DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

TWENTY-THIRD ANNUAL REPORT

OF THE

DIRECTOR

OF THE

UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1901-2

WASHINGTON

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., October 4, 1902.

SIR: I have the honor to transmit herewith a report of the operations of the United States Geological Survey for the year ending June 30, 1902.

Thanking you for the active personal interest you have taken in the work of the Survey, especially in the development of the Hydrographic Branch,

I am, with respect,

Your obedient servant,

Chas. D. Walcott,
Director.

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

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

By CHARLES D. WALCOTT, DIRECTOR.

INTRODUCTION.

The work of the Geological Survey during the fiscal year 1901–2 was to a large extent a continuation of that of the previous year, described in the Twenty-second Annual Report. A few details of organization were changed, but the general work was carried on in essentially the same manner as in other years. The record of accomplishment, both in field and in office, will be given after a few subjects of special interest have received consideration.

RECLAMATION OF ARID LANDS.

At the last session of Congress many years of effort to place on a permanent and satisfactory basis the scientific examination and development of the arid lands of the United States culminated in important and far-reaching legislation. For several decades one of the pressing questions before Congress has been the best method of utilizing the drought-stricken regions of the country and of making possible the creation there of prosperous homes. In the acquisition of data bearing on the subject, in the discussion of the benefits to be obtained, and in the preparation of definite plans and legislative bills, the former Director of the Survey, Maj. J. W. Powell, was the leader. His report on the lands of the arid region, written in 1877 and 1878 and printed as a public document, as one of the volumes of the Geographical and Geological Survey of the Rocky Mountain Region, has been termed a classic, and has

served as the primer or text-book for innumerable writers, who have copied or enlarged on the suggestions therein made.

The ideas advanced by Major Powell in various reports and addresses have been highly commended or vigorously attacked. They served to stimulate public interest in the matter; indeed, for many years they were what may be termed the storm center of the agitation. With characteristic persistence he at all times insisted on the great importance of the arid lands in the ultimate development of the country, and by sheer force of character kept the subject alive.

When the present United States Geological Survey was formed, by what is known as the organic law contained in the act of Congress of March 3, 1879, the following proviso was attached to the paragraph relating to the office of Director of the Geological Survey:

> That this officer shall have the direction of the Geological Survey, and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain, and that the Director and members of the Geological Survey shall have no personal or private interests in the lands or mineral wealth of the region under survey, and shall execute no surveys or examinations for private parties or corporations. (Stat. L., vol. 20, p. 394.)

Under this general authorization Major Powell continued, with his other duties, the mapping of the streams of the arid region and the study of the water resources. The results of this work attracted the attention of Congress, and in 1887 he, as Director of the Survey, was called upon to consider the question of Federal recognition of the subject of irrigation.

On March 20, 1888, a resolution was approved which required the Secretary of the Interior, by means of the Director of the Geological Survey, to make an investigation of that portion of the arid regions where agriculture is carried on by means of irrigation; to ascertain the natural advantages for the storage of water, the practicability of constructing reservoirs and their cost and capacity, as well as the amount of water available for storage, and all other facts necessary to the consideration of the questions of water storage and irrigation. This was followed by the passage of an act (approved

October 2, 1888) containing an appropriation of $100,000 for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation.

In a subsequent act (approved March 2, 1889) the sum of $250,000 was appropriated for continuing this work. Field work had already been actively begun; a large number of reservoirs had been surveyed and estimates of the cost of construction had been prepared. Several features of the law led to strong opposition on the part of various speculative and grazing interests, and the clause permitting the reservation of lands susceptible of irrigation was, unfortunately, interpreted in such a way as practically to withdraw most of the public lands of the West. A sudden revulsion of popular sentiment took place, and in the law approved April 30, 1890, appropriations for the work were discontinued and a portion of the law of October 2, 1888, was repealed, throwing open lands to be benefited but reserving the reservoir sites. By the same law the right to acquire title to public land was limited to 320 acres. There was also reserved from the lands thereafter taken up the right of way for ditches and canals constructed under the authority of the United States.

The matter of reclamation by national authority was thus left in an anomalous position. The Geological Survey was authorized to segregate reservoirs and to undertake other preliminary work, but specific appropriations for the purpose were cut off, except as the work was incidental to the topographic survey. In the the presentation of arguments for the continuation and extension of topographic surveys in the West one of the strong points constantly brought forward was the importance of these in the future reclamation of the arid lands. It was urged that these maps were needed to outline the catchment basins and to obtain ultimately facts upon which a knowledge of the water resources of the country could be based. In short, the topographic surveys were considered as embracing an examination of the rivers, in part at least, and a small amount of work which is now classed as hydrographic was continued under this head.

In 1894, the somewhat bitter feeling which had arisen dur-

ing the early discussions having subsided, a small appropriation was made, by act approved August 18, 1894, for determining the water supply of the United States. This was increased from time to time until, in the act of June 6, 1900, the appropriation was made $100,000, and it has recently been increased to $200,000. Throughout the decade following the attack upon what was known as the Powell irrigation survey there has been a gradually increasing recognition of the value of the observations and data collected, and through the various experiments made in legislation there has resulted a consensus of opinion that, after leaving the matter in large measure to private and corporate efforts and to the initiative of the several States, there must be a broad treatment of the subject by the National Government.

As one of the first indications of the growing popular interests in the subject may be cited the fact that in the platforms of nearly all political parties taking part in the Presidential campaign of 1900 a clause was inserted calling attention to the national aspects of irrigation. The Vice-President elected that year, Hon. Theodore Roosevelt, emphatically announced his position in respect to the matter, and when, upon the death of Mr. McKinley, he succeeded to the Presidency, in his first message he dwelt at considerable length upon the importance of a better treatment of forestry and irrigation subjects in the interest of the broadest and fullest development of the country.

The President's clearly defined principles served to unite and make effective the diverse opinions concerning the best way of entering upon the reclamation of the arid lands, and the result became apparent in the bills before Congress. The data acquired through many years of patient investigation, following the beginnings made by Major Powell, afforded definite information upon which the committees of Congress and the individuals interested could base their statements or conclusions, and at all times the records of this Survey were freely drawn upon for material useful in the presentation of the matter. Finally, the various bills in Congress relating to irrigation were consolidated or laid aside in favor of what is now known as the Reclamation law, which was signed by the

President on June 17, 1902. This law sets aside the proceeds of the sales of public lands as a fund to be used in the construction of reservoirs and large canals. It is general in terms, and much is left to the discretion of the Secretary of the Interior, so that it may be said that ultimate success depends most largely upon wise administration.

Upon the passage of this law the Director of the Survey submitted to the Secretary of the Interior a plan for making the preliminary examinations necessary to the drawing of specifications and the letting of contracts for construction. This plan, subsequently approved by the Secretary, in effect allows a gradual increase of the work carried on in the Division of Hydrography of the Survey by adding to the number of skilled engineers already employed, the new men being obtained from the eligible lists furnished by the Civil Service Commission. In this way men who are familiar with the conditions in the arid regions and who have had many years' experience there are enabled to continue their work, and the large investment made by the Government in the past is conserved and rendered effective. A continuity of purpose and of personnel has thus been secured from the time that Congress first authorized the Director of the Geological Survey to take up this work, and the early plans and expenditures have become effective even beyond the hopes of the men who began this great undertaking.

LAWS AND REGULATIONS GOVERNING PRINTING AND DISTRIBUTION OF SURVEY PUBLICATIONS.

A joint resolution approved May 16, 1902, made a number of changes in the classes and the distribution of the publications of the Survey printed at the Government Printing Office. The new legislation is a step in advance, as the Survey had outgrown the former provisions governing its publications.

The joint resolution reads as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That hereafter the publications of the Geological Survey shall consist of the annual report of the Director, which shall be confined to one volume of royal octavo size; monographs, of quarto size; professional papers, of quarto size;

bulletins, of ordinary octavo size; mineral resources, of ordinary octavo size; water-supply and irrigation papers, of ordinary octavo size; and such maps, folios, and atlases as may be required by existing law.

That hereafter the reports of the Geological Survey, except the annual report of the Director, shall be published in editions as recommended in each case by the Director and approved by the Secretary of the Interior, but not to exceed ten thousand copies.

That whenever the edition of any of the reports of the Survey shall have become exhausted, and the demand for it continues, there shall be published, on the requisition of the Secretary of the Interior, as many additional copies of the report as the Director of the Survey shall state will, in his judgment, be necessary to meet the demand.

That the bulletins and professional papers shall be distributed gratuitously, and not sold; and that of the number published one thousand copies shall be delivered to the Senate and two thousand copies shall be delivered to the House of Representatives for distribution.

That the provision of law approved June eleventh, eighteen hundred and ninety-six, restricting the water-supply papers to one hundred pages and to editions of five thousand copies, shall be, and hereby is, rescinded.

That the Director of the Survey shall transmit to the Library of Congress two copies of every report of the Bureau as soon as the first delivery to the Survey is made, such copies to be additional to those received by the Library of Congress under existing law.

The law governing the publication and distribution of the topographic maps and geologic folios, which are prepared in the Engraving and Printing Division of the Survey, is as follows:

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Director of the Geological Survey be, and is hereby, authorized and directed, on the approval of the Secretary of the Interior, to dispose of the topographic and geologic maps and atlases of the United States, made and published by the Geological Survey, at such prices and under such regulations as may from time to time be fixed by him and approved by the Secretary of the Interior, and that a number of each map or atlas not exceeding five hundred shall be distributed gratuitously among foreign governments and Departments of our own Government, to literary and scientific associations, and to such educational institutions or libraries as may be designated by the Director of the Survey and approved by the Secretary of the Interior.

SEC. 2. That one copy of each map and atlas shall be sent to each Sen-

ator and each Representative and Delegate in Congress, if published within his term; and that a second copy shall be placed at the disposal of each Senator, Representative, and Delegate.

Approved, February 18, 1897.

Pursuant to this resolution the following letter was addressed to the Secretary of the Interior:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 26, 1897.

SIR: In accordance with the provisions of the joint resolution providing for the distribution of the topographic maps and geologic atlases of the United States Geological Survey approved by the President February 18, 1897, I have the honor to submit the following plan for the distribution of said maps and atlases, and to invite your consideration and approval of the same:

TOPOGRAPHIC SHEETS.

Of the topographic maps, it appears desirable that we print an edition for use in connection with the official work of the Survey and to meet important local demands for purchase by parties who wish to make use of the same, and it also appears desirable that two copies of each sheet be supplied to each Senator, Representative, and Delegate from the State or Territory in which the mapped area is located. Such an edition might be regarded as a proof edition, and should not exceed 500 copies.

The final edition of a sheet should be 2,000 copies, and the distribution should be as follows:

For Members of Congress, two copies of each sheet to each member	888
For distribution to institutions, etc., as provided in joint resolution approved February 18, 1897	500
For office use in the Survey	122
For sale	500
Total edition	2,000

It is recommended that single copies of the topographic atlas sheets be sold at 5 cents, and that such maps when ordered in lots of 100 or more be sold at 2 cents each, these prices to apply to the preliminary or proof edition as well as to the final edition; and for maps involving an area of two or more atlas sheets, the price to increase in proportion.

GEOLOGIC AND TOPOGRAPHIC ATLASES (FOLIOS).

The geologic atlases are now distributed by the superintendent of documents, as follows, under joint resolution approved March 3, 1887;

the act governing public printing and binding, approved January 12, 1895; and joint resolution approved February 26, 1896:

Designated depositories	450
Libraries which have been designated by Senators and Representatives	1,686
Total stated distribution	2,136

In addition, it is now recommended that the following further distribution be authorized:

For distribution to institutions, etc., as provided by joint resolution, approved February 18, 1897	500
To each member of Congress 2 copies	888
For official use of the library and members of the Survey	76
For sale	1,400
Total edition	5,000

It is recommended that the folios be sold at 25 cents each, except such as may contain an unusually large amount of matter—an amount sufficiently large to warrant regarding them as double atlases—these to be sold at 50 cents each, and larger ones in the same proportion.

It has been customary to give each author of an atlas 25 copies for personal distribution, and also to distribute to persons in the district to which any given atlas relates and who have rendered assistance to its author, by service or otherwise—the names and addresses to be indicated by the author—from 20 to 100 copies. In view of this practice, I would recommend that hereafter each author be permitted to purchase 25 copies of each atlas for personal distribution at the nominal price of 5 cents each, and that if he wishes to make a distribution to individuals in the area to which the atlases appertain, in recognition of services rendered, as above explained, he be permitted to purchase these likewise at the nominal price of 5 cents each; the atlases in all such cases being sent out officially by the Survey to addresses given by the authors.

I would further recommend that members of the Survey force, other than authors, who may wish to possess copies of the atlases for their own libraries or for unofficial use, be permitted to purchase not exceeding two copies of each at the same rate—5 cents each.

In the event of the publication of an atlas of unusual interest, such as that of the Yellowstone Park, the edition to be increased at the discretion of the Director, so as to meet the demand for it.

There will be submitted to the Department at an early date a list of the topographic maps and geologic atlases which it is proposed to distribute to foreign governments, the Departments of our own Government, literary and scientific associations, and educational institutions and libraries, as provided in joint resolution. A printed copy of the resolution, as approved, is hereto attached.

I am, with respect, your obedient servant,

CHARLES D. WALCOTT, *Director.*

The honorable the SECRETARY OF THE INTERIOR.

The regulations embodied in the foregoing letter were approved by Secretary D. R. Francis on February 27, 1897.

EMPLOYMENT IN THE GEOLOGICAL SURVEY.

All positions in the Geological Survey are now classified under the civil-service act and can be filled only through examination, except the office of Director (which is filled by Presidential appointment, subject to confirmation by the Senate) and the subordinate place of laborer. The excepted class includes also the place of field assistant, to be referred to farther on.

There are on the roster at this date, holding appointments from the Secretary of the Interior to classified and unclassified places, 436 persons. Of these, 225 fall within the scientific and engineering group, embracing geologists, chemists, hydrographic engineers, topographers, statisticians, etc., and 82 are of the class of artisans and skilled workmen, including draftsmen, photographers, engravers, printers, etc. The executive and administrative force consists of 100 persons, the Director excepted. The ordinary laborers in the office, not classified, number 29.

During the field season the chiefs of divisions and parties employ temporary aids for the geologic, hydrographic, and topographic field work, the number varying considerably from month to month. These aids must possess more or less skill or experience, must be not under 20 years of age, and, if college students, must bind themselves to remain in the service until the close of the field season, if required. The monthly pay varies from $25 to $100, according to skill and experience; and the necessary living and traveling expenses of the men while under orders are borne by the Survey.

In this connection the Director desires to mention the relations which have subsisted between the Survey and the Civil Service Commission. Owing to the wide range of technical knowledge required for the performance of the Survey's work, perplexing questions are continually arising in connection with appointments. These the Commission has met in a spirit which shows an intelligent appreciation of the conditions and

a sincere desire to do all that may be possible under the law to facilitate the work of the Bureau.

PLAN OF OPERATIONS.

