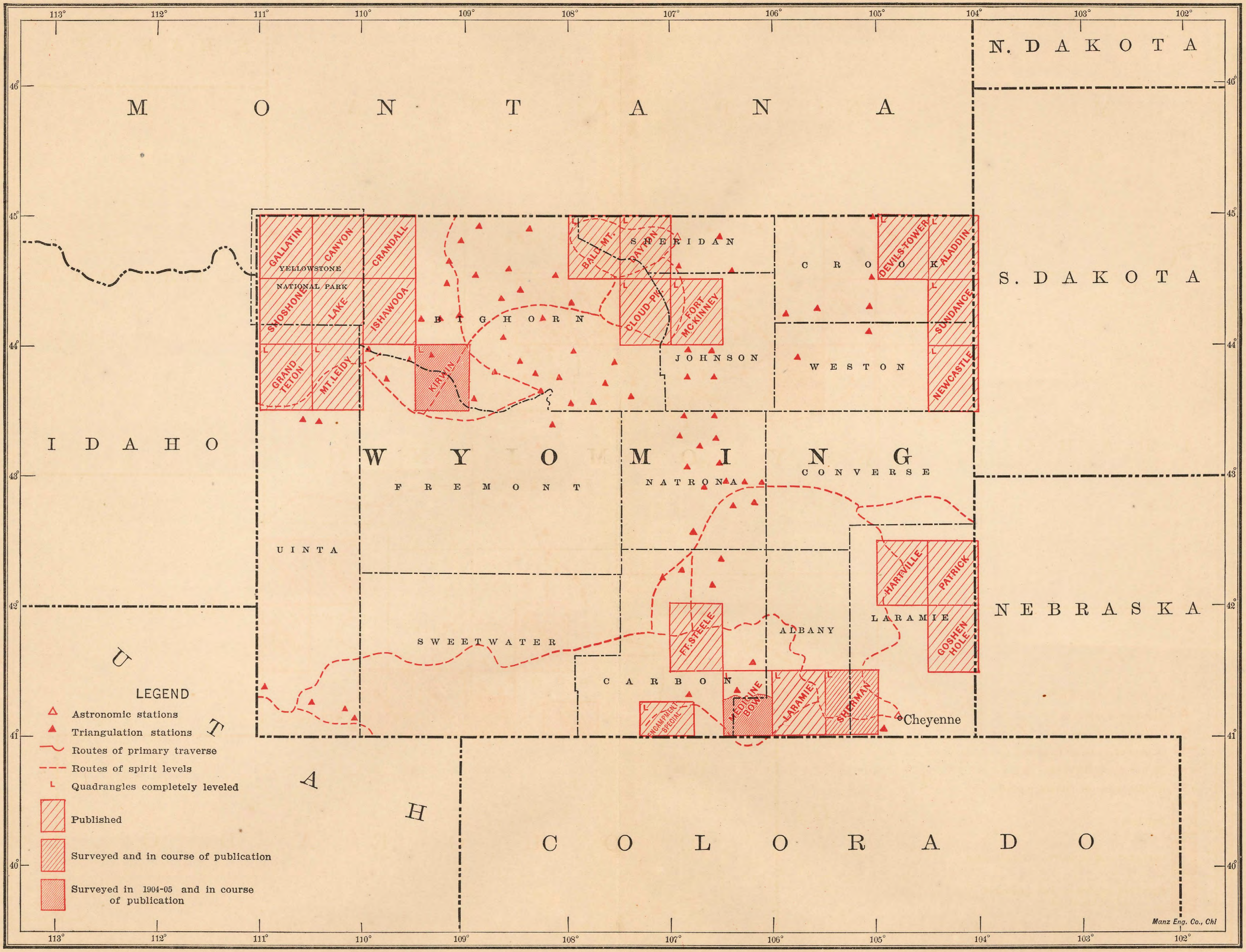
South Dakota.—River measurements were continued in this State, under the general direction of Mr. Raymond F. Walter, with headquarters at Belle Fourche.

Texas.—Measurements of the more important rivers were continued by Prof. Thomas U. Taylor, of the University of Texas.

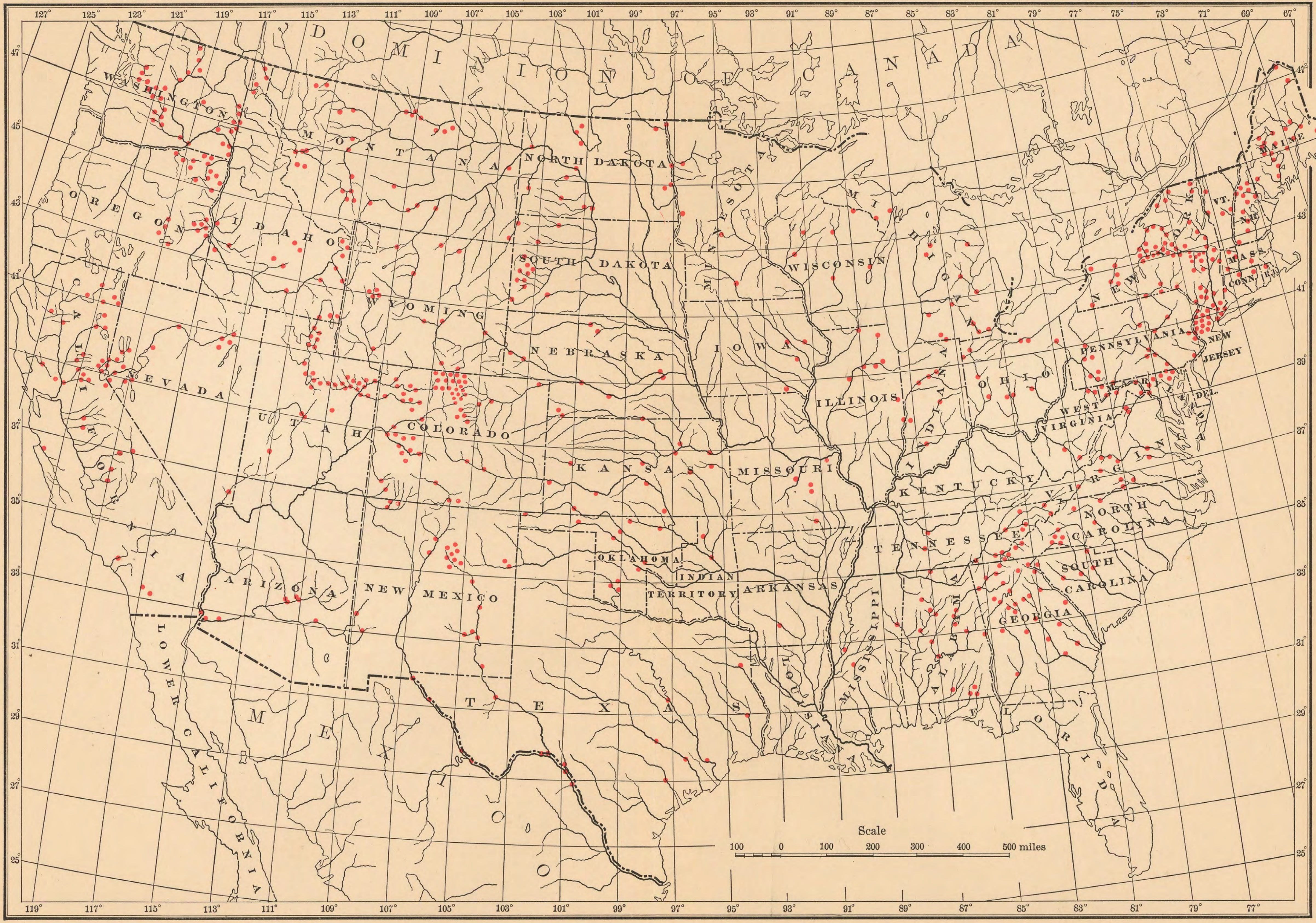
Utah.—With the exception of the work in the vicinity of the Uinta Indian Reservation, which was carried on by Mr. H. S. Reed, the work in this State was under the direction of Mr. George L. Swendsen.

Washington.—Hydrographic work in this State was continued under the general direction of Mr. T. A. Noble, with headquarters at Spokane.

Wyoming.—Stream gagings were continued on the important streams in this State by Mr. A. J. Parshall.



MAP OF WYOMING, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND PRIMARY CONTROL



MAP OF UNITED STATES, SHOWING LOCATION OF PRINCIPAL RIVER STATIONS MAINTAINED DURING 1904-05

LOCATION OF RIVER STATIONS.

The locations of the principal river stations maintained during the fiscal year 1904–5, as enumerated in the following list, are shown on Pl. XXV:

Gaging stations, by States, maintained during fiscal year 1904–5.

River.	Station.	River.	Station.
ALABAMA.		CALIFORNIA.	
Alabama	Selma.	Alamo channel	Calexico.
Black Warrior	Cordova.	Alamo	Rockwood.
Do	Tuscaloosa.	Alamitos canal	Calexico.
Black Warrior (Locust Fork)	Palos.	American River	Fairoaks Bridge.
Cahaba	Centerville.	Arroyo Seco	Soledad.
Choccolocco	Jenifer.	Ash Creek	Adin.
Choctawatchee	Geneva.	Bear	Sheridan.
Clear Creek	Elk.	Bigpine and Owens River canal.	Bishop.
Conecuh	Beck.	Bigpine Creek	Bigpine.
Coosa	Riverside.	Bishop Creek	Bishop.
Double Bridges Creek	Geneva.	Bishop Creek canal.	Do.
Elk	Elkmont.	Boundary canal	Calexico.
Pea	Pera.	Cache Creek	Lower Lake.
Tallapoosa	Sturdevant.	Do	Yolo.
Talladega	Nottingham.	Collins (G.), canal	Bishop.
Tombigbee	Epes.	Collins (A. O.), canal	Do.
ARIZONA.		Dell canal	Do.
Colorado	Yuma.	Donner Creek	Truckee.
Gila	Dome (Gila City).	East Side canal	Citrus.
Do	San Carlos.	Farmers' canal	Bishop.
Imperial canal	Yuma.	Feather	Oroville.
Salt	McDowell.	Hemlock canal	Calexico.
Do	Roosevelt.	Hillside canal, north	Bishop.
San Francisco	Alma.	Hillside canal, south	Do.
San Pedro	Charlestown.	Holt canal	Calexico.
Tonto Creek	Roosevelt.	Independence	Hobart Mills.
Verde	McDowell.	Imperial canal	Calexico.
		Do	International Boundary.
ARKANSAS.		Kaweah	Three Rivers.
Ouachita	Malvern.	Kern	Bakersfield.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
CALIFORNIA—cont'd.		CALIFORNIA—cont'd.	
King	Red Mountain.	Triunfo	Calabasas.
Do	Sanger.	Truckee	Mystic.
Little Truckee	Boca.	Do	Tahoe City.
McNally canal	Bishop.	Tule	Porterville.
McCloud	Baird.	Tuolumne	Lagrange.
Malibo Creek	Calabasas.	Turlock canal	Do.
Merced	Yosemite Valley.	West Carson	Woodfords.
Do	Merced Falls.	West Walker	Coleville.
Modesto canal	La Grange.	West Valley Creek	Likely.
Mohave	Victorville.	Willow Creek	Standish.
Mokelumne	Clement.	Do	Merrillville.
Do	Electra.	Do	Susanville.
New	Calexico.	Wisteria canal	Calexico.
Do	Brawley.	Yosemite Creek	Yosemite Valley.
Owens	Round Valley.	Yuba	Smartsville.
Owens River canal	Bishop.	COLORADO.	
Owens	Independence.	Animas	Durango.
Pine Creek	Round Valley.	Arkansas	Canyon City.
Pit	Canby.	Do	Pueblo.
Do	Bieber.	Blue	Kremmling.
Pit (South Fork)	Jess Valley.	Canadian	Cowdrey.
Powers canal	Bishop.	Cimarron	Cimarron.
Prosser	Hobart Mills.	Clear Creek	Forkscreek.
Puta Creek	Middletown.	Conejos	Magote.
Rawson canal	Bishop.	Eagle	Eagle.
Rock Creek	Round Valley.	Elk	Trull.
Sacramento	Red Bluff.	Frazier	Coulter.
Do	Sacramento.	Grand	Glenwood Springs.
Sanger canal	Alvord.	Do	Hot Sulphur Springs.
San Gabriel	Azusa.	Do	Kremmling.
San Luis Rey	Pala.	Do	Palisades.
Santa Ana	Warm Springs.	Grand (North Fork).	Grand Lake.
Santa Maria	Santa Maria.	Grand Lake outlet	Do.
Santa Ynez	Santa Barbara.	Grizzly Creek (Little).	Hebron.
Susan	Susanville.	Grizzly Creek (Big)	Do.
Stanislaus	Knights Ferry.	Gunnison	Cimarron.
Stevens canal	Citrus.	Do	Cory.
Stony Creek	Fruto.		
Tenaya	Yosemite Valley.		

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
COLORADO—cont'd.		COLORADO—cont'd.	
Gunnison	Whitewater.	Yampa	Maybell.
Hot Sulphur Springs.	Fields ranch.	Do	Steamboat Springs.
La Plata	Hesperus.	CONNECTICUT.	
Laramie	Glendevey.	Housatonic	Gaylordsville.
Marvine Creek	Buford.	Salmon	Leesville.
McIntyre	Glen Eyre.	Shetucket	Willimantic.
Michigan Creek	Cowdrey.	GEORGIA.	
Do	Walden.	Alcovy	Covington.
Milk Creek	Axial.	Apalachee	Buckhead.
Muddy	Kremmling.	Broad	Carlton.
North Platte	Cowdrey.	Broad (South)	Do.
Do	Hebron.	Cannoochee	Groveland.
Do	Pinkhampton.	Cartecay	Cartecay.
North Platte (North Fork).	Higho.	Chattahoochee	Norcross.
Purgatory	Barela.	Do	West Point.
Rio Grande	Cenicero.	Coosawattee	Carters.
Do	Del Norte.	Etowah	Canton.
Roaring Fork	Hebron.	Do	Rome.
Snake (Little)	Maybell.	Flint	Albany.
South Platte	Denver.	Do	Woodbury.
Do	Julesburg.	Ocmulgee	Flovilla.
Do	Kersey.	Do	Macon.
Do	South Platte.	Oconee	Dublin.
Tenmile	Kokomo.	Do	Greensboro.
Troublesome	Troublesome.	Do	Milledgeville.
Uncompahgre	Delta.	Ohoopee	Reidsville.
Do	Eldredge Siding.	Oostanaula	Resaca.
Do	Montrose.	Savannah	Augusta.
White	Meeker.	Sweetwater Creek	Austell.
Do	Rangely.	Soque	Demorest.
White (North Fork).	Buford.	South	Lithonia.
White (South Fork).	Do.	Tallulah	Tallulah Falls.
Williams Fork	Hot Sulphur Springs.	Williams Swamp Creek.	Davisboro.
Williams	Hamilton.	IDAHO.	
Yampa	Craig.	Bear	Dingle.
		Do	Preston (Battle Creek).

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
IDAHO—continued.		INDIANA—cont'd.	
Bear Lake	Fish Haven.	White (West Branch).	Indianapolis.
Blackfoot	Presto.	Wabash	Terre Haute.
Boise	Boise.	St. Joseph	Fort Wayne.
Do	Highland.	St. Marys	Do.
Fall	Fremont.	INDIAN TERRITORY.	
Do	Marysville.	Canadian	Calvin.
Kootenai	Bonners Ferry.	Grand	Fort Gibson.
Do	Porthill.	Verdigris	Calvin.
Lost	Chilly Station.	IOWA.	
Do	Mackay.	Cedar	Cedar Rapids.
Pend Oreille	Priest River.	Des Moines	Fort Dodge.
Priest	Do.	Do	Keosauqua.
Snake	Minidoka.	Iowa	Iowa City.
Snake (North Fork)	Ora.	Wapsipinicon	Stone City.
Snake (South Fork)	Lyon.	KANSAS.	
Succor	Homedale.	Arkansas	Arkansas City.
Teton	St. Anthony.	Do	Dodge.
Weiser	Weiser.	Do	Hutchinson.
Willow Creek	Prospect.	Do	Syracuse.
Wood (Big)	Gimlet Station.	Beaver Creek (Ladder).	Scott City.
Wood (Little)	Carey.	Blue	Manhattan.
Cœur d'Alene Lake.	Cœur d'Alene.	Cimarron	Arkalon.
ILLINOIS.		Kansas	Lecompton.
Des Plaines at Jackson Creek.	Channahon.	Osage	Ottawa.
Illinois	Minooka.	Neosho	Neosho Rapids.
Do	Peoria.	Republican	Junction City.
Rock	Rockton.	Smoky Hill	Ellsworth.
Vermilion (North Fork).	Danville.	KENTUCKY.	
Rock	Sterling.	Dicks	Danville.
Kankakee	Momence.	Kentucky	Frankfort.
Sangamon	Decatur.	MAINE.	
INDIANA.		Androscoggin	Dixfield.
Eel	Cataract.	Aroostook	Fort Fairfield.
Tippecanoe	Delphi.	Carrebassett	North Anson.
Wabash	Logansport.	Cold Stream	Enfield.
White (East Branch)	Shoals.		

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
MAINE—continued.		MICHIGAN.	
Dead	The Forks.	Au Sable	Bamfield.
Fish	Wallagrass.	Boardman	Traverse City.
Kennebec	North Anson.	Escanaba	Escanaba.
Do	The Forks.	Fawn	White Pigeon.
Machias	Whitneyville.	Flint	Flint.
Mattawamkeag	Mattawamkeag.	Grand	Grand Rapids.
Messalonskee	Waterville.	Do	North Lansing.
Moose	Rockwood.	Huron	Dexter.
Penobscot	West Enfield.	Do	Dover.
Penobscot (East Branch).	Grindstone.	Do	Flat Rock.
		Do	French Landing.
Phillips Lake	East Holden.	Iron	Iron River.
Piscataquis	Foxcroft.	Kalamazoo	Allegan.
Roach	Roach River.	Manistee	Sherman.
Sandy	Madison.	Menominee	Iron Mountain.
St. Croix	Spragues Falls, near Baring.	Muskegon	Newaygo.
MARYLAND.		Red Cedar	Agricultural College.
Antietam	Sharpsburg.	Rifle	Omer.
Broad Creek	Mill Green.	St. Joseph	Mendon.
Deer Creek	Churchville.	Tittabawassee	Freeland.
Georges Creek	Westernport.	Thunder Bay	Alpena.
Gunpowder Falls (Little).	Belair.	MINNESOTA.	
Gunpowder Falls (Great).	Glencoe.	Minnesota	Mankato.
Monocacy	Frederick.	Mississippi	Anoka.
Patapsco	Woodstock.	Do	Sauk Rapids.
Potomac	Point of Rocks.	Otter Tail	Fergus Falls.
Savage	Bloomington.	Red Lake	Crookston.
Wills Creek	Cumberland.	Rum	Anoka.
Youghiogheny	Friendsville.	MISSISSIPPI.	
MASSACHUSETTS.		Pearl	Jackson.
		Tombigbee	Columbus.
Connecticut	Sunderland.	Yazoo	Yazoo City.
Deerfield	Deerfield.	MISSOURI.	
Quaboag	West Warren.		
Swift	West Ware.	Courtois Creek	Scotia.
Ware	Ware.	Gasconade	Arlington.
Do	Gilbertville.	Greer Spring	Greer.
Westfield	Russell.	Meramec	Eureka.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
MISSOURI—cont'd.		NEBRASKA.	
Meramec	Meramec.	Loup	Columbus.
Meramec Spring	Do.	Niobrara	Valentine.
MONTANA.		North Platte	Bridgeport.
		Do	Mitchell.
Beaver Creek	Ashfield.	Do	North Platte.
Beaver Creek overflow.	Bowdoin.	Platte	Columbus.
Belt Creek	Belt.	Do	Lexington.
Big Blackfoot	Bonner.	Red Deer Lake	Woodlake.
Big Horn	Fort Custer.	Republican	Benkelman.
Bitterroot	Grantsdale.	Do	Bostwick.
Do	Missoula.	Republican (South Fork).	Benkelman.
Deep Creek (Smith River).	Truly.	NEVADA.	
Gallatin	Logan.	Carson	Empire.
Harlem canal	Zurich.	East Carson	Gardnerville.
Highwood Creek	Highwood.	East Walker	Yerington.
Jefferson	Sappington.	Humboldt	Golconda.
Madison	Norris.	Do	Oreana.
Marias	Shelby.	Do	Palisade.
Milk	Havre.	Humboldt (North Fork).	Elburz.
Do	Malta.		
Missoula	Missoula.	Humboldt (South Fork).	Elko.
Missouri	Cascade.		
Missouri (Little)	Alzada.	Lake Winnemucca inlet.	Wadsworth.
Musselshell	Shawmut.	Muddy	Moapa.
Paradise Valley canal.	Chinook.	Pine Creek	Palisade.
		Truckee	Vista.
Pryor Creek	Huntley.	Do	Wadsworth.
St. Mary	Damsite.	Walker	Wabuska.
Do	International Line.		
Sun	Augusta.	NEW HAMPSHIRE.	
Sun (South Fork)	Do.	Ammonoosuc	Bretton Woods.
Swift Current	St. Marys.	Androscoggin	Shelburne.
Teton	Belleview.	Ashuelot	Winchester.
Do	Chouteau.	Connecticut	Orford.
West Gallatin	Salesville.	Contoocook	West Hopkinton.
Yellowstone	Billings.	Israel (above South Branch).	Jefferson Highland
Do	Glendive.		
Do	Livingston.	Israel (below South Branch).	Do.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
NEW HAMPSHIRE—continued.		NEW MEXICO—continued.	
Little	Twin Mountain.	Rio Grande	Rio Grande.
Merrimac	Franklin Junction.	Do	San Marcial.
Pemigewasset	Plymouth.	San Francisco	Alma.
Saco	Center Conway.	San Juan	Farmington.
Zealand	Twin Mountain.	Sapello	Los Alamos.
NEW JERSEY.		Ute Creek	Near Logan.
Delaware	Lambertville.	NEW YORK.	
Millstone	Millstone.	Allegheny	Red House.
Musconetcong	Bloomsbury.	Ausable River	Keeseville.
Passaic	Chatham.	Black	Felts Mills.
Do	Millington.	Bouquet	Willsboro.
Pompton	Pompton Plains.	Canada Creek (East)	Dolgeville.
Ramapo	Mahwah.	Catskill Creek	South Cairo.
Raritan	Bound Brook.	Chadakoin	Jamestown.
Do	Finderne.	Chemung	Chemung.
Raritan (North Branch).	Pluckemin.	Chenango	Binghamton.
		Chittenango Creek	Chittenango.
Raritan (South Branch).	Rowland Mills.	Delaware (East Branch).	Hancock.
Wanaque	Wanaque.	Delaware (West Branch).	Do.
Whippany	Morristown.		
		Esopus Creek	Kingston.
NEW MEXICO.		Do	Olive Bridge.
Animas	Aztec.	Fish Creek	Saratoga.
Do	Farmington.	Genesee	Mount Morris.
Canadian	Logan.	Do	Rochester.
Gallinas	Las Vegas Hot Springs.	Graefenburg reservoir.	New Hartford.
Gila	Cliff.	Honeoye Creek	East Rush.
Hondo	Main Street Bridge, Roswell.	Hoosic	Buskirk.
Do	Reservoir site, Roswell.	Indian Lake	Indian Lake.
		Hudson	Fort Edward.
Mora	Lacueva.	Do	Mechanicsville.
Do	Weber.	Richelieu	Fort Montgomery.
Mora canal	Lacueva.	Lake George outlet.	Ticonderoga.
Pecos	Santa Rosa.	Mohawk	Little Falls.
Do	Carlsbad.	Do	Dunsbach Ferry.
Do	Roswell.	Moose	Moose River.
Do	Fort Sumner.	Oak Orchard Creek.	Medina.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
NEW YORK—cont'd.		NORTH DAKOTA.	
Oneida	Euclid.	Cannon Ball	Stevenson's ranch.
Onondaga Lake outlet.	Long Branch.	Des Lacs	Foxholm.
		Heart	Richardton.
Oriskany Creek	Oriskany.	Knife	Broncho.
Do	Oriskany at Coleman's.	Little Missouri	Medora.
Oswegatchie	Ogdensburg.	Little Muddy	Williston.
Oswego	High Dam.	Missouri	Bismarck.
Do	Minetto.	Do	Mannhaven.
Raquette	Messena Springs.	Do	Nesson.
Do	South Colton.	Do	Williston.
Reels Creek	Utica.	Mouse	Foxholm.
Salmon	Pulaski.	Do	Minot.
Saranac	Plattsburg.	Pembina	Neche.
Schoharie	Prattsville.	Red River of the North.	Fargo.
Schroon	Warrensburg.	Do	Grand Forks.
Seneca	Baldwinsville.	Sheyenne	Haggart.
Skaneateles outlet	Willow Glen.	OHIO.	
Susquehanna	Binghamton.	Black	Elyria.
Wappinger Creek	Wappinger Falls.	Cuyahoga	Independence.
West Canada Creek	Trenton Falls.	Licking	Pleasant Valley.
Do	Twin Rock Bridge.	Mad	Springfield.
NORTH CAROLINA.		Mahoning	Youngstown.
Catawba	Morganton.	Maumee	Sherwood.
Dan	Madison.	Olentangy	Columbus.
Davidsons	Davidsons River.	Scioto	Do.
French Broad	Horseshoe.	Tiffin	Defiance.
Hiwassee	Murphy.	Miami	Dayton.
Mills (North Fork)	Pinkbed.	Muskingum	Zanesville.
Mills (South Fork)	Sitton.	OKLAHOMA.	
Nottely	Ranger.	Arkansas	Tonkawa.
Tennessee (Little)	Judson.	Arkansas (Salt Fork)	Alva.
Tuckasegee	Bryson City.	Beaver Creek	Beaver.
Valley	Tomotla.	Canadian (North Fork).	Woodward.
Yadkin	North Wilkesboro.		
Do	Salisbury.	Do	Elreno.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.
OKLAHOMA—cont'd.	
Cimarron	Kenton.
Do	Waynoka.
Elk	Near Hobart.
Otter Creek	Mountain Park.
Otter Creek (Dry Fork).	Do.
Otter Creek (Horse Branch).	Do.
Red (Elm Fork)	Mangum.
Red (North Fork)	Granite.
Do	Snyder.
Red (Salt Fork)	Mangum.
Turkey Creek	Olustee.
Washita	Anadarko.
OREGON.	
Bear Creek	Silverlake.
Bridge Creek	Do.
Bully Creek	Vale.
Chewaucan	Paisley.
Deschutes	Bend.
Grande Ronde	Elgin.
Do	Hilgard.
John Day	McDonald.
Malheur	Vale.
Do	Ontario.
Do	22 miles above Vale.
Malheur Lake	Narrows.
Owyhee	Owyhee.
Powder	Baker City.
Silver Creek	Riley.
Do	Silverlake.
Silvies	Burns.
Do	Silvies.
Silver Lake	Silverlake.
Umatilla	Gibbon.
Do	Umatilla.
Do	Yoakum.
Walla Walla	Milton.
OREGON—cont'd.	
Walla Walla (South Fork).	Milton.
Wallowa	Elgin.
Do	Wallowa.
Wallowa Lake	Joseph.
Willow Creek	Dell.
Do	Malheur.
PENNSYLVANIA.	
Allegheny	Kittanning.
Blacklick Creek	Blacklick.
Casselman	Confluence.
Juniata	Newport.
Kiskiminitas	Salina.
Laurel Hill Creek	Confluence.
Lehigh	South Bethlehem.
Monongahela	Lock No. 4.
Susquehanna	Harrisburg.
Do	McCalls Ferry.
Susquehanna (North Branch).	Wilkesbarre.
Susquehanna (West Branch).	Williamsport.
Youghiogheny	Confluence.
SOUTH CAROLINA.	
Broad	Alston.
Catawba	Catawba.
Saluda	Waterloo.
Seneca	Clemson College.
Tugaloo	Fort Madison.
Wateree	Camden.
SOUTH DAKOTA.	
Beaver Creek	Edgemont.
Belle Fourche	Belle Fourche.
Cheyenne	Edgemont.
Grand	Seim.
Hat Creek	Edgemont.
Missouri (Little)	Camp Crook.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.
SOUTH DAKOTA—continued.	
Moreau	Bixby.
Rapid Creek	Rapid.
Red Water	Belle Fourche.
Spearfish Creek	Spearfish.
White	Interior.
TENNESSEE.	
Cumberland	Nashville.
Duck	Columbia.
French Broad	Newport.
Hiwassee	Reliance.
Holston	Rogersville.
Holston (South Fork).	Bluff City.
Nolichucky	Greeneville.
Ocoee	McCays.
Pigeon	Newport.
Tennessee	Chattanooga.
Do	Knoxville.
Watauga	Elizabethton.
TEXAS.	
Brazos	Richmond.
Do	Waco.
Colorado	Austin.
Do	Columbus.
Guadalupe	Cuero.
Neches	Evadale.
Pecos	Pecos.
Do	Moorehead.
Devils River	Devils River.
Rio Grande	El Paso.
Do	Below mouth Devils River.
Do	Eagle Pass.
Do	Langtry.
Do	Below Presidio.
Do	Above Presidio.
Do	Fort Hancock.
Sabine	Longview.
San Saba	San Saba.