The plan of operations for the fiscal year 1901–2 was laid before the Secretary of the Interior on April 24, 1901, and was approved by him on the 25th. This detailed plan is on file in the Department. The work of the year, hereinafter reviewed, was executed in conformity with the plans submitted and approved.

APPROPRIATIONS.

For and during the fiscal year 1901–2 there was appropriated for the work of the United States Geological Survey the sum of $1,079,800. 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	$11,200

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		$32,390
For pay of skilled laborers, etc		16,000
For topographic surveys	$250,000	
For pay of two geographers and two topographers	9,200	
Total for topographic work		259,200
For geological surveys	150,000	
For pay of four geologists	13,700	
Total for geologic work		163,700
For paleontological researches	10,000	
For pay of two paleontologists	4,000	
Total for paleontologic work		14,000
For chemical and physical researches	20,000	
For pay of one chemist	3,000	
Total for chemical work		23,000
For general investigations in Alaska		60,000
For gauging streams, etc		100,000

For preparation of illustrations	$16,280
For preparation of report on mineral resources	50,000
For purchase of books and distribution of documents	5,000
For engraving and printing maps	70,000
For rent	11,200
For survey of the forest reserves	130,000

There was appropriated in the same act, for engraving, printing, and binding publications of the Geological Survey, $45,000; 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 the Director	$15,000	
For engraving illustrations for monographs and bulletins	10,000	
For printing and binding monographs and bulletins	20,000	
Total for engraving, etc		$45,000

The deficiency act approved February 14, 1902, contained the following items:

For continuing the investigation of the mineral resources of Alaska (to continue available during the fiscal year 1903)	$60,000	
For engraving and printing geological maps	5,000	
Total		$65,000

The deficiency act approved April 7, 1902, contained the following item:

For furnishing additional office rooms	$7,830
Grand total	1,079,800

ALLOTMENTS.

ALLOTMENTS TO GEOLOGIC WORK.

The total appropriation for geologic work for the fiscal year 1901–2 was $163,700. There remained unexpended at the beginning of the field season of 1901 a balance of $10,091.17 from the appropriation for 1900–01. This amount was included in allotments made to geologic parties for the field season of 1901 and expended before the expiration of the fiscal year for which it was appropriated. The total allotments, therefore, amounted to $173,791.17. In addition, there was appropriated by the State of Pennsylvania $8,000, and by the State of New York $1,000, for cooperation in geology with the Federal Survey, on condition that a like amount be expended from the Federal appropriation for work in the States mentioned.

Allotments to geologic parties.

Party, etc.	Amount.
Executive office	$13,660.00
Adams, G. I. (Arkansas, Indian Territory, Wyoming, Colorado)	2,000.00
Becker, G. F. (California)	4,550.00
Branner, J. C. (California)	450.00
Campbell, M. R. (Pennsylvania, Ohio, Indiana, Kentucky, West Virginia)	8,250.00
Chamberlin, T. C. (northern and eastern United States)	8,400.00
Clark, W. B. (Maryland)	1,000.00
Cross, Whitman (Colorado, New Mexico)	8,250.00
Dale, T. N. (New York, Vermont)	2,500.00
Darton, N. H. (Wyoming, South Dakota)	2,600.00
Diller, J. S. (California, Oregon)	6,700.00
Eldridge, G. H. (California)	5,500.00
Emerson, B. K. (Massachusetts)	350.00
Emmons, S. F. (Colorado, Wyoming, Arizona)	7,200.00
Gilbert, G. K. (Utah, Nevada)	7,500.00
Girty, G. H. (Pennsylvania, New Mexico)	2,575.00
Hague, Arnold (Yellowstone National Park)	2,000.00
Hayes, C. W. (Ohio, Tennessee, Texas, Louisiana, Arkansas, and Colorado)	8,500.00
Hill, R. T. (New Mexico, Arizona, Texas)	5,750.00
Jaggar, T. A. (Arizona)	2,900.00
Keith, Arthur (Tennessee, North Carolina, South Carolina, Georgia)	4,550.00
Kemp, J. F. (New York)	500.00
Knight, W. C. (Wyoming)	350.00
Lindgren, Waldemar (Arizona, California)	7,425.00
Prosser, C. S. (Ohio)	300.00
Ransome, F. L. (Arizona, International Boundary)	7,300.00
Smith, G. O. (International Boundary)	5,800.00
Smith, W. S. Tangier (Missouri, Kansas)	2,375.00
Stose, G. W. (Pennsylvania, map editing)	2,950.00
Taff, J. A. (Indian Territory, Oklahoma)	3,950.00
Van Hise, C. R. (Michigan, Minnesota, Connecticut)	12,125.00
Vaughan, T. W. (general correlation)	2,200.00
Weed, W. H. (Montana)	7,600.00
White, David (Appalachian region)	3,250.00
Williams, H. S. (Connecticut, New York)	3,450.00
Willis, Bailey (International Boundary)	7,500.00
Wolff, J. E. (Vermont)	700.00
Contingent	831.17
Total	173,791.17

ALLOTMENTS TO PALEONTOLOGIC WORK.

The total appropriation for paleontologic work for 1901–2 was $14,000, which was allotted to the various sections of the work as follows:

Allotments to paleontologic work.

Section, etc.	Amount.
Mesozoic	$2,100
Cenozoic	3,000
Paleobotanic	5,500
Preparation of monographs on vertebrate fossils	2,500
Contingent	900
Total	14,000

ALLOTMENTS TO TOPOGRAPHIC WORK.

The sum appropriated for topographic surveys was $250,000. Besides this general appropriation, certain stated salaries, aggregating $9,200, were appropriated for men engaged in topographic work, making the total appropriation for topography $259,200, which was allotted as follows:

Allotments to topographic work.

Section, etc.	Amount.
Atlantic section	$95,000
Central section	59,200
Rocky Mountain section	36,400
Pacific section	35,000
Purchase and repair of instruments	10,000
Office and contingent expenses	23,600
Total	259,200

ALLOTMENTS TO FORESTRY WORK.

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

Allotments to forestry work.

Section, etc.	Amount.
Rocky Mountain section of topography	$41,700
Pacific section of topography	46,300
Forest surveys	25,000
Purchase and repair of instruments	3,000
Office and contingent expenses	14,000
Total	130,000

ALLOTMENTS TO HYDROGRAPHIC WORK.

The appropriation of $100,000 for gaging streams, etc., was allotted as follows: $35,000 to pay roll, $18,000 to reservoir surveys and gagings, $18,000 to diversion surveys and gagings, $10,000 to artesian surveys and gagings, $10,000 to water-power surveys and gagings, $4,000 to sanitary surveys and gagings, and $5,000 to instruments and miscellaneous.

The appropriation was apportioned as follows:

Apportionment of appropriation for hydrography.

Arizona	$3,200
California	16,000
Colorado	6,400
Idaho	3,200
Kansas	4,000
Montana	8,000
Nebraska	4,000
Nevada	6,400
New Mexico	1,600
North Dakota	4,000
Oregon	800
South Dakota	1,600
Texas	1,600
Utah	3,200
Washington	2,400
Wyoming	4,800
New England and New York	3,200
Pennsylvania	800
Maryland	800
Virginia and West Virginia	800

North Carolina and South Carolina	$5,600
Georgia, Alabama, Mississippi, etc	6,400
Ohio and miscellaneous	6,400
Artesian, etc	4,800
Total	100,000

MISCELLANEOUS ALLOTMENTS.

Chemistry and Physics.

For pay of all persons connected with the chemical and physical work, and for the purchase of supplies, apparatus, etc., the entire appropriation of $23,000 was allotted.

Mineral Resources.

The entire appropriation for the preparation of the report on mineral resources, $50,000, was allotted to the gathering and compilation of statistical data for the calendar year 1901 and the preparation of a report thereon, which is in press.

Engraving and Printing Maps, etc.

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

WORK OF THE YEAR.

The general organization of the Survey, by branches and divisions, remained unchanged, and the approved plan of operations was carried out in all essential particulars.

GEOLOGIC BRANCH.

Administration of Geologic Branch.

In view of the rapid growth of the Geological Survey and the increasing burden of administrative duties devolving upon the Director, it became necessary during the year to create a new office, that of Geologist in Charge of Geology. This office was created on March 1. Up to that time the duties had in a measure devolved upon the Assistant in Geology to the Director. The duties pertaining to this new office are administrative, and comprise all matters of that character relating to geology

and paleontology. In accordance with an order of March 1, all monthly and annual reports from geologists and paleontologists, all communications relating to plans and estimates for field and office work, requisitions for assignment of field and office assistants, requisitions for outfits and instruments, manuscripts for publication, and other similar administrative matters are now addressed to the Geologist in Charge of Geology instead of to the Director. Chiefs of scientific divisions and all other geologists and paleontologists are expected to keep this officer fully informed in regard to the progress of their work in its administrative relations and to cooperate freely with him. The creation of this office is not intended to interfere with freedom of conference between the Director and any geologist or paleontologist, and does not in any way change the relations of the various chiefs of divisions to the geologists and paleontologists as defined in the Twenty-first and Twenty-second Annual Reports. On March 1 Mr. C. W. Hayes was appointed Geologist in Charge of Geology, and assumed the duties of that office at once.

Another change in the administration was the appointment, on February 7, of Mr. Alfred H. Brooks to the charge of geologic work in Alaska. Heretofore this work has been under the direction of a committee, an arrangement which was not entirely satisfactory. Mr. Brooks is now held directly responsible for the formulation and efficient execution of all plans for geologic work in that Territory. He is instructed to confer with Mr. Goode, who has charge of the topographic work in Alaska, concerning plans, the allotment of funds from the Alaskan appropriation, and the personnel of parties.

With the foregoing exceptions the organization of the Geologic Branch remains as described in the Twenty-first and Twenty-second Annual Reports. The direction of the scientific work remains in the hands of the geologists in charge, as follows:

Bailey Willis, geologist in charge of areal geology.

T. C. Chamberlin, geologist in charge of Pleistocene geology.

C. R. Van Hise, geologist in charge of pre-Cambrian and metamorphic geology.

S. F. Emmons, geologist in charge of metalliferous ores.

C. W. Hayes, geologist in charge of nonmetalliferous economic deposits.

T. W. Stanton, paleontologist in charge of paleontology.

D. T. Day, geologist in charge of mining and mineral resources.

G. F. Becker, geologist in charge of physical and chemical research.

This form of organization has proved even more efficient during the last year than when first established. It has resulted in securing desirable coordination among the various lines of work pursued by the Geologic Branch, in improving the effectiveness of the Survey force, and in raising the standard of publications.

Appropriation for Geologic Branch.

The appropriation for geology for the fiscal year 1901–2 was $150,000 for geologic surveys in various portions of the United States and $13,700 for salaries of geologists. The appropriation for salaries of paleontologists was $4,000, and for expenses of paleontologic work $10,000. In addition to these appropriations, $5,000 was contributed by the State of Pennsylvania and $1,000 by the State of New York for cooperative geologic work in those States, making a total of $183,700 available for geologic work, including paleontology. A separate appropriation of $60,000 was made for investigating the mineral resources of Alaska. This was employed for both geologic and topographic work in that Territory.

Detailed Statement of Work of Geologic Branch.

WORK OF GEOLOGISTS IN CHARGE OF DIVISIONS.

Division of Areal Geology.—Mr. Bailey Willis, geologist in charge, spent three months in the field—from July to September, inclusive. The account of his field work will be found in its appropriate place elsewhere (p. 65). After his return to Washington Mr. Willis continued his duties as Assistant in Geology to the Director. Until March 1 this included, as previously, the administration of the work of the Geologic Branch, attention to the routine of office details, the adjustment of expenditures and appropriations, and the consideration of plans with reference to future geologic work. Throughout

the year Mr. Willis was engaged more or less constantly in the consideration of matters submitted to him as geologist in charge of areal geology, and especially after the 1st of March he gave his attention almost wholly to the review of manuscripts submitted for publication as folios of the Geologic Atlas. Mr. Willis has acted as chairman of the committees on Illustrations and on Geologic Names, and has served on the committee to revise the Geologic Classification presented in the Tenth Annual Report, on the committees on Advertising and Buildings, and on committees holding other administrative relations.

Division of Pleistocene Geology.—Prof. T. C. Chamberlin, geologist in charge, was occupied throughout the year chiefly in the direction and supervision of the work of the division. He exercised close supervision of field operations, by means of frequent full reports from the field geologists. In connection with the work of the division he held field conferences in Wisconsin with Messrs. Van Hise and Weidman, in Michigan with Mr. Leverett and State Geologist Lane, in the District of Columbia with Mr. Darton, in Maryland with Mr. Willis, and in New Jersey with Messrs. Kümmel and Knapp. He also spent considerable time in the examination of manuscripts submitted for publication which related particularly to Pleistocene geology.

Division of Pre-Cambrian and Metamorphic Geology.—Prof. C. R. Van Hise continued in charge of this division, devoting the greater part of his time to the immediate supervision of the work of the division, both in the field and in the office. During the year he spent considerable time in reading referred manuscripts of reports pertaining to pre-Cambrian and metamorphic geology. The two which made the largest demands on his time are the monographs on the Mesabi and Vermilion districts, by C. K. Leith and J. M. Clements, respectively. The remainder of his time was devoted to the final revision of his treatise on metamorphism, to be published as a monograph. At the end of the fiscal year nine of the twelve chapters were completed and the three remaining chapters were in the first draft.

Assisted by Mr. W. M. Smith, Professor Van Hise spent the months of July and September in western Massachusetts and Connecticut and southeastern New York, in a general study of the stratigraphy of that area, in order to correlate the work of Messrs. Emerson, Wolff, Hobbs, and Merrill. This is a region of extraordinary difficulty, in which one area can not be mapped independently of others. It was therefore necessary to make general structural studies in company with these geologists, separately or two or more together. The result was an agreement as to the succession of geologic formations in the region. It remains for each of the geologists concerned to adjust the geologic boundaries within his own district in accordance with the general plan agreed upon.

The month of August was spent by Professor Van Hise in Colorado in two general lines of study: First, a study of the structural relations of the Archean and Algonkian in the Front Range of Colorado; and, second, a general study of the principles of ore deposition as illustrated by the Cripple Creek, Aspen, and San Juan districts.

Division of Economic Geology; Section of Metalliferous Ores.—Mr. S. F. Emmons, geologist in charge, devoted his field season in part to a resurvey of the Leadville mining district and in part to supervision of investigations being carried on under his direction. Early in July he began field work at Leadville, Colo., with John D. Irving as assistant. The object of this work was to examine, so far as they were accessible, all mine workings that had been opened since the close of his original field work in the district in 1881, with a view to making a supplemental report on its geology and ore deposits. The original report recognized the extreme complexity of the geologic structure, but could not foresee the manifold ramifications of the intrusive bodies and the details of their relations to the ore deposits that have been disclosed by the drifts of the numerous mines exploited in the last twenty years. It was early recognized that a study of these later openings might result in important contributions to our knowledge of the laws governing ore deposition, and perhaps render further aid to the development of the ore bodies still untouched.