River.	Station.
UTAH.	
American Fork	American Fork.
Ashley Creek	Vernal.
Bear	Collinston.
Bench ditch	Headgate.
Blacksmith Fork	Hyrum.
Blacksmith Fork Aqueduct.	Do.
Canal No. 1	Headgate.
Chalk Creek	Coalville.
Currant Creek	Road crossing.
Duchesne (North Fork).	Myton.
Duchesne (West Fork).	3 miles above forks.
Great Salt Lake	Saltair.
Green	Green River.
Do	Ouray.
Do	Jenson.
Hobble Creek	Springville.
Indian Creek	Strawberry Valley.
Jordan	Lehi.
Lake Creek	Forks of Lake Creek.
Do	Myton.
Lake Creek (East Fork).	Do.
Lake Creek (West Fork).	Do.
Logan	Logan.
Do	Provo.
Lost Creek	Croydon.
Price	Spring Glenn.
Provo	Provo.
Provo, mouth of canyon.	Do.
Provo, at R. G. W. bridge.	Do.
Provo, above T. P. Co.'s dam.	Do.
Red Creek	Above Narrows.
Rock Creek (East Creek).	10 miles above mouth.
San Pete	Gunnison.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
UTAH—continued.		WASHINGTON—con.	
Sevier	Gunnison.	Cedar	Ravensdale.
Spanish Fork	Lake Shore.	Clealum	Roslyn.
Spanish Fork, mouth canyon.	Spanish Fork.	Chelan	Lake Chelan.
Strawberry	Strawberry Valley.	Columbia	Julia.
Uinta	Fort Duchesne.	Do	Pasco.
Do	Ouray School.	Cow Creek	Keystone.
Do	Whiterocks.	Grande Ronde	Zindel.
Weber	Croydon.	Hangsman Creek	Tekoa.
Do	Oakley.	Do	Poole's ranch, Tekoa.
White	White River dam.	Hangsman Creek (North Fork).	Tekoa.
Whiterocks	Whiterocks.	Kachess	Easton.
VERMONT.		Little Spokane	Spokane.
Otto Creek	Middlebury.	Methow	Pateros.
White	Sharon.	Naches	Nile.
Winooski	Richmond.	Do	North Yakima.
VIRGINIA.		Palouse	Elberton.
Appomattox	Mattoax.	Do	Hooper.
Banister	Houston.	Rock Creek	St. John.
Dan	South Boston.	Salmon Creek	Malott.
James	Buchanan.	Satus Creek	Alfalfa.
Do	Cartersville.	Sinlahekin	Loomis.
Do	Holcomb Rock.	Skykomish (South Fork).	Index.
James (North Branch).	Glasgow.	Snoqualmie	Snoqualmie.
New	Radford.	Spokane	Spokane.
Roanoke	Roanoke.	Tieton	North Yakima.
Shenandoah (North Branch).	Riverton.	Wenache	Cashmere.
Shenandoah (South Branch).	Front Royal.	Yakima	Kiona.
Staunton	Randolph.	Do	Lake Keechelus.
WASHINGTON.		Do	Union Gap.
Asotin Creek (power house).	Asotin.	Do	Easton.
Asotin Creek (Shelman's ranch).	Do.	Do	Selah Gap.
Atanum Creek	Yakima.	WEST VIRGINIA.	
		Cheat	Morgantown.
		Greenbrier	Alderson.
		New	Fayette.

Gaging stations, by States, maintained during fiscal year 1904–5—Continued.

River.	Station.	River.	Station.
WEST VIRGINIA—cont'd.		WYOMING.	
Ohio	Wheeling.	Big Horn	Thermopolis.
Opequon Creek	Martinsburg.	Boulder Creek	New Fork.
Potomac (North Branch).	Piedmont.	Clear Creek	Buffalo.
		Fall Creek	Fishers Ranch.
Potomac (South Branch).	Springfield.	Green	Greenriver.
Shenandoah	Millville.	Laramie	Jelm.
Tuscarora Creek	Martinsburg.	North Platte	Alcova.
WISCONSIN.		Do	Guernsey.
Black	Neillsville.	Do	Saratoga.
Chippewa	Eau Claire.	Pine Creek	Pinedale.
Flambeau	Ladysmith.	Piney Creek	Kearney.
Wisconsin	Merrill.	Pole Creek	Fayette.
Do	Necedah.	Shoshone	Cody.
Wolf	New London.	Snake (South Fork).	Moran.

Division of Hydrology.

The organization of this division and the scope of its activities have been fully described in preceding annual reports and were not materially changed during the last fiscal year. It is composed of two sections, the eastern and the western, the field of the first embracing the States east of the Mississippi and those bordering that river on the west, and that of the second including the so-called reclamation States and Territories and Texas. The eastern section remained in charge of Mr. M. L. Fuller and the western in charge of Mr. N. H. Darton.

EASTERN SECTION.

During the last fiscal year an attempt was made to complete investigations already begun and to prepare reports on the same, rather than to extend examinations into new fields. The number of States in which field work was carried on is therefore considerably less than in the preceding fiscal year. The year has been marked, however, by an increase in cooperative work, and several investigations were conducted jointly with the geologic branch. In the office a system for collecting well records and samples was inaugurated and has given very promising results.

COOPERATION WITH STATE ORGANIZATIONS.

The year was marked by a growing disposition on the part of State geological surveys to cooperate in the investigation of underground water resources, or to arrange for a subdivision of the work between the National and the State organization. In Vermont Prof. George H. Perkins, State geologist, continued to voluntarily assist the Survey in the collection of well data, and plans looking to a detailed investigation of the wells, springs, and public water supplies of the State during the next fiscal year were made. In Connecticut arrangements were made with Prof. William North Rice, State geologist, whereby the investigation of the water resources of the State is to be left to the United States Geological Survey, Prof. H. E. Gregory, of the State Survey, being assigned to the charge of the work. A request from Dr. J. M. Clarke, State geologist of New York, for cooperation in spring investigations was received, but as that work had already been completed a union of forces was not advisable at the time, though arrangements will probably be made for cooperation in future investigations.

Dr. H. B. Kümmel, State geologist of New Jersey, continued to place at the disposal of the Survey, for incorporation in a report to be prepared by Mr. G. N. Knapp, all records received by the State Survey. In Maryland an informal plan was arranged with Prof. W. B. Clark, State geologist, whereby cooperative work in the investigation of artesian waters will be undertaken as soon as certain detailed stratigraphic work essential to an understanding of the artesian problems is completed by the State organization.

Dr. T. L. Watson, State geologist of Virginia, cooperated with the Survey in the collection of well and spring data, and a joint report will be prepared by Mr. Watson and Mr. Fuller. A plan for future cooperation in the State has been approved by the Director. This plan provides for the investigation of the mineral springs of the State by the United States Geological Survey, the investigation of the Coastal Plain geology by Virginia and Maryland acting in coöperation, and a detailed study of the water resources by the United States and Virginia surveys.

A plan for a preliminary joint report by Mr. Fuller and Mr. Earle Sloan, State geologist of South Carolina, was made, and it is expected that this will be followed by a detailed cooperative investigation of the stratigraphy and water resources of the Coastal Plain. During the fiscal year Georgia continued to cooperate in the study of the water supplies of that State and the stratigraphy of the Coastal Plain, and a report was prepared by Mr. S. W. McCallie, assistant State geologist. Cooperative work in Alabama is progressing under an agreement with Dr. E. A. Smith, State geologist.

In addition to cooperation in the field work and underground water investigations, as outlined above, the State geologists of Alabama, Iowa, Michigan, Minnesota, West Virginia, Maryland, and Kentucky cooperated in the collection of well records and samples. Two plans were followed: In Kentucky and Maryland the State geologists acted as the Survey's representatives, collecting the samples and records at the local offices and forwarding them to the Washington office. In the remaining States the local geologists furnished clippings, names of drillers, notices of wells, and other information or assistance, the actual collection of the samples being left to the National Survey.

In addition to the arrangements for cooperation with the various States, the Survey has been in communication, through Mr. Antonio Olyntho, commissioner to the Louisiana Purchase Exposition, with the Government of Brazil.

JOINT WORK.

In several of the lines of investigation conducted by the eastern section of hydrology, where the problems were to a considerable extent geologic, cooperative arrangements were made with the geologic branch. This was done in the investigation of the geology and water resources of certain portions of Mississippi, Arkansas, Missouri, Kentucky, and Tennessee, and it is anticipated that a similar plan will be followed in the investigation of the Atlantic Coastal Plain.

GENERAL OFFICE WORK.

Correspondence.—The correspondence of the section greatly increased during the year, there being a large number of applications from well owners and drillers for information in regard to the prospects for obtaining artesian water. Nearly every State in the eastern half of the country is represented in these requests, while the information desired includes that relating to the supplies of all classes of rocks, both igneous and sedimentary. Much assistance has been rendered by various members of the geologic branch, especially by Mr. E. C. Eckel, who furnished many valuable data in regard to the water supplies of numerous localities in New York State. A number of applications for information in regard to springs suitable for commercial purposes were also received. Requests for the interpretation of well records, the recognition of samples, and for information as to the depth of oil- and gas-bearing sands were especially numerous, resulting largely from the knowledge that the Survey is undertaking special work in this line.

Work of Mr. M. L. Fuller.—During the month of July, and from October 12, 1904, to April 30, 1905, Mr. Fuller was occupied in the office with administrative work as chief of section, including correspondence and editorial work, and with the preparation of reports.

The compilation of the bibliography and index of the publications of the Survey relating to underground waters was completed and published as Water-Supply and Irrigation Paper No. 120, and a paper containing a large number of tables for use in artesian water investigations was nearly completed. Data relating to the general water resources, wells, and springs of nearly every village in the States of North and South Carolina and in northeastern Arkansas were collected by correspondence for the purpose of forming a basis for future field investigations. In the latter part of the fiscal year considerable time was devoted to the supervision of the work of collecting records and samples and to the preparation of a report on the work. Within the year Mr. Fuller was engaged in field work on geology and underground waters in the following States: Ohio, Illinois, Michigan, Missouri, Arkansas, Kentucky, and Tennessee (see work by States).

The following papers were published by Mr. Fuller during the year in addition to the official reports mentioned on page 188.

Evidence of caves in Put in Bay, Ohio, on question of land tilting. Science, new series, vol. 20, p. 761, Dec. 2, 1904.

Pleistocene history of Fishers Island, New York. Am. Geol., vol. 35, p. 50, January, 1905.

Causes and periods of earthquakes in the New Madrid area, Missouri and Arkansas. Science, new series, vol. 21, pp. 349–350 (abstract), Mar. 3, 1905.

Artesian flows from unconfined sandy strata. Engineering News, vol. 53, pp. 329–330, Mar. 30, 1905.

Audubon's account of the New Madrid earthquake. Science, new series, vol. 21, pp. 748–749, May 12, 1905.

Failure of wells along the lower Huron River, Michigan, in 1904. Board of Geol. Survey, Michigan, 1904.

Measurement of low artesian heads. Engineering News, vol. 53, p. 593, June 8, 1905.

Papers on the underground waters in certain counties in western Michigan, on some of the large springs in the Ozarks of Missouri and Arkansas, on a convenient gage for measuring low artesian heads, on the construction of artificial fountain and geyser springs, on water supplies for the farm, and on the geology of Fishers Island, New York, were also prepared by Mr. Fuller and are in process of publication.

Work of Prof. Charles S. Slichter.—Professor Slichter during the year compiled the results of his field experiments in Long Island, New York, Texas, and elsewhere in a report entitled "Field Measurements of the Rate of Movement of Underground Waters," and submitted it for publication as a Water-Supply and Irrigation Paper (No. 140). In addition he undertook the preparation of a new and enlarged edition of his report on the Motions of Underground Waters, the demand for which continued after the exhaustion of the first edition.

Work of Mr. D. W. Johnson.—A report by Mr. Johnson on "Relation of the Law to Underground Waters" was submitted and published as Water-Supply Paper No. 122. It gives the first comprehensive summary, prepared in this country, of the subject, and will meet the rapidly increasing demand for information concerning the application of the law to underground waters, and will assist in the efforts which are being made in several States to enact laws governing the use of such waters.

Work of Mr. B. L. Johnson.—Mr. B. L. Johnson, who was appointed hydrologic aid as a result of the February examination, began work on a bibliography of the underground waters of the United States on June 15. The Government publications, exclusive of those of the Geological Survey, will be first to receive attention, their review being followed by that of State, scientific, and technical publications.

Work of Mr. A. C. Veatch.—The work of Mr. Veatch in connection with the collection of well records and samples is considered on pages 185–188. In addition to this, Mr. Veatch completed a very detailed and important report on the geology and underground waters of northern Louisiana and southern Arkansas, and prepared, under the direction of Prof. C. S. Slichter, a theoretical report on certain fluctuations of wells observed on Long Island in 1903. The work was conducted at the University of Wisconsin, where instruments for studying the observed curves and other facilities for the work were available. A report on the underground water resources of Long Island is in process of publication as Professional Paper No. 44.

COLLECTION OF WELL RECORDS AND SAMPLES.

The collection of records as an aid to the study of geology has always formed an incidental part of the work of the geologists in the field, but since the beginning of the more precise stratigraphic and structural work of recent years the collection of records has, in certain regions, become a very important part of the Survey's work. In some localities, as in Pennsylvania, many records have been preserved and have been collected by geologists in the individual localities as the data became necessary for determining details of structure and stratigraphy. Unfortunately, however, only the larger operators in general have kept permanent records of their wells. The average driller, if he records any data at all, in most cases loses or mislays the record within a comparatively short time. For this reason it is essential in a large number of cases to obtain the information when the well is being sunk, if it is to be had at all.

The necessity of records finally became so great, especially in connection with the study of oil and gas fields, that it was thought a section might advantageously be organized for the purpose of systematically collecting such data. At the request of Mr. M. R. Campbell, Mr. M. L. Fuller, who was then assisting him in oil and gas investigations, prepared in 1902 a plan for such a section, the work of which was to include among other lines of investigation the following: The collection and filing of samples of oil-bearing rocks, together with samples of associated beds; the obtaining of representative records and information as to structure of oil pools; the compilation of a card catalogue of all available records for Survey use; the preparation of a bibliography of oil and gas papers; the compilation of correlation tables of the various producing sands; the preparation of statistics on production, and the answering of inquiries of operators regarding structure and other points relating to oil and gas.

Lack of available funds made it impossible at that time to take up the plan as a part of the work of the geologic branch, but in November of the same year a memorandum embodying a plan for a proposed "well division," to include water, oil, and gas wells, was submitted to the Director by Mr. F. H. Newell, chief of the hydrographic branch. Under this plan it was proposed to give special attention to the collection of well records and the compilation of a card catalogue, which should be available to the entire Survey. The plan was approved, and Mr. Fuller was assigned by the Director to the charge of the eastern section on December 23. The charge of the western section was given to Mr. N. H. Darton.

The designation "well division" gave place later to that of hydrology without change of scope of work. Plans for collecting well records were taken up immediately on the organization of the division, but, because of the lack of available funds and assistants, it was necessary for the time to confine attention entirely to water. Blank forms for mailing to well owners were devised and extensively used during the season of 1903, with the result that a large number of records and other data were collected and published in Water-Supply and Irrigation Paper No. 102. The larger part of the records, however, gave little information as to the strata penetrated, although a considerable number of detailed records were obtained from scattered localities and published in the paper mentioned.

In the summer of 1903 it became desirable, in order to make fine distinctions in glacial materials on Long Island, New York, where the geology and water resources were under investigation, to collect samples from the wells drilled on the island. This work of collecting samples was in charge of Mr. A. C. Veatch, acting under the direction of Mr. Fuller. The willingness of operators and drillers to assist and the value of the material obtained emphasized the desirability of organizing a similar system for the entire country. Accordingly, in the fall of 1903, Mr. Veatch drew up an outline for a proposed system for collecting and preserving well samples, and on July 1, 1904, the work was begun in the eastern section of the division of hydrology. About two-fifths of the expense of operation has been borne by the eastern section, and the remainder has been shared equally by the western section of hydrology and the geologic branch.

Such collection of well samples is not entirely new, a number of States having undertaken a more or less systematic collection of samples as a part of their work. The Second Geological Survey of Pennsylvania especially gave great attention to this feature, employing several men in collecting and tabulating well records, of which several thousand were published. In some cases observers were stationed at important wells by the State survey to insure the collection of the samples.

Because of the great area necessarily covered by the work of the United States Geological Survey, it was impossible to place observers at the wells, but it was believed that if cooperation on the part of the drillers could be secured very important results would be obtained. This cooperation could in general be expected only when drillers would be substantially benefited by the work; consequently in the development of the plan this point was kept constantly in mind, and arrangements were made for answering promptly such questions as the drillers might submit in regard to the work, and for interpreting records and examining samples on request. In return the driller is requested to furnish written records of his wells and samples of the materials penetrated, his assistance to be acknowledged in reports issued annually. The results obtained during the year in which the system has been in operation are very gratifying, the practical nature of the plan having appealed to drillers and others interested in wells, with the result that many offers of cooperation have been received. The working plan outlined by Mr. Veatch has proved to be simple in operation, economical as to labor, convenient to handle, and effective in results.

The primary step in the work is to obtain addresses of drillers or owners of wells in process of drilling. These are obtained from (1) city directories, gazetteers, etc.;

(2) parties volunteering to cooperate; (3) trade and engineering publications; (4) geologists and others in the the fields, and (5) newspaper clippings. To the addresses thus obtained letters describing the work of the Survey and inviting cooperation are sent, and, if a favorable reply is received, notebooks for recording the data and a small franked canvas bag for shipping samples free of cost through the mails are forwarded to the cooperator. The notebook, in addition to the space for recording data, contains directions for the collection and recognition of samples. The samples are commonly taken every 10 feet, or at every change of material, dried on a board or otherwise, and placed in the bag. A small label, giving data as to sample number, location, owner of well, driller, depth of sample, etc., is inclosed. The samples, on receipt, are transferred to glass bottles, examined as soon as possible, and stored in cases prepared specially for the purpose. The economy of space is such that over 200,000 samples can be stored in a 10- by 15-foot room. The samples are filed by wells, which are numbered consecutively as the reports are received, the numbers being entered on record cards which are filed alphabetically under States and counties.

It is the intention to issue annually a report giving the results of the year's work, and in accordance with this plan a report covering the first six months of the operation of the system was prepared at the beginning of 1905 and issued early in the year (Bulletin No. 264). This report, which was prepared by Messrs. Fuller, Lines, and Veatch, contains discussions of the importance of well records and an account of the organization of the work of collecting records and samples, a full description of the methods of work, a list of the persons cooperating in furnishing samples or records, a summary of wells reported, and the results and detailed records of a considerable number of wells.

From its beginning, on July 1, to September 15 the work of the sample system was carried on by Mr. Veatch, assisted by Mr. E. F. Lines. On Mr. Veatch's voluntarily relinquishing the work to take up more strictly scientific lines of investigation the routine work devolved upon Mr. Lines, who continued to conduct it until he was transferred to the geologic branch on April 1, when the work was placed in charge of Mr. Samuel Sanford.

During the fiscal year two field trips were made—the first, in July, 1904, by Mr. Lines to arrange with State geologists of certain central States for cooperation in the collection of records, and the second by Mr. Sanford to the South Atlantic States for the purpose of arranging with drillers for the saving of samples.

REPORTS.

Eight reports, covering a portion of the work of the section, appeared as water-supply papers or bulletins within the fiscal year. These are as follows:

Underground waters of southern Louisiana, with discussion of their uses for water supplies and for rice irrigation, by G. D. Harris and M. L. Fuller: Water-Sup. and Irr. Paper No. 101.

Contributions to the hydrology of eastern United States, 1903, by M. L. Fuller and others: Water-Sup. and Irr. Paper No. 102.

Water resources of the Philadelphia district, by Florence Bascom: Water-Sup. and Irr. Paper No. 106.

Contributions to the hydrology of eastern United States, 1904, by M. L. Fuller and others: Water-Sup. and Irr. Paper No. 110.

Underground waters of eastern United States, by M. L. Fuller: Water-Sup. and Irr. Paper No. 114.

Bibliographic review and index of papers relating to underground waters published by the United States Geological Survey, 1879–1904, by M. L. Fuller: Water-Sup. and Irr. Paper No. 120.

Relation of the law to underground waters, by Douglas W. Johnson: Water-Sup. and Irr. Paper No. 122.

Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch: Bull. No. 264.

The series of Contributions to the Hydrology of Eastern United States, of which the volumes for 1903 and 1904 have appeared, gives an opportunity for the publication of many papers which are not of sufficient length to warrant separate publication. The two reports issued have been very favorably received, and a third volume, similar to that of 1904, has been prepared (Water-Supply Paper No. 145).

WORK BY STATES.

Maine.—During the year Prof. W. S. Bayley, assistant geologist, continued to collect data relating to the public water supplies, wells, and springs of the State, with the object of preparing a complete report on the water

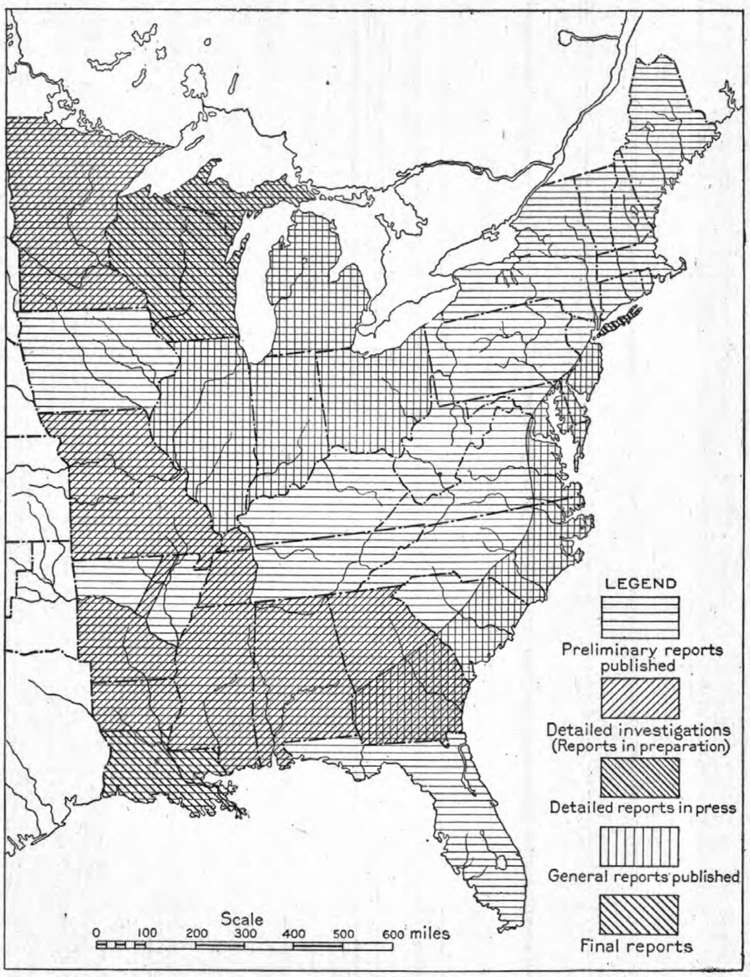


FIG. 1.—Map showing progress of hydrologic work in eastern half of United States.

resources of Maine. The work was practically completed at the end of the fiscal year.

In connection with the investigations for the geologic branch, Mr. George Otis Smith collected water data for certain of the quadrangles along the coast, and in addition made a special investigation of the water supply from a basin of glacial gravels near Augusta, which examination had an important bearing on questions of water supply for that city.

The following publications relating to underground waters of the State were issued:

[Well and spring records], by W. S. Bayley: Water-Sup. and Irr. Paper No. 102, pp. 27–55.

[Underground waters], by W. S. Bayley: Water-Sup. and Irr. Paper No. 114, pp. 41–56.

Well records, by E. F. Lines: Bull. No. 264, pp. 52–53.

New Hampshire.—The work in this State was conducted under the direction of Mr. J. M. Boutwell, assistant geologist, but, owing to the pressure of his regular mining work, Mr. Boutwell was unable to undertake field investigations within the State. A report giving the results of the investigation of the underground water conditions in the vicinity of the Government forts at Portsmouth and based on field work conducted during the last fiscal year was prepared by Mr. George Otis Smith at the request of the War Department. The report pointed out the probability of obtaining satisfactory supplies, and showed the occurrence of flowing wells in igneous rocks in this vicinity.

The following reports relating to underground waters of the State were published:

[Well and spring records], by J. M. Boutwell: Water-Sup. and Irr. Paper No. 102, pp. 56–72.

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 57–59.

Well records, by E. F. Lines: Bull. No. 264, pp. 56–57.

Vermont.—Prof. George H. Perkins continued to voluntarily cooperate with the Geological Survey in obtaining information relating to the wells and springs of the State, but no field work was conducted for the United States Geological Survey during the fiscal year 1904–5, although plans for taking up and completing the investigation of underground waters at an early date were considered.

The following publications relating to underground waters of the State were issued:

[Water supplies, analyses, and well and spring records], by George H. Perkins: Water-Sup. and Irr. Paper No. 102, pp. 73–93.

Water resources of the Fort Ticonderoga quadrangle, Vermont and New York, by T. Nelson Dale: Water-Sup. and Irr. Paper No. 110, pp. 126–129.

Water resources of the Taconic quadrangle, New York, Massachusetts, and Vermont, by F. B. Taylor: Water-Sup. and Irr. Paper No. 110, pp. 130–133.

[Underground waters], by George H. Perkins: Water-Sup. and Irr. Paper No. 114, pp. 60–67.

Massachusetts.—Prof. W. O. Crosby continued in charge of the investigations in this State. During the year he prepared and submitted a report on the "Water Supply of Sand Plains of the Delta Type," based on very detailed studies of certain large plains at Clinton. Professor Crosby also devoted some time to the preparation of a paper on the wells of the Boston basin, a report on which will soon be submitted.

The following publications relating to underground waters of the State were issued:

[Well and spring records], by W. O. Crosby and Laurence La Forge: Water-Sup. and Irr. Paper No. 102, pp. 94–111.

Additional well records in Massachusetts, by F. A. Champlin: Water-Sup. and Irr. Paper No. 102, pp. 112, 117.

Water resources of the Taconic quadrangle, New York, Massachusetts, and Vermont, by F. B. Taylor: Water-Sup. and Irr. Paper No. 110, pp. 130–133.

Drilled wells of the Triassic area of the Connecticut Valley, by W. H. C. Pynchon: Water-Sup. and Irr. Paper No. 110, pp. 65–94.

Triassic rocks of the Connecticut Valley as a source of water supply, by M. L. Fuller: Water-Sup. and Irr. Paper No. 110, pp. 95–112.

[Underground waters], by W. O. Crosby: Water-Sup. and Irr. Paper No. 114, pp. 68–75.

Well records, by E. F. Lines: Bull. No. 264, pp. 52–53.

Rhode Island.—No field work was conducted in the State during the fiscal year, but the following reports, based on investigations of the previous fiscal year, were published:

[Well and spring records], by W. O. Crosby: Water-Sup. and Irr. Paper No. 102, pp. 119–125.

[Underground waters], by W. O. Crosby: Water-Sup. and Irr. Paper No. 114, pp. 63–75.

Connecticut.—Prof. H. E. Gregory, assistant geologist, remained in charge of the work in this State during the year, but owing to serious illness no field work was undertaken. The following reports relating to the underground waters of Connecticut appeared within the year:

[Well records], by H. E. Gregory: Water-Sup. and Irr. Paper No. 102, pp. 127–159.

Additional well records in Connecticut, by C. L. Grant: Water-Sup. and Irr. Paper No. 102, pp. 160–165.

Additional well records in Connecticut, by F. A. Champlin: Water-Sup. and Irr. Paper No. 102, pp. 165–168.

Drilled wells of the Triassic area of the Connecticut Valley, by W. H. C. Pynchon: Water-Sup. and Irr. Paper No. 110, pp. 65–94.

Triassic rocks of the Connecticut Valley as a source of water supply, by M. L. Fuller: Water-Sup. and Irr. Paper No. 110, pp. 95–112.

[Underground waters], by H. E. Gregory: Water-Sup. and Irr. Paper No. 114, pp. 76–81.

Well records, by E. F. Lines: Bull. No. 264, pp. 44–45.

New York.—Mr. F. B. Weeks continued work on the springs of the State, making several trips to the field. The report is well under way.

Dr. E. M. Kindle made an investigation of the underground waters of the Harford-Owego area in connection with his geologic surveys, and prepared a short report on the same. A report on the waters of a gravel-filled valley near Tully, N. Y., was also prepared by Mr. George B. Hollister.

The following publications relating to underground waters of the State were issued:

[Well and spring records], by F. B. Weeks: Water-Sup. and Irr. Paper No. 102, pp. 169–206.

The new artesian water supply at Ithaca, New York, by Francis L. Whitney: Water-Sup. and Irr. Paper No. 110, pp. 55–64.

Water resources of the Fort Ticonderoga quadrangle, Vermont and New York, by T. Nelson Dale: Water-Sup. and Irr. Paper No. 110, pp. 126–129.

Water resources of the Taconic quadrangle, New York, Massachusetts, and Vermont, by F. B. Taylor: Water-Sup. and Irr. Paper No. 110, pp. 130–133.

[Underground waters], by F. B. Weeks: Water-Sup. and Irr. Paper No. 114, pp. 82–92.

Well records, by E. F. Lines: Bull. No. 264, pp. 58–59, 91.

New Jersey.—During the year Mr. G. N. Knapp, under the direction of Mr. H. B. Kümmel, State geologist, continued work on the preparation of a report and on new well records submitted from time to time. The completion of the report has been delayed by the necessity of establishing certain geologic correlations of importance.