Hence, by personal visits from year to year, when time could be spared from other duties, Mr. Emmons has endeavored to keep in touch with the underground developments. In 1890 he began a systematic resurvey of the district, but, having no scientific assistant, found himself overwhelmed with the amount of underground mapping required, and was unable to carry the mechanical part of the work to completion. In the last summer's work Mr. Irving's training in underground observations and his skill as a draftsman, proved of invaluable aid. Mr. Emmons also had the assistance of Mr. Cudlipp, an experienced draftsman, in reducing and compiling maps of the various mines. It was found necessary to suspend this work about October 11, and some additional field work will be required during the present summer. At the close of the work Mr. Irving proceeded to Globe, Ariz., where he acted as assistant to Mr. Ransome in the survey of that district.

During August Mr. Emmons spent a week in guiding the geologic excursion of the Geological Society of America through the mountains of Colorado and in attending the Denver meeting of that society.

Throughout the summer, by means of correspondence, he exercised supervision over various parties carrying on work in this division, and over the work of Mr. Knight in Wyoming. During October Mr. Emmons visited the Globe district, in Arizona, for conference with Messrs. Ransome and Irving, who were making an economic survey of that region, and, later, the Clifton-Morenci district, for conference with Mr. Lindgren. During the month of November, under leave of absence, Mr. Emmons visited the principal mining districts of Mexico with the American Institute of Mining Engineers, of which he is vice-president.

Mr. Emmons returned to Washington on the 1st of December, and devoted the remainder of the year to office work. During this period his time was largely taken up with various administrative duties, such as reading manuscripts submitted for publication, conferring and advising with geologists in regard to the preparation of their reports, and preparing reports on subjects of immediate administrative importance to

the Director. His personal scientific work has been mainly the preparation of manuscript and illustrations for the reports on the economic geology of the northern Black Hills and the supplemental report on the Leadville district.

Division of Economic Geology; Nonmetalliferous Economic Deposits.—Mr. C. W. Hayes, geologist in charge, was occupied for several months during the early part of the year in connection with the preparation of a series of reports on the several coal fields of the United States. These were published in the Twenty-second Annual Report, Part III.

He also spent some time, in collaboration with Messrs. Vaughan and Spencer, in the preparation of a report on the geologic reconnaissance of Cuba, which has been published as a part of the Military Governor's annual report for 1901. (See "Spencer party" and "Vaughan party," pp. 57 and 60.)

In September Mr. Hayes visited Vermont for conference with Mr. Dale concerning work in progress in the Vermont marble deposits and with Professor Kemp concerning the investigation of recently discovered asbestos deposits. He also visited Ohio to confer with Mr. Griswold regarding his investigation of the Berea grit oil sand in the Cadiz quadrangle. (See "Griswold party," p. 45.)

Mr. Hayes spent the month of October in the Texas-Louisiana oil fields with William Kennedy, field assistant. In December he made a trip to California for conference with Mr. Eldridge regarding the California oil fields and with Professors Branner and Lawson regarding work in economic geology. Returning by way of Texas, he spent the month of January in the Texas-Louisiana oil fields and in the examination of oil and asphalt prospects in Arkansas.

On March 1 Mr. Hayes was appointed Geologist in Charge of Geology (see p. 26), and devoted the remainder of the year almost entirely to administrative duties in connection with current work of the Geologic Branch and the preparation of plans for the coming field season.

Division of Paleontology.—Mr. T. W. Stanton, paleontologist in charge, spent the entire year in the office. On account of the accumulation of unstudied material and unfinished manuscripts, it did not seem best to go into the field As in the

preceding year, all the time not occupied with routine matters or with special assignments to more urgent duties was devoted to the study and description of the Lower Cretaceous invertebrate faunas of the Texan region, on which Mr. Stanton has been engaged for several years for the purpose of preparing a monograph on the subject. Early in the year he spent twenty days in the preparation of a brief paper on the stratigraphy of the region about Sierra Blanca, Tex. This paper, which is intimately connected with the studies just mentioned, is intended for publication as an introduction to a bulletin by Prof. F. W. Cragin on the Jurassic paleontology of that region.

On February 1 Mr. Stanton was detailed to visit Cambridge, Mass., to take charge of the manuscripts and collections belonging to the Geological Survey that had been in the hands of the late Prof. Alpheus Hyatt. This trip occupied two weeks, and a special report was made to the Director describing the extent of the collections and manuscripts found. The manuscript for a monograph on the Pseudoceratites of the Cretaceous by Professor Hyatt was found to be in an advanced state of preparation, and it was considered desirable that Mr. Stanton should lay aside other work as far as possible and edit this manuscript, so that it might be ready for publication by the end of the year. Nearly two months were given to this work.

Other work of an administrative nature which occupied Mr. Stanton for considerable periods during the year consisted of the examination and preparation of reports on collections of fossils for members of the Survey and others, criticism of referred manuscripts, work on the committee on Rules for Classification and Nomenclature, and revision of the catalogues of types of Mesozoic invertebrates in the National Museum.

Mr. T. E Williard served during the year, when not in the field, as general laboratory assistant to the paleontologists of the Survey who are located in the National Museum building.

Division of Mining and Mineral Resources.—Mr. David T. Day, geologist in charge, continued to direct the work of this division, a report of which will be found on pages 82 to 99.

Division of Physical and Chemical Research.—Mr. George F. Becker, geologist in charge, continued to direct the work of this division, a report of which will be found on pages 119 to 121.

WORK OF GEOLOGIC PARTIES.

Adams party.—Mr. George I. Adams spent the first half of July, in cooperation with Mr. Joseph A. Taff, in the survey of the Tahlequah (Indian Territory) quadrangle. On July 15 he began the resurvey of the Cottonwood Falls (Kansas) quadrangle, assisted by Mr. J. W. Beede. The remainder of the month was devoted to establishing the stratigraphic section for this area. Mr. Beede continued work in the Cottonwood Falls quadrangle, completing the resurvey September 9. On August 1 Mr. Adams outfitted at Cheyenne, Wyo., and began the survey of the Patrick and Goshen Hole (Wyoming) quadrangles. This work was undertaken with special reference to the question of water supply, and was done under the direction of the Division of Hydrography. Mr. Ernest F. Burchard served as assistant. The field work was completed at the end of September.

During the month of October Mr. Adams made a preliminary survey of the Greeley (Colorado) quadrangle, studying the general and economic geology and the water resources. From July 15 to September 15 Mr. John Bennett was occupied under Mr. Adams's direction in collecting fossils and in studying the stratigraphy of the Kansas Coal Measures. Between December 27 and January 11 Mr. Adams was in the field on the east coast of Florida, examining supposed occurrences of oil and gas.

The remainder of the year was devoted to office work. The following reports have been prepared for publication: Fayetteville (Arkansas) folio; Water-Supply Paper No. 70, on the geology and water resources of the Patrick and Goshen Hole quadrangles; and a bulletin on the stratigraphy and paleontology of the Kansas section of the Carboniferous, prepared in cooperation with Messrs. White and Girty.

Alden party.—Under the direction of Professor Chamberlin, Mr. William C. Alden was engaged from July 1 to October 26 in the survey of those parts of Walworth, Rock, and Green counties, Wis., included within the Brodhead, Janesville, and Shopiere quadrangles and of the unfinished parts of the Koshkonong, Whitewater, and Delavan quadrangles. Before leav-

ing the field a short reconnaissance trip was made in southwestern Green County for the purpose of investigating the glacial diversion of the Pecatonica River. This work by Mr. Alden was in continuation of the investigation of the Pleistocene geology of southeastern Wisconsin which has been carried on for several seasons. It is expected to embody the results of this work in a series of geologic folios.

From November 1 to June 30, with the exception of parts of the months of April and June, when not engaged on survey work, Mr. Alden was employed in office work. This has included the preparation of manuscript for the Burlington-Racine folio, consisting of the Bayview, Racine, Muskego, Silver Lake, Eagle, and Geneva (Wisconsin) quadrangles, and for the Whitewater folio, consisting of the Whitewater, Delavan, Shopiere, and Koshkonong quadrangles. The preparation of these manuscripts is well advanced. Some preliminary work was also done on the manuscript of the Janesville (Wisconsin) folio, and considerable work on the manuscripts and maps of the Chicago folio and of the Gaines (Pennsylvania) folio. From July 1 to 21 Mr. Alden was aided in his work by Messrs. Eliot Blackwelder and William Averill as volunteer assistants.

Bascom party.—Prof. Florence Bascom continued, under the immediate supervision of Professor Van Hise, the preparation of the manuscript and maps for the Philadelphia special folio, and completed an investigation of the crystalline formations of Cecil County, Md. The latter investigation was conducted in cooperation with the Maryland geological survey. The report is now in press, and is to appear as a volume of that survey. Since the completion of this report Professor Bascom has been occupied with the investigation of the same crystalline belt in its continuation into eastern Pennsylvania. This investigation is largely concerned with two problems: First, the determination of the age and structural relations of the great mica-gneiss formation; and, second, a petrographic and areal separation of the granite-gneiss and gabbro-gneiss of Chester and Delaware counties.

Bayley party.—Prof. W. S. Bayley spent two and one-half

months in the iron-bearing area west of the Menominee district in Wisconsin and Michigan. This area comprises the mines at and adjacent to Florence and Commonwealth in Wisconsin and those about Iron River in Michigan. The district is heavily drift covered, and therefore it is not practicable to map the formations in such detail as in the other more important iron-bearing districts of the Lake Superior region. The field work for this district was finished September 10. Aside from the time necessary to put his field notes in order, Professor Bayley gave his entire time during the year, in the office, to continuing the preparation of a monograph on the Menominee district.

Branner party.—Prof. J. C. Branner continued during the year field and office work on the geology of the Santa Cruz quadrangle (California), and made excursions into the regions adjoining for the purpose of obtaining light upon the geology of this particular area. Professor Branner received much valuable assistance in working out the complex structure of the region from Mr. J. F. Newsom, of Stanford University, who ran a large number of traverse lines for the purpose of locating the faults and other structural features. The study of the paleontology was continued by Mr. Ralph Arnold, whose work in this line was very helpful. Most of the Miocene diabase areas were located on the map, and a petrographic study of these rocks was made by Mr. H. L. Haehl, who has prepared a report on the subject. Hitherto the rocks of the so-called Golden Gate, or Franciscan, series, which cover a large part of the Santa Cruz quadrangle, have been grouped together. An attempt, apparently successful, was made to separate the different rocks of this group. The glaucophane-schists of the area were studied by Mr. E. H. Nutter, who has prepared a report on them. The andesite flow near Stanford University was studied by Prof. Milnor Roberts, of the University of Washington, and it is expected that his results will soon be available for publication.

It is believed that the geologic mapping of the Santa Cruz quadrangle will be finished and the folio prepared for publication during the coming season.

Campbell party.—Mr. M. R. Campbell had immediate supervision of several parties engaged in areal and economic work in New York, Pennsylvania, and Indiana.

The cooperative survey of the Salamanca and Olean quadrangles had not been completed on July 1, 1901, and consequently it was extended into the fiscal year recently closed. This work was under the direct supervision of Prof. L. C. Glenn, who left the field July 12 for work in Pennsylvania, leaving Myron L. Fuller, assisted by Charles Butts, to complete the work. Mr. Butts remained until July 16 and Mr. Fuller until August 21, when the survey of the quadrangles was completed, and both joined the parties working in Pennsylvania.

The work in Pennsylvania was conducted as follows: Mr. Myron L. Fuller was assigned to the survey of the Tioga quadrangle, on which he was engaged from August 21 to October 1; Mr. George B. Richardson was assigned to the Indiana quadrangle, on which he worked from July 1 to September 15; and Mr. Campbell, assisted for various periods throughout the summer by Professor Glenn, Lester H. Woolsey, Myron L. Fuller, Charles Butts, and George B. Richardson, surveyed the Brownsville, Connellsville, Kittanning, and Latrobe quadrangles. This work in Pennsylvania was carried on under an agreement for cooperation entered into between the Director of the United States Geological Survey and the geological commission of Pennsylvania. In accordance with this agreement, the expenses of the work were equally divided between the Geological Survey and the State.

Areal mapping was begun in Indiana on July 1 by Prof. George H. Ashley, who surveyed the Velpen and Degonia quadrangles. Mr. Campbell visited this region in September for conference and supervision of the work, which was completed September 5.

During the office season Mr. Campbell was occupied chiefly in the preparation of the Masontown-Uniontown and the Brownsville-Connellsville folios. He was assisted in the office by Mr. Richardson, who completed the preparation of the Indiana folio; by Mr. Fuller, who prepared the Gaines and the

Elkland-Tioga folios, which have been submitted for publication; by Professor Glenn, who prepared, for the New York State survey, a report on the Salamanca and Olean quadrangles and also a report on the same subject for Survey publication, and by Professor Ashley, who prepared a report on the Velpen and Degonia quadrangles, which constitute the eastern half of the Patoka (Indiana) folio. The two quadrangles forming the western half will require some resurveying before the folio can be completed. Mr. Campbell was also assisted in the office by Mr. Butts, Mr. A. H. Rudd, and Mr. R. W. Stone. Mr. Lester H. Woolsey was employed for a part of May in making a detailed examination of certain parts of the field, for which additional data were required.

Mr. Campbell prepared for publication a report on a reconnaissance of the borax deposits of the Mohave and Death Valley region (Bulletin No. 200), which is in press.

Clark party.—Prof. W. B. Clark had charge of the Coastal Plain work in Maryland and adjacent States. Associated with him were Messrs. G. B. Shattuck, G. C. Martin, Arthur Bibbins, and B. L. Miller. The investigations of this area have comprised studies of all the horizons from the Lower Cretaceous (Jurassic?) to the Pleistocene and have embraced both the areal geology and the paleontology of the formations. A monograph on the Eocene was published by the State organization in cooperation with the Survey, and a second one on the Miocene is already in press.

The areal work has been extended over considerable territory in the southern portion of the State, along the Potomac River and Chesapeake Bay, as well as in the northern part of the State around the head of Chesapeake Bay. The continuation of the formations into Delaware on the north and Virginia on the south has been established, the attempt having been made to employ formational units of sufficiently wide range to embrace the entire Chesapeake Bay district. Much more detailed work, of both stratigraphic and economic value, has been attempted by Professor Clark and his associates than by earlier investigators in this field. Many special studies are in progress.

Cross party.—Early in July Mr. Whitman Cross outfitted at Durango, Colo., with Messrs. Ernest Howe and J. Morgan Clements as assistants. Until July 8 the party was engaged in areal mapping of the Needle Mountains quadrangle, about half of the area being covered. The area mapped embraced the southern slopes of the Needle Mountains, which are among the most rugged peaks of Colorado, several summits exceeding 14,000 feet in elevation, while the Animas River cuts a canyon through them to a depth of more than 6,000 feet. The area covered also included the zone along the eastern side in or near the valley of Vallecito Creek.

From August 9 to October 15 the party was engaged in completing the areal mapping of the Silverton (Colorado) quadrangle, adjoining the Needle Mountains quadrangle on the north. Work had been done in this quadrangle in 1899 and 1900, but had not been finished, owing to the necessity for a better topographic map. During the first part of the summer the final revision of the topographic map was completed, and photographic copies of the revised map were available for use after August 28.