The following publications relating to underground waters of the State were issued:

Water resources of the central and southwestern Highlands in New Jersey, by Laurence La Forge: Water-Sup. and Irr. Paper No. 110, pp. 141–155.

[Underground waters], by G. N. Knapp: Water-Sup. and Irr. Paper No. 114, pp. 93–103.

Well records, by E. F. Lines: Bull. No. 264, pp. 56–59, 90–91.

Delaware.—The only work done within the year was the collection of records incidental to the investigation of the underground waters of New Jersey. The only publication relating to this State is the following:

[Underground waters], by N. H. Darton: Water-Sup. and Irr. Paper No. 114, pp. 11–113.

Pennsylvania.—No field work was conducted by this section in Pennsylvania during the fiscal year, but the following papers, based on the work of the geologic branch, were issued:

Water resources of the Chambersburg and Mercersburg quadrangles, Pennsylvania, by George W. Stose: Water-Sup. and Irr. Paper No. 110, pp. 156–158.

Water resources of the Curwensville, Patton, Ebensburg, and Barnesboro quadrangles, Pennsylvania, by F. G. Clapp: Water-Sup. and Irr. Paper No. 110, pp. 159–163.

Water resources of the Elders Ridge quadrangle, Pennsylvania, by Ralph W. Stone: Water-Sup. and Irr. Paper No. 110, pp. 164–165.

Water resources of the Waynesburg quadrangle, Pennsylvania, by Ralph W. Stone: Water-Sup. and Irr. Paper No. 110, pp. 166–167.

Water resources of the Philadelphia district, by Florence Bascom: Water-Sup. and Irr. Paper No. 106, pp. 69.

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 104–110.

Well records, by E. F. Lines: Bull. No. 264, pp. 62–71, 92–97.

Maryland.—A short report on the water resources of the Pawpaw and Hancock quadrangles was prepared by Messrs. George W. Stose and George C. Martin, the data being obtained in connection with surveys for the geologic branch. No field work was conducted by this section, but a provisional arrangement was made with Prof. W. B. Clark, State geologist, looking toward cooperation in underground-water investigations in 1906. Professor Clark has also cooperated in the collection of well records and samples, the collecting being done from the Maryland office and duplicate records and samples being furnished the United States Geological Survey. The following publications appeared within the year:

Water resources of the Accident and Grantsville quadrangles, Maryland, by G. C. Martin: Water-Sup. and Irr. Paper No. 110, pp. 168–170.

Water resources of the Frostburg and Flintstone quadrangles, Maryland and West Virginia, by G. C. Martin: Water-Sup. and Irr. Paper No. 110, pp. 171–173.

[Underground waters], by N. H. Darton and M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 114–123.

District of Columbia.—Mr. N. H. Darton began the preparation of a detailed report on the artesian waters of the District. The following paper was published:

[Underground waters], by N. H. Darton and M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 124–126.

Virginia.—Acting under a plan of cooperation, Mr. T. L. Watson, State geologist, collected a large amount of data relating to the general water resources, wells, and springs of Virginia. These will be compiled by Mr. M. L. Fuller into a statistical report for publication by the State Survey. This work is preliminary to a detailed investigation of the springs, which Mr. Fuller expects to undertake in 1906, and of the Coastal Plain stratigraphy and water resources, which he will conduct in conjunction with Mr. Watson in 1907. A short report on certain of the hot springs of the State was prepared by Mr. Walter H. Weed.

The following publication relating to the underground waters of the State was issued:

[Underground waters], by N. H. Darton and M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 127–135.

West Virginia.—The only field work during the year was that conducted by Messrs. George W. Stose and George C. Martin for the geologic branch in the Pawpaw and Hancock quadrangles, and by Mr. George H. Ashley in the Nicholas quadrangle. A short report on each of these areas was prepared for publication.

Mr. I. C. White, State geologist, cooperated in the collection of well records and samples. The following papers appeared:

Water resources of the Frostburg and Flintstone quadrangles, Maryland and West Virginia, by G. C. Martin: Water-Sup. and Irr. Paper No. 110, pp. 171–173.

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 271–272.

North Carolina.—No field work was conducted in the State during the year, but a large amount of data relating to general water resources, wells, and springs was collected by Mr. M. L. Fuller by correspondence. The following reports were issued:

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 136–139.

Water resources of the Cowee and Pisgah quadrangles, North Carolina, by Hoyt S. Gale: Water-Sup. and Irr. Paper No. 110, pp. 174–176.

South Carolina.—During the fiscal year South Carolina was very thoroughly canvassed by correspondence, and reports as to the general water resources, wells, and springs were received from nearly every village. These will be compiled by Mr. M. L. Fuller in a report for publication by the State Geological Survey. Arrangements for cooperation in future work in the State were made with Mr. Earle Sloan, State geologist.

The following publication was issued within the year:

[Underground waters], by L. C. Glenn: Water-Sup. and Irr. Paper No. 114, pp. 140–152.

Georgia.—During the year Mr. S. W. McCallie continued to collect well and spring data and to investigate the geology in its relation to the occurrence of ground waters. A detailed study of the Coastal Plain stratigraphy, including the collection of a large number of fossils, was made. The fossils were identified by Messrs. W. H. Dall and T. W. Vaughan.

The following publications relating to the underground waters of the State were issued:

[Water supply, well, and spring records], by S. W. McCallie: Water-Sup. and Irr. Paper No. 102, pp. 207–236.

Measurements of springs in Georgia, by B. M. Hall: Water-Sup. and Irr. Paper No. 102, pp. 236–237.

Experiment relating to problems of well contamination at Quitman, Georgia, by S. W. McCallie: Water-Sup. and Irr. Paper No. 110, pp. 45–54.

[Underground waters], by S. W. McCallie: Water-Sup. and Irr. Paper No. 114, pp. 153–158.

Well records, by E. F. Lines: Bull. No. 264, pp. 46–47.

Florida.—No work was conducted in the State during the year, but the following publications were issued:

[Well and spring records], by M. L. Fuller: Water-Sup. and Irr. Paper No. 102, pp. 238–274.

Measurement of springs in Florida, by B. M. Hall: Water-Sup. and Irr. Paper No. 102, pp. 274–275.

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 159–163.

Well records, by E. F. Lines: Bull. No. 264, pp. 44–45.

Minnesota.—Prof. C. W. Hall, in addition to his duties at the University of Minnesota, continued work on the springs and underground waters for the Survey, made progress on his report on the water resources of the State, and assisted in the collection of well records and samples. The following publications appeared within the year:

[Well and spring records], by C. W. Hall: Water-Sup. and Irr. Paper No. 102, pp. 441–488.

Well records in Lyon County, Minnesota, by J. E. Todd: Water-Sup. and Irr. Paper No. 102, p. 481.

[Underground waters], by C. W. Hall: Water-Sup. and Irr. Paper No. 114, pp. 226–232.

Well records, by E. F. Lines: Bull. No. 264, pp. 54–58.

Wisconsin.—No work was conducted in Wisconsin during the fiscal year. The report by Mr. Alfred R. Schultz was edited and transmitted to the State Geological Survey for publication. A short report on the water resources of the Mineral Point quadrangle was prepared by Mr. U. S. Grant. The following are the publications issued within the year:

[Underground waters], by Alfred R. Schultz: Water-Sup. and Irr. Paper No. 114, pp. 233–241.

Well records, by E. F. Lines: Bull. No. 264, pp. 76–77.

Michigan.—During the fiscal year a very detailed and comprehensive investigation of the water supply of the drift was conducted by Mr. Frank Leverett, assisted by C. A. Davis, Isaiah Bowman, W. M. Gregory, and Jon Andreas Udden. There are several hundred areas of flowing drift wells within the State, each of which was studied in considerable detail. Several problems of interest developed during the work, especially in relation to the temperature gradient and the flow of water from unconfined sandy strata. Many valuable analyses were made by Mr. S. J. Lewis, detailed for the work by Mr. M. O. Leighton, chief of the division of hydro-economics. An unusually complete report on the geology and the waters of the drift was prepared.

During August and September, 1904, Mr. M. L. Fuller, chief of section, made a special investigation of the failure of wells in the Carleton district, southwest of Detroit, and prepared a report which was published by the State Geological Survey of Michigan. Mr. Fuller also visited about twenty flowing-well areas in the western portion of the State and prepared reports for incorporation with those of Mr. Leverett.

Mr. A. C. Lane, State geologist, cooperated in the saving of well samples, and Mr. Robert E. Horton prepared a report on the drainage of swamps into wells. Much valuable land has been reclaimed in this way, and the process promises to become an important one in thinly inhabited regions where there is little danger of polluting domestic supplies. Mr. C. A. Davis conducted investigations on the cause of the deposition of calcite in well points and of the clogging of pipes by a soft black substance supposedly of organic origin. Special studies by Mr. Leverett were also made on the height of the water table in glacial hills and on the cause of the low head of certain wells.

The following publications relating to the underground waters of the State were issued:

[Well and spring records], by W. F. Cooper: Water-Sup. and Irr. Paper No. 102, pp. 489–512.

[Underground waters], by M. L. Fuller: Water-Sup. and Irr. Paper No. 114, pp. 242–247.

Well records, by E. F. Lines: Bull. No. 264, pp. 52–53.

Iowa.—The work in this State remained in charge of Prof. W. H. Norton, who continued his work on its artesian waters. He was temporarily assisted by Prof. J. A. Udden and Mr. Howard E. Simpson. Professor Norton also cooperated in the collection of well records and samples.

The following publications relating to the underground waters of the State were issued:

[Underground waters], by W. H. Norton: Water-Sup. and Irr. Paper No. 114, pp. 220–225.

Well records, by E. F. Lines: Bull. No. 264, pp. 48–49, 82–84.

Illinois.—Mr. M. L. Fuller spent a few days in the month of June, 1905, in southern Illinois, investigating the physiography of the old Ohio channel now occupied by Cache River and The Bay. The study was made in connection with that of the geology and water resources of northeastern Arkansas, to which problem that of the Illinois district is related.

The following publications relating to the underground waters of the State were issued:

[Underground waters], by Frank Leverett: Water-Sup. and Irr. Paper No. 114, pp. 248–257.

Well records, by E. F. Lines: Bull. No. 264, pp. 46–49, 80–81.

Indiana.—No work was conducted in Indiana in the fiscal year 1904–5, but the following reports, based on earlier work, were issued:

[Underground waters], by Frank Leverett: Water-Sup. and Irr. Paper No. 114, pp. 258–264.

Well records, by E. F. Lines: Bull. No. 264, pp. 48–49, 82.

Ohio.—As in Indiana, no work was conducted in the State. The following reports were published:

[Underground waters], by Frank Leverett: Water-Sup. and Irr. Paper No. 114, pp. 265–270.

Well records, by E. F. Lines: Bull. No. 264, pp. 60–63, 92.

Missouri.—In Missouri the work was continued in charge of Prof. E. M. Shepard, who spent a portion of the summer of 1904 in the study of the artesian waters of the State and in the investigation of the possible relation of artesian waters to certain phenomena of the New Madrid earthquake. In the spring of 1903 Professor Shepard was assisted by Mr. E. E. Ellis, geologic aid, in collecting well records and in analyzing waters. Many drill samples were collected, and a number of carefully worked out geologic sections were prepared. Among the problems undertaken were the definite outlining of flowing-well districts; a comparative study of the composition of the waters and their relation to geologic horizons; the discovery of buried river channels in the northeastern part of the State; the recognition of anticlinal folds which may have been connected with the deflection of Missouri River at certain points; and the discovery of evidence of the probable extension of the St. Peter sandstone along the west, northwest, and southwest flanks of the Ozark zone. Artesian pressure as a factor in the New Madrid earthquake was pointed out in a paper on this earthquake, published in the January-February number of the Journal of Geology, 1905.

Mr. M. L. Fuller visited the New Madrid area in company with Professor Shepard in the fall of 1904, and studied a number of the earthquake features in Missouri and adjoining portions of Arkansas, and, in the spring of 1905, spent two weeks in the study of physiographic and earthquake problems in the southeastern portion of the State. Mr. Fuller also spent several days in an examination of the springs and underground streams of a portion of Greene County.

A report on the water resources of the Joplin quadrangle was prepared by Mr. W. S. Tangier Smith, and an account of a number of large springs of the Ozarks was prepared by Mr. M. L. Fuller from notes furnished by Messrs. E. Johnson, jr., H. F. Bain, and E. M. Shepard.

The publications which appeared within the year are as follows:

[Well and spring records], by E. M. Shepard: Water-Sup. and Irr. Paper No. 102, pp. 389–390.

Wells of Joplin and vicinity, by W. S. Tangier Smith: Water-Sup. and Irr. Paper No. 102, pp. 404–408.

Water supply of Livingstone County, Missouri, by R. Hawkins: Water-Sup. and Irr. Paper No. 102, pp. 410–416.

Spring system of the Decaturville Dome, Camden County, Missouri, by E. M. Shepard: Water-Sup. and Irr. Paper No. 110, pp. 113–126.

[Underground waters], by E. M. Shepard: Water-Sup. and Irr. Paper No. 114, pp. 209–219.

Well records, by E. F. Lines: Bull. No. 264, pp. 54–55.

Arkansas.—During the months of May and June, 1905, Mr. M. L. Fuller was engaged in an investigation of the underground waters, geology, physiography, and earthquake phenomena of northeastern Arkansas, and the material for a report on the last two subjects was obtained. Mr. Fuller also investigated the use of water for the irrigation of rice, the growing of which promises soon to become a very important industry, as an abundant supply of water for the purpose of irrigation can be obtained from wells at many points.

Mr. A. F. Crider, assisted by Mr. L. W. Stephenson, spent the months of May and June, 1905, in an investigation of the geology of northeastern Arkansas and its relation to underground waters, acting under the direction of Mr. M. L. Fuller. Special attention was paid to the geology of Crowleys Ridge, with the result that several horizons worthy of mapping as formations were differentiated. The presence of fairly well-defined water horizons was established, and many interesting facts as to the distribution of the buried Cretaceous and the surface Tertiary deposits were discovered. The following reports relating to the underground waters of the State were published:

[Well and spring records], by A. H. Purdue: Water-Sup. and Irr. Paper No. 102, pp. 374–388.

Summary of the water supply of the Ozark region in northern Arkansas, by George I. Adams: Water-Sup. and Irr. Paper No. 110, pp. 179–182.

[Underground waters of northern Arkansas], by A. H. Purdue: Water-Sup. and Irr. Paper No. 114, pp. 188–197.

[Underground waters of Louisiana and southern Arkansas], by A. C. Veatch: Water-Sup. and Irr. Paper No. 114, pp. 179–187.

Well records, by E. F. Lines: Bull. No. 264, pp. 42–43.

Kentucky and Tennessee.—Mr. M. L. Fuller visited the Embayment area of Kentucky and Tennessee in June, 1905, and investigated the earthquake features in the vicinity of Reelfoot Lake, obtaining data upon which a report of the earthquake will be prepared.

Mr. L. C. Glenn continued work on his report on the geology and underground waters of the Embayment area in Tennessee and Kentucky. In Kentucky Mr. C. J. Norwood, director of the local survey, cooperated in the collection of well records and samples.

The following publications relating to the underground waters of these States were issued:

Well records of Tennessee, by L. C. Glenn: Water-Sup. and Irr. Paper No. 102, pp. 358–367.

Well records in Kentucky, by L. C. Glenn: Water-Sup. and Irr. Paper No. 102, pp. 369–373.

Water resources of the Middlesboro-Harlan region of southeastern Kentucky, by George H. Ashley: Water-Sup. and Irr. Paper No. 110, pp. 177–178.

[Underground waters], by L. C. Glenn: Water-Sup. and Irr. Paper No. 114, pp. 198–208.

Well records, by E. F. Lines: Bull. No. 264, pp. 50–51, 70–71.

Louisiana.—No field work was done in this State during the fiscal year, but a report on the underground waters of the northern part of the State was prepared and submitted by Mr. A. C. Veatch.

The following reports relating to the underground waters of the State were published:

Underground waters of southern Louisiana, with discussion of the use of water supplies, by G. D. Harris and M. L. Fuller: Water-Sup. and Irr. Paper No. 101, pp. 98.

[Underground waters of northern Louisiana], by A. C. Veatch: Water-Sup. and Irr. Paper No. 114, pp. 179–187.

Well records, by E. F. Lines: Bull No. 264, pp. 52–53.

Mississippi.—In conjunction with the geologic branch, the eastern section of hydrology continued work on the geology and underground waters of the State. The field work, conducted by Mr. E. C. Eckel, assisted by Mr. A. F. Crider, was completed early in 1905, and a report was prepared for publication.

The following publications relating to the underground waters of the State were issued:

Well records, by L. C. Johnson: Water-Sup. and Irr. Paper No. 102, pp. 332–357.

[Underground waters], by L. C. Johnson and E. C. Eckel: Water-Sup. and Irr. Paper No. 114, pp. 171–178.

Well records, by E. F. Lines: Bull. No. 264, pp. 54–55, 87.

Alabama.—Mr. E. A. Smith, State geologist, continued cooperation, completing the field work on artesian waters in the summer of 1904, and during the winter he was engaged on the report of this work. He also cooperated with the section in the collection of well records and samples.

The following publications relating to the underground waters of the State were issued:

Well records, by E. A. Smith: Water-Sup. and Irr. Paper No. 102, pp. 276–329.

[Underground waters], by E. A. Smith: Water-Sup. and Irr. Paper No. 114, pp. 164–170.

Well records, by E. F. Lines: Bull. No. 264, pp. 42–43.

WESTERN SECTION.

In the work of this section Mr. N. H. Darton, geologist in charge, had the assistance of Mr. W. C. Mendenhall, geologist, and Messrs. C. A. Fisher, W. T. Lee, G. B. Richardson, and C. E. Siebenthal, assistant geologists. Several special assistants were engaged during the field season, mainly professors of geology in western colleges, who devoted a portion of their time to the work. Part of their services was rendered in connection with cooperation between the Federal Survey and State surveys.

Work already begun was carried forward and a number of new areas were investigated. There is great demand for information relating to underground waters in all portions of the West, but the area is so vast that, with limited means, it is not practicable to obtain quickly the desired data for all the districts. As far as possible, work has been done where the information would serve the interests of the largest number of people, or where the problems are such that investigation would probably throw light on the principles governing the occurrence of underground water or on the geologic relations of the district. During the last season considerable attention was paid to the geology of dam sites and of regions in which reservoirs are contemplated.

OFFICE WORK.

Work was continued on the catalogue of deep wells of the United States, and it has been completed and sent to the printer (Water-Supply Paper No. 149). The preliminary list which appeared in Water-Supply Papers Nos. 57 and 61 proved to be useful, and the new list is similar in scope, but has many additions, bringing it as nearly to date as practicable.

WORK BY STATES AND TERRITORIES.

Arizona.—The principal investigations in this Territory were conducted by Mr. Willis T. Lee, in the valley of Colorado River, from the mouth of the Grand Canyon to Yuma. Most of the valleys and mountain ranges in this area were examined and a report was prepared and submitted for publication. Progress was also made with the preparation of the report on the underground waters of the high plateau area of the northern-central and northeastern portions of the Territory.

Of the two publications listed below, giving results of work in the State, the first was issued and the second sent to the printer within the year:

Underground waters of Gila Valley, Arizona, by W. T. Lee: Water-Sup. and Irr. Paper No. 104.

Underground waters of the Salt River Valley, by W. T. Lee: Water-Sup. and Irr. Paper No. 136.

California.—In southern California hydrologic investigations were carried out during the fiscal year 1904–5 by Mr. W. C. Mendenhall, geologist. The greater part of the preceding year was occupied with the collection of data in the field, and the preparation of reports was under way July 1, 1904. By the first of January, 1905, three were submitted on as many subdivisions of the coastal plain of southern California, and early in 1905 a fourth, on the hydrology of the San Bernardino Valley, was submitted for publication. Meanwhile a part of the results secured in southern California were made known through other channels than official publications. A number of papers were prepared and delivered before various engineering societies and institutes at Los Angeles, Pomona, Anaheim, Santa Barbara, Rialto, and other places. A paper in which a general résumé of conditions in southern California appeared was delivered before the National Irrigation Congress at El Paso, Tex., and still another was read before the Southern California Water Congress held in Los Angeles on the 13th of March, 1905. This congress, indeed, was called largely because of the more thorough understanding of the conditions governing underground water supplies which has resulted from the investigations of the division of hydrology in this field.

Field work was continued along a number of lines and in several localities during the year. In the fall of 1904 a set of observations on the fluctuations of the water plane in various parts of southern California was begun. These observations were continued throughout the remainder of the fiscal year, and will soon have been under way long enough to furnish a safe basis for preliminary conclusions as to the relative effects of drought and development in bringing about those changes in ground-water levels which have been noted in many parts of this field. The field work was completed for a report on the underground waters of the foothill belt of southern California, and this report will be prepared and submitted early in the next fiscal year.

In February and March, 1905, an examination of the conditions which control the underground water supplies in the Coachella Valley, between Los Angeles and Yuma, was carried out by Mr. Mendenhall for the Reclamation Service. The results of these studies will be embodied in a report at an early date. Early in April was begun another important investigation on the underground waters of the San Joaquin Valley. This work is under way at the close of the year and will be carried on during the coming year. The work is being done for the Reclamation Service and at its expense, but the men and methods developed in the division of hydrology are being utilized.

Mr. Willis T. Lee during the year made a reconnaissance of Owens Valley to ascertain the conditions bearing upon the prospects for underground water supplies. A report was prepared and submitted for publication.

The following publications relating to underground waters in the State were in the hands of the printer at the end of the fiscal year:

Development of underground waters in the eastern coastal plain region of southern California, by W. C. Mendenhall: Water-Sup. and Irr. Paper No. 137.

Development of underground waters in the central coastal plain region of southern California, by W. C. Mendenhall: Water-Sup. and Irr. Paper No. 138.

Development of underground waters in the western coastal plain region of southern California, by W. C. Mendenhall: Water-Sup. and Irr. Paper No. 139.

Hydrology of the San Bernardino Valley, by W. C. Mendenhall: Water-Sup. and Irr. Paper No. 142.

Colorado.—Much attention was devoted to questions of underground water supply in this State, and investigations were made in several districts. Mr. Darton continued his study of the Arkansas Valley artesian area in the eastern part of the State to ascertain the limits of the district in which flows are obtainable and the volume of water available. The geologic structure was determined, so that the depths of the water-bearing strata can be predicted with a fair degree of accuracy. The report which was prepared is accompanied by maps showing the geology, depths to Dakota sandstone, wells, flow area, intake zone and other features, and cross sections illustrating the underground relations.

Mr. C. A. Fisher completed the Nepesta folio, which is now in course of publication in the Geologic Atlas of the United States. It has a special sheet showing depths to water, area of flow, etc., in the region east of Pueblo.

Mr. C. E. Siebenthal completed a detailed examination of the artesian basin in the San Luis Park, and the report will soon be ready for transmittal. The water from artesian wells is a most important feature in this valley, and much interest is manifested in the extent of the flow area and the volume of water available. As wells are very numerous, and a large volume of water is flowing from them, special consideration was given to the question of the source and permanency of the water supply.

In view of the extensive reclamation works now in progress in the Uncompahgre Valley, it was deemed desirable to investigate the underground waters upon which many of the settlers must depend for their domestic supply. Accordingly, Mr. C. E. Siebenthal spent a portion of last season in the valley investigating the geologic structure and ascertaining the conditions relating to underground waters. It was found that in some portions of the region water-bearing strata lie at moderate depths, and in some districts they may be expected to furnish flows. The report on the results of this investigation is now partly prepared.

During the early part of the winter a canvass was made of the deep wells in Denver and vicinity, with the view of ascertaining if there was any new evidence relating to the prospects for deeper-seated waters than those now developed. The results were somewhat encouraging, for it is believed that additional supplies may be obtained by borings sufficiently deep to reach some of the lower sandstone horizons. This work is not yet completed, and it is expected that the matter will receive further consideration during the coming season.

The following publication relating to the underground waters of the State was issued within the year:

Geology and underground water resources of the Central Great Plains, by N. H. Darton: Prof. Paper No. 32.

Nebraska.—Mr. G. E. Condra made a detailed investigation of the geologic structure of the southwestern and south-central portions of this State, mainly in the Republican Valley, for the purpose of determining the prospects for artesian wells and the depths to the water-bearing Dakota sandstone. The report by Mr. Condra on northeastern Nebraska is in preparation. A new map was drawn to serve as a base on which to represent the depths to the artesian waters and to show the area in which flows may be expected.

The following publication issued within the year refers to the underground waters of the State:

Geology and underground water resources of the Central Great Plains, by N. H. Darton: Prof. Paper No. 32.

New Mexico.—Considerable progress was made in various parts of New Mexico in extending our knowledge of the distribution and relations of the underground water supplies. The greater part of the work was done by Mr.

W. T. Lee, who made investigations in the vicinity of Las Cruces, Albuquerque, and other places in the Rio Grande Valley. Mr. Lee also examined the Staked Plains region about Portales, to ascertain the extent of the territory in which artesian flows may be expected.

Mr. C. A. Fisher prepared and transmitted for publication a report on his investigation of the underground waters of the Pecos Valley, in the Roswell district.

Of the two papers listed below, the first was published and the second sent to the printer within the year:

Zuni salt deposits, by N. H. Darton: Bull. No. 260, pp. 565–566.

Geology and underground water resources of the Jornada del Muerto, by C. R. Keyes: Water-Sup. and Irr. Paper No. 123.

North Dakota.—Prof. D. E. Willard continued his investigations of the underground and artesian water conditions in the Red River Valley, with a view to preparing a general report on underground waters of the State. Material was also obtained for a special report on the area of the Wahpeton quadrangle, which will soon be transmitted for publication.

The following publications relating to the State were issued within the year:

Casselton-Fargo folio, by C. M. Hall and D. E. Willard: Geologic Atlas U. S., folio No. 117.

Lignite of North Dakota and its relation to irrigation, by Frank A. Wilder: Water-Sup. and Irr. Paper No. 117.

Oklahoma.—No field work was done in this Territory during the fiscal year 1904–5, but the following report was transmitted for publication:

Geology and underground water resources of Oklahoma, by C. N. Gould: Water-Sup. and Irr. Paper No. 148.

South Dakota.—Prof. J. E. Todd extended his studies of the James River artesian area into the Byron and Redfield quadrangles. Much attention was given to the question of the volume and pressure of the wells, with a view to determining whether the multiplicity of borings is causing a diminution of the water supply. Professor Todd also completed a report on the southeastern termination of the artesian area for the Elk Point folio. As lands within the artesian basin are taken up by settlers, it becomes a matter of great interest to ascertain the limit of the area in which flows are obtainable, and this was one of the chief purposes of Professor Todd's work.

Mr. Darton spent several weeks in the field in the region about Belle Fourche, studying the geologic structure, to ascertain the depths to the underground waters and the area in which flows may be expected. The results will be incorporated in the report on the northern Black Hills region, now in preparation. There is much interest in underground water resources about Belle Fourche at present, owing to the extensive settlement that is expected when the irrigation works of the Reclamation Service are in operation.

The following publications relating to the underground waters of the State were issued within the year:

Geology and underground water resources of the Central Great Plains, by N. H. Darton: Prof. Paper No. 32.

Edgemont folio, by N. H. Darton and W. S. Tangier Smith: Geologic Atlas U. S., folio No. 108.

Geology and water resources of part of the lower James River Valley, South Dakota, by J. E. Todd and C. M. Hall: Water-Sup. and Irr. Paper No. 90.

Huron folio, by J. E. Todd: Geologic Atlas U. S., folio No. 113.

De Smet folio, by J. E. Todd and C. M. Hall: Geologic Atlas U. S., folio No. 114.

Texas.—The principal investigations in Texas during the year were in the eastern Panhandle, where Prof. C. N. Gould made an examination of the geology and structure of Hansford, Hutchinson, Carson, Armstrong, Ochiltree, Roberts, Gray, Donley, Lipscomb, Hemphill, Wheeler, and Collingsworth counties.

Mr. G. B. Richardson continued his investigations of the underground water conditions in the western portion of the State, about El Paso, for incorporation in the El Paso folio.

The following publications relating to the underground waters of the State were sent to the printer within the year:

Report of a reconnaissance in trans-Pecos Texas, by G. B. Richardson: Univ. of Texas Mineral Survey, Bull. No. 9.

Observations on the ground waters of the Rio Grande Valley, by C. S. Slichter: Water-Sup. and Irr. Paper No. 141.

Utah.—Mr. G. B. Richardson spent the greater part of the summer of 1904 in the valleys of Utah Lake and Jordan River, making an investigation of the underground water resources. Part of the work was done in cooperation with the State, and a special investigation was made of projects for increasing the water supply of Salt Lake City. During the winter a report of the results was prepared, which is now ready for publication.

Washington and Oregon.—The following publications relating to the underground waters of these States were issued within the year:

Geology and water resources of a portion of east-central Washington, by Frank C. Calkins: Water Sup. and Irr. Paper No. 118.

Underground waters of Washington, by Henry Landes: Water-Sup. and Irr. Paper No. 111.

Report on the geology of central Oregon, by I. C. Russell: Bull. No. 252.

Wyoming.—Field work in this State was continued by three parties, and the geology and underground water relations of a large area were investigated. Mr. Darton continued his examination of the uplifted beds along the flanks of the Bighorn Mountains, extending the observations of previous seasons southward into the district drained by Powder River and Tensleep Creek. A preliminary report of the results of the several seasons' field work in the Bighorn Range was prepared and transmitted for publication as a professional paper, and four folios for the Geologic Atlas of the United States—the Dayton, Fort McKinney, Bald Mountain, and Cloud Peak—were completed and transmitted for publication.