Mr. Clements left the party September 30 to resume his university duties at Madison, Wis.

On completion of the Silverton work, on October 15, Mr. Cross was directed to examine the site of a tunnel by which it is proposed by the Division of Hydrography to divert the waters of the Gunnison River into the Uncompahgre Valley. This examination was completed on October 19, and later a report was made to the Director.

In the latter part of October Messrs. Cross and Howe spent several days in making observations in the region adjacent to the Durango quadrangle, necessary for the completion of the Durango folio.

From November 1 to the end of the fiscal year Mr. Cross was engaged in office work, with the assistance of Mr. Howe for the entire period, and of Mr. L. H. Woolsey for the greater part of the time. He was chiefly occupied in the preparation of the Silverton folio. For the reason that the work has been conducted during several seasons with different assistants, a

large amount of labor has been necessary in collating the field notes and in studying the rock collections. The maps for the Silverton folio are practically completed, and the preparation of the folio text is well advanced.

During the year Mr. Cross devoted considerable time to special work in petrography, along two lines: (1) A review of the development of systematic petrography during the nineteenth century, and, in cooperation with other petrographers (Messrs. Iddings, Pirsson, and Washington), (2) the formulation of a new classification of igneous rocks. Both of these works are completed and are now in course of publication in the Journal of Geology.

Mr. Cross has served as a member of the committees on Photographic Laboratory and Chemical Analysis, and has also acted as chairman of the committee on Petrographic Reference Collection. Numerous questions have been referred to the latter committee for report, including manuscripts dealing with petrographic subjects. The work of caring for the reference collection and preparing it for use was carried on by Mr. L. H. Woolsey, under the direction of Mr. Cross. Mr. Cross also served as a member of the special committee to revise the rules of the Survey pertaining to Nomenclature, devoting the greater part of his time for one month to the work of this committee.

Dale party.—Mr. T. Nelson Dale continued, throughout the field and office season, work previously inaugurated in New York and Vermont. He was assisted in the field by Fred H. Moffit. Areal mapping to the extent of 213 square miles was done on the Kinderhook, Whitehall, Ticonderoga, Fort Ann, and Wallingford quadrangles in New York and Vermont. In the office, sections and maps for the Mettawee and Taconic folios were prepared, a bulletin (No. 195) on structural details in the Green Mountain region and eastern New York was prepared and submitted for publication, and a paper on the causes of the Taconic landscape was almost completed.

Darton party.—The work of Mr. N. H. Darton throughout the year was done mainly in connection with the Division of Hydrography of the Survey, and was directed toward ascertaining the structure and stratigraphy of the central Great

Plains region. Detailed mapping was continued in the adjoining mountain ranges on the west, where the principal formations are upturned. Several months were spent in the Bighorn Mountains, Wyoming, in the Dayton and Fort McKinney quadrangles, studying the stratigraphy and mapping the greater part of the sedimentary formations for folio publication. In this work Mr. Darton was assisted by Mr. C. A. Fisher, who gave special attention to the coal measures in the Laramie formation. Reconnaissance surveys were extended over portions of the adjoining Cloud Peak and Bald Mountain quadrangles.

Pending the extension of topographic surveys and mapping of pre-Cambrian rocks in the Black Hills, but little field work was done in this region during the last year. Visits were made to various points to obtain special data, particularly in the vicinity of Newcastle, where also Mr. Fisher spent some time studying the relations of the Dakota and Lakota sandstones.

In December Mr. Darton spent several weeks in making a a reconnaissance of the geology near the line of the Santa Fe Pacific Railroad from Albuquerque, N. Mex., to Flagstaff, Ariz., mainly for the purpose of ascertaining the prospects for underground water supplies.

During the winter Mr. Fisher made a reexamination of the Oligocene deposits in a portion of the Platte Valley, from the vicinity of Scotts Bluff to Goshen Hole, to ascertain the limits of the Titanotherium beds (Chadron formation) He found the formations clearly defined, especially by the fossil bones, and verified former mapping.

Prof. J. E. Todd continued, under Mr. Darton's supervision, the mapping of the geology and the study of underground water conditions in the James River Valley. He prepared the Mitchell and Huron folios for publication, and obtained material for a water-supply paper.

Prof. C. M. Hall, also under Mr. Darton's supervision, completed the Castleton and Fargo folios, and prepared a water-supply paper on a portion of the Red River Valley, which is nearly ready for transmittal. He also completed the De Smet folio.

During the office season Mr. Darton prepared the Newcastle (Wyoming) folio for publication, and made considerable progress on maps of the Sundance (Wyoming) folio, now nearly ready for transmittal.

Much progress was made during the last year in the preparation of a preliminary report on the geology and water resources of the central Great Plains, on which Mr. Darton and his assistants have been working for several years. A map of this region, embodying all available data, was prepared, but another season's field work will be required to complete it and to obtain important information on some of the stratigraphic problems. It is believed that in this report on the Great Plains it will be possible to present all the broader features of stratigraphy, structure, and distribution of the principal formations, and to set forth the prospects for underground waters in extensive areas. Additional deep wells will be required to ascertain the water resources in several important districts.

A large amount of correspondence was carried on by Mr. Darton to supply information regarding the prospects for underground waters in various portions of the United States. He also gave attention to the collection and filing of deep-well records throughout the country, and to the collection of data relating to underground temperatures.

Diller party.—Mr. J. S. Diller spent the month of July about Crater Lake, Oregon, studying the development of Mount Mazama and its engulfment, which gave rise to the depression now partly filled by Crater Lake. Water escapes from this lake only by evaporation from the surface and by percolation through the base of the mountain. To determine the amount of the latter, the rate of evaporation from the lake surface and its subsidence were measured and compared, and incidentally the temperature of the lake was observed with specially prepared thermometers to a depth of nearly 2,000 feet.

During August, September, and the early part of October, assisted by Mr. H. R. Johnson, Mr. Diller devoted his time to a preliminary survey of the copper region of the Redding (California) quadrangle, outlining a series of fossiliferous rocks ranging from the Pliocene to the Devonian. These are inter-

sected and interbedded by numerous igneous rocks, in connection with which the deposits of copper ores generally occur.

During the office season Mr. Diller completed the preparation of a paper on the wreck of Mount Mazama, of the Crater Lake region, which has lately been made a national park; and to this paper was added a description of the rocks of that region by Prof. H. B. Patton. The whole is now in press as Professional Paper No. 3. The text of the Port Orford (Oregon) folio was completed and submitted for publication, and the manuscript of a report concerning the physiographic development of the Klamath Mountains (Bulletin No. 196) was revised and enlarged, in accordance with observations made in May and June, 1901, and was submitted for publication. Several months were devoted to studying the notes and collections made in the Redding quadrangle and to the preparation of a preliminary paper on the copper region of California, for publication in the Engineering and Mining Journal.

Mr. Diller continued throughout the year in charge of the petrographic laboratory. Messrs. Fred C. Ohm and William O Ohm were employed continuously throughout the year in making thin sections and otherwise preparing material for petrographic study. Mr. W. S. Robbins assisted in the laboratory from September to February, inclusive, and at other times was employed in connection with petrographic collections. The whole number of thin sections made in the petrographic laboratory during the year is 5,468; besides, 2,650 cuts were made in sawing 765 specimens, and 84 specimens were polished. This is an increase of 1,471 sections over the number made last year.

Mr. Diller served throughout the year as a member of the committee on the Petrographic Reference Collection, and as chairman of the committee on the Petrographic Laboratory.

Eldridge party.—Mr. George H. Eldridge was engaged throughout the year in the examination of the petroleum fields of California. The districts examined embrace the Salinas Valley, the Parkfield region, the Coalinga, Kreyenhagen, Devils Den, Temblor, McKittrick, Midway, Sunset, and Bakersfield districts, all in the San Joaquin Valley; the Santa

Maria field; the Summerland district; the region of the Ojai; the extended valley of the Santa Clara, with its numerous subdistricts, Santa Paula, Sulphur Mountain, Sespe, Torrey Canyon, Piru Creek, Pico, Newhall, and others; the Puenta Hills, an almost continuous field for an east-west distance of between 15 and 20 miles; and the Los Angeles district.

The nature of the work was stratigraphic, structural, and economic. The first involved the study of a number of formations, which in the aggregate embrace hardly less than 25,000 feet of sediments, the entire series, at one horizon or another, being not only oil bearing but oil yielding. The second phase of the work, the structural, was the observation of the folds into which the strata of the productive areas have been thrown, with an attempt to determine their value as bearing upon the presence of petroleum. The third phase involved the examination of several hundred well records, by which a reasonably intelligent view of the underground conditions of the occurrence of the oil has been obtained. Finally, an attempt was made, so far as time permitted, to correlate the formations of the several regions upon stratigraphic and paleontologic grounds, and to accomplish some advance in existing knowledge of the geology of the southern portion of the Coast Range. The field work was practically completed at the close of the fiscal year.

Emerson party.—Prof. B. K. Emerson during the last year completed and presented for publication the results of an investigation of the crystalline rocks of the Providence and Narragansett quadrangles in Rhode Island. This is primarily a study of the green schists and porphyries of the region.

A part of the summer of 1901 was devoted to a reexamination of the rocks of the Becket (Massachusetts) quadrangle, since certain gneisses which had been mapped as sedimentary are now considered to be in part eruptive. This change of opinion has made necessary the restudy of certain parts of Worcester County. Further, the discovery that the Carboniferous rocks of the Worcester Basin have a wide extension westward nearly to the Connecticut River has also made desirable a restudy of other regions in Worcester County.

In the laboratory Professor Emerson made a detailed study of both the basic and the acid rocks of Massachusetts west of the Boston Basin and east of the Housatonic Valley, especially of the interesting Belchertown series, which ranges from tonalite to very basic rocks. The nine quadrangles which make up Worcester County have been mapped, and a revision of this work to correspond with the change of opinion regarding the extent of the sedimentary gneisses and the western extension of the Carboniferous is well advanced. The text of a monograph on Worcester County is also well advanced, and from this can be derived material for the Ware and Quinsigamond folios.

Gilbert party.—Mr. G. K. Gilbert was occupied during the months of July, September, and October in field work in western Utah, the special subject of investigation being the mode of origin of the basin ranges, whether by local uplift or through erosion of the intervening valleys. He was accompanied by Mr. W. D. Johnson, specially detailed from the Division of Hydrography, who acted as topographer and geologist. As topographer he mapped a portion of the west front of the Wasatch Range, the Fish Spring Range, and the greater part of the Swasey Range, and gathered much material for the improvement of the general map of western Utah. As geologist he examined several high peaks west of the Wasatch Range, for the purpose of studying evidences of Pleistocene glaciation. This field work was closed at Salt Lake City, where Mr. Johnson remained to perform the necessary office work on his maps.

Early in October Mr. Gilbert joined the Director at La Junta, Colo., and accompanied him on a geologic reconnaissance in New Mexico, Arizona, and southern California, assisting in detailed field work in the Grand Canyon of the Colorado. Mr. Gilbert returned to Washington November 15.

Office work comprised the continued study of problems connected with the summer's field work, the study of problems of nomenclature and classification arising in the preparation of the Geologic Atlas of the United States, and the revision of manuscripts prepared by others. Mr. Gilbert served as chairman

of the special committee appointed to consider problems of Geologic Nomenclature.

Girty party.—Mr. George H. Girty was occupied during the early part of the field season in northern Ohio, chiefly in Medina County, studying the stratigraphic and faunal succession of the Waverly group. He was assisted for a short time by Mr. Thomas Piwonka.

On the 1st of September Mr. Girty joined Mr. Hill's party at El Paso, Tex. He remained with that party two months, investigating the stratigraphy and paleontology of portions of the trans-Pecos region of Texas and New Mexico.

The office season was occupied by Mr. Girty in the preparation of a number of small reports and on collections made by geologists in connection with their stratigraphic work. He also spent some time in preliminary work on the extensive collection of Upper Carboniferous fossils from Kansas, the basis of a complete report now in preparation; also in writing a preliminary report on notes and collections made in Texas during the year, and a report on the Carboniferous geology and faunas of Colorado, which is practically completed.

Gregory party.—Mr. H. E. Gregory continued his work on the areal geology of Connecticut, under the administrative supervision of Prof. H. S. Williams and the scientific supervision of Professor Van Hise. He was assisted in the field by Messrs. W. E. Ford, jr., and Charles H. Warren. During the field season detailed areal mapping was extended over the Tolland, Woodstock, Putnam, Gilead, Norwich, and Moosup 15-minute quadrangles in Connecticut and the Burrillville quadrangle in Rhode Island Sections were prepared for petrographic study, but owing to demands made on Mr. Gregory's time by his teaching, he made little progress in elaborating the results of his field studies.

Mr. L. G. Westgate submitted a completed report, with specimens, maps, etc., covering his work, previously done as assistant, on the Farmington folio.

Griswold party.—Arrangements were made with the Topographic Branch of the Survey by which the services of Mr. W. T. Griswold were obtained for a portion of the year, for the

purpose of investigating the structure of the Berea grit oil sand in the Cadiz (Ohio) quadrangle. Mr. Griswold had mapped this quadrangle topographically during the earlier part of the season, and in the course of his regular topographic work had obtained valuable data bearing on the problems of economic geology in the region. He was therefore in position to work out the geology of the oil-bearing sands with much more economy than would have been possible without these preliminary observations. He devoted a part of September and October to field work, and during the office season prepared a report, which has been submitted for publication and will shortly appear as Bulletin No. 198. It is believed that the application of exact instrumental measurements marks a distinct advance in the study of oil fields, and that Mr. Griswold's report is of value both for the information it gives to the operators of this particular field and as an example of exact methods in the study of oil fields.

Hague party.—Mr. Arnold Hague was engaged in survey work for about half the time during the last year. He was occupied chiefly in continuing the preparation of a monograph on the Yellowstone National Park. The arrangement and cataloguing of the collections for final deposition in the National Museum was completed, with the exception of the collections illustrating sediments from the geyser and hot-spring areas. Mr. William Hallock, of Columbia University, who was an assistant in the field for three years, has transmitted two reports for publication as parts of the monograph. The first is on the drainage areas of the region, and the second relates to the physics of geysers.

During the latter part of the year Mr. Hague served as chairman of the library committee, and devoted considerable time to the consideration of changes in library administration, with a view to rendering the Survey library more effective.

Hayes party.—Shortly after the discovery of oil at Beaumont, Tex., in January, 1901, Mr. William Kennedy was employed as field assistant, to make a thorough investigation of the stratigraphy and structure of the Gulf Coastal Plain in Texas and Louisiana. This work was continued throughout

the summer, under the immediate direction of Mr. Hayes, who spent the month of October in the field with Mr. Kennedy. Mr. Hayes also spent the greater part of January in this field, and was able to visit and examine all the more promising localities for oil production. Mr. Kennedy completed his field work and returned to Washington on February 19. He was engaged in office work the remainder of the year, in the preparation of a report on the Texas-Louisiana oil fields.

Hill party.—Mr. Robert T. Hill spent September and October in the trans-Pecos region of western Texas, New Mexico, and Arizona. Much additional material was collected concerning the geographic distribution of the mountains and deserts, their geologic structure, and their economic resources. Inasmuch as this region is large and difficult of access, its preliminary examination can not be completed until another year of field work has been devoted to it. It is expected that the results of these studies will then be fully published.

Some time was spent by Mr. Hill in the Coastal Plain region of Texas, in connection with investigations of the oil fields.

A large part of the office season was devoted by Mr. Hill to final proof reading and preparation for publication of Part VII of the Twenty-first Annual Report, consisting of a report on the geology of the Black and Grand prairies of Texas.

In the latter part of May Mr. Hill was granted leave of absence for the purpose of visiting the islands of Martinique and St. Vincent, to study the recent volcanic eruptions in that region. This expedition was under the auspices of the National Geographic Society.

Hobbs party.—Mr. W. H. Hobbs spent two and one-half months in the field, in areal mapping of the metamorphic rocks of Connecticut. He was assisted by Messrs. S. H. Ball and A. F. Smith. The area provisionally surveyed, about 300 square miles in extent, is located in the Danbury, Derby, Bridgeport, and Norwalk quadrangles. This work, with that of previous years, completes the provisional mapping for the Housatonic and Litchfield folios and also of those quadrangles in Connecticut south of the Litchfield to Long Island Sound. The structure of the region is so complicated that it was nec-

essary to extend the provisional mapping over a considerable area in order to ascertain its relations to the surrounding districts. Now that this work has been accomplished, Mr. Hobbs plans to revise the mapping in order to adjust it to the results which have been reached in the region as a whole.

Jaggar party.—Mr. T. A. Jaggar, jr., was engaged throughout the field season, from July to September, inclusive, in the investigation of the Bradshaw Mountains (Arizona) quadrangle and of the mining geology of that region. Some time was devoted to office work in the preparation of the Bradshaw Mountains folio. Mr. Jaggar was assisted in this work by Mr. Charles Palache.

Under Mr. Jaggar's immediate supervision field and office work was continued by Mr. Laurence La Forge and volunteer assistants in the Boston and Boston Bay (Massachusetts) quadrangles for the preparation of the Boston folio.

Mr. Jaggar was also occupied in office work on the Spearfish and Sturgis (South Dakota) quadrangles, in the preparation of the Spearfish-Sturgis folio.

In May Mr. Jaggar left for Martinique for the purpose of studying the volcanic phenomena of the West Indian islands, going under the auspices of the National Geographic Society and of Harvard University.

Keith party.—Mr. Keith began field work August 8, and continued until November 24. He was assisted by Mr. Hoyt S. Gale from July 1 to the end of the field season. Mr. Gale was engaged during July, under Mr. Keith's immediate supervision, in detailed topographic and structural work in the Cambrian quartzites in the northeastern part of the Roan Mountain quadrangle. He also spent a week in mapping the Archean formations along the French Broad River, in the Asheville quadrangle. Mr. Keith's work was along two distinct lines, and consisted in (1) the completion of the geologic work for folio publication in areas previously surveyed, and (2) the determination of the age and stratigraphic equivalence of the Ocoee formations in North Carolina and Tennessee, including new areal work and revision for details. Work was prosecuted in the following quadrangles: Wytheville and Abingdon, in Virginia; Roan Mountain, Asheville, Greenville, and Mount

Guyot, in Tennessee and North Carolina; and Cowee, Mount Mitchell, and Morganton, in North Carolina. The net results of the work of this field season have been the practical completion of field work in the Greenville, Asheville, Mount Guyot, and Mount Mitchell quadrangles, the determination of the sequence and details of Cambrian formations throughout the mountain section of North Carolina and Tennessee, the determination of the Cambrian age of the Ocoee formations and their correlation with the previously known Cambrian series, and the determination of the members and sequence of the Archean and Algonkian formations in the entire area covered by the work.

After the close of the field season the remainder of the year was devoted to office work, which included the plotting of notes and the drawing of geologic boundaries, which work has been completed for the entire area surveyed, with the exception of the Roan Mountain quadrangle, the base map of which is undergoing topographic revision. Office work was also done on the map and sections for the report on the Bingham mining district, Utah, the field work for which was done during the last fiscal year.

Kemp party.—Prof. J. F. Kemp spent a few days in July on the northeastern slope of Mount Marcy, New York, completing observations on the small area in the Marcy quadrangle not previously visited. On August 1, assisted by Douglas W. Johnson, he began work on those portions of the Whitehall and Ticonderoga quadrangles which lie west of the valley of Lake Champlain and on the pre-Cambrian rocks which to a small extent lie east of it, near Whitehall. Important conclusions were reached in regard to the occurrence and distribution of pre-Cambrian and later Paleozoic formations in the Champlain region and in regard to the structure and mineral resources of these rocks. Studies were also made of the Pleistocene geology and physiography of this region, particularly the influence of recent faulting on the present topography.

Professor Kemp spent a few days of September in the study of recently discovered deposits of asbestos in northern Vermont, and he prepared a report on these deposits, which was published in the annual volume on Mineral Resources of the United States for 1901.

Knight party.—Prof. Wilbur C. Knight was engaged for a portion of the field and office season in the areal and economic survey of the Laramie (Wyoming) quadrangle, for use in the preparation of a geologic folio. During the progress of the work conferences were held with Messrs. Emmons and Willis, and the work has been done more or less immediately under their supervision.

Leith party.—Mr. C. K. Leith began the areal mapping of the Mesabi iron-bearing district of Minnesota in the season of 1900–01, and it was resumed by him on July 1, 1901, with Mr. Mark Newman as field assistant. During the previous season the mapping had been extended a little west of Hibbing. During the season of 1901–2 the mapping was extended westward from Hibbing to the Mississippi River, beyond which point it is not practicable to follow the iron-bearing rocks, because of the heavy covering of drift. The length of the western part of the range mapped was 35 miles and the average width 5 miles, making about 175 square miles. On the completion of this work Mr. Leith prepared detailed maps, on a large scale, of interesting localities in the productive portion of the district lying east of Hibbing. A large portion of his time was given to a comprehensive study of the ore deposits of the district. This areal mapping of the district being completed, the field work was closed October 1.

During the remainder of the year Mr. Leith gave his entire time to work on a monograph on the Mesabi iron-bearing district of Minnesota. This monograph has been completed and submitted for publication (Monograph XLIII). It contains 450 pages of typewritten manuscript and is accompanied by a large number of plates, including a detailed map of the district, showing very accurately the distribution of the iron-bearing formation.

Leverett party.—Under the direction of Professor Chamberlin Mr. Frank Leverett was engaged from July 1 to September 30, except for two weeks given to reading the proof of Monograph XLI, in field work in central and western Michigan (Lower Peninsula). This work embraced the mapping of the glacial deposits, with a study of their structure and topog-

raphy and their relation to water supplies. The chief scientific problems involved were (1) the relation of the ice lobes from Saginaw Bay and Lake Michigan, which spread from their respective basins into the western part of the peninsula and produced an intricate system of moraines and drainage channels, which were worked up only in part; and (2) the extent of Lake Chicago beyond the limits of Lake Michigan, and its relations to the retreating ice sheet. This also is not worked out sufficiently to permit conclusions to be drawn, and the work remains to be continued during the present fiscal year. In the early part of October Mr. Leverett mapped the Pleistocene formations of the Kittanning (Pennsylvania) quadrangle. On October 12 work was resumed in Michigan, in the region north of Saginaw Bay, preparatory to the working out of the glacial history of Alcona County, which had been arranged between the Director and State Geologist Lane. The work was extended over Alcona County by November 8, when Mr. Leverett left the field. The winter was given to office work. A brief report of his work in Alcona County was prepared by Mr. Leverett for publication in the annual report of the State geologist of Michigan, in accordance with the previous arrangement with the Director. Reports on the Pleistocene formations of the Olean and Salamanca (New York) quadrangles and the Kittanning (Pennsylvania) quadrangle were then prepared. A considerable part of the winter and spring was devoted to the preparation of a monograph on the products of the glacial lobes of Indiana and Lower Michigan. Mr. Leverett took the field again on May 26, 1902, in northeastern Indiana, and for two weeks gave attention to the relations of the Erie-Saginaw and Lake Michigan lobes, in the northern part of the State. On June 9 he proceeded to Newcastle, Ind., to work out more definitely the border of the early and the late Wisconsin drift and the drainage conditions along and near the drift borders during the drift deposition. This work is still in progress.

Lindgren party.—Mr. Waldemar Lindgren devoted the first part of the fiscal year—from July 1 to the end of October—to the detailed examination of the gravel deposits belonging to

the old Neocene stream system of the Sierra Nevada. Leaving Washington on July 1, Mr. Lindgren arrived in San Francisco on July 11, having remained one week in the vicinity of Salt Lake City in order to study some features of the Bingham mines in company with Mr. Boutwell. From July 11 to October 25 he devoted his entire time to the study of the auriferous gravels, visiting a large number of deposits extending from Tuolumne County to the northern part of Butte and Plumas counties, where the gold-bearing rocks disappear under the cover of the volcanic flows of northern California. A large amount of material bearing on these Neocene rivers was obtained, which it is proposed to embody in a monograph, under the title of "The Neocene rivers of the Sierra Nevada."

Late in October Mr. Lindgren began the mapping of the Clifton (Arizona) quadrangle, which was continued until January 1, when a detailed examination of the copper deposits of that region was begun. This investigation was continued until the middle of March, when the geologic work on the quadrangle was resumed, being completed May 1.

Mr. Lindgren was assisted by Mr. J. M. Boutwell in his work on the gravel deposits of California and later in the Clifton quadrangle; also in the detailed investigation of the mining geology.

Mr. Boutwell returned to Washington early in March to complete his report on the Bingham district, Utah.

Early in May Mr. Lindgren undertook the investigation of certain alleged occurrences of gold in the Cretaceous shales in western Kansas. This examination, together with necessary sampling, occupied his time until May 22, when he returned to Washington. Throughout the remainder of May and the whole of June Mr. Lindgren was occupied in office work, consisting in part of the study of notes and collections from Arizona, but largely also in the examination and assaying of samples of the alleged gold-bearing shales from Kansas.

During the year Mr. Lindgren published two papers, one in the Transactions of the American Institute of Mining Engineers, entitled "The character and genesis of certain contact deposits," and the other in the Twenty-second Annual Report

of the Survey, entitled "The gold belt of the Blue Mountains of Oregon."

Prosser party.—Prof. Charles S. Prosser was occupied in office work throughout the greater part of the year, until the beginning of June, 1902. His work consisted of the revision of the maps, sections, and text for the Cottonwood Falls (Kansas) folio, the field work for which had been revised by Mr. J. W. Beede, under the supervision of Mr. George I. Adams, during the previous summer. In connection with this work Professor Prosser reviewed the literature and classification of the Upper Paleozoic formations of the Great Plains, and prepared a paper on this subject, entitled "A revised classification of the Upper Paleozoic formations of Kansas," which appeared in the Journal of Geology. Under the auspices of the Ohio geological survey, Professor Prosser studied the Devonian and Carboniferous formations of Ohio, and published some of his results in the Journal of Geology, in a paper entitled "The Sunbury shale of Ohio." This work was regarded as a necessary prerequisite for the mapping of the East Columbus quadrangle.

In June, 1902, field work was begun in the Columbus quadrangles, with a view to the preparation of a geologic folio. Professor Prosser was assisted in this work by Mr. Edgar R. Cumings.

Ransome party.—Mr. F. L. Ransome was assigned to two distinct fields of work during the last year—(1) the detailed investigation and geologic mapping of the Globe (Arizona) quadrangle, including a study of the copper deposits of the district and the preparation of a special geologic map, on a scale of 1,000 feet to the inch, of the country adjacent to the more important mines; and (2) a geologic reconnaissance of a strip of country, from 10 to 20 miles wide, lying immediately south of the forty-ninth parallel and extending from Porthill, on the Kootenai River, in northern Idaho, to Lake Osoyoos, in northern Washington.

Late in June, 1901, Mr. Ransome organized a field party, with Mr. William J. Sinclair as assistant, at Bonners Ferry, Idaho, and started westward. The reconnaissance was completed on September 3, and on that day Mr. Sinclair was left

in charge of the party, at Lake Osoyoos, with instructions to return to Bonners Ferry by the most convenient route and disband the party. This was successfully accomplished, and Mr. Sinclair concluded his field season at Spokane on the 30th of September. The object of this work, which was done at the request of the Department of State, was to determine the condition of monuments and trails on the international boundary, and to make a geologic reconnaissance of the region.

From Osoyoos Lake Mr. Ransome returned to Washington, and was engaged during the latter half of September and the first half of October in the preparation of a preliminary report on the conditions of the monuments, the state of the roads and trails, and the general character of the mineral resources of that section of the Northwest Boundary region traversed by his reconnaissance. He was also occupied in part during this time in reading proofs of reports on the Silverton and Rico districts, in Colorado, and in selecting and transmitting to the National Museum representative collections to illustrate the economic geology of those districts.

Field work in the Globe district of Arizona was resumed October 20, with Mr. John D. Irving as assistant, and was completed by the end of January. Detailed mapping of this district developed unlooked-for geologic complexity. Probably very few regions exhibit so well exposed and intricate a network of closely spaced faults.

Mr. Ransome returned to Washington on February 6, and began the preparation of maps and text for a report and a folio on the Globe quadrangle, both of which have been completed and transmitted for publication.

During the year Mr. Ransome served as a member of the committees on Petrographic Reference Collection and Geologic Names. As a member of the Northwest Boundary committee, he assisted in preparing a joint report on the field operations of the last season and their results in so far as the latter bore on questions raised by the Department of State. The purely geologic results of the Northwest Boundary reconnaissance were not included in that report, and will be published at some future time.

During the year Mr. Ransome published "The economic geology of the Silverton quadrangle," as Bulletin No. 182, and "The ore deposits of the Rico Mountains," in the Twenty-second Annual Report, Part II.

Salisbury party.—Prof. R. D. Salisbury was engaged throughout the field season in directing the work of various assistants in Montana, Wyoming, and Utah. He also examined certain areas in the mountains of Colorado, with a view to the direction of future work, and inaugurated work in the mountains near Santa Fe, N. Mex. In the latter region he was accompanied by Messrs. John E. Webb and William A. Averill, volunteer assistants, who continued the work during the available season.

Under the direction of Professor Salisbury, Mr. W. W. Atwood was engaged for about two months—in July, August, and September—in the study of the glacial phenomena of that portion of the Wasatch Mountains which lies between parallels 40° 15′ and 41°, and which is within the Salt Lake quadrangle. Within this area the positions of fifty Pleistocene glaciers, each exceeding a mile in length, were determined. Traces of several smaller glaciers and of more than a dozen névé fields were also found and mapped. The work of the season proved that there were in these mountains at least two ice epochs, separated by a long interglacial interval. Mr. Atwood was accompanied by Messrs. William Peterson, William J. Averett, H. B. Atwood, and Arthur Church, who served as volunteer assistants.