Mr. C. A. Fisher extended the field work on the Bighorn Mountains across the northern portion of the Bighorn basin, and prepared a report descriptive of the structure, the underground and surface waters, and various economic resources, including coal and other minerals.

Prof. C. C. O'Harra continued his work in the region of the northern Black Hills, especially with a view to ascertaining the structure and underground water conditions in the Belle Fourche and Little Missouri valleys.

It was found that there are excellent prospects for artesian flows along the Little Missouri River in the vicinity of the Wyoming–Montana State line. The results of Mr. O'Harra's work will be included in the Devils Tower folio, and also incorporated in the report on the geology and underground water resources of the northern Black Hills region.

The following publications relating to the State were issued within the year:

Geology and underground water resources of the Central Great Plains, by N. H. Darton: Prof. Paper No. 32.

Newcastle folio, by N. H. Darton: Geologic Atlas U. S., folio No. 107.

Coal of the Black Hills, by N. H. Darton: Bull. No. 260, pp. 429–433.

Division of Hydro-Economics.

The investigations carried on by the division of hydro-economics embrace all those features of hydrographic work which are based upon the quality of water and its fitness for economic use. It has been impossible, as well as impracticable, to take up the entire subject in all its breadth and diversity. The work was therefore confined to the study of practical problems of immediate utility.

During the fiscal year 1904–5 the division was continued under the charge of Mr. Marshall O. Leighton, hydrographer, who gave a large amount of time to field investigations as well as to administrative work. He was assisted by the following persons:

Mr. Richard B. Dole, assistant engineer, gave the entire year to an investigation of the quality of the waters in the State of Minnesota, under a contract for cooperative work between the Minnesota State board of health and the Geological Survey.

Mr. Samuel J. Lewis, assistant engineer, conducted an investigation of the quality of the ground water in the State of Michigan and general hydro-economic investigations in West Virginia, and had supervision of the apparatus for the field assay of water and the files for chemical data maintained in connection with the general work at Washington.

To Mr. Horatio N. Parker, assistant hydrographer, was delegated the field work in connection with the investigation of the Potomac River drainage basin and its water resources, and the direction of the field work which is being carried on in connection with the collection of data for the construction of a normal chlorine map for the Atlantic Coastal Plain region—a continuation of that already prepared in New York and New England.

Mr. Sheldon K. Baker, hydrographic aid, was detailed during the greater part of the year to an investigation of the quality of the ground waters in the Salt River Valley and their probable behavior after the new irrigation system now being installed is put in operation. He also carried on detailed studies in the upper part of the Salt River basin to determine the source of sodium chloride in the water of this stream and the probability of its economic elimination.

Mr. Herman Stabler, hydrographic aid, was employed during the first six months in the Carson Sink to determine the character and depth of the ground waters beneath the area which it is proposed to irrigate under the name of the Truckee-Carson project. During the latter part of the year he was employed in the State of Ohio, under a contract for cooperative work between the Ohio State board of health and the Geological Survey.

CHARACTER OF WORK.

One of the ultimate objects of the work of this division is to secure data concerning the character of the water in every portion of the United States, sufficiently complete to make it possible to define the various regions in the United States in which water of favorable character can be secured, and the sources of such water. The value of a water depends largely upon the foreign ingredients it contains. For some purposes it is necessary to have a water pure, or as nearly pure as it commonly occurs in nature; for such purposes the waters occurring in many parts of the country, containing large proportions of incrusting or corrosive constituents, can not be used without serious damage. For other purposes it may be advantageous to use a water containing a considerable proportion of the appropriate kind of foreign ingredient. Therefore, in the consideration of the economic value of the water supplies of the United States, it becomes necessary to study the various industries which require water, to determine the character of water best suited to their needs, and, having found by investigation the general quality of water in every section of the country, to indicate the areas in which the several industries may find the most favorable conditions with respect to water supplies.

A study like that above outlined involves the collection of an enormous amount of analytical data. Such collection has been in progress ever since the beginning of the hydro-economic work. The compilation and arrangement of the data, so that they may serve their purpose and be constantly available for the use of engineers, chemists, and other persons desiring specific information, is one of the most important branches of the division's work.

In the collection of this mass of material it has been the endeavor so to arrange and correlate it that it may be applied immediately to some important local problem. Therefore, wherever investigations were carried on, the local features were preserved, and the reports on such are already available. The investigations conducted in West Virginia and Kentucky, for example, have immediate local interest by reason of the fact that throughout areas of large extent in these States sources of good water are exceedingly scarce and in some places apparently absent. In such areas it is apparent that a special study of the character of water from all sources has an immediate bearing upon the interests of municipalities, manufacturing industries, and railroads. The work performed in Kansas, in connection with the collection of chemical data, is directed especially to that part of the State in which mine wastes have damaged the waters which must eventually be used for municipal supplies by rapidly growing cities. Similarly, all the work assists in the solution of local problems, relating either to the character of the water supply or to the character of polluting material and its effects upon the water resources.

In the charge of the members of this division was placed during the last year the investigation of several problems connected with the reclamation of the arid West, two of which have been noted in the statement regarding the personnel of the division. The fitness of water for purposes of irrigation, especially of water which underlies irrigated areas, is one of the questions to be considered in connection with the determination of the feasibility of a project or its maintenance after completion. The work done under this head will be discussed in subsequent pages.

METHODS.

There are two methods by which the work above described may be carried on, each having its peculiar fitness to the character of the investigation. The samples of water to be examined may be collected and transported to a laboratory and there the conventional procedure be followed in the precise determination of foreign ingredients; or the determination may be made according to approximate methods in the field, in which case the results immediately become known to the investigator. The first method is necessary in connection with investigations in which precise data must be secured, and, of course, whenever determinations of a character not amenable to field treatment must be made. Field methods serve most useful purposes in connection with investigations of an industrial character, in which it is necessary only to note with "commercial accuracy" the character of a water or the amount of any particular ingredient it may contain.

The perfecting and application of the field methods mentioned in previous annual reports have proved to be the best and most profitable single service performed by the division. By these methods it is possible to cover areas in a few days which under the old established methods would require either months or expensive equipment and many operatives.

With the equipment, determinations can be made of turbidity, color, iron, chlorine, sulphates, total hardness, alkalinity, normal carbonates, acid carbonates, and calcium.

COOPERATIVE INVESTIGATIONS.

In the fall of 1904 an arrangement was made with the Bureau of Chemistry of the United States Department of Agriculture for a joint investigation of the character of spring waters which have been largely advertised and placed on the market. The agreement provides that collections of samples shall be made by the hydrographic branch of the Geological Survey, all traveling and subsistence expenses necessary in the collection of such samples to be paid from the appropriation allotted to that branch; that the Bureau of Chemistry shall provide containers and pay transportation charges on same to the various springs and back to Washington; that the cost of analysis shall be borne by the Bureau of Chemistry, and that the results shall be the joint property of both parties to the agreement. Work under this agreement has progressed so favorably that it suggests the advisability of further cooperative work between the various Government bureaus which have certain interests in common although their objects may be widely diverse. It is probable that a large amount of duplication in the scientific work carried on under Federal authority might be avoided by such cooperation.

MINNESOTA AGREEMENT.

Under an agreement made and entered into August 1, 1904, the sum of $1,000 was appropriated from the allotment of the hydro-economic division to be used in connection with a similar sum appropriated by the Minnesota State board of health to carry on an investigation into the character of the ground and surface waters of the State of Minnesota, with especial reference to their availability for use as municipal and industrial supplies. The part of the work undertaken by the Survey was that of chemical examination of samples taken periodically from designated points, while the State board of health undertook to carry on a coincident biologic examination of samples from the same points.

Mr. Richard B. Dole, assistant engineer, was detailed to carry on the work for the Geological Survey, while Dr. F. F. Wesbrook, who has attained eminence as an authority in bacteriologic investigations, was placed in charge of the biologic work by the State board of health. These investigations were closed June 30, 1905, and there is now in preparation a joint report on the water resources of Minnesota, which will be published as a water-supply and irrigation paper. It promises to be an excellent paper on the quality of water and its applicability to economic use.

OHIO AGREEMENT.

Under an agreement made and entered into March 1, 1905, between the Geological Survey and the Ohio State board of health, an investigation is in progress concerning the effects on streams of special industrial wastes, their persistence, their relation to health, and their danger to natural water resources. This investigation also includes a test of the efficiency of sewage-disposal works now erected at various points in connection with many municipalities in the State of Ohio. The Ohio agreement reads as follows:

This agreement, made and entered into this first day of March, 1905, between F. H. Newell, chief engineer, for and on behalf of the United States Geological Survey, party of the first part, and Dr. Frank Warner, president, and Dr. Charles O. Probst, secretary and executive officer, for and on behalf of the Ohio State board of health, party of the second part—

Witnesseth: That there shall be conducted in the State of Ohio a cooperative survey to determine the character of the natural waters in the streams of said State during a period of four months from March

1, 1905, and that the two parties shall cooperate in supporting said survey, as follows:

1st. That the sum of eight hundred dollars ($800) shall be set aside by the party of the first part and an equal sum by the party of the second part, for the purpose of carrying on said survey during the stated period.

2d. That the work performed under this cooperative agreement shall be confined to an investigation of the effects of special industrial wastes upon streams, tracing out their persistence, their relation to health, and their damage to natural water resources; also an investigation of the efficiency of sewage-disposal works now erected at various points in connection with the various municipalities in the State of Ohio, such work to be carried on as hereinafter provided.

3d. That special attention be given to the effects of wastes from tanneries, distilleries, and strawboard works, and that in connection with such investigation experiments shall be carried on to determine the best methods of disposal, purification or recovery of valuable materials in the wastes from said industries.

4th. That a member of the staff of the U. S. Geological Survey, duly classified by the U. S. Civil Service Commission, shall be designated to carry on said survey under the joint direction of both parties to this contract; that said official shall be paid the sum of $83.33 for each month during the term of this contract, or a total of $333.33.

5th. That the salary and necessary traveling and subsistence expenses of said official shall be paid by the party of the first part.

6th. That the party of the second part shall provide a suitably equipped laboratory for chemical and bacteriological work, and properly qualified officials to carry on such investigations as may be found necessary to the work, and that in case it shall be found necessary to provide engineering services, such services shall be furnished by the party of the second part.

7th. That equipment of local stations for experimental work in connection with investigations upon various industrial wastes shall be provided by the party of the second part.

8th. That the transportation of samples from any part of the field of investigation to the laboratory shall be borne by the party of the second part.

9th. That in case it shall be found previous to the close of the term of this contract that the expenses incurred under this agreement by the party of the first part will be greater or less than those incurred by the party of the second part, adjustment shall be made as follows: In case the expenses incurred by the party of the first part are more than those of the party of the second part, the difference shall be applied by the party of the second part toward the payment of field expenses and subsistence of the appointee of the party of the first part; while in the event that the expenses incurred by the party of the first part are less than those by the party of the second part, adjustment shall be made along similar lines in favor of the party of the second part.

10th. That the amount and character of the work performed shall be, so far as it is possible to estimate, of a cost equivalent to that stated at the beginning of this contract;

And be it further agreed that the work provided for in this contract shall be carried on under the joint supervision of Mr. M. O. Leighton, chief of the division of hydro-economics, U. S. Geological Survey, for and on behalf of the party of the first part; and Dr. Charles O. Probst, secretary and executive officer, Ohio State board of health, for and on behalf of the party of the second part. The arrangements and further details in connection with the carrying on of surveys contemplated in this contract shall be arranged and mutually agreed upon by the officials herein designated, with the approval and consent of parties to this contract;

And be it further agreed that all accounts to be paid by the party of the first part under the terms of this agreement shall be prepared in conformity with its rules and regulations;

And be it further agreed that orginal field notes and records of the work performed under this agreement shall be the property of the party of the first part;

And be it further agreed that each of the parties hereto shall furnish to the other monthly reports of the work performed, it being understood, however, that such reports shall be considered the property of the party of the first part so far as first rights of publication thereof are concerned. In the publication of said reports by the party of the first part, the relationship of each party to said report shall be clearly stated and the party of the second part shall be provided with an equitable number of copies thereof to be mailed to the lists of names prepared by the party of the second part.

It is further agreed that, in case the party of the second part should desire to use for purposes other than that of publication any of the data collected under this agreement, the data desired shall be used without reserve by said party.

In testimony whereof we have hereunto set our hands the date and year first written herein.

[Approval of Director of United States Geological Survey and signatures of officials named in opening paragraph.]

Under the above agreement Mr. Herman Stabler, hydrographic aid, was detailed to carry on the work and has made gratifying progress in the solution of several of the perplexing problems presented in Ohio.

INVESTIGATION OF THE POTOMAC RIVER BASIN.

One of the most important investigations made by the hydro-economic division is that which was begun in the fall of 1904 on the Potomac River and tributaries. There were two reasons for taking up so extensive an investigation of the Potomac. The first was the desirability of studying in detail some representative drainage area running across the Atlantic Coastal Plain, the study to include all matters having even a remote connection with the water flowing from the basin; as the Potomac River had already been rather extensively studied and was convenient to the National Capital, it presented a favorable and economical opportunity for operations. The second reason for undertaking this particular investigation was the demand which had been made by the citizens of the District of Columbia, headed by the Fish and Game Association. As a result of this agitation a preliminary report concerning the pollution and the sources thereof was presented to the Commissioners of the District of Columbia, who forwarded it to the United States Senate, and that body ordered it printed and issued as a Senate document.

The Potomac investigation includes—

(1) An extensive series of water analyses, the samples taken at points that are believed to be those which will afford the best information concerning the river.

(2) A complete reconnaissance of the drainage area with respect to the sources of pollution.

(3) A hydrographic study of the amount of water flowing in the stream and in its various tributaries, such studies to be taken up in connection with the amount and character of the pollution and the variation thereof from season to season.

(4) In cooperation with the Bureau of Forestry, a study of the condition of the drainage area with respect to its forests and the relation of the forested and deforested areas to stream flow. Such a study is of the greatest importance in connection with all stream investigations,

and the minute study which is being made in the Potomac basin will afford a valuable basis for further investigations in other States.

(5) A study of the fish in the river and its tributaries by the Bureau of Fisheries, together with experiments with reference to the effect of the various industrial wastes which are turned into this stream. Such experiments are being carried on at the Bureau of Fisheries under conditions that appear to be fairly representative of those which obtain in the Potomac drainage area. The wastes which are used have been confined largely to those collected within the area itself.

The result of this joint investigation will be a symposium to be published by the Survey, and it is believed that it will be the most complete study of hydro-economic questions in connection with a river system that has ever been published.

DISTRIBUTION OF WORK BY STATES.

Maine.—The only work of this character carried on in this State during the fiscal year 1904–5 is that of the weekly analysis of composite daily samples of water from Androscoggin River, at Brunswick, by Prof. Franklin B. Robinson, of Bowdoin College. Androscoggin River has been selected as a typical river of the north Atlantic drainage area, and the results will be used in connection with similar data now being collected upon other rivers in a study of chemical denudation in the United States.

New York and Vermont.—During July, August, and September, 1904, an examination of the pollution of Lake Champlain was carried on under the direction of Mr. Marshall O. Leighton, for the purpose of determining the effect of wastes from various industrial plants and of the sewage from the city of Burlington upon the lake as a water supply. The results of this investigation have been set forth in Water-Supply and Irrigation Paper No. 121, entitled a "Preliminary Report upon the Pollution of Lake Champlain."

The interstate investigation of pollution along Hoosic River, noted in last year's report as being carried on under the direction of Prof. William T. Mason, of Rensselaer Polytechnic Institute, Troy, N. Y., was continued during the past year by Mr. James R. Evans, of Troy.

Pennsylvania.—A report on the quality of the water in the Susquehanna River basin appeared in the fall of 1904 (Water-Supply Paper No. 108). A complete examination was carried on with reference to the sources of pollution along Schuylkill River preparatory to a systematic examination of the water. In the western part of the State a chemical survey of the waters was commenced by Mr. Samuel J. Lewis, assistant engineer. This survey will, when completed, include a determination of the character of all the available sources of water supply, both ground and surface, in the region.

New York, Delaware, Maryland, Virginia, and West Virginia.—The collection of samples of unpolluted water for the determination of normal chlorine and the construction of a normal chlorine map was carried on by Mr. H. N. Parker, assistant hydrographer. The work in Maryland, West Virginia, and Virginia upon the Potomac River has already been described.

Georgia and Florida.—During November and December, 1904, an extensive examination was made of the ground waters and a few surface waters in southern and southeastern Georgia and northern Florida. This work was undertaken in cooperation with the division of hydrology, to complete data upon the subject already gathered by that division. To assist in this work free transportation was granted by the railroads operating in Georgia.

Kentucky.—The extensive work undertaken in Kentucky by the division in cooperation with Prof. Chase Palmer, of Central University of Danville, Ky., was briefly referred to in last year's report. This work is a consummation of that which was begun in 1903 by Professor Palmer. At the outset the work was confined to the sanitary analyses of waters of Kentucky, Salt, Dix, and Green rivers, the samples being taken periodically at chosen points along these streams. This work was continued for a period of one year and afforded sufficient material to make possible the determination of the characteristics of the water under diverse climatic conditions, so far, at least, as such analyses afford means for such determination.

Following this work, Professor Palmer engaged in the determination of foreign ingredients in the ground and surface waters of the entire State, and up to the present time has covered Boyle, Garrard, Mercer, Anderson, Lincoln, Woodford, Franklin, and Scott counties. It is proposed to continue this work until the State is covered.

Michigan.—During January and February of the present year an extensive examination was made of the drift, rock, and surface waters of the southern peninsula of Michigan. The investigation was made at this time primarily for the purpose of securing data for the division of hydrology, to be used in a report on the subject of Michigan ground waters, by Mr. Frank Leverett. In this investigation the field methods described on page 213 were used exclusively, and the results obtained are substantiated by such analytical data as are available from other sources. The investigation was made in about six weeks. The examination of so large an area and the analysis of so great a number of samples by the old laboratory methods would have been exceedingly expensive and required months of time.

Minnesota.—The work in this State has been described on pages 214–215.

Iowa.—Three lines of work were maintained in Iowa. The first was a field examination of the waters in Des Moines River and tributaries, together with such other incidental surface supplies as were accessible, and the waters from certain characteristic wells. In addition to this chemical examination, minute observations and records were made of the conditions prevailing along the whole length of the stream with respect to water supply, sewage pollution, etc. This work was done in the field by Mr. Richard B. Dole, assistant engineer, and Mr. Herman Stabler, hydrographic aid.

The second line of work was an examination of the water of Iowa River and tributaries, similar in many respects to that of the Des Moines, but carried on from Iowa College, Grinnell, Iowa, under the charge of Mr. W. M. Barr. The investigations made in connection with this examination were entirely inorganic and the analyses were performed in the laboratory at Grinnell. A report upon the results of this investigation will be issued in due time.

The third investigation in Iowa is one of the most important carried on by the division, the object being to determine the variation in foreign and harmful constituents of the water from the deep wells so abundant in that State. It was noted that after some Iowa artesian wells had been used for a considerable period an analysis of the waters showed that they contained a much smaller proportion of objectionable ingredients than they did when the well was first opened. It was seen that if such conditions are universal throughout the State, knowledge of the fact would, from an industrial and domestic standpoint, make a considerable difference in the attitude of the people with respect to artesian waters. If it were possible to show continued improvement in the condition of such waters, it would only be a question of time when the great majority of them would flow water sufficiently soft for industrial purposes. This work was carried on by Prof. W. S. Hendrixson, of Iowa College, Grinnell, Iowa, for and on behalf of the division of hydro-economics, and by Prof. William H. Norton, of Cornell College, Mount Vernon, Iowa, for and on behalf of the division of hydrology.

Kansas.—The work in this State has been referred to on pages 212–213.

Oklahoma.—A preliminary investigation was made of the quality of ground and surface waters in Greer and Kiowa counties for the purpose of determining, for the benefit of the Reclamation Service, whether or not foreign ingredients render the water unsuitable for irrigation. It was found that in the North Fork of Red River, the proposed supply for the irrigation project, the amount of sodium chloride is too high for the water to be successfully used upon the land. It developed, however, that the sodium chloride is largely derived from three springs along Elm Fork, the water of which may readily be isolated and the salt diverted from the stream. Under such a plan the water in Red River would be entirely unobjectionable from this standpoint. A further examination was made of the ground waters beneath the area which it is proposed to irrigate, with the result that it was found that these waters over extended areas approach close to the surface and frequently contain large amounts of sodium chloride. This investigation emphasizes the necessity for a complete drainage system in connection with any project which may be established in that part of the country. A thorough knowledge of the conditions can be acquired only after further study.

New Mexico.—A preliminary examination was made of the waters of the Hondo project, near Carlsbad, and of the artesian flow in the great basin south of Carlsbad along Pecos River. No waters of an objectionable character were found in this region. In the Carlsbad project, however, a considerable amount of very bad water was discovered, due to poor drainage of the irrigated country thereabout. Inasmuch as the country has been irrigated for a sufficiently long time to show the necessity for drainage, and the areas are now so marked as to enable the engineers to make an effective drainage system at once, further expenditure for ground-water examination was deemed unnecessary.

Arizona.—The work in this Territory has been outlined on page 211.

Nevada.—The work in this State has been outlined on page 211.

WATER-SUPPLY PAPERS.

The following water-supply papers, written by members of the division or by persons cooperating therewith, were published within the year:

No. 103. A review of the laws forbidding pollution of inland waters in the United States, by Edwin B. Goodell.

No. 108. Quality of water in the Susquehanna River drainage basin, by Marshall O. Leighton.

No. 113. The disposal of strawboard and oil-well wastes, by Lemuel Sackett and Isaiah Bowman.

No. 121. A preliminary report upon the pollution of Lake Champlain, by Marshall O. Leighton.

PUBLICATION BRANCH.

Editorial Division.

TEXTS.

The following tables exhibit the character and amount of the work done in the textual section:

Manuscripts edited during the year 1904–5.

Publications.	Pages (usually typewritten).
Twenty-fifth Annual Report	579
Monograph XLVIII	1,002
Third Annual Report of the Reclamation Service	1,180
Professional papers Nos. 36, 38, 39–47, 49, 50, and two not yet numbered	6,697
Bulletins Nos. 243, 245–249, 251–265, 267, 269–271, 273, 275, 277, and two not yet numbered	8,370
Water-supply papers Nos. 109 (additional pages), 111, 114, 115, 117–151, and 153	11,818
Geologic folios Nos. 112–125, and two not yet numbered	2,306
Mineral Resources for 1903 (in part)	2,517
Mineral Resources for 1904 (in part)	974
Press bulletins	948
Field assignments for 1905	147
Miscellaneous—specifications for reclamation work, etc	488
Total number of manuscript pages edited	37,026

Proof sheets read and corrected during the year 1904–5.

Publications.	Final printed pages.
Twenty-fifth Annual Report	414
Monograph XLVIII	880
Third Annual Report of the Reclamation Service	644
Professional Papers Nos. 29, 30, 32–39	2,159
Bulletins Nos. 233–264, 266	5,718
Water-Supply Papers Nos. 97–103, 105–122, 124, 126–128, 130, 132, 144	6,179
Geologic Folios Nos. 110–125	217
Mineral Resources for 1903 (some chapters abridged in making up volume)	1,617
Mineral Resources for 1904 (in part)	296
Press bulletins	175
Field assignments for 1905	73
Total number of pages of proof (including plates) read and corrected	18,372

The reading of the proof sheets of the publications tabulated above required the handling of 7,449 galley proofs and 33,415 page proofs.

Indexes prepared during the year 1904–5.

Publications.	Pages indexed.
Twenty-fifth Annual Report	388
Monograph XLVIII	520
Third Annual Report of the Reclamation Service	644
Professional Papers Nos. 29, 30, 32–39	1,927
Bulletins Nos. 233–264, 266	5,303
Water-Supply Papers Nos. 97–103, 105–118, 121, 122, 124, 126–128, 130, 132	5,469
Mineral Resources for 1903	1,204
Field assignments for 1905	73
Total number of pages indexed	15,528

Some additional work on the general index of Survey publications was done, but there was not opportunity to bring it down to date.

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 following table shows the increase in the work of this section during the last five years, and is, doubtless, a good indication of the growth of the Survey generally. The increase during the last year is especially marked.

Table showing increase in work of textual section during last five years.

Year ending June 30—	Manuscript pages (usually typewritten) edited.	Proof (final pages) read.	Indexes (pages) prepared.
1900	17,834	8,696	5,450
1901	22,111	9,469	6,602
1902	21,774	10,427	7,282
1903	20,756	12,933	9,445
1904	27,409	11,498	10,452
1905	37,026	18,372	15,528

GEOLOGIC MAPS.

At the beginning of the year work was in progress on 11 folios, and 13 others were on file prepared for engraving. During the year 14 additional folios were transmitted to the section. Sixteen folios, Nos. 110 to 125, inclusive, listed in the following table, were completed and issued during the year:

Geologic folios issued during the fiscal year ending June 30, 1905.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area.	Price.
110	Latrobe	Pennsylvania	79°15′-79°30′	40°15′-40°30′	228	$0.25
111	Globe	Arizona	110°45′-111°	33°15′-33°30′	249	.25
112	Bisbee	do	109°45′-110°	31°20′-31°30′	170	.25
113	Huron	South Dakota	98°-98°30′	44°-44°30′	857	.25
114	De Smet	do	97°30′-98°	44°-44°30′	857	.25
115	Kittanning	Pennsylvania	79°30′-79°45′	40°45′-41°	226	.25
116	Asheville	North Carolina Tennessee	82°30′-83°	35°30′-36°	969	.25
117	Casselton-Fargo	North Dakota Minnesota	96°30′-97°30′	46°30′-47°	1,640	.25
118	Greeneville	Tennessee North Carolina	82°30′-83°	36°-36°30′	963	.25
119	Fayetteville	Missouri Arkansas	94°-94°30′	36°-36°30′	963	.25
120	Silverton	Colorado	107°30′-107°45′	37°45′-38°	236	.25
121	Waynesburg	Pennsylvania	80°-80°15′	39°45′-40°	229	.25
122	Tahlequah	Indian Territory Arkansas	94°30′-95°	35°30′-36°	969	.25
123	Elders Ridge	Pennsylvania	79°15′-79°30′	40°30′-40°45′	227	.25
124	Mount Mitchell	North Carolina	82°-82°30′	35°30′-36°	969	.25
125	Rural Valley	Pennsylvania	79°15′-79°30′	40°45′-41°	226	.25

On June 30, 1905, seven folios were in process of engraving, the Aladdin, Bradshaw Mountains, and Sundance being nearly completed, and seven were on file ready for publication. The following table gives the names of folios in process of engraving and the stage of progress each has attained:

Geologic folios in process of engraving June 30, 1905.

Name.	Stage.
Aladdin, Wyo.-S. Dak.-Mont	Color stones of map in preparation.
Beaver, Pa	Engraving begun.
Bradshaw Mountains, Ariz	Color stones of sections in preparation.
Clifton, Ariz	Engraving of map completed.
Ebensburg, Pa	Engraving begun.
Muscogee, Ind. T	Do.
Needle Mountains, Colo	Map transferred to stone.
Redding, Cal	Engraving begun.
Rico, Colo	Map transferred to stone.
Sundance, Wyo.-S. Dak	Maps being printed.

The following table gives the names of folios ready for publication:

Geologic folios awaiting engraving June 30, 1905.

Bald Mountain, Wyo.	Nantahala, N. C.-Tenn.
Cloud Peak, Wyo.	Nepesta, Colo.
Dayton, Wyo.	Ouray, Colo.
Dover, Del.-Md.-N. J.	Patuxent, Md.-D. C.
Fort McKinney, Wyo.	St. Mary, Md.-Va.
Mineral Point, Wis.-Ill.	Snoqualmie, Wash.

TOPOGRAPHIC MAPS.

On July 1, 1904, there were in the editor's files 66 atlas sheets and special maps awaiting editorial examination and approval for engraving. This number was afterwards reduced to 60, as follows: Calhoun, Ky., and Mentor, Ohio, withdrawn for additional field work; Little

Backbone Special, Ariz., Bully Hill Special, Cal., and Cartersville Special, Ga., withdrawn with a view to publication in some other form; Boquillas, Tex., and Chisos Mountains, Tex., listed last year as separate atlas sheets, engraved and published as a single map with the name Chisos Mountains. As a result of the field season of 1904, 108 new maps were received and two others (Penobscot Bay, Me., and Watkins Glen, N. Y.) were reduced from published atlas sheets. Of these 170 maps (60+108+2), 104 were edited and approved for engraving, leaving 64 now in hand. Eighty-five unpublished atlas sheets were in the custody of the editor on June 30, 1905, and have not yet been transmitted to the engravers. Twenty-one of these were edited and approved.

On pages 231–234 is a list of 105 atlas sheets and special maps engraved and published during the year. The detailed proof reading of these 105 sheets was all done in this section, as well as the proof reading of the corrections, more or less extensive, to 154 sheets. Eleven of the latter were extensively corrected, and published with new edition dates.

The number of unpublished topographic maps in hand at the close of the year was 126. Of these, 22 are products of the field season of 1903, but their engraving is well advanced. Last year nearly twice as many, or 41, of the 1902 product were reported unpublished.

Two detailed experimental topographic city maps—"City of St. Louis" and "Pittsburg and Vicinity"—were published during the year, each on the scale of 1:24,000. Pittsburg and Vicinity is 36 by 52 inches, and the City of St. Louis 36 by 44 inches. These maps are not engraved; they are photolithographs, and the editing and proof reading were done in this section.

An ever-increasing share of the time of the force at the disposal of the editor of topographic maps is required for the revision of the geographic nomenclature on maps to illustrate the various publications of the Survey in book form. The number of map illustrations increased from 176 examined during the fiscal year 1899–1900 to 343 in the year just past. The latter are enumerated below:

Bulletins Nos. 242, 243, 244, 246, 247, 249, 250, 251, 252, 255, 256, 259, 260, 263, 265, 266, 267, 268, 270	90
Monograph XXXII	15
Twenty-fifth Annual Report	25
Professional Papers Nos. 35, 36, 37, 38, 39, 41, 42, 43, 44, and 45	53
Water-Supply and Irrigation Papers Nos. 109, 111, 112, 113, 114, 115, 116, 117, 120, 121, 136, 137, 138, 139, 140, 141, 142, 144, 145, 147, 148, and a paper withdrawn from publication	160
Total	343

The 15 mailing circulars, numbered 9–323, giving information concerning the topographic maps and folios published by the Survey, each illustrated by an index map, were all revised and reprinted during the year. Three of them were revised and reissued three times each, 3 others twice each, and of the remaining 9, one edition of each was published. Besides these, index maps to illustrate 5 special circulars showing results of "Cooperative topographic surveys" were prepared and proof read.

The Geographic Dictionary of Alaska, published in 1902 as Bulletin No. 187 of the Geological Survey, was revised and enlarged and is nearly ready for printing.

Division of Engraving and Printing.

The number of employees was 86, consisting of 1 chief engraver, 2 draftsmen, 2 map revisers, 1 clerk, 1 engraver's clerk, 1 stenographer, 1 mechanician, 25 copperplate map engravers, 5 lithographic engravers, 45 printers and assistants, 1 skilled laborer, 1 photolithographer.

The total appropriation for the work of the division was $100,000, which was expended as follows: Salaries for the year, $76,880; piecework engraving, $4,235; supplies and maintenance, $18,885.

On July 1, 1904, there were reported on hand for engraving, manuscript atlas sheets and special maps to the number of 127. This number was afterwards reduced to 121, as explained in the report of the editor of topographic maps, page 227. During the year 108 new sheets were received from the topographic branch. Two (Penobscot Bay and Watkins Glen) were reduced from published atlas sheets. This gives a total of 231 atlas sheets and special maps, which classify in three groups.

Group I comprises 105 sheets (double sheets counted as one), which were published during the year or were in press at the close of the year.

Group II comprises 41 sheets, which were in process of engraving at the close of the year.

Group III comprises 85 sheets, which at the close of the year had not yet been transmitted to the engravers.

It appears, therefore, that at the close of the year there were in hand 126 unpublished atlas sheets and other maps, and that the engraving of 41 of these was in various stages of progress.

In addition to the engraving of new atlas sheets, corrections, more or less extensive, were made on the plates of 154 sheets. Editions of 115 of these sheets were printed after correction. Editions of 319 sheets were printed and delivered during the year. Of these, 209 are maps heretofore published, of which 11 (Castine, Me.; Denison, Tex.-Ind. T.; Greeneville, N. C.-Tenn.; High Bridge, N. J.; Mount Marcy and Vicinity, N. Y.; New Milford, Conn.; Passaic, N. J.-N. Y.; Rome, Ga.-Ala.; Telluride, Colo.; Waterbury, Conn.; and Yellville, Ark.-Mo.) bear new-edition dates; 198 are reprints, and 110 are new maps.

During the year 16 geologic folios were published (see list on page 226.) In this number are 7 folios reported partly finished last year. The number now in hand partly completed is 8. The Franklin Furnace folio continues as reported June 30, 1904.

It may seem from the foregoing statement that there was a considerable decrease in the output of newly engraved topographic atlas sheets. The reason for this seeming discrepancy is that it was deemed best during the past season to delay arrangements for piecework engraving until the end of the year, rather than to make expenditures during the early part or middle of the year. During June, however, several thousand dollars' worth of piecework engraving was issued, and although the work was not completed in the fiscal year 1904–5, it will be paid for from the appropriation for that year, and consequently the amount of work represented by the sum allotted therefor should be credited to that year.

The call for photolithographic work has continually increased. In addition to that done in connection with the topographic branch, it is being extensively used for the work of the Reclamation Service. There is great need of more space in which to carry on this process and for the installment of additional apparatus.

The practice of making celluloid transfers, as mentioned in the Twenty-fifth Annual Report, was continued this year, with uniformly satisfactory results.

Topographic atlas sheets and other maps engraved and printed or in press during the fiscal year 1904–5.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′	*Feet.*	
Amity, Pa	40	00	80	00	20	1:62,500
Anson, Me	44	45	69	45	20	1:62,500
Ashtabula, Ohio	41	45	80	45	20	1:62,500
Assinniboine, Mont	48	30	109	45	20	1:62,500
Batavia, N. Y	42	45	78	00	20	1:62,500
Berea, Ohio	41	15	81	45	10	1:62,500
Bingham, Me	45	00	69	45	20	1:62,500
Boonville, N. Y	43	15	75	15	20	1:62,500
Bowdoin, Mont	48	15	107	30	20	1:62,500
Butte Special, Mont. [a]					20	1:15,000
Caledonia, N. Y	42	45	77	45	20	1:62,500
Centerpoint, W. Va. (called Salem in Twenty-fifth Ann. Rept.)	39	15	80	30	20	1:62,500

[a] Revised and enlarged.

Topographic atlas sheets and other maps engraved and printed or in press during the fiscal year 1904–5—Continued.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′	*Feet.*	
Chickasha, Ind. T.–Okla	35	00	97	30	50	1:125,000
Chinook, Mont	48	30	109	00	20	1:62,500
Chisos Mountains, Tex. [a]					100	1:125,000
Chocowinity, N. C	35	30	77	00	10	1:62,500
Clarington, Ohio–W. Va	39	45	80	45	20	1:62,500
Cleveland and Vicinity, Ohio					20	1:62,500
Columbia, S. C	35	30	87	00	50	1:125,000
Congress, Ariz	34	00	112	30	100	1:125,000
Copake, N. Y	42	00	73	30	20	1:62,500
Cripple Creek Special, Colo. [b]					50	1:25,000
Denton, Md	38	45	75	45	10	1:62,500
Devils Tower, Wyo	44	30	104	30	50	1:125,000
Eldon, Mo	38	15	92	30	20	1:62,500
Falkland, N. C	35	30	77	30	10	1:62,500
Flushing, Ohio	40	00	81	00	20	1:62,500
Gardiners Island, N. Y	41	00	72	00	20	1:62,500
Georgetown, Colo	39	30	105	30	100	1:62,500
Greene, N. Y	42	15	75	45	20	1:62,500
Guadalupe, Cal	34	30	120	30	100	1:125,000
Harlem, Mont	48	30	108	45	20	1:62,500
Harrodsburg, Ky	37	30	84	30	50	1:125,000
Havre, Mont	48	30	109	30	20	1:62,500
Hobart, N. Y	42	15	74	30	20	1:62,500
Houtzdale, Pa	40	45	78	15	20	1:62,500
Hurlock, Md	38	30	75	45	10	1:62,500
Independence, Kans. [b]	37	00	95	30	20	1:125,000
Kaiser, Cal	37	00	119	00	100	1:125,000
Kaweah, Cal	36	00	118	30	100	1:125,000
Lake City, Colo	38	00	107	15	100	1:62,500
Laramie, Wyo. [b]	41	00	105	30	50	1:125,000
Long Lake, N. Y	44	00	74	15	20	1:62,500
Macksburg, Ohio	39	30	81	15	20	1:62,500
Manchester, N. H	42	45	71	30	20	1:62,500
Mannington, W. Va.–Pa	39	30	80	15	20	1:62,500
Marietta, Ohio–W. Va	39	15	81	15	20	1:62,500
Middlebury, Vt	44	00	73	00	20	1:62,500
Montague, Tex.–Ind. T	33	30	97	30	50	1:125,000

[a] Double sheet. [b] Resurvey.

Topographic atlas sheets and other maps engraved and printed or in press during the fiscal year 1904–5—Continued.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′	*Feet.*	
Morganton, N. C. [a]	35	30	81	30	100	1:125,000
Moriches, N. Y	40	45	72	45	20	1:62,500
Mount Aix, Wash	46	30	121	00	100	1:125,000
Needles Special, Cal.–Ariz					50	1:125,000
Nepesta, Colo. [b]	38	00	104	00	25	1:125,000
Newburg, Ind.–Ky	37	45	87	15	20	1:62,500
Newcastle, Pa	40	45	80	15	20	1:62,500
New Matamoras, Ohio–W. Va	39	30	81	00	20	1:62,500
Nineveh, N. Y	42	00	75	30	20	1:62,500
Niwot, Colo	40	00	105	00	20	1:62,500
Nogales, Ariz	31	00	110	30	100	1:125,000
Nunda, N. Y	42	30	77	45	20	1:62,500
Okanogan, Wash	48	00	119	30	100	1:125,000
Orwell, N. Y	43	30	75	45	20	1:62,500
Osoyoos, Wash	48	30	119	00	100	1:125,000
Ouray, Colo	38	00	107	30	100	1:62,500
Ovando, Mont	47	00	113	00	100	1:125,000
Oxford, N. Y. (called Coventry in Twenty-fifth Ann. Rept.)	42	15	75	30	20	1:62,500
Penobscot Bay, Me	44	00	68	30	20	1:125,000
Peoria, Ill	40	30	89	30	10	1:62,500
Perry, Ohio	41	45	81	00	20	1:62,500
Philippi, W. Va	39	00	80	00	20	1:62,500
Portage, N. Y. (called Genesee Falls in Twenty-fifth Ann. Rept.)	42	30	78	00	20	1:62,500
Richland Center, Wis	43	00	90	00	20	1:125,000
Richmondville, N. Y	42	30	74	30	20	1:62,500
Riverhead, N. Y	40	45	72	30	20	1:62,500
Rocky Mount, N. C	35	45	77	45	10	1:62,500
Rogersville, Pa	39	45	80	15	20	1:62,500
Saco Special, Mont					20	1:62,500
Sag Harbor, N. Y	40	45	72	15	20	1:62,500
St. Clairsville, Ohio	40	00	80	45	20	1:62,500
St. Regis, N. Y	44	15	74	15	20	1:62,500
Salineville, Ohio	40	30	80	45	20	1:62,500
San Antonio, Tex. [c]	29	15	98	15	10	1:62,500
Santa Ynez, Cal	34	30	119	30	100	1:125,000

[a] Resurvey. [b] Revised and reengraved. [c] Double sheet.

Topographic atlas sheets and other maps engraved and printed or in press during the fiscal year 1904–5—Continued.

Quadrangle and State.	Position of SE. corner. Latitude.		Longitude.		Contour interval.	Scale.
	°	′	°	′	*Feet.*	
Shelter Island, N. Y	41	00	72	15	20	1:62,500
Sherman, Wyo	41	00	105	00	50	1:125,000
Skykomish, Wash	47	30	121	00	100	1:125,000
Slide Mountain, N. Y	41	45	74	15	20	1:62,500
Stehekin, Wash	48	00	120	30	100	1:125,000
Taberg, N. Y	45	15	75	30	20	1:62,500
Tehama, Cal	40	00	122	00	10	1:62,500
Tehipite, Cal	36	30	118	30	100	1:125,000
Trent River, N. C	35	00	77	15	10	1:62,500
Tucson, Ariz	32	00	110	30	100	1:125,000
Vina, Cal	39	45	122	00	10	1:62,500
Waddington, N. Y	44	45	75	00	20	1:62,500
Watkins Glen, N. Y	42	00	76	30	40	1:125,000
Wayne, Mich. (called Northville in Twenty-fifth Ann. Rept.)	42	15	83	15	20	1:62,500
Wayne Creek, Mont	48	30	108	30	20	1:62,500
Westminster, Md.-Pa	39	30	76	45	20	1:62,500
Wilson, N. C	35	30	77	45	10	1:62,500
Winterville, N. C	35	30	77	15	10	1:62,500
Woodsfield, Ohio	39	45	81	00	20	1:62,500
Yantic, Mont	48	30	109	15	20	1:62,500
Yuma, Cal.-Ariz	32	30	114	30	50	1:125,000

Résumé by States.

Arizona	5
California	9
Colorado	6
Illinois	1
Indiana	1
Indian Territory	2
Kansas	2
Kentucky	1
Maine	3
Maryland	3
Michigan	1
Missouri	1
Montana	10
New Hampshire	1
New York	23
North Carolina	7
Ohio	12
Oklahoma	1
Pennsylvania	6
South Carolina	1
Texas	3
Vermont	1
Washington	5
West Virginia	6
Wisconsin	1
Wyoming	3
Total	115
Deduction for sheets counted in more than one State	10
Balance	105

In addition to the foregoing, the following maps were published during the year; these are photolithographs and not permanent engravings:

Photolithographic maps published.

Title.	Number of sheets.	Size of sheets.	Contour interval.	Scale.
		Inches.	*Feet.*	
Boston and Environs	1	36 by 48	20	1:24,000
City of St. Louis	1	36 by 44	20	1:24,000
Kennebec River, Me. (Skowhegan to Moosehead Lake)	5	16½ by 20	10 and 20	1:24,000
Pittsburg and Vicinity	1	36 by 52	20	1:24,000
Sacramento Valley, Cal., Sheet A	1	27 by 44	5	2 in.=1 mi.
Salt River Irrigation Project, Ariz.	2	36 by 52	5	2 in.=1 mi.
Shoshone Irrigation Project, Wyo.	1	36 by 49	20	2 in.=1 mi.

The combined editions of the 16 geologic folios that were issued amounted to 86,559 copies, which required 3,658,788 printings. Of miscellaneous matter, such as map circulars, press bulletins, various blank forms, the St. Louis Special map, etc., there was necessarily a large amount printed, the number of copies being 446,642, which required 1,550,251 printings.

From the foregoing statements the following totals are derived:

Totals derived from the foregoing statements.

Engraving of topographic atlas sheets:
- Sheets completed (counting double sheets two) 101
- Sheets completed in part 42
- Sheets corrected 154

Engraving of bases for geologic folios:
- Bases completed 19
- Bases completed in part .... {Ebensburg, Pa; Redding, Cal; Beaver, Pa; Muscogee, Ind. T} 4

Printing:	Number of copies.	Number of printings.
Topographic atlas sheet (319)	721,179	2,913,066
Geologic folios completed (16)	86,559	3,658,788
Miscellaneous printings	446,642	1,550,251
Total	1,254,380	8,122,105

Maps mounted	950
Transfer impressions made and sent to contracting printers	425
Negatives made:	
Phototracing	230
Photolith	1,108

INSTRUMENT SHOP.

The work of repairs to instruments was under the immediate charge of Mr. Ernest Kübel.

Besides supervising the more intricate details of plate making and electrotyping, Mr. Kübel's work more especially consisted in overhauling and putting in repair for field use all instruments sent from the topographic branch, as well as some from the hydrographic branch. An exact record was kept of all details thus attended to. Repairs to instruments were as follows:

Instruments repaired in 1904–5.

Telescopic alidades	126	Fitting shoes on traverse tripod legs	80
Wye (Y) levels	83	Johnson movement tripods	143
Transits	7	Traverse tripods	115
Box compasses	84	Level tripods	78
Declination compasses	34	Theodolite tripods	14
Circular levels	21	Transit tripods	12
Locke levels	9	Protractors	3
Abney levels	4	Aneroid barometers	5
Rod levels	4	Proportional dividers	4
Tape lines	39	Drawing instruments (dividers and pens)	8
Sight alidades	108	Tally registers	17
Pocket compasses, prismatic and clinometer	31	Screws and sockets, standardized	502
Plane-table plates	179	Striding levels	6

The progress of the copperplate and electrotype work is shown in the following table:

Copperplate making and electrotyping.

New plates made	310
Plates resurfaced	32
Plates cut to sizes ordered	13
Plates electrotyped, "bassos"	24
Plates electrotyped, "altos"	28

ADMINISTRATIVE BRANCH.

Executive Division.

Work not otherwise assigned, such as that pertaining to appointments, records, correspondence, etc., as well as the watch, messenger, and labor force, was, as in previous years, in general charge of the chief clerk, Col. H. C. Rizer, who has supervision of all the business of the Survey, and also serves as Acting Director whenever the Director is in the field.

CORRESPONDENCE, RECORDS, SUPPLIES, AND SHIPMENTS.

Nearly every branch of the work showed increase in volume. The detailed record for the year follows:

Mail desk.—There were 124,883 pieces of first-class mail received during the year.

Appointments, attendance, etc.—A summary of the work of the year will be found in the paragraphs which follow:

Tabular statement of appointments.

Appointments (including those by transfer and reinstatement):		
Permanent	328	
Temporary[a]	80	
		408
Reappointments, changes of official designation and of basis of salary payment, and other changes affecting neither the number of employees nor the aggregate of salaries		136
Extensions of temporary appointments		50
Promotions		342
Reductions		1
Separations (including resignations, dismissals, revocations of appointments, deaths, etc.)		177
Aggregate changes		1,114

A comparison of the number of changes made during 1904–5 with the number made during the preceding fiscal year shows an increase of 210.

There are now on the Survey roster holding appointments from the Secretary of the Interior 992 names, an increase since June 30, 1904, of 210.

Not included in the roster of regular appointments, but properly mentioned in connection therewith in this report of the work done at the appointment desk, are the

[a] Limited to six months or less.

authorizations issued by the Secretary of the Interior and by the Director for the temporary employment of field assistants and others in office duty—that is, assistants who are outside of the classified service. A large proportion of these authorizations were in connection with the organization of the force for the fuel-testing operations which the Survey had undertaken at St. Louis. Similarly, mention should here be made of the six designations by the Secretary of the Interior of members of the Survey force as special disbursing agents.

The work of the appointment desk also included the preparation of letters, statements, and reports, relating in the main, though not entirely, to appointment business; and also the issuance of identification cards and the procurement from the telegraph companies of government rate cards for use in the field.

The attendance work has grown in about the same ratio as the appointment work. A record of the absences during the year of every member of the force was kept at the appointment desk.

No attempt will be made to show the number of grants of annual leave, but of applications for sick leave and leave without pay about 800 were handled during the year as against 475 during the previous year. Each one of these was examined, charged, and prepared for presentation to the Secretary of the Interior.

Property accountability.—The work in connection with the system of property accountability increased materially last year. The new field covered by the several branches of work has naturally increased the quantity of property acquired by the Survey and the Reclamation Service.

The number of vouchers handled, on which all non-expendable property has been purchased and paid for by the chief disbursing clerk and thirty-one special disbursing agents, during the year 1904–5, was 22,097; the number of vouchers handled during the preceding year was 16,352—an increase last year of 5,745, or about 35 per cent.

Abstracts of purchases were prepared for the several custodians, subcustodians, and chiefs of parties, as follows:

Abstracts of purchases prepared.

Reclamation	212	Instruments	13
Gaging streams	83	Office	15
Topography	189	State topography	31
Surveying forest reserves	101		
Geology	73	Total for 1904–5	765
Mineral resources of Alaska	19	Total for 1903–4	413
Mining and mineral resources	10		
Fuel testing	7	An increase of about 85 per cent	352
Photography	12		

Twenty-five abstracts of "Property relieved of" were prepared, which showed all nonexpendable property that had become unserviceable by fair wear and tear, and disposed of by auction sale or inspection report.

The amount of money derived from the sale at public auction of property examined by competent inspectors and found unserviceable was $3,787.49, which was turned over to the division of disbursements and accounts; during the fiscal year 1903–4, $1,918.22 was received from the same source—an increase last year of $1,869.27.

Property returns for all the custodians, nine in number, were prepared quarterly, and permanent records of the same are on file in the office.

Preparation of vouchers.—The number of vouchers prepared for the purchase of supplies in open market and under contract was 2,333, an average of 195 per month; the average per month for 1903–4 was 144—an increase last year of 51 per month, or about 35 per cent.

Owing to a consolidation by the division of disbursements and accounts of all appropriations on one "Abstract of disbursements," with the exception of "Reclamation fund," "Testing fuel," and "Investigation of structural material," the number of vouchers prepared in the section of correspondence and records for payment has been materially decreased since the first of May, as bills from the same merchant payable from different appropriations are entered and paid on the same voucher.

Purchase and distribution of supplies.—The following table indicates the amount of this work performed:

Record of purchase and distribution of supplies.

Applications made to the Secretary of the Interior for authority to purchase supplies (involving an expenditure of $417,972.89)	413
Requisitions drawn on the Department for miscellaneous supplies	316
Requisitions filled from stock on hand	395
Orders drawn on dealers and others	3,652
Bills received and checked (approximate)	4,382

Express, freight, and registered mail.—There was an increase in the number of express and freight shipments during the last fiscal year. In the amount of mail registered there was a decrease, owing to the fact that since December 9, 1904, packages of less value than one dollar have been sent by ordinary mail.

The change made in the manner of issuing and handling the Survey bills of lading, perfected last year, has proved most satisfactory. The adoption of a similar system by the several Departments of the Government was recommended by the Comptroller of the Treasury.

Record of express, freight, and registered mail handled.

	1905.	1904.	1903.
Freight and express:			
Pieces shipped	3,037	1,954	2,934
Pieces received	4,585	3,969	2,668
Total pieces handled	7,622	5,923	5,602
Registered mail:			
Pieces forwarded:	26,571	39,164	50,758
Pieces received	2,307	1,953	1,994
Total pieces handled	28,878	41,117	52,752
Accounts checked	339	339	254

Stationery.—During the last year it was necessary to keep two clerks regularly at work in the stationery room, owing to the large amount of supplies that had to be wrapped and shipped to the Survey field force. During the year 8,238 requisitions for blanks, blank books, and miscellaneous supplies were filled, 1,598 requisitions were drawn on the Department, 1,137 for printing and blank books, and 461 for stationery supplies. The stationery clerks have also had charge of the distribution of incoming mail.

Miscellaneous.—Miscellaneous work consisted of custom-house entries, tracing shipments, transmitting packages to members of the Survey located at the National Museum, issuing bills of lading, obtaining bids for supplies, the preparation of mimeographed circulars for the whole Survey, etc.

DOCUMENTS.

The steady increase in the work of this section demanded the addition of two persons to the clerical force.

There were received during the year 160 new documents, 123 new maps, and 202 reprints of maps, making a total of 477 publications and maps received, or more than 1½ publications for each working day in the year. The publications received were: Twenty-fifth Annual Report; Monograph XLVII; Professional Papers Nos. 21–33, 35, 39; Bulletins Nos. 222, 224, 225, 226, 229, 230–246, 248, 249, 250, 252, 253, 254, 255, 258–262, 264; Water-Supply and Irrigation Papers Nos. 89, 93, 95–122, 124, 126, 128; Mineral Resources of the United States, 1903, and separates therefrom to the number of 42; 8 separates of Mineral Resources of the United States, 1904; 6 miscellaneous publications; geologic folios Nos. 107–121, 123; 325 topographic maps, of which 123 were new editions and 202 were reprints of previous editions, the total combined editions of atlas sheets numbering 736,696 sheets; 8 special maps, the total editions numbering 10,318.

During the year 351,732 volumes, 40,779 folios, and 566,016 maps were sent out.

The total amount received and turned into the Treasury as a result of sales of publications was $14,040, an increase of $3,301.25, or more than 29 per cent, over the amount received during the preceding year.

During the year 61,251 letters were received and answered.

A summarized statement of disbursements follows:

Analysis of disbursements.

Opposite the following heads appear the total expenditures under the various appropriations:

1.	Salaries of scientific assistants	$29, 900. 00
2.	Skilled laborers and various temporary employees	19, 941. 42
3.	Topographic surveys	296, 545. 33
4.	Geologic surveys	161, 750. 08
5.	Paleontology	8, 754. 80
6.	Chemical and physical researches	18, 650. 58
7.	Preparation of illustrations	17, 706. 89
8.	Mineral resources of the United States	49, 803. 32
9.	Books for the library	1, 759. 04
10.	Gaging streams, etc	179, 854. 50
11.	Geological maps of the United States	95, 250. 83
12.	Mineral resources of Alaska	77, 815. 67
13.	Salaries, Office of Geological Survey	32, 281. 50
14.	Surveying forest reserves	122, 657. 41
15.	Furnishing new addition, Geological Survey	9, 788. 82
16.	Testing fuel	105, 607. 94
17.	Testing structural materials of the United States	5, 278. 93
	Total	1, 233, 347. 06

FINANCIAL STATEMENT.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1905.

	Geological Survey, 1905.	Geological Survey, 1904 and 1905.	Geological maps of the United States, 1905.	Surveying forest reserves, 1904 and 1905.	Furnishing new addition, Geological Survey, 1904 and 1905.	Testing fuel.	Testing structural materials of the United States.	Total.
Appropriations: Acts approved Feb. 18, 1904; Apr. 27, 1904; Apr. 28, 1904; Jan. 5, 1905; Mar. 3, 1905	$382,920.00	$555,000.00	$100,000.00	$130,000.00	$10,500.00	$227,000.00	$12,500.00	$1,474,868.25
Amount carried forward from previous report						56,948.25		
Amounts expended classified as follows:								
Services	288,990.39	356,239.99	76,760.50	81,248.96		64,917.19	884.00	869,041.03
Traveling expenses	34,513.70	44,912.59	88.80	3,287.81		4,846.88	180.43	87,830.21
Field subsistence, supplies, and expenses	16,852.63	115,870.99		33,761.46		32,060.27	4,205.00	202,750.35
Instruments	2,227.06	4,022.19		2,404.81		1,254.02		9,908.08
Laboratory material	3,654.60					1,690.31		5,344.91
Photographic material	3,868.59	1,522.21		13.15		82.81		5,486.76
Books and maps	1,995.63	258.63						2,254.26
Stationery and drawing material	1,315.90	2,506.80	25.50	333.50		445.79		4,627.49
Illustrations for reports	1,709.80		90.90					1,800.70
Office supplies, repairs, and equipment	2,090.50	3,063.69		72.00	9,787.04	89.64	9.50	15,112.37
Correspondence	595.24	544.75	1.39	142.89		173.02		1,457.29
Materials for engraving and printing maps			18,282.94					18,282.94
Railroad accounts settled at United States Treasury:								
Passenger	583.58	1,194.54		341.45				2,119.57
Freight	254.43	5,974.70	.80	1,051.38	1.78	48.01		7,331.10
Total expenditures	358,652.05	536,111.08	95,250.83	122,657.41	9,788.82	105,607.94	5,278.93	1,233,347.06
Balance unexpended July 1, 1905	24,267.95	18,888.92	4,749.17	7,342.59	711.18	178,340.31	7,221.07	241,521.19
Probable amount required to meet outstanding liabilities	23,750.87	18,888.92	4,749.17	7,342.59	711.18	178,340.31	7,221.07	241,004.11

Library.

Periodicals.—About 300 periodicals are received regularly in the library. These are entered on cards as received, and current numbers are kept where they are readily accessible. When the volumes are completed, they are prepared for the bindery, and when bound are placed on the shelves with the corresponding set.

Books accessioned.—The permanent record of books is kept in the accessions book, and during the year 2,661 books were entered in this record. The total number of books which have been accessioned is 58,681.

Cataloguing.—The work of cataloguing the publications of the State geological surveys was continued. All of the eastern and southern States, except New York and Pennsylvania, are completed and also a portion of the central western States. The work of cataloguing the sections of petrology, mineralogy, and crystallography is completed. By arrangement with the Librarian of Congress, these cards were sent to him to be printed, and printed cards are now available for all the State surveys catalogued and also for the greater part of the books on petrology and mineralogy. The monographs, bulletins, water-supply papers, and professional papers of the Survey have all been catalogued, and printed cards are now available. The result of this work of cooperation with the Library of Congress is that all the prominent geologic publications are catalogued, and printed cards are available for the use of all libraries and individuals within a very short time after the publications are placed in circulation.

Binding of books.—During the year 1,800 books were bound. The preparation of all books for binding will in future be performed by the library.

Bibliographic work.—The Bibliography of North American Geology, etc., for 1903 was printed as Bulletin No. 260, and the Bibliography for 1904 was completed and submitted for publication (Bulletin No. 271). During the year there was also prepared a bibliography of radium literature, which is to be published in connection with other material on radium prepared by Mr. George F. Kunz.

Translations.—The work of translating letters and other administrative material for the office is performed in the library.

Purchase of books.—All the important purchases of books were made with the approval of the chairman of the library committee, and all of the allotment of $2,000 was expended. The greater part of the material added to the library is received in exchange for Survey publications.

Circular list of new publications.—These lists are prepared and published at intervals of two to three months, and the demand for them is constantly increasing. An edition of 2,300 of each circular is now printed.

Relations with other libraries.—During the year, in addition to the cooperation with the Library of Congress in cataloguing and printing cards, the librarian prepared a series of catalogue cards, showing the methods of this library, for exhibition at the Lewis and Clark Exposition, at Portland. Extended tests in the use of thick and thin cards were also made. This work was done at the request of the Librarian of Congress.

New book stacks and map cases.—At the last session of Congress $7,000 was appropriated for the construction and installation of steel book shelving and map cases. Plans were prepared and bids requested under the direction of the Secretary of the Interior. Contract for the book stacks was made with the Library Bureau and for map cases with the General Fire Proofing Company, and these will be installed during the coming summer; then all the wooden book shelves and the greater part of the wooden map cases now in the library will be discarded.