Also, under the immediate direction of Professor Salisbury, Mr. Fred H. H. Calhoun, accompanied by Mr. Bruce MacLeish as a volunteer assistant, was engaged in July, August, September, and the early part of October (three months only) in the examination of the Pleistocene formations in the northern part of Montana. The area studied embraced about 8,000 square miles, lying just south of the forty-ninth parallel and just east of the Rocky Mountains. The purpose of the study was to map the glacial formations produced by the continental ice sheet moving from the northeast, on the one hand, and the tongue-like glacial formations produced by the mountain glaciation from the west, on the other hand.

Under Professor Salisbury's direction, Messrs. George H. Garrey and Eliot Blackwelder were engaged during August and September in the mapping of the glacial formations in northwestern Montana, northern Idaho, and northeastern Washington, the greater part of the time being spent in the latter State, between Chelan Falls and Newport. The purpose of the work was to outline the southern limits of glacial formations produced by the Cordilleran ice sheet.

Otis Smith party.—Mr. George Otis Smith, assisted by Mr. Frank C. Calkins, was occupied from July to October in making a reconnaissance along the international boundary in the western part of Washington. The district between Lake Osoyoos and Blaine, Wash., was traversed, the monuments along the international boundary were inspected, and the greater part of the area was mapped, both topographically and geologically. The results of this field work were incorporated in the joint report to the Secretary of State, made in cooperation with Messrs. Willis and Ransome. Another joint report was prepared, in cooperation with the same gentlemen, respecting a route for the proposed trail in the vicinity of the international boundary. A brief article descriptive of the geology of the Mount Baker mining district was also prepared and published in the Engineering and Mining Journal.

During the remainder of the office season the text and maps for the Ellensburg folio were completed and transmitted for publication, and office work was also done on the Mount Stuart folio. A paper entitled "The geology and physiography of central Washington" was prepared and transmitted for publication as a professional paper; a brief paper on the ore deposits of the Tintic district, Utah, was presented at the Philadelphia meeting of the American Institute of Mining Engineers; and an introductory chapter on the geology of Maine was prepared for publication in a water-supply paper.

Mr. Smith served during the year on the committee on Petrographic Reference Collection and spent some time in the review of referred manuscripts.

Tangier Smith party.—Mr. W. S. Tangier Smith was engaged throughout the field season, from July to the middle of

November, in an investigation of the lead and zinc deposits of the Ozark region, having been assigned to that work in the spring of 1901, with a view to the preparation of a monograph on the lead and zinc deposits of the region. He was occupied in a detailed investigation of the stratigraphy and structure of the Joplin district, together with a study of the distribution and association of the various minerals of the region, with special reference to the economic problems involved. Some work was also done in southwestern Missouri outside of the Joplin district. During the last month in the field Mr. Smith was assisted by Mr. F. B. Laney.

Mr. Smith was engaged during the office season largely in the preparation of folio material based on field work in the Black Hills and southeastern Wyoming during the preceding season. The remainder of the time was occupied in working up the material obtained in the Joplin district.

Spencer party.—Mr. Arthur C. Spencer was, at the beginning of the fiscal year, still employed in field work on the geology of Cuba, on which he had been engaged since April, 1901. Returning to Washington July 15, he was occupied until November 1, in cooperation with Mr. Vaughan, in the preparation of a report on the reconnaissance of Cuba, made under the direction of Mr. Hayes.

After December 1 Mr. Spencer gave some time to the examination of referred manuscripts, but was principally engaged in a study of the origin of the mountain features of Alaska and British Columbia. The results of this investigation are of a general nature and tend to show that the present relief of that portion of North America which lies north of the United States and adjacent to the Pacific Ocean has originated since the Eocene Tertiary, through regional uplift unaccompanied by tangential compression of the earth's crust. The results of this study are embodied in a paper to be published in the Bulletin of the Geological Society of America.

Spurr party.—Mr. J. E. Spurr was on leave of absence for the greater part of the year, being employed as consulting mining engineer and geologist for the Sultan of Turkey. He returned in the early part of June, 1902, and began preparations for field work in a mining district in the West.

Stose party.—Mr. George W. Stose was occupied throughout the year chiefly with the duties connected with the editing of geologic maps. The report of this work will be found on pages 168 to 172.

During the field season, from July 1 to the middle of October, Mr. Stose spent some time in field work in the survey of the Chambersburg (Pennsylvania) quadrangle and in a reconnaissance of the adjacent areas on the east and west. This region is one which exhibits typically the structures of the Appalachian Valley belt. It contains sedimentary rocks ranging in age from Lower Cambrian to Upper Silurian, as well as pre-Cambrian volcanic rocks. The strata are intricately folded and faulted and have well-developed schistosity.

Field work on the Chambersburg folio was well advanced, but was not entirely completed during the field season.

Taff party.—Mr. Joseph A. Taff was occupied from the beginning of the year until August 18 in the completion of areal and economic surveys of the Tahlequah and Sallisaw (Indian Territory) quadrangles. About half of the Sallisaw quadrangle had been surveyed in 1899. Mr. Taff was assisted by Mr. George I. Adams from the beginning of the season until August 1, and by Mr. C. N. Gould until October 10. On the completion of work in these two quadrangles he undertook a special reconnaissance of the Arbuckle and Wichita mountains. In this work, which was completed at the end of October, he was assisted by Messrs. C. N. Gould and E. O. Ulrich.

In the reconnaissance of the Arbuckle and Wichita mountains, in which the assistance of Mr. Ulrich was especially valuable, the following important scientific conclusions were reached: (1) That the large igneous masses in the axial parts of both these ranges are pre-Cambrian; (2) that a thick section of Cambrian and Ordovician sediments rests upon these old igneous masses; (3) that a widespread chert formation lying between the Silurian and Mississippian rocks is of Devonian age; (4) that the Arbuckle, and probably the Wichita, uplift occurred during the latter part of the Carboniferous and before the deposition of the Red Beds, and that the Red Beds now rest unconformably across all older Paleozoic rocks in the

west end of the Arbuckle Mountains and extend completely around the Wichita Mountains unconformably upon older strata. Abundant collections of fossils were obtained from the Cambrian and Silurian formations.

During the office season, in addition to carrying on other work, Mr. Taff was occupied in the compilation of notes on the Sallisaw and Tahlequah quadrangles and of notes made during the reconnaissance of the Wichita Mountains, and in the preparation of descriptive text for the Atoka and Tishomingo folios, preliminary text for the Tahlequah folio, and a preliminary report on the geology of the Arbuckle and Wichita mountains, in Indian Territory and Oklahoma.

Taylor party.—Under the direction of Professor Chamberlin, Mr. F. B. Taylor was engaged from July 1 to July 20 in field work on the Pleistocene geology of the Housatonic (Massachusetts) quadrangle, in extension of work begun in October, 1900. From July 21 to September 8 he was engaged in the preparation of a report and maps for the surficial geology of the Housatonic folio. From October 7 to November 26 Mr. Taylor was employed in field work on the surficial geology of the Taconic (New Hampshire–Massachusetts–New York) quadrangle. From December 16 to December 23 he was engaged in preparing a map for the geologist in charge of Pleistocene geology, showing the progress of work in the Taconic quadrangle. From June 1 to June 30, 1902, he was engaged in preparation for field work and in field work in the Taconic quadrangle.

Ulrich party.—Mr. E. O. Ulrich was engaged from July 1 to August 16 in field study of stratigraphic and paleontologic problems presented by the Paleozoic rocks in the southern half of the Appalachian Valley. Much evidence, both structural and faunal, was obtained tending to show that the Silurian deposits on the opposite sides of the valley were laid down in separate bodies of water, and that the line of the ancient barrier between the two is now roughly indicated by the northwestern border of the Tellico sandstone and the southeastern margin of the Rockwood formation.

On August 20 Mr. Ulrich joined Mr. Taff's party at Kiowa,

Ind. T., and remained with him until the close of the season, at the end of October. During this time he was engaged in investigating the Paleozoic rocks in the Arbuckle Mountains of Indian Territory and the Wichita Mountains of Oklahoma. This work resulted in important stratigraphic and paleontologic conclusions, and in the determination of the standard section for the Paleozoic strata of this region (see "Taff party," p. 58.)

In November Mr. Ulrich spent a few days in the examination of deposits of lithographic stone in eastern Kentucky, and subsequently prepared a report on the subject, which was published in the Engineering and Mining Journal.

The office season was devoted to the study of collections of Silurian fossils submitted by various members of the Survey, and to the preparation of reports on their geologic age. Some time was devoted to the preparation and preliminary study of Silurian fossils collected in the Southern Appalachian Valley, and to the preparation, in association with Mr. Charles Schuchert, of a preliminary paper on Paleozoic barriers and seas, for publication by the regents of the New York State Museum. Some time was also given to the text and maps for the Columbia (Tennessee) folio and to the text and illustrations for three reports on Miocene fossils, for publication by the Maryland geological survey. The first of these deals with the Ostracoda, and contains descriptions of 25 new species; the second describes the Bryozoa, of which 30 species were found to be new; and the third is on the hydroid corals, of which one new genus and three new species are described. A report was also prepared on the marine algæ and other fossils from Alaska collected by the members of the Harriman expedition and believed to indicate early Jurassic. This report will be published with the reports of that expedition.

Vaughan party.—Mr. T. Wayland Vaughan was engaged from July to December in the preparation of a report on the geologic reconnaissance of Cuba, made for the Insular Government, under the direction of Mr. Hayes, in the latter part of the preceding year.

From December to February he was occupied in work on the various paleontologic collections of the United States

Geological Survey deposited in the National Museum. A collection of Miocene and Upper Oligocene mollusks, made by himself in 1900, was identified, labeled, and catalogued. Papers were prepared on the Pliocene and Pleistocene fossil corals collected at Deadmans Island, off San Pedro, Cal., for Mr. Ralph Arnold, of Leland Stanford Junior University, and on the Miocene corals of Maryland and Virginia, for the Maryland geological survey.

On March 3 Mr. Vaughan began field work in the Gulf Coastal Plain, visiting localities in Texas, Louisiana, Alabama, Georgia, and North Carolina. His work consisted of the collection of fossils and a study of the stratigraphy of the region, with special reference to a monograph on fossil corals which he has in preparation.

Mr. Vaughan returned to Washington June 16, and devoted the remainder of the year to office work.

Weed party.—Mr. Walter H. Weed was assisted during the field season by Prof. Joseph Barrell and Mr. Ralph W. Stone, who were occupied from July to the end of September, under Mr. Weed's immediate direction, in mapping the areal geology of the Marysville (Montana) quadrangle and in studying the geologic structure of that region. Mr. Weed spent four weeks in July and August with the party in the Marysville quadrangle, chiefly in the investigation of the ore deposits of the Drum Lummon and Bald Butte mines and other ore deposits of that district. In the latter part of September Professor Barrell was obliged to return to his university duties, and field work was carried to completion by Mr. Stone. The work has served to elucidate the complicated geology of an area which, though small in extent, embraces some of the largest gold mines in the State of Montana. The facts gathered will permit the publication of a report which will give a full description of these interesting deposits and throw light on the occurrence of ore bodies in similar deposits in Montana and elsewhere. On the completion of the Marysville work, Mr. Stone assisted in the underground work at Butte, Mont.

Throughout the months from July to December, inclusive, with the exception of four weeks spent in the Marysville

quadrangle, Mr. Weed was employed in the investigation of the copper deposits of Butte, Mont. In this work he was assisted by Mr. H. W. Teague, as draftsman and underground assistant, with temporary employees for drafting and some underground surveying. This work was not completed when Mr. Weed left the field on the 11th of December, returning with Mr. Stone to Washington, by way of Diamondville, Wyo., where a short stop was made to examine the coal mines in that vicinity.

In January Mr. Weed was directed by the Secretary of the Interior to visit the hot springs of Arkansas and make an examination of the various springs, with the object of identifying each spring in such a manner as to permit a correlation of notes made by previous observers and the analyses made by the Department of Agriculture. He was further directed to prepare a short popular account of the geologic features of that region; this has been published by the Department of the Interior in connection with the analyses of the hot waters.

In February Mr. Weed was granted leave of absence, permitting him to make a trip to Sonora, Mexico, on private work, in the course of which he obtained valuable geologic information which will be of service in connection with the studies of the geology of Arizona ore deposits, under investigation by the Survey.

During the remainder of the office season Mr. Weed was engaged chiefly in the preparation of his report on the ore deposits of the Butte, Mont., district.

Professor Barrell contributed his time gratuitously to the working up of his notes on the Marysville locality throughout the winter, and his report is now well advanced.

Mr. Stone assisted Mr. Weed for a short time in office work, and was then assigned to Mr. M. R. Campbell.

Weeks party.—Mr. F. B. Weeks was engaged in office work throughout the entire year. During the year he completed the manuscript for a "Bibliography and index of North American geology, paleontology, petrology, and mineralogy for the years 1892 to 1900, inclusive," which forms Bulletins Nos. 188 and 189. He also completed the manuscript for "North

American geologic formation names: bibliography, synonomy, and distribution," which has been published as Bulletin No. 191. Much time was consumed in reading the proof of these publications.

Mr. Weeks has prepared and now has ready to submit for publication the manuscript of the annual "Bibliography and index of North American geology, paleontology, petrology, and mineralogy for the year 1901," which will be published as Bulletin No. 203.

Thoughout the year Mr. Weeks served as a member of the committee on Geologic Formation Names, and as secretary of the committee on Classification and Nomenclature.

White party.—Mr. David White spent the greater part of July in collecting fossils from the "lower red ash group" of coals in the northern anthracite field of Pennsylvania, and in a stratigraphic study of this group, with a view to the identification of the beds at a number of localities and the reference of the series to the subdivisions of the Coal Measures generally recognized in other portions of the Appalachian region. From August 15 to October 24 he was occupied in special studies of various portions of the Southern Appalachian coal field in northwestern Georgia and northeastern Alabama and the Chattanooga region of eastern Tennessee, for the purpose of obtaining stratigraphic and paleontologic data for the classification and correlation of the numerous formations in the Upper Carboniferous locally recognized in these districts. A large part of the time Mr. White was occupied in gathering paleontologic material, in which he was assisted by Mr. T. E. Williard, chiefly in the Birmingham district in Alabama.

During the office season reports were prepared on the coals of the Pottsville, Allegheny, and Conemaugh formations of the bituminous coal fields of Pennsylvania, and on coals of western Maryland. These reports form parts of the series of papers on the coal fields of the United States published in the Twenty-second Annual Report, Part III.

A summary of the floras of the Upper Carboniferous and Permian formations of Kansas was prepared and submitted for publication as a part of a bulletin by George I. Adams on

the Coal Measures of Kansas. This report contains such correlations of the terranes as seemed to be warranted by the paleobotanic material now in hand.

The remainder of the office season was occupied with informal examinations and reports for various geologists on Paleozoic plant materials from Indian Territory, Arkansas, West Virginia, Pennsylvania, Maryland, New York, and Maine; in the identification of small collections for the National Museum; and in the continuation of the monographic study of the Pottsville floras. Owing to the limited funds available for this study, progress was small, work being confined to the floras of the Pottsville in the States north of the Ohio and Potomac rivers.

Several minor papers, based in part or wholly on material in the collections of the United States National Museum, were prepared or published during the year.

Williams party.— Prof. H. S. Williams continued throughout the year his investigations in Devonian paleontology and correlation, assisted by Mr. E. M. Kindle. In connection with the mapping of the areal geology of the Olean and Salamanca (New York) quadrangles, questions of classification and correlation arose, pertaining chiefly to Devonian formations. Special investigations were directed to the solution of the difficulties by a detailed study of the Devonian faunas of this province. Full collections of the successive local faunas were made in the counties of Columbia, Northumberland, Bradford, Tioga, and Potter, in Pennsylvania, and from the adjoining counties in New York, for the purpose of gaining evidence as to the geographic distribution and modification of these faunas and of their relationship to the lithologic character of the formations. An analysis was completed of two long local sections (Catawissa and Leroy), for which faunal charts were prepared, throwing much light on the special problems as well as on the general principles to be applied in correlating formations by means of their fossil faunas.

In connection with this series of investigations Mr. H. F. Cleland completed a report on the analysis of the fauna of the Hamilton formation as seen in the Cayuga Lake section, cen-

tral New York. The Tropidoleptus fauna, of the Hamilton formation, has been subjected to exhaustive analysis, and a paper has been prepared showing its geographic and geologic relations. In this study some important results regarding the lapping of clearly defined and distinct faunas have been reached.

The work of elaborating the Chapman sandstone fauna of Maine was continued during the year. A collection of the St. Helens Island breccia, obtained through the assistance of the geologic department of McGill University, was arranged and labeled, and preliminary studies were made which will lead to valuable conclusions regarding the age of these rocks.

Collections from the Globe and Clifton (Arizona) quadrangles were examined and their geologic values reported on.

During the year a convenient laboratory for the storage and use of the Devonian collections of the Survey was arranged in connection with the geologic department of Yale University.

Willis party.—On the 1st of July Mr. Bailey Willis entered upon a reconnaissance of the region adjacent to the forty-ninth parallel between west longitudes 113° 30′ and 116° 30′. The primary object of this reconnaissance was to ascertain the condition of marks and monuments along the international boundary. The work was performed in accordance with instructions from the Secretary of State. Mr. Willis was assisted by Prof. Stuart Weller and Mr. George I. Finlay. Field work occupied the months of July, August, and September. The party went from Duck Lake, Montana, by way of Waterton Lake, Canada, south to McDonald Lake, which was reached on August 11. Thence the route was up the North Fork of Flathead River to the boundary and westward to Tobacco Plains, at which place the party was reorganized, September 9–11. After crossing the Kootenai River the party proceeded by the old boundary trail to the forks of the Yaak, whence the major part of the outfit was sent out to Libby, on the Great Northern Railroad, on the 17th of September. From the Yaak to the Mooyie River no trail exists across the heavily timbered Yaak Mountains, and from Mooyie to Porthill the Canadian Pacific Railroad furnished the only available

outlet. With one companion Mr. Willis traversed this portion of the line, and arrived at Bonners Ferry on September 26. Proceeding thence to Kalispel, he disbanded his party and returned to Washington, arriving October 4.

In connection with the special investigation of the boundary monuments, Mr. Willis examined the stratigraphy and structure of the northern Rocky Mountains in Montana and Idaho. It was ascertained, on the basis of fossils collected by Mr. Weller, that the strata of the Rocky Mountains are chiefly of Algonkian age. In structural geology the most important observation related to the existence of a great overthrust fault by which Algonkian rocks have been shoved northeastward at least 7 miles, upon the Cretaceous of the plains.

During the winter Mr. Willis, in connection with his administrative duties, was engaged in preparing a report on the examination of the Northwest boundary, being associated with Messrs. Ransome and Smith of the Geologic Branch, Barnard of the Topographic Branch, and Sinclair of the Coast and Geodetic Survey. This report was completed and submitted to the Director on March 7, 1902.

As an incidental result of the reconnaissance described, the geologic observations have been cast into an article on the stratigraphy and structure of the northern Rocky Mountains in Montana, which will appear in the Bulletin of the Geological Society of America.

Wolff party.—During the field season of 1901 Prof. John E. Wolff completed the mapping of the pre-Cambrian rocks which occupy the southeastern portion of the Equinox (Vermont) quadrangle. He also completed the revision of parts of the Greylock quadrangle, forming a part of the area of the Taconic folio. This was done in part in company with Professor Van Hise and others, in order to settle certain disputed points as to the proper correlation of some of the formations. Generally satisfactory results were obtained. During the remainder of the field season work was done in the western and southwestern portions of the Wilmington (Vermont) quadrangle. During the winter, in office, work was continued on the Franklin (New Jersey) folio, which is practically completed.

WORK OF PALEONTOLOGIC PARTIES.

Dall party.—Mr. William H. Dall was engaged during the early part of the year in field work on the Pacific coast, examining the Tertiary formations in the Carson and Eureka districts, in cooperation with Mr. J. S. Diller. On the completion of this work Mr. Dall proceeded to the vicinity of San Francisco, where he expected to meet Dr. J. C. Merriam, of the University of California, for the purpose of examining characteristic localities of the San Pablo and other formations recently discriminated. In the absence of Dr. Merriam Mr. Dall proceeded to the San Pedro region, where many collections have recently been made by local geologists, whom he has been for some time assisting, by correspondence, in identifying fossils and in other ways. Mr. Dall spent several days in the San Pedro district, when he was suddenly recalled to Washington.

During the year Mr. Dall devoted several months to work on a collection of Tertiary fossils gathered by Mr. Palache, of the Harriman expedition, on the peninsula of Alaska, north of the Shumagin Islands. These fossils he was able to identify as Eocene and thus to fill the gap previously existing in the geologic column of Alaska between the Middle Cretaceous and the Oligocene lignite beds, on which he had reported several years ago.

On the completion of the report on these Alaska fossils Mr. Dall took up his work on the Tertiary fauna of the southeastern Coastal Plain of the United States, on which he has been engaged for several years. Good progress was made in this work, and it is hoped that its conclusion will be reached during the present year.

During the year Mr. Dall examined and reported on the geologic horizon of a large number of collections of fossils brought in by members of the Survey, particularly by Messrs. Diller, Vaughan, Gilbert, Hamlin, Becker, and Arnold. None of this work is in arrears. Many demands on his time and attention have been made by students throughout the United States in the form of requests for identification of fossils, advice in regard to collecting fossils, making stratigraphic observa-

tions, etc. Although consuming much time, this work is regarded as highly important, since it keeps the Survey work in touch with the private student, and interests many who subsequently are able to render substantial service to science. One hundred and nine such requests were made and attended to during the year.

Mr. T. Wayland Vaughan cooperated with Mr. Dall during part of the year and rendered much service in the arrangement of the collection of Eocene material in a provisional way, pending the final study of the same.

Mr. Frank Burns was engaged chiefly in cleaning, sorting, and registering material in the collection during a large part of the year. In April, May, and part of June he was engaged in field work, collecting in South Carolina and North Carolina.

The Maryland geological survey has made extensive use of the Survey collections in connection with its reports on the Tertiary geology of the State, and facilities for study, specimens for figuring, and general advice have been freely placed at the disposal of Messrs. Martin and Glenn, engaged by the State survey in this work.

Knowlton party.—Mr. F. H. Knowlton was occupied during the month of July at The Dalles, Oreg., in collecting fossils from the John Day Basin of north-central Oregon. He was assisted by Prof. John C. Merriam, of the University of California. The object of this field work was, in addition to collecting fossils, to study the formations in place and determine their field relations, before publishing a report on the fossil flora. Collections of plants were obtained from the Clarno and Mascall formations at Cherry Creek, Bridge Creek, Van Horn's ranch, and a number of minor localities.

On the completion of this field work Mr. Knowlton proceeded to San Francisco, where he spent three weeks in studying the collections of Tertiary plants in the University of California. This work proved of great value, as it enabled him to correct a number of errors regarding the distribution of the plants of the auriferous gravels of California and of the John Day Basin.

Mr. Knowlton returned to Washington on September 1 and began the preparation of a final report on the fossil flora of the John Day Basin, which was completed about the middle of April and submitted for publication as Bulletin No. 204. He has since been engaged in the preparation of a monograph on the flora of the Puget formation.

At intervals during the year Mr. Knowlton was called upon to study and report on collections of fossil plants obtained by various members of the Survey and others. The following collections were studied and reported on: From the Snake River Plains, Idaho, for Prof. I. C. Russell; from near Hyampom, Cal., and from Hayfork, Trinity County, Cal., for Mr. J. S. Diller; from Kowak River Valley, Alaska, for Mr. W. C. Mendenhall; from southern California, for Mr. Whitman Cross; from Washington, for Mr. George Otis Smith; from the vicinity of the Bighorn Mountains, Wyoming, for Mr. N. H. Darton; fossil plants obtained by the Harriman Alaskan expedition, for Mr. G. K. Gilbert; plants from Montana, for Mr. Earl Douglas; from western British Columbia, for the geological survey of Canada; and fossil plants obtained by Mr. Bailey Willis on the Northwest boundary survey.

Osborn party.—Prof. Henry Fairfield Osborn continued throughout the year in charge of vertebrate paleontology. With the assistance of Messrs. W. K. Gregory and Abram E. Anderson, the monograph on the Titanotheres was pushed forward as rapidly as possible. This work was more difficult than had been expected, but it promises to reach satisfactory conclusion, and will probably be ready for publication within a few months. Elaborate studies and measurements have been made in the collections of the National, Carnegie, Harvard, and Yale museums and in the American Museum of Natural History. Under Professor Osborn's direction Mr. N. H. Darton, accompanied by Messrs. J. B. Hatcher and Eberhard Fraas, made a special survey of the titanothere beds of South Dakota. Fairly accurate measurements were made of the levels at which the different species occur, which served more exactly to define the Oligocene distribution of these animals.

Considerable progress was also made on the monograph on

the Sauropoda, especially in the collection of material and in the examination of collections in the Carnegie, National, and American museums.

Arrangements were made for the selection of Mr. J. B. Hatcher as the author of the monograph on the Ceratopsia, and of Mr. F. A. Lucas as the author of the volume on the Stegosauria.

Considerable correspondence was had with various members of the Survey regarding paleontologic questions which arose from time to time, and a report was made to the Director on the question of classification and nomenclature.

Ward party.—Mr. Lester F. Ward was engaged during the entire year in the preparation of the second paper of a series on the status of the Mesozoic floras of the United States, of which the first paper was published in the Twentieth Annual Report, Part II. The chapter on the older Mesozoic of Arizona embodies the results of investigations made in the fall of 1899 and the spring of 1901. The chapter on the Jurassic flora of Oregon consists chiefly of an extended systematic paper describing a large flora from that region, prepared by Professor Fontaine and edited by Mr. Ward. The chapters on the flora of the Shasta formation and on the Kootanie flora of Montana are by Professor Fontaine, and have been waiting for some time to be introduced in their proper place. The chapter on the Potomac formation, which is to be somewhat extended, is not yet completed. The historical part was finished at the end of April, but there is in Professor Fontaine's hands a large amount of new material sent him by the State of Maryland, according to an agreement between the Geological Survey and that State. His report is to be embodied in the present paper, with the understanding that the State survey will republish it, using the same plates.

The usual amount of bibliographic work on paleobotany was done during the year, chiefly by Miss Schmidt, who spent the month of May in the libraries of Boston and Cambridge in connection with the work.

ALASKA.

Throughout the early part of the year the general supervision of Alaskan work was continued in charge of a committee composed of R. U. Goode, geographer, and Bailey Willis, Assistant in Geology to the Director. In February Alfred H. Brooks was appointed geologist in charge of geologic work in Alaska, and was put in administrative charge of all the geologic work carried on by the Survey in the Territory. Mr. Goode, in charge of the topographic work, and Mr. Brooks were appointed as a committee for the consideration and submission of plans for Alaskan surveys.

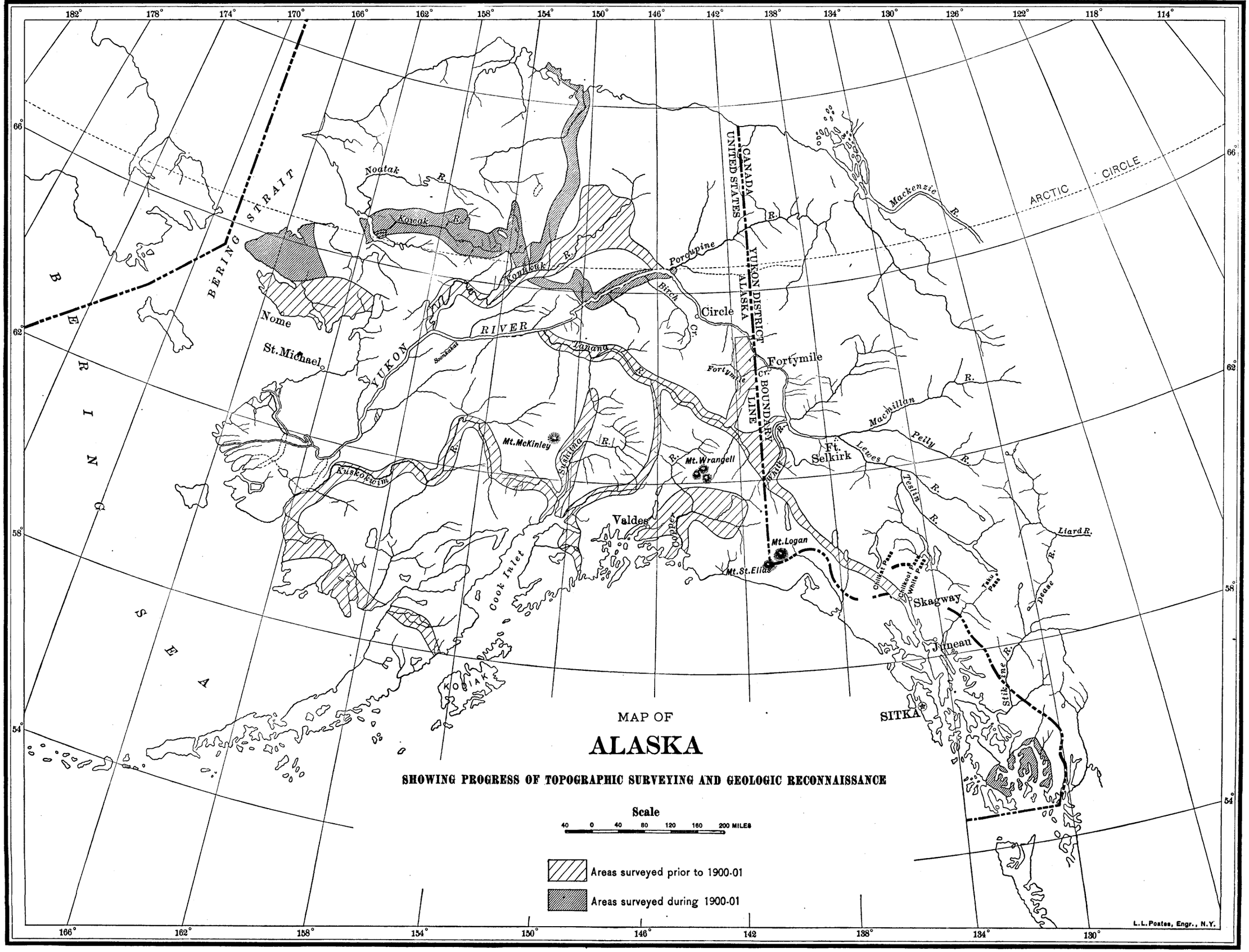
The appropriation of $60,000 for the investigation of the mineral resources of Alaska permitted the sending to the field of four parties, three of which were equipped for both geologic and topographic work. Of these, two worked in the region north of the Yukon, one in Seward Peninsula, and one in southeastern Alaska. The two northern parties were engaged in reconnaissance and exploratory work; the Seward Peninsula party did areal mapping and paid special attention to the placer deposits of that region; the southeastern Alaska party made an examination of the Ketchikan mining district, where important developments are going on, and a preliminary geologic reconnaissance of all southeastern Alaska.