Division of Illustrations.

The section of illustrations and the photographic laboratory were consolidated on April 6, 1905, into a division of illustrations.

SECTION OF GRAPHIC ILLUSTRATIONS.

The following list shows the number of drawings prepared:

Illustrations prepared during the year 1904–5.

Maps	231	Miscellaneous	510
Sections and diagrams	1,133	Total	5,230
Paleontologic drawings	2,679		
Photographs	677		

Illustrations to accompany 65 publications (31 water-supply papers, 23 bulletins, 9 professional papers, 1 atlas, and 1 Congressional document) were transmitted.

The following table shows the number of subjects reproduced and the processes adopted for their reproduction:

Number of illustrations reproduced and the processes of reproduction employed.

	Chromolithography.	Lithography.	Photo-lithography.	Zinc etchings.	Wax engravings.	Half-tone engravings.	Electros (cuts).	Engraving on copper.	Photo gelatine.	Total.
Bulletins Nos. 208, 239, 243–247, 249–252, 255–257, 259, 260, 262, 263, 265–268, 270	41	0	1	172	24	317	43	3	0	601
Water-supply papers Nos. 114–118, 121–145, 147, 148	23	...	1	204	231	204	87	0	0	750
Professional papers Nos. 35–44	58	0	5	122	116	275	65	1	10	652
Monograph XXXII, atlas	24	3	....	.....	.....	.....	....	....	....	27
Congressional document (Roads in Alaska)	...	...	....	1	.....	9	....	....	....	10
Total	146	3	7	499	371	805	195	4	10	2,040

At the present time the material to accompany 36 reports and papers is in hand. A large number of the illustrations for these reports have already been prepared.

Proofs to the number of 2,133 were received and examined critically, and the full printed editions of 136 plate inserts were examined at the Government Printing Office after delivery there by the contractor.

During the year 103 electrotypes were furnished outside applicants.

PHOTOGRAPHIC LABORATORY.

There was a very considerable increase in all branches of the work. The percentage of increase is as follows: Wet plates, 49 per cent; paper negatives, 200 per cent; map prints, 43 per cent; dry plates, 37 per cent; glossy and matte prints, 48 per cent; slides, 90 per cent. The work was done promptly and in a satisfactory manner.

Almost as many paper negatives were returned to the laboratory as were made during the year. The saving resulting from the system installed last year of filing these paper negatives for future use is difficult to estimate, but is considerable.

Many minor improvements have been made in the laboratory for the purpose of expediting and lessening the cost of the work. A subject index of the Survey negatives was begun and is being rapidly pushed to completion. When complete this index will be an invaluable aid to the geologists of the Survey, also to schools and colleges. As in previous years, several schools made use of the Survey collection of negatives for educational purposes.

About the usual number of fossil and other specimens were photographed during the year. These are not separated in the totals given.

Following is a tabulated statement of the work of the laboratory for the year:

Work done in the photographic laboratory, 1904–5.

Month.	Negatives.				Slides.	Prints.			
	Wet.	Paper.	Dry.	Total.		Map.	Glossy.	Mat.	Total.
1904.									
July	91	118	281	490	......	877	440	90	1,407
August	286	297	994	1,577	......	1,481	1,248	233	2,962
September	257	271	377	905	29	1,261	603	158	2,022
October	255	274	1,278	1,807	8	1,216	868	357	2,441
November	148	181	1,375	1,704	3	979	1,395	130	2,504
December	338	341	547	1,226	72	1,988	1,457	371	3,816
1905.									
January	331	339	791	1,461	88	1,756	1,900	1,680	5,336
February	433	437	295	1,165	65	1,746	942	2,580	5,268
March	395	588	227	1,210	......	1,961	972	3,310	6,243
April	383	359	98	840	......	2,844	1,063	1,556	5,463
May	311	342	508	1,161	32	2,579	941	11,515	5,035
June	299	303	372	974	......	2,630	892	5,602	9,124
Total	3,527	3,850	7,143	14,520	297	21,318	12,721	17,582	51,621

Size.	Negatives.			Prints.
	Glass.	Paper.	Total.	
30 by 42	....	264	264	1,474
28 by 34	762	899	1,661	4,768
22 by 28	368	641	1,009	3,906
20 by 24	1,836	1,893	3,729	8,255
14 by 17	271	153	424	2,915
11 by 14	316	....	316	498
8 by 10	265	....	265	2,702
6 by 8	231	....	231	6,792
5 by 7	1,879	....	1,879	10,555
4 by 5	4,742	....	4,742	9,765
Slides	297	....	....	....
Total	10,670	3,850	14,520	51,621

RECLAMATION SERVICE.

The Reclamation Service, created to carry into effect the act of Congress of June 17, 1902, is not a part of the Geological Survey, but was placed by the Secretary of the Interior under the control of the Director of the Survey.

During this the third year of the existence of the Reclamation Service the organization was practically completed, the practices outlined, and the most important projects begun. Plans were made for larger works in all parts of the arid West, involving the investment of practically the entire fund, which now amounts to about $30,000,000.

The following pages give a summary of the operations in each State and Territory during the fiscal year 1904–5. More complete data may be found in the Third Annual Report of the Reclamation Service, printed as House Document No. 28, Fifty-eighth Congress, third session.

ARIZONA.

In this Territory attention was given first, under the reclamation law, to the consideration of the relative merits of the two large reservoir sites which had been previously known and widely discussed. These are the San Carlos site, on Gila River, and the Salt River site on Salt River, the principal tributary of the Gila. The former was examined in connection with the surveys of the Buttes reservoir site, authorized by act of Congress approved July 1, 1898, which appropriated $20,000 for ascertaining the depth to bed rock at Buttes and estimating the cost of construction of a dam across the river.

In addition, general examination has been made of opportunities of storing water in various parts of the Territory, and of the underground waters of Salt River Valley that may be made available by pumping. The work in Arizona is under the charge of Mr. Louis C. Hill, supervising engineer.

SALT RIVER PROJECT.

This project involves the construction of a dam 270 feet high for the storage of 1,100,000 acre-feet of water and of power plants for pumping water for irrigation in the lower valley. The estimated cost of the dam and power plants is about $3,600,000.

The dam site is on Salt River, about 70 miles above Phoenix and immediately below the mouth of Tonto Creek. Water stored at this point will be turned down Salt River and utilized on 160,000 to 200,000 acres of land in the vicinity of Phoenix. Most of the land is in private ownership, but all the surrounding public land has been withdrawn pending survey. In addition to this, it is estimated that by developing the flow available along Salt River and using it for pumping an area amounting to nearly 40,000 acres can be added to the irrigated district in Salt River Valley. The power developed along the river would be transmitted to substations properly located and there distributed at a lower voltage to pumping stations so situated as to furnish water for irrigation.

An association of the water users has been formed for the purpose of dealing with the Secretary of the Interior and guaranteeing the carrying out of the purposes of the law and the repayment of the cost of reclamation. In February, 1904, the Secretary of the Interior approved a form of contract which it was proposed to enter into with this association. This form was submitted to the association and was accepted by vote on May 10, 1904.

The locality is so nearly inaccessible that the freight on bricks, lime, and cement is practically prohibitory. Arrangements have therefore been made to manufacture these on the ground, the necessary materials being convenient.

A waterworks system has been installed for the purpose of supplying potable water to the camp and town at Roosevelt, and the telephone line connecting the headworks of the upper power canal with the Arizona dam has been completed.

The building for the cement mill is completed, the machinery is installed, and the mill was put in operation early in January, 1905. The Phoenix-Roosevelt road is finished. The final location of a power canal at the mouth of the Verde is practically complete. The cadastral survey of the irrigable lands in Phoenix Valley has been completed. The contract for the dam has been let to J. M. O'Rourke & Co., of Galveston, Tex.

Complete tests of the irrigation plants in Salt River Valley are being carried on. These include tests of steam, steam-electric, hydro-electric, and gasoline plants, ranging in capacity from 10 to 500 horsepower. The data obtained, together with the work on the underground flow, which is already completed, will furnish the basis for the design of the pumping plants which will form part of this project.

The quality of water in Salt River Valley is variable, some of it containing so large an amount of sodium chloride, or common salt, that its continued use for irrigation is detrimental to crops. It is therefore necessary to determine the amount of salt in the river at different stages and the proportion which the river carries at progressive points from the upper to the lower end of the valley. An examination of the ground waters in the lower valley has also been made, in order that the data might be considered in connection with the establishment of pumping stations. The investigations were carried on by Mr. S. K. Baker, hydrographic aid, under the direction of Mr. M. O. Leighton, hydrographer in charge of hydro-economic work, and occupied a period of seven months, from April to November, inclusive, as described on page 211 of this report.

SAN CARLOS PROJECT.

This reservoir site is on the White Mountain Indian Reservation in Arizona, below the mouth of San Carlos Creek, on Gila River. A dam at this point will impound about 300,000 acre-feet of water at a cost of little more than $1,200,000. The stored water can be turned down

Gila River and taken out for use in the broad valley in the vicinity of Florence and on the Gila River Indian Reservation near Sacaton. Investigations were begun here in 1899, and deep borings for bed rock made during June of that year. The water supply is scanty, but the chief difficulty will be with the large amount of silt carried by Gila River.

Investigations of the foundation problem were begun by the Reclamation Service in February, 1903. The steam diamond drill and the rest of the apparatus were under the general direction of Mr. C. R. Oldberg. The work was discontinued in August, 1903, fifteen holes having been sunk to bed rock and diamond-drill cores taken therefrom. At present, observations of river flow and sediment are being continued and reconnaissance surveys have been made of possible reservoir sites on the upper Gila. A detailed topographic map has been made of the dam site, and a contour map partly made of the reservoir.

CALIFORNIA.

In this State the principal reclamation projects under consideration are in the extreme southeast, along Colorado River; in the northern end of the State, adjacent to Oregon, and near the center, in Owens and Sacramento valleys. Reconnaissance surveys are being carried on along the headwaters of Sacramento River to obtain facts bearing upon the feasibility of a general system of irrigation from that stream and its tributaries. This work is under the general charge of Mr. J. B. Lippincott, with office at Los Angeles.

YUMA PROJECT.

The Yuma project contemplates the irrigation of land on both sides of Colorado River, in Arizona and California, in the immediate vicinity of the town of Yuma. The extent of the irrigable area can not be stated absolutely until the canals and levees are finally located, but it is estimated that over 100,000 acres will be available in the valleys, exclusive of the mesa. From this area it will be necessary to deduct from 10 to 20 per cent for sand dunes and sloughs. The soundings for bed rock indicate that a high diversion dam is impossible, and that therefore the mesa lands southeast of Yuma can not be irrigated by means of a gravity canal because of their elevation.

In the Yuma Indian Reservation, on the California side of the river, it is estimated that there will be within the levees 16,000 acres, and on the Arizona side 91,000 acres under the system, making a total of 107,000 acres. Of this area it is estimated that 5,000 acres next to the Mexican line in Arizona will be subject to overflow in such a way as to temporarily exclude them from the irrigable areas; in addition a small percentage of the remaining lands are known to be in sand dunes that will be above the level of the canal lines. In all it is estimated that on both sides of the river there will be a total of 86,700 acres of irrigable land, of which 73,100 acres are in Arizona. The water supply of the Colorado is adequate for the irrigation of this area.

The Laguna weir site has been selected as the most desirable for the construction of a weir to serve the lands near Yuma, a high dam and high-line canal being considered impossible. The type of weir selected is one that has been tried during the last fifty years at numerous places in India and Egypt under similar conditions. Three dams on practically this same plan, all of which have served their purpose efficiently and are in operation to-day, have been constructed on the Nile within the last fifteen years.

The disposition of the silt of the Colorado is one of the most difficult features of this undertaking. It is known that its amount is very large. The river is on a grade of approximately 1 foot to the mile above the Laguna weir site, so that a weir 10 feet high will make a settling basin of relatively quiet water, approximately 10 miles long, above it. At the east end of the weir, constructed in solid granite rock and excavated 3 feet below low water in the river, will be a sluiceway 100 feet wide. At the west end the sluiceway, also in granite, will be only 40 feet wide, but will be planned so as to permit enlargement to meet possible future needs. These sluiceways will be closed by large gates operated by hydraulic machinery. The diversion canals will take their water above these gates from the sides of the sluiceways. The area of these sluiceways being so great, the water movement toward the canal will be slow and most of the sediment will be deposited before reaching the canal intake. When this has accumulated to a considerable extent the sluice gates will be opened. It is estimated that the capacity of each sluiceway will be approximately 20,000 second-feet, and that this great volume of water will carry out with it the sediment deposited above the intake of the canal. The ordinary low-stage flow of Colorado River is from 3,500 to 4,000 second-feet, so the capacity of the sluiceways will be about five times the low-water flow of the river. These figures are given for purposes of comparison only.

As a result of a number of experiments it has been found that the most of the silt is carried along near the bottom of the river and that the surface water is relatively free from sediment. It is planned, therefore, to take the water into the canals by a skimming process over a long row of gates, so that the canal can be filled by drawing but 1 foot in depth of water from the surface of the river. The main sluice gates will be of the Stoney type of iron-roller gate. There will be three on the Arizona side and one on the California side. Each will be 35 feet wide and about 15 feet high. If the settling capacity in the sluiceways is not sufficient for the exclusion of enough of the silt they may be extended upstream so as to increase the length of time required for the water to pass through them, thus permitting the settlement of a greater proportion of the silt.

The dam will be 4,780 feet in length, between granite abutments, 240 feet in width up and down stream, and will have a maximum height of 19 feet above the bed of the stream.

Every portion of this weir and headworks as designed will be of rock, concrete, or steel, with the exception of the sheet piling, which will be driven entirely below the water level, and so will not decay. Every portion of the weir will be what is known as "permanent construction." Work of this character will of course be expensive, but it has been proved to be sound economy to build in this way.

The capacity of these canals at their intakes will be 1,300 second-feet on the Arizona side and 200 second-feet on the California side. The amount of silt that would be daily delivered into the Arizona canal if diversion were made directly from the stream would approximate 14,000 cubic yards of wet mud by volume, and it is not believed to be possible for a canal to continuously operate successfully for the irrigation of lands along the valleys of the Colorado unless some very substantial arrangements are made at the headworks for handling this silt. This and the fact that the water must be held to a fixed level at the canal heading for all stages of the river is believed to justify the expenditure proposed for these headworks, which will cost approximately $1,000,000.

Careful study has been made of the existing canals in the vicinity of Yuma and Imperial to determine the shape that they naturally assume, and the roughness of the bottom and sides, which tends to retard the velocity. Based upon these data, the canals have been designed so that the water in them will flow at a higher velocity throughout than in the settling basins above their heads—such a velocity as will occasion a minimum loss by seepage and evaporation. The gates and drops of these canals and the Yuma bridges are designed as steel-concrete structures. Estimates have been made for a distribution system to furnish water to each 160-acre tract. Some small areas of land in upper Gila Valley and below Yuma will have to be served by pumping plants that will lift the water from 10 to 25 feet. The power for doing this may be furnished by a central-power plant to be erected above

Yuma. This power plant will also be used in connection with the drainage system.

One of the most difficult problems in connection with this project is the crossing of Gila River. It has been considered necessary to make this perfectly safe, and for this purpose a structure has been designed that will cross beneath the river, its top being several feet below the lowest point of the stream bed. This structure will be of steel and concrete, about 5,200 feet in length.

The valley lands under the Yuma project are suitable for the growth of staples, particularly forage plants. On the mesa, however, the lands are adapted to the growth of all varieties of semitropical plants and early fruits and vegetables. They will be capable of extensive cultivation and of occupation in small areas.

OWENS VALLEY PROJECT.

Owens Valley is on the eastern slope of the Sierra Nevada, in Inyo County, Cal., at an elevation of about 4,000 feet. The stream measurements during the last winter show that 199,000 acre-feet of water could be made to pass through the Long Valley reservoir site at the head of Owens Valley. It is estimated that in average years 240,000 acre-feet of water over and above the amount now beneficially appropriated will be available for storage in Long Valley. Probably from 80,000 to 100,000 acres of land can be irrigated, as compared with 30,000 under existing conditions. A drainage system will be essential, and the water thus collected from the upper end of the valley may properly be used for the irrigation of other lands in the lower end. The opportunities for developing water power, which are very great, can probably be used for pumping additional water from the saturated lands to other irrigable lands.

Stream measurements are being made on Owens River and its tributaries and on all the canals in Owens Valley. A determination is being made of the duty of water, the irrigated areas are being located and classified, and evaporation records are being kept. Preliminary surveys have been made of all the lakes and possible reservoir sites on the tributaries of Owens River entering below Long Valley, with a view of augmenting the supply of storage water from this source. This has been the principal work of the past summer.

KLAMATH PROJECT.

Klamath River is the outlet of Klamath Lake, Oregon. It flows through large swamp areas in Klamath County, Oreg., and by an overflow process feeds Lower Klamath Lake, on the Oregon–California boundary. After issuing from Lower Klamath Lake, it flows southwestward through Siskiyou, Humboldt, and Del Norte counties, Cal., and empties into the Pacific. In this lake region irrigation is essential to successful agriculture.

The basin of Klamath River was visited by Mr. John T. Whistler, engineer, in October, 1903, who reported on November 2, 1903. Mr. H. E. Green, engineer, also visited the basin in October, 1903, and reported thereon. These reports were preliminary and were considered sufficient justification for a further investigation into this section during 1904. For this purpose Mr. T. H. Humphreys, assistant engineer, reporting to Mr. J. B. Lippincott, supervising engineer for California, was detailed to the work in 1904.

Klamath basin is on the eastern side of the Cascades, or Coast Range, in a high plateau region, between elevations of 4,000 and 4,200 feet.

The climatic conditions are such as to permit of the growth of staple crops, but to prohibit the growth of the more delicate fruits and vegetables. The rainfall is between 10 and 15 inches. Without irrigation few crops can be raised with certainty, but with it the lands become productive. The lands to be irrigated have been investigated by a soil expert, who pronounces them to be generally of a high order of fertility. An effort will be made to preserve a navigable channel from Klamath Falls to the south end of Lower Klamath Lake.

There are three valleys, known as Langells, Yonna or Alkali, and Poe, in the basin of Lost River. Under the proposed upper canal system they contained 5,505 acres of public lands, and 42,852 acres of private holdings, a total of 48,357 acres.

Two reservoir sites, known as the Clear Lake reservoir site, on Lost River, and the Horse Fly reservoir site, on Miller Creek, may be utilized. The impounding of these flood waters will cut off the greater portion of the present water supply of Tule Lake, which is a basin without outlet, and also furnish water for the irrigation of these valleys. Future study may show that it is not necessary to use both reservoirs for these purposes.

The Lower Klamath basin, exclusive of Tule Lake, contains 54,076 acres of public land and 86,721 acres of private land, a total of 140,797 acres. These lands will be reclaimed by a diversion canal from the upper Klamath and by the lowering of the outlet of Lower Klamath Lake at Keno.

Tule Lake bed contains approximately 94,476 acres of land, all of which is public. This is an interstate lake. It is estimated that by withholding the flood waters of Lost River, which is the main source of water supply of this lake, in Clear Lake and Horse Fly reservoir sites, and by diverting the remaining portion of Lost River into Klamath River, about 47,000 acres of the land in the bed of this lake would be uncovered by evaporation.

The State of California has given the right to lower these lakes and has conveyed to the United States Government, for disposal under the reclamation act, its title to all these lake-bed lands, by an act approved February 3, 1905. Oregon has made a similar concession, by an act approved January 20, 1905. By the act of Congress approved February 9, 1905, the Secretary of the Interior was authorized to lower the level of these lakes and to dispose of any land that may come into possession of the United States under the terms and conditions of the reclamation act.

It appears feasible to divert a portion of the waters of Klamath River into Shasta Valley, in Siskiyou County, Cal. A reconnaissance has been made of this portion of the project, but as yet no definite figures can be presented. Possibly in the neighborhood of 60,000 acres of land can be reclaimed in this valley, and petitions have been received from many landowners in that section requesting this construction.

The total area of public land in the Klamath project is estimated as 106,827 acres and the area of private land as 129,573 acres, a total of 236,400 acres. The estimate provides for the irrigation of the area in question and the construction of laterals to each 160-acre tract. Main drainage canals will be built in such portions of the project as may require drainage to prevent alkali or to lower water levels. The landowners will be expected to construct their own drainage laterals to these mains. The topographic conditions of this project are such that no great and expensive works have to be constructed before irrigation can begin. The project can be built in sections, and it will be possible to begin the delivery of water to some of the irrigable lands within a year after construction begins.

The lands of the Klamath basin are extensive and excellent, the water supply is adequate in volume and quality, and the cost per acre of proper irrigation and drainage is unusually low. All works planned are for permanent construction and substantial in character, thus insuring the minimum maintenance charge. Distribution laterals will be built to each 160-acre tract. Main drainage ditches will be constructed, to which the landowners may build tributaries where deemed necessary. Private water rights have been carefully considered and satisfactory agreements signed by the parties at interest. The reports of the engineers and experts are favorable and the Secretary of the Interior has adopted the Klamath project and made an allotment for its construction. The necessary authority has been obtained from the States and the Nation to build the works as planned. It will be necessary for the landowners to comply with the provisions of the law and the regulations of the Department by joining the Water Users' Association and signing up their land before construction will begin. Provided this is done, the works can be promptly built.

SACRAMENTO VALLEY PROJECT.

Sacramento Valley is the northern portion of the great central valley of California. It contains 4,196 square miles, and the total area of its basin, including its mountainous portions, is 26,187 square miles. The water supply is very great, particularly from the northern and eastern portions; from 1878 to 1885 the mean annual discharge, as measured at Collinsville, was 25,936,000 acre-feet. The valley is very fertile, but its southern portion is subject to extensive overflow. In March, 1904, 800,000 acres were flooded.

The investigations of Sacramento Valley contemplate the general reconnaissance of the entire basin of the river, the search for reservoir sites, the gaging of streams, and the approximate determination of the areas of irrigable land. The work is being carried on in cooperation with the State of California, and also in harmony with the work being done by the topographic branch of the Geological Survey, which is mapping the valley lands, and the Forest Service of the Agricultural Department, which is examining the forest reserves.

Up to the present time the western side of the drainage basin and the northern portion of the basin as far as Pit River, inclusive, have been examined and reservoir sites surveyed. Sites have been found that aggregate in estimated capacity 1,800,000 acre-feet.

COLORADO.

In this State special attention has been devoted to the Uncompahgre Valley project. Surveys have also been conducted looking to the reclamation of lands in the northwestern part of the State by waters from White and

Yampa rivers. An examination has been made of the opportunities for reclamation of land near Grand Junction, Colo., and in addition reconnaissance has been carried on in various parts of the State.

UNCOMPAHGRE VALLEY PROJECT.

This project is located in Montrose and Delta counties, in western Colorado, on the western side of the main range of the Rocky Mountains. The water supply is from Gunnison and Uncompahgre rivers, from the former of which it is expected that water will be taken by means of a tunnel about 6 miles in length, beginning in the Grand Canyon of the Gunnison and ending in Uncompahgre Valley a few miles northeast of the town of Montrose. From the lower portion of the tunnel the water will be taken around the edge of the valley for the purpose of irrigating about 120,000 acres of land, a considerable part of which is in private ownership in small tracts. It is estimated that this project will cost in the aggregate approximately $3,500,000 and that it will take four years to complete it. The first withdrawal of land, comprising about 137,000 acres, was ordered January 31, 1902, in anticipation of the passage of the reclamation act. The lands to be irrigated are in the vicinity of the towns of Montrose and Delta and are traversed by the narrow-gage branch of the Denver and Rio Grande Railroad. The principal crops raised are fruits, grains, alfalfa, and vegetables.

The topographic map of the lands under the project, on a scale of 1 inch to 1,000 feet, with contour intervals of 10 feet, has been completed. Final locations of tunnel and main canal have been completed and a considerable part of the canal has been constructed. A road has been constructed across Vernal Mesa, joining the two ends of the tunnel. A telephone system has been built.

A contract for the construction of the tunnel was signed in December, 1904, and considerable progress has been made on construction. In May the approaches had been excavated, and the tunnel had been excavated for a distance of 630 feet from the lower portal. The company holding the contract became involved in financial difficulties and unable to proceed with the work, and it became necessary for the United States to take possession, which was done on May 27, and the work has since continued on force account.

On May 30, while the workmen were removing temporary timbers and placing permanent ones, a sudden cave-in occurred, which buried 10 men, 6 of whom were killed and 4 were extricated alive.

GRAND RIVER PROJECT.

This project contemplates the reclamation of approximately 60,000 acres of land in the vicinity of Grand Junction, on Grand River, in Mesa County, Colo., the water to be taken from Grand River about 20 miles above the town of Grand Junction. Preliminary examinations of this project have been made for a number of years past by local engineers, and in June, 1902, investigations under the reclamation act were ordered by the chief engineer, and Mr. Gerard H. Matthes was placed in charge of the work.

During the season of 1902 and the winter of 1902–3 preliminary surveys were made with a view to constructing a canal high enough to reach over 200,000 acres in Colorado and Utah. This was found to be not feasible, however, and an examination by the board of consulting engineers, consisting of Messrs. A. P. Davis, G. Y. Wisner, and W. H. Sanders, resulted in the condemnation of this high line and in a recommendation that a lower line be surveyed, which it was believed would be found feasible for the irrigation of the 60,000 acres in Mesa County above mentioned.

No field work has been done on this project since 1903. This is due to the fact that an irrigation district has been formed under the laws of the State of Colorado, through which the construction of the project by private capital is contemplated. It is not proposed that any work shall be done on this project so long as it is under serious consideration by local capitalists. It is thought, however, that the project is a very worthy one, and the board of consulting engineers and the district engineer have recommended that, if it is impracticable for private capital to handle the situation, the Reclamation Service should again take hold of the project upon the completion of the Uncompahgre Valley project.

COLORADO RIVER STORAGE PROJECTS.

As it has been found necessary to store water in the Rocky Mountain region for the regulation of the flow of Colorado River, with a view to the reclamation of land along the lower Colorado in Arizona and California, certain reservoir sites have been withdrawn in western Colorado, two of these being on Grand River in Grand County, and two on Yampa River, in Routt County. Preliminary examinations have been made of all these sites, and some of them have been surveyed.

The Kremmling reservoir site, the most important of all the sites thus far withdrawn for the purpose of assisting in the reclamation of lands on the lower Colorado, is located in the western part of Grand County, and covers an area of about 14,000 acres at the 181-foot contour. It has been estimated that its storage capacity is about 1,500,000 acre-feet. Lands covering this site, amounting to 39,680 acres, were withdrawn May 12, 1904. Surveys of the site will be made in the immediate future.

IDAHO.

In this State there are a number of projects for the reclamation of arid land in both public and private ownership. The most important of these is the so-called Minidoka project, on Snake River below American Falls, where the lands are almost entirely public, and the Payette-Boise project, in the southwestern part of the State, where the lands are mainly in private ownership. The latter may be reclaimed by storage and control of the waters of the Payette and Boise rivers. A third project is in the southeastern part of the State near the headwaters of Snake River, where a vast extent of desert public land can be reclaimed by storage of flood waters if suitable reservoirs can be found. The work is under the general direction of Mr. D. W. Ross, with office in Boise.

MINIDOKA PROJECT.

This project is located on Snake River in the southern part of Idaho, where it is proposed to reclaim from 130,000 to 150,000 acres of desert land belonging to the United States. Water is to be taken from Snake River, the dam being located about 40 miles below American Falls and 6 miles south of Minidoka station, on the Oregon Short Line Railroad.

The distributing system on the north side of the river and the final location of the main south-side canal have been planned; also estimates covering the second division of the work, embracing the entire canal system on the north side of the river, have been completed. Construction on the dam and spillway began during November, 1904, and is still in progress.

PAYETTE-BOISE PROJECT.

This project contemplates the reclamation of about 300,000 acres of land in the Boise and Payette valleys, in the southwestern portion of Idaho. Most of this land is in private ownership in relatively small tracts, about five-sixths of the area being at present without facilities for irrigation. The area is in or adjacent to Snake River Valley, and is traversed by the Oregon Short Line, the Boise, Nampa and Owyhee, and the Idaho Northern railroads.

In March, 1904, petitions, lists of lands, and plats showing location of irrigable land under the project were forwarded by an organization committee of water users to the Secretary of the Interior, with a request that the preliminary examination of the project be extended and completed, and funds set aside for the construction of the necessary works, construction to be commenced upon the perfecting of an organization of landowners approved by the Secretary. The landowners were encouraged in their effort to perfect the necessary organization, and surveys were continued with a view of ascertaining the feasibility of the project. Several meetings have been held by the organization committee of the landowners, at one of which articles of incorporation were presented, and a board of directors, consisting of 11 members, was named to act for the first year.

Surveys of the main canal lines of this proposed system were completed in August, 1904, and plane-table parties organized to prepare line topography on a scale of 400 feet to 1 inch, with contour intervals of 5 feet, and of dam sites, points of diversion, and locations where work is likely to be somewhat difficult in greater detail. This topographic work has been completed and the preparation of plats and estimates will be made.

Investigations have been made of the storage possibilities on Boise River and on Payette drainage. They indicate that it will be feasible to utilize Big Payette Lake for storage purposes, it being possible to reduce the level of the lake 25 feet by means of a short tunnel or cut about 1,600 feet long, and to raise it 5 feet by means of a dam. This can be done at comparatively small cost and will give a storage capacity of 120,000 to 140,000 acre-feet, considerably more than will be required on Payette River. The investigations made in connection with this project point to its entire feasibility. More than 300,000 acres of desert lands of first-class quality can be reclaimed by it.

DUBOIS PROJECT.

This project is located in the upper portion of Snake River Valley, southwest of Dubois, in Blaine and Fremont counties, Idaho. It is proposed to reclaim about 200,000 acres of desert land belonging to the United States, by means of a large canal heading on South Fork of Snake River, near St. Anthony. The land is nearly level and is near the lower end of the sinks of Little Lost River. It is traversed on the east by the Utah and Northern Railroad. It will apparently be feasible to convert Lewis and Shoshone lakes into a reservoir, and to construct a canal from a point a short distance below Lewis Lake, to divert the water of the South Fork into the North Fork drainage. If this plan should prove feasible, it would then be possible to utilize the flow of the South Fork on the lands in the vicinity of St. Anthony and the Dubois tract, or on the lands tributary to South Fork of Snake River, or both. The conditions at this point will perhaps determine the feasibility of the Dubois project. It will, at any rate, solve the problem of water supply for the lands tributary to the North Fork drainage.

Withdrawals of the different sites suitable for reservoir purposes have been made from time to time. These withdrawals, together with the withdrawals of irrigable lands, will serve to protect this project and render it feasible to take up the work of construction when deemed advisable.

KANSAS.

UNDERFLOW INVESTIGATIONS.

The region under investigation is the drainage basin of Arkansas River, extending from Garden, Kans., westward toward the State line. South of the river channel there are 5 to 10 miles of sand hills. There are usually 2 or 3 levels of bottom lands, while north of the bottom lands and south of the sand hills is an elevated flat area. For a number of years the bed of the Arkansas has been dry during the summer months. Irrigation during July and August has been practically confined to the bottom lands, where some water has been recovered by pumping.

The investigation of the underflow of Arkansas River was begun June 11, 1904. The work consisted in accurately mapping the water plane within a distance of 6 to 10 miles from the river channel, and in making observations by the electrical method of the rate of movement of the underflow. The slope of the water plane has been found to be between 7 and 8 feet to the mile in a general easterly direction, and from 2 to 3 feet to the mile toward the river channel from the country immediately to the north and south. At the first set of underflow stations, which extended in a north-south line about $2\frac{1}{2}$ miles west of Garden, the velocities of the ground water were found to be remarkably uniform, varying between 8 and 11 feet per twenty-four hours. The gravels, except occasional layers of silt, were exceedingly uniform in size and character of grain. The stations at which the determinations were made extended from the edge of the sand hills on the south to a distance of about 2 miles north of the river channel.

Similar determinations have been made at a series of stations near Sherlock, Deerfield, and at points near Lakin and Hartland. The results differed little from those obtained at the earlier stations, except that more sorting of the gravels has taken place at these latter points, giving greater variety to the rate of movement. The usual velocities vary between 6 and 24 feet for twenty-four hours, the average being not far from 8 feet per twenty-four hours.

The quantity of ground water that is passing downstream is so great and the water passes through the gravels so freely that there is no surplus left to form surface streams or to form a perennial supply for Arkansas River.

The average rainfall upon the very flat catchment area near Garden is about 20 inches per year. A very large part of this must pass into the open and porous soils, so that the actual contribution to the underflow must be considerable. If the gravels beneath the plains were not so coarse and so deep and wide, the seepage waters would be obliged to seek release in surface streams. But the underground conditions are such that ample drainage is offered by porous beds of gravel several hundred feet in depth.

The work done thus far indicates that the water of the Arkansas underflow has its origin in the rainfall upon the sand hills to the south and upon the bottom lands and plains to the north. A few plains streams like Bear Creek entirely disappear as surface streams before the Arkansas is reached. A noteworthy feature of the underflow is the lack of any natural north or south limitation to it. The velocities at the edge of the sand hills on the south and at considerable distances from the river channel on the north are about the same as near the bed of the river. There is nothing surprising in this, but it shows that it is impossible to place any north or south limit to the eastward-moving ground waters.

The investigation has shown that in time of flood Arkansas River contributes water to the underflow. The movement of the ground water away from the river channel was measured during high water and found to be 12 feet for twenty-four hours.

Existing pumping plants which supply water for irrigation along the Arkansas have been carefully tested. The cost of pumping is low on account of the very large amount of water obtained when the water in the wells is lowered only 5 to 7 feet.

It is proposed to design a pumping plant to collect the underflow waters for irrigation and to make as careful an estimate of its cost and the amount of water recoverable as the circumstances will permit. When these estimates are completed, a judgment can be formed as to the practicability of the recovery of the underflow on a large scale.

MONTANA.

In Montana principal attention has been given to the possibilities of reclamation of lands along Milk River, in the northern part of the State. In addition a reconnaissance has been made on the rivers to the south, namely, the Marias, Sun, Teton, and Madison, and preliminary surveys have been carried along some of the rivers between the Missouri and the Yellowstone. Examinations have also been made of the opportunities of development on the lower Yellowstone, as described under the heading of North Dakota.

MILK RIVER PROJECT.

Milk River rises in the undulating foothills of the Rocky Mountains, near the boundary line between Montana and Canada. Its headwaters flow northeastward into Canada, and the stream continues for about 100 miles eastward parallel with the international boundary and then turns southeastward, passing through the northern part of Montana and emptying into Missouri River.

The valley through which Milk River passes is broad and contains many thousand acres of excellent arid land. The summer flow of the stream is not sufficient for the irrigation of any considerable part of this area, and it has been proposed to reenforce the supply by turning into the headwaters of Milk River the abundant waters of the St. Mary basin, immediately adjacent to the source of Milk River.

In order to avoid passing through Canada, this can probably be done by an expensive line turning southward across the head of Milk River and emptying into Cutbank Creek, a tributary of Marias River. From the latter the water may be taken into the Milk River Valley and kept in Montana throughout its course. The Milk River project is divided into three sections—the St. Mary subproject, the Marias subproject, and the lower Milk River project. The progress of the work in connection with each project will be described under appropriate headings.

St. Mary subproject.—St. Mary River rises on the eastern slope of the main range of the Rocky Mountains. It flows northward into Canada, its waters finally reaching Hudson Bay. Owing to the heavy snowfall in the basin, the annual run-off is large. It is proposed to store this water in St. Mary Lakes, in order that it may be used to increase the supply for Milk River Valley, if it can be successfully diverted. The examinations made indicate that, at a cost of approximately $2,000,000, the water could be stored and taken to Cutbank Creek, a tributary of Marias River.

Investigations were first started on this project in 1900, work around St. Mary Lakes being under charge of Mr.

G. H. Matthes. During the year 1901 Mr. Cyrus C. Babb was placed in charge, and the investigations have since been under his direction. Work was continued during 1902 and 1903, and covered investigations of water supply, canal surveys, detail surveys of reservoir dam sites, and borings for bed rock at the St. Mary dam site.

Marias subproject.—This is the second principal subproject for increasing the water supply from St. Mary Lakes. The water diverted into Marias River must be taken out by means of a dam located in the canyon of Marias River and a large canal crossing the divide to the Milk River drainage. The board of consulting engineers has reported favorably on the general scheme as proposed—that is, the building of a 190-foot earth dam and a canyon diversion canal 17.4 miles long. Diamond-drill borings have been made at the dam site and have proved satisfactory. A reservoir site, known as Lonesome Lake, has been discovered between the Marias and Big Sandy Creek, in which 208,000 acre-feet can be stored.

Lower Milk River project.—It is proposed to utilize the stored waters of St. Mary Lakes, as brought down through the Marias River and supplemented by the natural flow of Milk River, on the arable lands of the latter stream. The country ranges in general elevation from 2,150 to 2,400 feet, and it is better adapted to irrigation than the plateau region in the vicinity of St. Mary Lakes. By depending on Milk River alone and storing in Chain Lakes reservoir the two years' minimum run-off of Milk River, sufficient water for 68,000 acres will be available.

Field work is practically completed under the Dodson diversion system. Preliminary survey of the Bowdoin north canal and Bowdoin south canal, extending from Bowdoin Lake as far as Glasgow, on, respectively, the north and south sides of Milk River, are completed. The survey of the reservoir site and dam sites on upper Beaver Creek have also been completed.

Examination of the field sheets of topographic surveys west of Havre shows that there is a reservoir site 30 miles northwest of Havre, known as Chain Lakes reservoir site. Investigations of this will soon be completed. A canal on the south side of Milk River, heading near Chinook, and extending through the Fort Belknap Indian Reservation, is being surveyed.

From September 12 to 19, 1904, a board of consulting engineers went over the entire area from St. Mary Lakes to lower Milk River. Their report is to the effect that owing to the discovery of the Chain Lakes site the Milk River project looks more feasible than before. The total area available for irrigation in the Milk River Valley is 250,000 acres.

SUN RIVER PROJECT.

Sun River receives the drainage from the eastern portion of the Rocky Mountain region south of St. Mary River and north of Helena, Mont. An examination of this stream was made by Mr. H. M. Wilson in 1890–91, the results being printed in the Twelfth Annual Report of the United States Geological Survey, part 2, pages 120–133. The stream carries a considerable amount of water. There are known to be several reservoir sites, and there is a large body of irrigable land, much of it in public ownership.

About July 1, 1904, a party for the investigation of this project was organized, with Mr. S. B. Robbins, engineer, in charge. Work was begun by running a line of levels from Sun River, near reservoir No. 1, to what is known as Freezeout basin, and in making a plane-table survey of the latter to determine the practicability of utilizing it as a storage reservoir. In October, 1903, about 300,000 acres were withdrawn from entry, and on September 15, 1904, request was made for the withdrawal of about 250,000 acres additional, making a total of about 550,000 acres withdrawn under this project.

CROW RESERVATION PROJECT.

This refers to the irrigation in pursuance of the act of Congress approved April 27, 1904, of certain bodies of land lying along the Yellowstone and Bighorn rivers in the State of Montana. Most of the lands to be reclaimed lie in the ceded portion of the Crow Indian Reservation.

Under this act the Crow Indians ceded to the United States a strip of land in the northern part of their reservation, subject to certain conditions, which included the payment of $1,150,000 and the surveying of the lands. The Indians on the ceded strip are to have a reasonable time within which to elect whether they will remain there or remove to the diminished reservation and have their improvements appraised and sold. After the completion of allotments to Indians the residue of the ceded lands are to be subject to withdrawal and disposition under the reclamation act. It is provided, however, that if the lands withdrawn under the reclamation act are not disposed of within five years after the passage of the act of April 27, 1904, then all of the lands are to be disposed of as other lands provided for in the act.

The price of these lands is to be $4 per acre when entered under the homestead laws, in addition to the cost of reclamation. Lands under the reclamation act are not to be entered or settled upon until sixty days after the President's proclamation opening the general lands to settlers.

On the Bighorn River, from the Fort Custer Military Reservation to the mouth of the river, are about 30,000 acres of fine land, including about 10,000 acres inside the Fort Custer Military Reservation, but outside of the ceded strip. All of this land could be covered by a canal diverting water from Bighorn River. Another canal from the Bighorn, taking water from the mouth of the canyon, would cover approximately 17,000 acres on the ceded strip and 27,000 acres on the reserve, this land lying on the high bench west of the river and adjoining the lower tract previously mentioned.

There is a possibility of the high-line canal crossing the divide between the Bighorn and Yellowstone rivers. By this perhaps 10,000 additional acres of land could be covered that could not be profitably irrigated from the Yellowstone.

In all there are about 175,000 acres of land to be watered from Bighorn River under the Crow Reservation project.

On the Yellowstone is a fine body of irrigable land, comprising about 30,000 acres, extending from Huntley to the mouth of Bighorn River. This land can be irrigated at a low cost per acre. In addition to the large tracts already mentioned there are about 30,000 acres lower down the Yellowstone, extending from Bull Mountain to Forsyth. Of this land about half is on the reservation; the rest is mostly in private ownership. In May, 1904, Messrs. A. P. Davis and C. H. Fitch made a preliminary examination of the tracts and ordered that the preliminary survey and general investigations be at once undertaken. The first party was put in the field about June 1, 1904, and ran a line of levels to determine the feasibility of a high-line canal from the mouth of the Bighorn Canyon. Toward the last of June this work was completed, and it was decided to make a preliminary location of the high-line canal. About the middle of July a topographic party was organized and put to work on the diversion sites and special features requiring detailed topography. In August a third party was outfitted and started on a preliminary canal location for the lands along the Yellowstone below Huntley. Gaging stations have been established on the Yellowstone at Billings, on the Bighorn at Fort Custer, and on Pryor Creek at Huntley. Discharge measurements have been made on these streams from time to time.

Three parties have been actively engaged on the preliminary surveys. The first party is locating a high-line canal, starting from Bighorn Canyon and covering lands west of Bighorn River. This survey has progressed as far as Two Leggin Creek and the location has been made with some care, as it is hoped that this canal can be carried through the Toluca divide to lands on the Yellowstone slope. The second party has taken detailed topography of the rough country adjacent to the diversion site above Huntley. The resulting maps will be used to make a careful study of the canal location in that vicinity. The third party has made a canal location to cover the lands below Huntley.

The opening of the reservation is being deferred until the lands have been surveyed and the engineers of the Reclamation Service have determined the irrigable lands to be withdrawn. If the lands withdrawn under the reclamation act are not disposed of within five years after the passage of the act of April 27, 1904, then they are to be disposed of as are the other lands provided for in the act. It is therefore desirable that diligence be used in pushing this project to construction.

Bids for the construction of the Huntley project were opened June 28, 1905, and construction will doubtless proceed without delay.

NEBRASKA.

NORTH PLATTE PROJECT.

North Platte River rises in northern Colorado, flows northward into Wyoming nearly to the center of the State, and then turns eastward and flows southeastward into Nebraska. From the center of Wyoming it receives Sweetwater River, which passes through valleys and occasional narrow gorges, and joins the North Platte at the entrance of the narrow canyon about 50 miles above Casper, the terminus of the Elkhorn Railroad.

The North Platte River projects contemplate, first, the storing of all the surplus water of North Platte River, and the regulation of the flow of the stream to meet the requirements of irrigation, power, or domestic uses; and, second, the diversion of the regulated flow from the river at points lower down into canals for the irrigation of lands in both Nebraska and Wyoming.

With these objects in view, storage was first sought. A well-known reservoir site on the Sweetwater was investigated, but the water supply was found insufficient. A second site, found at the mouth of the Sweetwater on

North Platte River, proved satisfactory. It is called the Pathfinder site.

The next step was to find irrigable land. That lying below the Pathfinder reservoir on both sides of the river from Alcova to Casper was first examined, but the cost was found to be prohibitive, and that between Casper and Douglas was next taken up. There appear to be about 20,000 acres on the south side, nearly all in private ownership. On the north side 25,000 acres may also be reclaimed. No further investigations are being made at present.

The survey of Goshen Hole showed that about 150,000 acres can be reclaimed in Nebraska and Wyoming, at a cost, however, probably exceeding $35 per acre. Goshen Hole lies on the south side of the river in the extreme eastern part of the State. The land is good; it lies at an elevation of about 4,000 feet, and is mostly in public ownership. The features of construction are an expensive diversion dam at Guernsey, a 140-mile canal, about 6 miles of tunnels, and several storage reservoirs.

Pathfinder Reservoir.—This is located on North Platte River at the mouth of the Sweetwater. The dam location is about 4 miles below that point in a granite canyon, 60 feet wide at the bottom, 160 feet at the top, and about 180 feet deep. The height may be made 220 feet by making the dam 250 feet long on top. The capacity exceeds 1,000,000 acre-feet. The reservoir has been mapped, preliminary estimates and drawings of the dam have been made, test pits sunk, power possibilities investigated, and the preliminary examinations practically completed. It is probable that the reservoir will hold all of the flood and surplus waters flowing into North Platte River at this point.

Bids for the construction of this dam were opened in Denver on June 15, and the construction will doubtless begin at an early date.

Goshen Hole subproject.—An endeavor was made to find along North Platte River land to which water stored in Pathfinder reservoir could be applied; little was found in Wyoming except that in Goshen Hole, where about 150,000 acres of good land can be irrigated. An expensive dam must be built in a narrow gorge on North Platte River at a point about 1 mile above the town of Guernsey. Its crest will be 100 feet above low water and 1,400 feet long. Drilling at the dam site has been completed, the drill penetrating sand and gravel to a depth of 90 feet, but no bed rock was found. The area was studied by George I. Adams, the results being given in Water-Supply Paper No. 70.

The investigations by the Reclamation Service were begun on April 1, 1903, the engineer in charge making a reconnaissance and organizing a survey of canal lines.

The canal line on the south side of North Platte River passes for the first 30 miles through a very broken country, where construction is difficult and expensive. The canal on the north side could be taken out and the waters conducted across the North Platte by means of an inverted siphon, crossing the river about 3 miles below Fort Laramie; this line would, however, be more expensive than the south-side line.

In either case the canal will be about 140 miles long, and will cover upward of 10,000 acres of irrigable land in western Nebraska. There are several good reservoir sites in Goshen Hole, and by utilizing these the size of the canal can be reduced and the cost materially decreased.

Survey of the north-side line was continued from the point where it was proposed to construct the inverted siphon and carried to a point about 10 miles east of the Wyoming-Nebraska line, a distance sufficient to show that a large amount of land can be covered, probably more than on the south side of the river. It was found that this extension is not feasible.

Interstate canal.—An examination has been made of the lands in eastern Wyoming and western Nebraska, lying on the north side of North Platte River. This examination indicated that a considerable body of land can be irrigated in Nebraska, amounting possibly to 100,000 acres, and about 25,000 acres in eastern Wyoming.

There are in both States, in private ownership, uncompleted canals, which were designed to extend much farther and to cover much more land than is at present served by them, the completion of the work having been prevented by financial reverses and other difficulties. An interstate canal is being constructed by the Reclamation Service. The results of such a canal would be superior to those which could be expected from the construction of the extensions for several reasons: (1) The cost would possibly be less per acre; (2) the landowners would acquire an interest in an assured water supply from the Pathfinder reservoir, and (3) questions of priority and of use would be eliminated. It may therefore be possible to irrigate 50,000 acres in addition to the land already mentioned.

The head-gate of the interstate canal will be at a point about midway between Guernsey and Fort Laramie, Wyo., on North Platte River, and the canal will extend into Nebraska to the vicinity of Bridgeport. Its length will probably be 150 miles; capacity at the head, 1,400 second-feet; area possible to irrigate from it, 200,000 acres, of which about 100,000 acres are above all existing or contemplated canals or extensions. Eighty per cent of this land is in the hands of the Government and subject to the provisions of the reclamation law. About 25,000 acres are under the Whalen Falls canal, not yet completed. By agreement with the owners of this canal, right of way through the canal has been secured and it will be enlarged and extended into Nebraska.

Bids for the construction of the main canal to the State line were opened May 16, and the contract will soon be signed.

NEVADA.

In Nevada an examination of the opportunities for reclamation was begun in 1889 and general surveys were made in 1890. Stream gagings have been continued at intervals since that date under charge of Mr. L. H. Taylor, and the large amount of information available concerning the water resources made it possible to reach an early conclusion regarding the merits of various projects. Work was therefore begun at an early date on the plans and estimates for utilizing the waters of Truckee and Carson rivers.

TRUCKEE-CARSON PROJECT.

The principal water supply for western Nevada comes from the mountains of California, near the western boundary of the State. The principal streams are Truckee, Carson, and Walker rivers. These converge toward the desert lands and disappear in sinks or lakes at altitudes of about 3,900 feet. Around these sinks are broad bodies of desert land, much of it of excellent quality when watered.

A number of reservoir sites on the headwaters of Truckee and Carson rivers have been surveyed and opportunities for diverting the water have been examined. The most important point at which water may be held is in Lake Tahoe, which lies across the State boundary, being partly in California and partly in Nevada. The outlet into Truckee River is in California, and the river continues in that State for several miles. The simplest project, from an engineering standpoint, is to utilize Lake Tahoe; but owing to the legal difficulties it has not been deemed wise to begin at the upper end of the river.

The waters of Truckee River are used for the irrigation of lands in the vicinity of Reno. Below these lands the river flows through a narrow canyon and then turns to the north, its waters being lost in Pyramid and Winnemucca lakes. In this lower canyon is now completed a canal, taking out the flood and excess waters of Truckee River, which would otherwise be lost in the lakes, and carrying them southeastward to a reservoir on the lower part of Carson River. In this same reservoir the excess waters of the latter stream can also be used. From this reservoir distributing canals are being built to cover about 200,000 acres of land near Carson Sink.

The main canal from Truckee to Carson River is completed, and was formally opened June 17, 1905. A large canal and headworks, to divert water from Carson River to the irrigable land to the south, have been completed, and the distributing system is under construction. A large area of land in Carson Valley will be under irrigation from this system in 1906.

Throughout the Carson Valley are numerous alkali flats and a general distribution of black and white alkali incrustants upon the surface. This material was originally distributed throughout the soil, but has accumulated in large quantities as the result of lack of drainage. The waters which fall upon the ground or flow beneath the surface dissolve the soluble alkalies and carry them along until halted in their course, when they evaporate rapidly, especially in warm weather, leaving a deposit of alkali upon the surface. This is the principal reason why in the Carson Valley there are so many alkali flats. They mark the places where drainage is poor.

The ground water under any region is the principal receptacle for all soluble substances in the ground, and in an alkaline section like Carson Valley the waters flowing beneath the surface generally contain large proportions of dissolved alkali, which may be detrimental to plant life if raised to the surface. The process of irrigation raises the ground-water table, and if no drainage ditches are provided the highly charged water will finally reach the surface and probably injure the crops. Therefore it is necessary to ascertain the character of the ground water and its variations throughout a proposed irrigation area in order that the highly alkaline spots may be recognized and intelligently managed.

The work involved in the ground-water investigation was carried on in Carson Valley from May 20 to October 1, in which time the entire area which it is proposed to irrigate, covering about 200,000 acres, was visited.

Wherever wells had been sunk the water was taken from them, but the larger proportion of the samples were collected from wells bored for that purpose with a hand auger. In this way data were obtained by which the alkaline constituents of the entire area were determined and a map prepared showing the variations in concentration of alkalies in the ground water.

NEW MEXICO.

In New Mexico preliminary work was begun in 1902 by Mr. W. M. Reed, district engineer, and a large number of localities have been examined. Out of the various projects suggested lower Rio Grande, Pecos, Hondo, Gallinas, Sapello, and Canadian rivers were selected for preliminary surveys.

HONDO PROJECT.

This project is located on Hondo River, a tributary of Pecos River, in southeastern New Mexico, about 12 miles southwest from the town of Roswell, in Chaves County. A complete survey has been made of the reservoir and inlet and outlet canals. The area and capacity of the reservoir and the quantities to be removed in the construction of the canals have been determined. Diamond-drill borings have been made at various points within the reservoir site to determine the nature of the underlying strata and to ascertain their imperviousness. Borings have also been made at points where the most important structures will be erected. A complete topographic map has been made of the reservoir site and of all the lands that would be susceptible of irrigation under this system.

The area to be irrigated under this project amounts to 10,000 acres, and the cost will be $275,000, or $27.50 per acre. The land that can be most easily and economically irrigated has passed from Government ownership by patent, and the people have formed an organization similar to the one in the Salt River Valley, Arizona, for the purpose of dealing with the Government and administering the affairs of the water users. More than 10,000 acres have been offered by signers of the articles of incorporation of the water users' association, and it remains for the Government to determine the exact boundary lines of the district to be irrigated.

Proposals for the construction of the reservoir were opened at Roswell, N. Mex., on September 6, 1904, and construction has rapidly advanced.

URTON LAKE PROJECT.

This project is on Pecos River, in eastern New Mexico, about 60 miles north of Roswell, in the vicinity of old Fort Sumner, the lands lying in Guadalupe and Chaves counties.

It is proposed to divert the waters of the Pecos by means of a dam and a canal about 35 miles long, the flood waters to be stored in a large natural basin or reservoir provided with an outlet tunnel and distributing canals. The irrigable lands are nearly all in public ownership and lie south of the reservoir site and on the east side of Pecos River. The land is excellent in quality, the climate is good, and it is probable that the irrigable portions will be immediately entered. The center of the irrigable tract is about 100 miles from Santa Rosa, a station on the Rock Island Railroad, and 25 miles from Kenna, a station on the Pecos Valley and Northeastern Railway, a part of the Santa Fe system. Probably 60,000 acres can be reclaimed under this project.

LAS VEGAS PROJECT.

This project is situated about 5 miles north of Las Vegas, on what is commonly known as the "Las Vegas grant." This grant is owned by the community of Las Vegas and is governed by a board of trustees.

It is proposed to conduct the water from both the Gallinas and Sapello rivers to a point about 5 miles north of the town of Las Vegas and here impound it by means of a dam constructed across a narrow point in an arroyo. The regular flow of these streams has been appropriated, and it is contemplated to store the flood waters coming from the high mountains to the west, which are claimed by the residents of this vicinity to be large in amount. Gaging stations have been established on both these streams to determine the amount of water available.

Steps have been taken by the board of trustees looking to the transfer to the United States of such lands as will be occupied by the structures and those to be irrigated under this project.

A map of the reservoir site, and of the lands susceptible of irrigation under this project, has been made and the inlet and outlet canals have been surveyed. The legal matters pertaining to the transfer of lands, etc., are being investigated by the representatives of the grant.

RIO GRANDE PROJECT.

It is proposed to store the flood waters of the Rio Grande at some point in New Mexico for the development of the open valleys along the course of the river. Surveys made in past years show that at a number of localities water may be held along the course of the stream, notably above Mesilla Valley and above El Paso.

The survey of the Engle reservoir site and of the dam site was completed in August, 1903. A survey of the irrigable lands was then begun and continued through Mesilla Valley to El Paso, Tex. Borings for the foundations at the Engle dam site were begun in October, 1903, and completed in February, 1904. Borings near Fort Selden, N. Mex., for a diverting dam have also been made and other studies of the Rio Grande conducted with reference to storage possibilities and supply of water. Consideration is being given to the international questions involved between the United States and the Republic of Mexico. Plans and estimates have been made for a storage dam at the Engle site and for a system of canals for irrigating all the good valley land below it in New Mexico and for furnishing water to be used in the vicinity of El Paso.

Requests have been made that the Government construct a diversion dam and several miles of canal on the

Rio Grande, near Penasco Rock, to deliver water to present ditches near Las Cruces. These applicants have been advised to make definite organization and submit application from the necessary area of land to guarantee the return of the cost of the project under the requirements of the reclamation act, so as to put the matter in definite form for consideration. The diversion dam is an essential part of the main reclamation project on the Rio Grande, and its construction is requested at once for the purpose of giving immediate partial relief to the inhabitants of Mesilla Valley. The flow of the Rio Grande at this point is so fluctuating in its character that sufficient water for irrigation can not be furnished any large tract without regulation in storage reservoirs; although a small tract can be provided with a supply which would permit the raising of crops and relieve temporary distress, if permanent headworks were placed in the river and connected with existing canals.

LA PLATA VALLEY PROJECT.

This project is located on La Plata River, in San Juan County, in northwestern New Mexico. The water supply will be obtained mainly from Animas River and its tributaries, and possibly from Los Pinos River, in Colorado. This supply may be diverted from Animas River, either by means of canals near the Colorado-New Mexico line of an aggregate length of approximately 100 miles, or by means of comparatively short tunnels through the high divide between Animas and La Plata rivers, and a much shorter line of canals connecting with the end of the tunnel.

For this project it will be necessary to supplement the minimum flow in Animas River during a portion of the irrigation season by storage, both at the head of La Plata Valley and on Animas River, there being an abundance of water for this purpose during the high-water period. The development of this project contemplates the reclamation of approximately 50,000 acres of land.

A preliminary investigation of this project was made in 1904, and also a reconnaissance of the drainage basin of Florida River from its headwaters nearly to the Colorado-New Mexico line for the purpose of locating storage facilities. Nothing feasible was discovered. Bishop Lakes, lying north of Durango and west of Animas River, were also investigated to determine their utility for storage purposes, but it was discovered that these sites had already been filed on and are being developed by a local corporation for power purposes.

NORTH DAKOTA.

A general examination of this State was made in 1903, and as a result attention was concentrated on the possibilities of reclaiming land in extreme western parts of the State. General field studies were also made of the occurrence of lignite and of the possibilities of using this material in generating power for pumping.

LOWER YELLOWSTONE PROJECT.

This project is located on Yellowstone River, the canal heading on the west or left bank about 20 miles below Glendive and about 2 miles below the mouth of Thirteenmile Creek. The survey was begun in August, and field work was finished for the season on October 24, 1903.

During May, 1904, surveys were made of what is known as the "low-line canal," heading about 20 miles below Glendive and about 2 miles below Thirteenmile Creek, the line being run with less fall than the "high-line canal." The results show that a canal about 70 miles in length will serve 70,000 acres, at a cost of about $30 per acre. The irrigable lands have been mapped, surveys for all special structures at head-gates and creek crossings have been made, and location of the center line of the canal on the ground has been completed. Borings have been made at the dam site and along the canal line and test pits put down along the line of the canal. The Lower Yellowstone Water Users' Association has been formed, a large per cent of the private lands subscribed, and a contract with the Secretary of the Interior has been signed.

Field work has been completed and final contract plans worked up. Bids for the main canal were opened June 1.

BUFORD-TRENTON PROJECT.

During the season of 1903–4 reconnaissance investigations and surveys were made to determine the feasibility of irrigating the lands along the Missouri River in North Dakota by the waters of that river, by means of pumping, power to be generated by the use of lignite from the extensive beds throughout this region.

The Buford-Trenton project is situated on the left bank of the Missouri River, close to the western boundary of the State, where 27,000 acres of irrigable lands can be reached at elevations above the low-water plane of the Missouri River varying from 20 to 115 feet. It is proposed to irrigate this area by means of two pumping plants.

BISMARCK PROJECT.

The Bismarck project lies in the vicinity of Bismarck. It will supply 15,000 acres of irrigable land at elevations varying from 25 to 65 feet above the low-water plane of the Missouri River at that point.

It is proposed to irrigate this tract by the installation of two pumping plants. Most of the land under this project is in private ownership. In November, 1904, the Secretary of the Interior gave his preliminary approval to the Buford-Trenton and Bismarck projects.

OKLAHOMA.

During the year surveys have been made covering a large area in northwestern and southwestern Oklahoma.

The locality that offers most favorable conditions for a project is a reservoir on the North Fork of Red River near Navajo post-office, about 5 miles north of Headrick, in Greer County, and about 9 miles west of Snyder, in Kiowa County. The dam site appears to be a good one and the reservoir capacity will probably be about 300,000 acre-feet.

Field parties have been organized to make accurate surveys, and drilling for bed rock at the dam site will be begun as soon as practicable. A complete plane-table survey of the reservoir site and the dam site will be made. A system of canals will be laid out and maps will be made of the land to be irrigated. Surveys and plans will also be made for diverting into evaporation basins the salt springs on Elm Fork of the river, about 50 miles above the Navajo Reservoir site. These springs discharge a saturated solution of salt, in volume from 2 to 3 cubic feet per second, which makes the entire river too salty for irrigation. The success of the project depends largely upon getting rid of this salt, but it is believed that this is entirely practicable.

OREGON.

A preliminary examination was made in this State in 1902, especial attention being given to the arid public lands in the central part of the State. In the early spring of 1903 an instrumental reconnaissance was made to determine the practicability of using water from Snake River on lands in the northeastern part of the State. In March, 1903, Mr. John T. Whistler was placed in charge of the work. A further preliminary examination of projects in Baker, Malheur, Harney, and Crook counties was made in March and April, 1903. As a result of these reconnaissances certain definite projects were selected for further examination on Umatilla and Malheur rivers and in Harney County.

UMATILLA PROJECT.

This project is located in the north-central part of the State near the Columbia and west of the Umatilla, a tributary of the Columbia. The area proposed to be irrigated contains about 60,000 acres of unimproved, rolling bench lands at an elevation of 300 to 600 feet above sea level. Most of this land is unpatented and has been withdrawn from all except homestead entries, pending surveys. Of the patented land the larger part is unimproved Northern Pacific Railway grant land.

Five gaging stations have been maintained during the last year on this river and its tributaries and systematic measurements carried on to determine the amount of water available.

In addition to mapping the topography of the various reservoir sites, topographic maps were made for 25 miles of feed canal and about 20 miles of distributary canal on a scale of 400 feet to 1 inch. Estimates based on these preliminary surveys indicated that it was practicable to irrigate the 60,000 acres. Test pits to determine the nature of the material underlying the reservoir site, embankment line, and canal line were made. An examination of these by the board of consulting engineers led to an unfavorable report on the project. A project embracing 20,000 acres east of the Umatilla River has been studied and the prospects for it are favorable.

MALHEUR PROJECT.

This project contemplates the reclamation of lands of Malheur Valley from above the town of Vale to Snake River. The irrigable tracts include about 45,000 acres of good bench land and an equal amount of bottom land lying on both sides of Malheur River.

The land under this project is mostly unimproved, but the greater portion of it is patented. Most of the patented land forms portions of The Dalles and the Willamette Valley and Cascade Mountain military road grants. The bench land where cultivated is exceptionally productive. The same is true of the bottom lands where not damaged by an excess of alkali. About 5,000 acres of bench lands and 10,000 acres of bottom land are already under cultivation. The entire summer flow of the Malheur and its tributaries in this region and practically all that of the Owyhee is now appropriated for these lands under irrigation, but measurements of the Malheur for more than five years indicate that it has abundant flood water to irrigate these lands if it can be held in suitable reservoirs until needed.

Preliminary surveys were authorized and begun in June,

1903. Two reservoir sites of sufficient capacity to retain all of the flood waters of Malheur River in ordinary years were found. Several other smaller reservoirs on Bully Creek and Willow Creek, tributaries of the Malheur, have been considered in connection with the reclamation of lands lying at an altitude above the reservoir sites on the main river. These sites have all been surveyed and mapped.

Gaging stations have been maintained during the past year on the Malheur River at Ontario, Vale, and Harper Ranch, on Bully Creek at Warm Springs, and on Willow Creek above Dell.

The irrigable lands have been mapped on a scale of 1,000 feet to 1 inch. Diamond-drill investigations for the foundations at dam sites were begun about the middle of July, 1904. The surveys are completed and estimates and plans for bids and construction are now being made.

SOUTH DAKOTA.

In this State attention has been given to reclamation possibilities west of Missouri River, especially to those in the vicinity of the Black Hills. Any reclamation attempted on any of the streams of this region must be based on storage of storm water and spring flow. With this in view the country around the Black Hills has been carefully investigated for storage possibilities and the north side selected as the most promising. The project here is known as the Belle Fourche, the water supply being from the Belle Fourche and its tributaries.

BELLE FOURCHE PROJECT.

Belle Fourche River rises in the east-central portion of Wyoming and flows northeast, then east, draining the western and northern portions of the Black Hills. This project involves the reclamation of lands to the northeast of the Black Hills, in Butte and Meade counties, S. Dak., by the diversion of the waters of Belle Fourche and Redwater rivers into a large basin east of the town of Belle Fourche. This basin is to be converted into a storage reservoir by the construction of an embankment of earth, riprapped with rock, across Owl Creek.

The reservoir will be filled by a large feeder canal $6\frac{1}{2}$ miles long, 40 feet wide on the bottom, and carrying 10 feet of water. Other water supply will be from Crow, Owl, Indian, Horse, and Willow creeks, which have large flood flows during limited periods.

From the reservoir, which will have sufficient capacity to impound water for all the lands to be irrigated, the water will be distributed to lands in the valley on both sides of Belle Fourche River, where between 85,000 and 90,000 acres of land may be reclaimed, the area depending on the water supply obtainable, the records of run-off not being sufficiently complete to determine the amount. These lands are tributary to the Chicago and Northwestern Railroad, which runs a few miles south of them.

During 1904 the south-side canal, which would water lands on the south side of Belle Fourche River in the vicinity of Vale and Empire, was surveyed and mapped on a scale of 200 feet to 1 inch. The survey of the extension of the north-side canal from the point reached in November, 1903, was resumed and the line extended to Elm Creek, where a large body of vacant land is located which may be brought under the project.

The mapping of the Owl Creek reservoir site has been completed on a scale of 1,000 feet to 1 inch, with 5-foot contour intervals. The Owl Creek reservoir is an extension of the Dry Creek reservoir obtained by changing the location of the dam to a point across Owl Creek just below the mouth of Dry Creek. The capacity is more than double that at the site first contemplated, while the cost will be much less than twice that of the first site.

The mapping of the Alzada reservoir site on the scale of 1,000 feet to 1 inch, with 5-foot contour intervals, has been completed and estimates have been made; also the feeder canal from Little Missouri River has been surveyed, to be used either for the diversion of this stream to the Belle Fourche or as an independent project.

The irrigable lands have been mapped on a scale of 1,000 feet to 1 inch, with 5-foot contour intervals. About 200 square miles have thus been mapped on both sides of the river above the Willow Creek divide.

Borings have been made at all dam sites and creek crossings for information as to foundations and at points from 500 to 1,000 feet apart along the canals for classification of material to be moved.

The organization of the private landowners has secured subscriptions for most of the private land under the project.

The available water supply has been estimated and plans for all permanent structures have been drawn.

Contracts for the feeder canal and headworks were signed on May 6 and 23, respectively, and the work will be prosecuted without delay.

UTAH.

In this State principal attention has been directed to the Utah Lake and Bear Lake projects, in accordance with the recommendations of the State commission and the requests of citizens interested. A general reconnaissance has been made of other projects and the relative merits of various schemes for reclamation have been compared.

UTAH LAKE PROJECT.

Utah Lake is near the center of the State, receiving its waters from numerous streams flowing from the Wasatch Mountains on the east. The outlet is north through Jordan River, which empties into Great Salt Lake, 42 miles distant. Water for irrigation is taken from Jordan River at a point at or below where it passes through a low range of hills, the canals diverging on each side of the river and covering valley land south of Salt Lake City.

Utah Lake is in effect a large storage reservoir, catching the mountain flow and delivering it into the canals. Unfortunately, however, the lake is too large for effective use, and the losses by evaporation are far in excess of the amount put to beneficial use.

Preliminary investigations were begun by the present chief engineer in the spring of 1889, and various measurements of inflowing waters, evaporation, etc., have been made at intervals during the fourteen years preceding the passage of the reclamation law. Systematic work has been done under the immediate direction of Mr. George L. Swendsen, with the advice and general supervision of Mr. D. W. Ross.

The entire bed of Utah Lake, covering 140 square miles, has been contoured at intervals of 1 foot. The eastern shore has been mapped in 5-foot contours, covering an area of 64 square miles. All the principal streams flowing into the lake have been systematically measured, both at its flood seasons and at low water. Information has also been obtained relating to adjudicated claims to water, the acreage and capacity of all canals, losses by evaporation, and other facts.

The field operations have included detailed examination of conditions relative to channel construction to lower the lake level and reduce the area of water surface; plane-table surveys of the parts of Jordan River and the Jordan canals involved in the project and of the sections concerned in the drainage to Utah Lake; study of all hydrographic conditions, including water supply, evaporation, and rainfall, and classification of lands under the project and their exhibition on a general map soon to be completed.

In view of the intricate water-right complications and of some uncertain physical problems that render the feasibility of the project doubtful, the investigations have been discontinued.

BEAR LAKE PROJECT.

Bear Lake is in northeastern Utah, extending into Idaho. It receives its waters from the adjacent small catchment area and overflows northward into Bear River at a point below its headwaters. This stream rises in the

Uinta Mountains, south of the lake, flows northward through Utah and the southeastern corner of Idaho, receiving, in this part of its course, some water from Bear Lake. It turns toward the south and passes into Cache Valley, and finally flows into Great Salt Lake. There are a number of bodies of irrigable land along the river, both in Idaho and in Utah.

A reconnaissance of this lake was made in 1889, and measurements of Bear River have been made at intervals since that time. Preliminary work under the reclamation law was authorized on July 29, 1902, and a reconnaissance was made. Two large areas of public land in southeastern Idaho were provisionally withdrawn on May 8, 1903.

The project as a whole is very large, involving the storage of 350,000 acre-feet of water in Bear Lake, and its utilization by means of long canals extending to large areas of arid land. The water is provided by diverting the upper portion of Bear River into Bear Lake and drawing down the lake itself so as to add to the available volume of storage. The results of the examinations have been used to prepare a general plan for the improvements necessary to irrigate the Marsh Valley and Bancroft areas, where about 180,000 acres have been withdrawn pending investigations.

It has been suggested by the arid land commission of Utah that the Bear Lake project should be extended to include the conservation and extended use of the waters of the Cache Valley streams, and such other additional supplies as it may be feasible to obtain, extending the entire system into northern Utah.

While the project is very desirable and physically feasible, the settlement of the water rights now accrued and likely to result from interstate complications will probably require several years.

STRAWBERRY VALLEY PROJECT.

The farmers in the southern portion of Utah have for many years been making an effort to secure an additional water supply, and in January, 1905, a strong appeal was made to the Reclamation Service to construct irrigation works along Strawberry River. In the upper portion Strawberry River flows through a large flat valley, at the lower end of which it enters a narrow canyon. The conditions offer a very fine site for a storage reservoir of such dimensions that two very inexpensive dams would store 300,000 acre-feet of water. The second dam is necessary because Indian Creek passes through a smaller valley and joins the Strawberry below the main Strawberry Canyon. The divide between these two valleys is low and Indian Creek valley would be flooded if the larger valley were utilized to its utmost capacity. The surveys necessary to determine the feasibility of the project are now being made.

WASHINGTON.

In this State systematic stream measurements have been made for several years on Yakima River and its tributaries, Spokane and Palouse rivers, and considerable reconnaissance work has been carried on locating reservoir sites and examining various projects. On the passage of the reclamation law this work was extended to cover the whole of the arid region of the State. A number of projects were investigated in a preliminary way. Those found worthy of further study are the Palouse project, the Okanogan project, and the Yakima project.

A grade line has been run from Priest Rapids, on Columbia River, to determine the amount of land which can be irrigated by a gravity system from Columbia River. It has been found that this plan is probably not feasible. Sufficient land can not be irrigated to warrant, at this time, the large expenditure necessary.

PALOUSE PROJECT.

During the winter of 1903–4 preliminary investigations and reconnaissance were conducted to determine the feasibility of irrigating about 100,000 acres from Palouse River. It was decided that the results warranted a thorough investigation and survey to determine fully the practicability of all the features of the scheme.

Surveys were made of the irrigable lands, and also of the reservoir sites, canal lines, and dam sites.

In the autumn of 1904 borings were begun and continued until June, 1905, to determine all underground conditions. They developed the fact that the feed-canal line and the main reservoir were underlain by extensive deposits of coarse gravel, necessitating expensive lining and puddling to make them hold water. Most of the irrigable land is also underlain by a subsoil of coarse sand, which, while favorable to cultivation and drainage, will greatly reduce the duty of water. These conditions seriously increase the cost of the project over the preliminary estimates.

A board of engineers examined the project in detail in April, 1905, and made a careful estimate of the cost, which proved to aggregate over six million dollars. In the present state of the reclamation fund this could not be undertaken with any prospect of completion for many years. Surveys are, therefore, being pushed in Yakima and Okanogan valleys to develop a more feasible project.

OKANOGAN PROJECT.

The irrigable lands included within the Okanogan project are on the west side of Okanogan River, in the northern part of the State, between the Canadian boundary and Columbia River. Their altitude is about 1,200 feet. Irrigation has been begun in a small way, and the land has been found to be of excellent quality for fruit and ordinary farm products. Water is obtained from Salmon Creek, a tributary of Okanogan River. The summer flow is not sufficient for the reclamation of any considerable area, and storage must be provided. There are a number of depressions or coulees containing small lakes, which it is expected to utilize for this purpose.

Requests were made by the citizens of Okanogan County for examination into the feasibility of undertaking the irrigation of these lands. Two dam sites and reservoir sites were surveyed, test pits were dug, about 11,000 acres of irrigable land were mapped on a scale of

1,000 feet to 1 inch, one outlet canal was surveyed, and various other matters were investigated. During 1904 all notes, maps, etc., were completed, the irrigable lands classified, and two additional canal lines and two reservoir sites were surveyed.

The project was examined in April, 1905, by a board of engineers, who reported that the water supply was probably sufficient for the irrigation of about 8,500 acres of desert land, and recommended the completion of surveys. These are now in progress, with a prospect that a feasible project will soon be worked out.

YAKIMA PROJECT.

In view of requests and petitions submitted to the Secretary of the Interior by those interested, a thorough reconnaissance of the water supply, the amount of water appropriated, the amount of unirrigated land available, and other problems affecting the feasibility of an irrigation project in Yakima Valley was conducted during the past year.

Three projects have been examined in Yakima Valley:

(1) The Leadbetter project, which will divert water from Yakima River near Prosser and cover about 190,000 acres on the north side of the river and 20,000 acres on the south side.

As the late summer flow of the river is all appropriated, it will be necessary to provide means for storing winter and spring flood waters for this canal. For this purpose surveys are being made of Lakes Clealum, Kachess, and Keechelus, on the headwaters of Yakima River.

(2) The Tieton project, which would divert water from Tieton River and carry it through canals and tunnels to about 24,000 acres of land west of North Yakima and in Cowiche Valley. Storage for this project would be provided at McAllister Meadows and Bumping Lake. Surveys on this project are now in progress.

(3) The Kittitas project, which would take water from Yakima River near the mouth of the Clealum and carry it to lands on both sides of the river near Ellensburg. A

branch would cross the river above Ellensburg by means of an inverted siphon. The area to be covered is estimated at 60,000 acres, of which nearly one-third has a partial water supply. These surveys are now in progress.

In the fall of 1903 the Northern Pacific Railway Company submitted to the Secretary of the Interior a report by Mr. H. K. Owens on the cost and feasibility of irrigating 73,000 acres of land on the left bank of Columbia River below Priest Rapids. A preliminary reconnaissance was made of these lands and the general feasibility of the proposed plan examined.

WYOMING.

SHOSHONE (CODY) PROJECT.

The Shoshone project contemplates the utilization of a portion of the surplus water of Shoshone River for the reclamation of land in the northern part of Bighorn County, Wyo.

Shoshone River receives its water from the high mountains adjacent to and east of Yellowstone National Park. The North Fork rises near the eastern boundary of the park, a few of its tributaries having their sources within its limits. For the first few miles of its course it flows southward, then eastward for about 45 miles to its junction with South Fork, which comes from the southwest and is of about the same length as North Fork, but discharges a smaller quantity of water. Just below the junction of its two forks Shoshone River enters a canyon 3½ miles in length. For a distance of one-half mile from the upper end this canyon is through solid granite. The narrowest place is 65 feet wide at the bottom, and 200 feet wide 250 feet above the bottom.

The drainage basin of Shoshone River above the canyon contains approximately 1,250 square miles, nearly all of it being within the Yellowstone Forest Reserve.

A comparatively small portion of this water has been utilized. Water to irrigate small areas has been taken out of North Fork above the canyon. A canal for irrigating about 14,000 acres in the vicinity of Cody has been constructed under the provisions of the Carey Act and obtains its water supply from South Fork. Water rights under the same law have been obtained for reclaiming about 20,000 acres a few miles above the mouth of Shoshone River.

The irrigable land and the reservoir site were mapped on a scale of 1,000 feet to 1 inch, with contour intervals of 10 feet, and the canyon was mapped on a scale of 100 feet to 1 inch, with contour intervals of 5 feet. The dam site was mapped on a scale of 50 feet to the inch, with contour intervals of 5 feet. About 200 square miles were mapped. The location of a conduit in the canyon and of canals covering the largest area of land that could be feasibly irrigated was projected on the topographic sheets, and plans for a dam and headworks at the head of the canyon were made.

The preliminary plans were passed upon by a board of engineers, and on February 10, 1904, the Secretary of the Interior set aside $2,250,000 of the reclamation fund for the construction of the project, "provided that satisfactory rights to land and water be secured, and provided that further consideration of details on the ground, by consulting engineers, results in favorable reports."

On February 13, 1904, Col. W. F. Cody, as the surviving partner of Cody & Salisbury, transferred the right of Cody & Salisbury to appropriate water from Shoshone River to the Secretary of the Interior.

On March 5, 1904, an application for a permit to construct a reservoir and to store 159,500 acre-feet of the water of Shoshone River was filed in the office of the State engineer of Wyoming. On March 28 an enlargement application of the Cody & Salisbury permit, covering land additional to the lands proposed to be reclaimed by Cody & Salisbury, was filed in the same office. Both applications were filed for and on behalf of the United States.

A wagon road has been constructed into the canyon, over which to transport material to the tunnels and dam site. Work on the construction of a telephone line from Cody to the dam site has commenced. The main canal and tunnels have been staked on the ground and a topographic survey of additional lands is under way. Designs have been made for an impounding dam of increased height. Borings at the dam site have been made, and the location of canal and tunnel lines and the topographic surveys of irrigable land are being continued.

Designs and specifications have been completed for a masonry dam in the canyon above Cody, to be 310 feet high, and for a tunnel to divert water from the river above Corbett. Proposals for these structures have been asked for and will be opened in Billings soon.

DISTRIBUTION OF OPERATIONS.

Surveys and examinations have been carried on in every State and Territory mentioned in the reclamation act. It has been necessary to extend these surveys over several projects or areas in each State and Territory in order to obtain definite knowledge upon which to base a selection of the most feasible project. Frequently the locality which seems to offer the best advantages is found, on careful study, not to be suitable, because the capacity of the reservoir site is shown to be less than that required, or the foundations are defective, or the flow on the stream is not great enough. Sometimes also the character of the soil is such that it is evident that under irrigation much of it will become swampy and require drainage, or alkali will inevitably be developed to such an extent that agriculture will be impracticable.

The surveys have, however, shown that there are in each State several feasible projects. But it is evident that if all of these projects should be undertaken there would not be sufficient funds in the immediate future for their completion; hence arises the necessity for the exercise of judgment, not only as to physical features, but also as to financial conditions. Moreover, the character of the land ownership and the claims to water constitute obstacles far more difficult to overcome than those interposed by nature. All of these matters and many others must be taken into consideration in directing the work.

POLICY.

Among the principles thus far developed in the administration of the Reclamation Service, which may aid in shaping the policy of the future, four may be mentioned here:

1. The money resulting from the disposal of public lands belongs to the nation and not to any community. When placed to the credit of the reclamation fund it will be used to provide the greatest number of favorable opportunities for home makers, subject to the restrictions of the reclamation law.

2. Each project undertaken must justify itself as an engineering and business proposition, and come within the requirements of the reclamation law.

3. The funds available and to become available in the next few years will be too limited to provide for more than a portion of the projects that will ultimately be developed. The projects now under construction should be completed and justify themselves to the American people before they are asked to give further aid to the reclamation of the arid and semiarid lands of the West.

4. The lands in private ownership which may be reclaimed must be subdivided and put into the hands of home makers who will cultivate the soil in small tracts of 160 acres or less. Large holdings must be subdivided, or an agreement be entered into to subdivide the tracts when water is available, in accordance with the terms of the reclamation act.

NECROLOGY.

GEORGE HOMANS ELDRIDGE.

George Homans Eldridge, son of Ellery and Sarah (Mathews) Eldridge, was born in Yarmouth, Mass., on Christmas day, 1854. He was named after two well-known physicians—Dr. George Shove, of Yarmouth, and Dr. John Homans, of Boston.

His boyhood education in the public schools of Yarmouth was followed by a six-year course in the public Latin School of Boston, from which he entered Harvard University in 1872, being graduated with the highest rank in his class in the natural sciences in 1876.

During his college course he spent the summers of 1875 and 1876 at Cumberland Gap, Kentucky, as volunteer aid to Prof. N. S. Shaler, who was then in charge of the State Geological Survey of Kentucky. This vacation work, undertaken by him rather as a pastime, gave him his first leaning toward geology and had a serious effect upon his future life.

For two or three years after graduation he was engaged in school teaching and tutoring, and early in 1879 he was appointed principal of the high school at Nahant, Mass. In 1879 the United States Geological Survey was created, to succeed all previous temporary organizations, and Prof. Raphael Pumpelly was placed in charge of investigations of the nonprecious minerals, especially iron and coal. Among the first special experts engaged by Professor Pumpelly for the active part of this work was Eldridge, whose special fitness for this new and peculiarly difficult work had been testified to by Professor Shaler, from his intimate knowledge of the qualities of the man gained during the vacation work under him in Kentucky. Special branches of investigation to which he was assigned were the base-metal deposits of the southern Appalachians and the coal fields of northern Montana, which up to that time were practically unexplored.

When, two years later, Professor Pumpelly took charge of the Northern Transcontinental Survey, which had been organized by Henry Villard, Eldridge was one of the first geologists employed by him and was given charge of the Rocky Mountain division, to which was intrusted the solution of some of the most difficult and critical problems involved. Some of the results of this work are found in

Volume XIII of the reports of the Tenth Census; but, owing to its sudden termination, the results of the Northern Transcontinental Survey were never fully published.

In the winter of 1883 financial disaster overtook the Northern Pacific Railroad, and the Northern Transcontinental Survey was, in consequence, suddenly disbanded. Of the geologists thus set free, Eldridge, on the recommendation of his former chief, Professor Pumpelly, was the first to be transferred to the United States Geological Survey to fill a vacancy in its corps of economic geologists.

From 1884 to 1890 Eldridge was attached to the division of mining geology. His work during this time lay mainly in Colorado. During these years his most important pieces of work were the stratigraphic problems connected with the southern Elk Mountains in Gunnison County, Colo., and those of the Denver Basin on the eastern foothills of the Rocky Mountains. In each case the completion of the work was unavoidably delayed by the inability of the topographic force to finish the necessary maps, and Eldridge was called upon to do no inconsiderable part of the topography himself, being eminently possessed of the topographic skill which forms so important a part of the American geologist's training.

Many other geological investigations in the Rocky Mountains were carried on by him during these years for which he received no public credit, the results having been either not yet published or else incorporated into the work of other geologists.

In 1890, while putting some finishing touches on his Denver Basin work, much of which was dependent for its data upon the records of artesian wells, he made his well-known study of the Florence oil field, which was the first scientific investigation of commercially successful oil production in the Rocky Mountain region, and a work that has had a most favorable influence upon an industry that has since assumed great importance in the West.

In 1891 the Florida division was created, of which Mr. Eldridge was put in charge. Work was usually carried on in Florida during the winter or spring months, and for a long time Eldridge still carried on work in the Rocky Mountain region during the summer, thus accumulating a double amount of field data and having less time than his fellows to make investigations in the office. It is not surprising, therefore, that his reports may have seemed to be unduly delayed.

In 1893 he published a preliminary sketch on the geology of the Florida phosphates, in the Transactions of the American Institute of Mining Engineers, and during the following two years, while field work was carried on during the spring months, his summer months were spent in the mountain regions of the West. In the meantime, topographical maps of parts of the phosphate region were being prepared, and in the early spring of 1896 he commenced a systematic survey of that region on a much more elaborate scale than the previous work, which was most energetically conducted well into the summer, when it was abruptly cut off by a special order of the Secretary of the Interior, which superseded everything else, and took him into Utah.

From that time on Eldridge was successively assigned to work in other parts of the country which, it was decided by his superior officers, must be completed at once to the exclusion of everything else, and he was thus able to devote only odd moments, stolen, as it were, from other labors, to this work with which he was so closely identified and had so much at heart. During the summers of 1893 and 1894 he was given charge of reconnaissance surveys of large areas in northwestern Wyoming and northeastern Idaho, respectively, for which no topographical maps had yet been prepared.

In the summer of 1895 he was assigned to the investigation of the mineral resources of the Uncompahgre and Uinta Indian reservations in Utah, a knowledge of which had become of importance to the Government because of the demand for the throwing open of these lands to public occupation. In that summer's work he investigated, alone and unaided, 7,000 square miles of very difficult country, and, as a result of his work, prepared in the following winter a report (published in the Seventeenth Annual, Part I) on the most important mineral resource of that area—the uintaite deposits—which was at that time the most comprehensive discussion of such deposits, not only for this region, but for the whole continent.

The discoveries of gold in Alaska had assumed so great an industrial importance that by its act of January 28, 1898, Congress ordered special geological and topographical surveys of that region. This was an entirely new branch of work for the Survey and required a novel and special organization of parties and methods of transportation which could not be governed to advantage at a distance of 6,000 miles from the field of work, but necessitated a responsible head who could direct the work on the spot. The qualifications for such a position were administrative capacity and tact of a high order, combined with geological experience and great physical endurance, and Mr. Eldridge was appointed geologist in charge of this work in February, 1898. He at once took charge of the outfitting and preparation of the various parties, which sailed from Seattle on the U. S. gunboat *Wheeling* on April 5. He had characteristically chosen for himself what promised to be the most difficult piece of work, and, with Mr. Robert Muldrow and several camp assistants, pushed his way up the Sushitna River to its head, and across the divide on foot to the drainage of the Tanana River.

His report on the work in Alaska being completed in April, 1899, he at once resumed work on the Florida phosphates, which was again interrupted by his assignment, at the commencement of the fiscal year 1899–1900, to the study of the asphalts and bituminous rock deposits of the entire United States. The results of this work were published in Part I of the Twenty-second Annual Report (1900–1901). This report, abundantly illustrated as it is and accompanied with maps of all the principal asphalt fields, by its exhaustive treatment practically constitutes a standard monograph on this class of deposits.

In the spring of 1901, immediately upon the completion of his asphalt report, Eldridge once more resumed work on the Florida phosphates, and had brought it to within a month or two of completion, when, on the opening of the field season, he was assigned to another investigation which was judged to be of greater immediate importance—that of the petroleum fields of California. He took up this work with his usual energy and thoroughness, and in the fall of 1902 he returned to Washington to write up his report on this, his last, and, as he thought, his greatest piece of work. From that time onward, summer as well as winter, with scarcely an interval of rest, he devoted his entire energies to the working up of the enormous amount of material he had gathered to elucidate the structure of those extremely complicated regions.

In October and November, 1904, he was ill for a month with a peculiar ailment that took the form of a low fever and baffled the physicians. In January, 1905, possibly before he was physically able, he made a trip to Cuba to examine some asphalt deposits, returning by way of Florida to examine the latest developments in the phosphates. This was his last field work. Within a month after his return to the office illness again obliged him to give up work. He underwent a painful surgical operation, from the effects of which he at first recovered so rapidly that he expected in a few weeks to resume his nearly completed work. This relief proved, however, to be only temporary. The former physical troubles returned, caused, as it proved, by sarcoma of the kidney, and after a painful and prolonged struggle he finally succumbed on June 29, 1905.

Even more than for his scientific ability will Eldridge's memory be cherished among his friends and associates for his strong and admirable personality, his high standards of personal morality, his exceptionally cheerful nature, and the keen interest and zest with which he entered into all his pursuits, whether of work or of recreation.

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