Pl. I shows the results of the work in Alaska to date.

Besides the office work connected with the field parties, a topographic map of Alaska was compiled by Mr. E. C. Barnard. On this map all the most recent topographic data were brought together.

WORK OF ALASKAN PARTIES.

Brooks party.—The party in southeastern Alaska was in charge of Alfred H. Brooks. A report on the coal resources of Alaska kept him in Washington until the latter part of June, and hence his field season was very short. Accompanied by Mr. Corey C. Brayton, geologic field assistant, he reached Ketchikan on the 15th of July, where several days were spent in outfitting and organizing a party. A gasoline launch had been brought from Seattle, and on this the party



MAP OF

ALASKA

SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING AND GEOLOGIC RECONNAISSANCE

Scale

40 0 40 80 120 160 200 MILES

Areas surveyed prior to 1900-01

Areas surveyed during 1900-01

L. L. Postes, Engr., N.Y.

of four lived and traveled during the progress of the work. As there was not sufficient money to permit systematic topographic work to be carried on, the reconnaissance chart of the Coast and Geodetic Survey was used as a base map for the geologic investigations. This was supplemented by such sketches and corrections as time and means permitted.

The party left Ketchikan on July 18, and made its way to Helm Bay and Smuggler Cove, on Cleveland Peninsula, where the gold deposits were examined. From this point the party encircled Revillagigedo Island, visiting Neets Bay, Bell Island, and Burroughs Bay en route. This trip was made for the purpose of determining the relation of the sedimentary beds to the granite of the Coast Range. Next, the gold-bearing properties near the upper end of Thorne Arm were examined, and the silver and lead deposits of George Inlet. The mining claims bordering on Tongass Channels were then visited, and after procuring additional supplies and fuel at Ketchikan the party proceeded to the lower end of Gravina Island, where several days were spent in examining the copper deposits of Seal Bay and Dall Head. On August 4 the party crossed Clarence Strait and spent several days in a hasty examination of some of the more important copper and gold claims in the vicinity of Niblack Anchorage. From this point a reconnaissance of Moira Sound was made, which was extended to the head of North Arm, where examination of the mining claims occupied the party until August 11. Two days were spent in the gold-bearing region in the vicinity of Dolomi, Johnson Inlet. The party then proceeded to the head of North Arm of Cholmondeley Sound, and made a trip across the portage and down Hetta Inlet to Copper Mountain, where a day was spent. Later the copper deposits on the South Arm of Cholmondeley Sound were examined, and the gold deposits of Kitkun Bay. Two days were spent in Skowl Arm, and on August 24 the party reached Kasaan Bay. The work in the Kasaan Bay district consisted of examining the copper deposits of Kasaan Peninsula and the gold deposits of the Hollis region. A short visit to Tolstoi Bay was made, after which the party returned to Ketchikan. A short trip to Vallenar

Bay, on Gravina Island, during which several claims were visited en route, completed the field work in the district.

During the period of two months the party had traveled some 1,200 miles, had visited upward of 150 claims and mines, and had made a rough geologic reconnaissance of 2,000 square miles. This was accomplished in spite of the fact that out of sixty days spent in the district it rained more or less during forty-five.

The Ketchikan mining district was found to contain many important ore bodies, and considerable development work is now in progress. The deposits include gold, silver, copper, lead, and nickel ores. The abundance of timber, cheap transportation, equable climate, and ample water supply are all favorable for rapid development.

In the latter part of the summer Mr. Brooks made a hasty reconnaissance of the northern part of southeastern Alaska. This was made for the purpose of establishing geologic correlations, and also with a view to obtaining information which would be of value in planning future work. The results of the field work have been embodied in a report entitled "Preliminary report on the Ketchikan mining district, with a sketch of the geology of southeastern Alaska," which is in press as Professional Paper No. 1. During the winter much of Mr. Brooks's time was given to administrative work connected with Alaskan geologic investigations.

Gerdine-Collier party.—The party organized for work on Seward Peninsula consisted of Thomas G. Gerdine, topographer in charge; Arthur J. Collier, assistant geologist; D. C. Witherspoon, field assistant, and five camp hands. A pack train of 12 animals was taken from Seattle.

The party reached Nome on June 16, and thence supplies were taken by sailing vessels to Teller, which was reached on July 11, the pack train traveling along the beach.

On July 12 topographic work, based on points established by the Coast and Geodetic Survey at Port Clarence, was commenced by Messrs. Gerdine and Witherspoon. The work was extended westward toward Cape Prince of Wales, including the drainage basins of the California, Don, Rapid, Kanauguk,

Anikovik, Yankee, and Mint rivers. From the junction of the Yankee and Mint rivers the route of travel was along an almost direct line to Ear Mountain, Mr. Witherspoon with one assistant working north toward the coast, while Mr. Gerdine with an assistant mapped the area lying south of the route of travel and north of the Agiapuk drainage basin. The area thus mapped includes the drainage basins of the York, McKillop, Nuluk, and Kugruk rivers.

From Ear Mountain the party proceeded toward Igloo, on the Kuzitrin River, arriving on September 3, having mapped portions of the headwaters of Agiapuk, American, and Mary rivers and Budd and Igloo creeks. At Igloo the party was divided, and Mr. Witherspoon proceeded with two men and five pack animals to Teller, completing the unmapped portion of the Agiapuk Basin lying between Igloo and Teller. From Teller the latter party proceeded overland to Nome. The remainder of the party, under Mr. Gerdine, proceeded from Igloo in a northwest direction up the Kugruk River, mapping the drainage area of this river to its source. Thence the party proceeded in a southeastward direction to Noxapaga, at the mouth of Turner Creek, on the Noxapaga River. From this point Messrs. Gerdine and Collier made a boat traverse down the Noxapaga and Kuzitrin rivers, sending the pack train across country to Lanes Landing, the party and pack train meeting at that point on September 25.

During the journey up the Kugruk and down the Kuzitrin rivers Mr. Collier made a number of traverses that add materially to the details of the topographic work.

From Lanes Landing the party started on the return trip for Nome by trail, arriving on September 30 and joining the party under Mr. Witherspoon.

The season was particularly unfavorable for topographic work, being backward and unusually rainy. Out of ninety-one days in the field there were only thirty-five clear days, the remaining being so foggy and rainy as to prevent entirely any kind of plane-table work. Notwithstanding these adverse circumstances, the work of the party resulted in a topographic survey of about 4,950 square miles, including most of Seward

Peninsula lying west of the one hundred and sixty-fourth meridian and north of surveys executed during the last field season by Messrs. Barnard and Peters. The treeless character of the country, the number of prominent and intervisible points, and the ease of travel made the country mapped almost ideal for plane-table work. The party sailed from Nome on October 6 and arrived at Seattle on October 17.

In addition to these topographic and geographic results, data were collected for the preparation of reconnaissance geologic and economic maps of the area surveyed. The formations differentiated during the season of 1900 in the southern half of the peninsula were traced northward, and observations were made of them in a new field, which will throw important light on their relations. Fossils of Lower Silurian age were collected from a number of localities north of Port Clarence. This is the first proof of rocks of this age found in Alaska. Fossils of Upper Silurian or Devonian age were also collected in rocks which have been correlated with the Nome series of schists and limestones.

The reported discoveries of placer gold in the northwestern part of the peninsula and within the Agiapuk drainage were investigated, and an examination was made of the recent discoveries of placer gold in the Kugruk and Kuzitrin districts and in a part of the Good Hope district. A large part of the region explored was found to be not only unproductive of placer gold at the present time, but to offer little encouragement to the prospector. The placers now producing gold were found to be irregularly distributed within a belt 30 to 50 miles wide, extending from Nome northeastward to Kotzebue Sound.

The topographic and geologic results have been submitted for publication in a report entitled "A reconnaissance of the northern portion of Seward Peninsula, Alaska," by Arthur J. Collier (Professional Paper No. 2).

Mendenhall-Reaburn party.—This party consisted of Walter C. Mendenhall, geologist, and D. L. Reaburn, topographer, with five camp hands.

The party made its way inland from Skagway by the White

Pass Railroad to the White Horse Rapids in the latter part of May, and thence by canoes it continued down the river to Lake Laberge. As the ice had not yet gone out of the lake, it was necessary to improvise sleds and drag the outfit across the ice. From the lower end of Lake Laberge the party continued to Dawson in canoes. From Dawson to Fort Yukon steamboat transportation was secured.

The topographic work was commenced at Fort Yukon on June 8. The astronomic position of Fort Yukon had been determined by Captain Raymond in 1865, and its altitude was assumed to be 500 feet above sea level. From Fort Yukon a plane-table traverse was run to Fort Hamlin, a distance of 193 miles. From this point the work was continued to the head of the Dall River and across a portage to the source of the Kanuti ("Old Man") River; then Kanuti River was descended in canoes, which had been brought from the head of the Dall. At Bergman, on the Koyukuk, the party was reoutfitted from supplies and equipments which had been forwarded to this place during the preceding summer. Leaving Bergman on July 18, the party ascended to the mouth of the Alatna, and then continued up that stream to the mouth of Help-me-Jack Creek. From the head of this creek a portage was found to Kichaiakaka Creek, and the party continued down the creek to its junction with the Kowak, which was reached on August 9. The survey of the Kowak to its mouth was completed September 3. The party then skirted Kotzebue Sound in canoes to Deering, which lies on the north side of Seward Peninsula, near Goodhope Bay. From Deering passage was secured on a steamer to Nome, and on October 6 the party left for Seattle, which was reached on October 17.

The total distance traversed, including some side trips to Walker Lake and Ambler River, in the Kowak Valley, was 1,169 miles. Of this distance 25 miles was portage and the remainder was traveled in canoes. Distances were determined by micrometer and stadia measurements and by plane-table triangulation, and elevations by vertical angles. The work was controlled by 19 latitude and 36 azimuth observations. The magnetic declination was determined at each azimuth station.

The results of this expedition include a topographic map of approximate accuracy along a route some 1,100 miles in length. Much of the region traversed was practically unknown from a geographic standpoint. While a part of the region had been roughly surveyed, the resulting maps had left much to be desired.

Aside from these important topographic and geographic results, data were gathered for the preparation of a geologic reconnaissance map, which will serve also as a preliminary economic map. Several formations have been distinguished and will be outlined, and those in which coal or gold have been found, or may be presumed to occur, will be appropriately designated. An undescribed and practically unknown occurrence of coal on the Dall River was visited, and evidence was gathered for the proper estimation of the value of the coals which have been reported in the past on the Lower Kowak. Reports of the occurrence of gold near the source of the Dall and Noatak rivers, and in the newly discovered Candle Creek district, on the south shore of Kotzebue Sound, were investigated.

Data on the navigability of streams, the existence and character of passes, timber supply and vegetation generally, native food sources, inhabitants, and climatic conditions were collected. Mr. Mendenhall has submitted the results of the work in a report entitled "Reconnaissance from Fort Hamlin to Kotzebue Sound by way of Dall, Kanuti, Alatna, and Kowak rivers," which will be published as Professional Paper No. 10.

Peters-Schrader party.—Mr. William J. Peters, topographer, in charge of the Colville River expedition, with Mr. Gaston Philip, field assistant, and two camp hands, left White Horse, the terminus of the White Pass and Yukon Railroad, February 22 and traveled with dogs and sleighs to the trading post Bergman, on the Koyukuk River, the point at which the surveys were to commence, a distance of about 1,050 miles, arriving April 16. Mr. F. C. Schrader, geologist of the expedition, and two camp hands started some weeks later to join and complete the party, and reached Bergman about May 1. The equipment of the expedition, which had been sent to

Bergman and there stored during the preceding open season, was found to be intact and in good condition.

As no definite information could be obtained from natives or prospectors regarding the practicability of crossing the range to the north and reaching navigable waters of the Colville River, it was deemed advisable to settle this question immediately, while frozen streams still permitted rapid travel. To accomplish this expeditiously the party was divided, Mr. Peters ascending the John River, while Mr. Philip went up the Alatna. On these preliminary reconnaissances traverse notes were recorded and plotted. Directions were determined with prismatic compasses, and distances were measured by pacing. The reconnaissances were completed by May 3, and determined the selection of the John River route. About 100 miles from the mouth of this river a low pass was found, and, as far as winter conditions would permit of judging, there existed a very short portage from the John River to a tributary of the Colville. The reconnaissance of the Alatna was carried up about 90 miles to its eastern branch, the Kutuark River.

The interval between May 4 and 14 was devoted to the starting of plane-table work in the vicinity of Bergman. After this date the snow was too soft for extensive traveling, and until the break of the river ice on May 28 the time was spent in determining instrumental constants and observations for time, latitude, azimuth, and magnetic variation. During this wait the equipment was overhauled for the canoe trip, provisions were repacked, and fittings were put on the canoes.

The river was not clear of ice until June 7. A day or two later the river steamer *Luella* took the party from Bergman to Bettles, from which point the expedition started in canoes up the John River. Plane-table points were occupied at intervals of about 10 miles, and the sketching on these points was strengthened by the stenometer traverse sketches which were made along the river.

On July 22 the divide was reached, and the outfit was transported across the short portage of 5 miles in the low pass between the John River and the Anaktuvuk, 125 miles by water from the mouth of the former.

The trip down the Anaktuvuk in canoes was begun July 24, and on August 8, after a journey of 113 miles, the confluence of the Anaktuvuk and Colville rivers was reached. From this point the journey was continued to the mouth of the Colville River and through the delta to the Arctic Ocean, a distance of 99 miles. The head of the delta was reached August 13 and the Arctic Ocean August 18. After August 5 plane-table methods were abandoned on account of the flat character of the topography, the absence of natural signals, the hazy atmosphere, and the necessity of rapid progress.

A plot of the route from camp of August 5 to the end of the traverse at Smith Bay, about 96 miles west of the Colville River and about 80 miles east of Point Barrow, was made by prismatic-compass bearings, distances being determined with the stenometer. Latitudes were obtained near the mouth of the Colville and also near the end of the traverse line. The traverse along the coast was not carried beyond Smith Bay, on account of the lateness of the season, it being necessary for the expedition to push on to Point Barrow as rapidly as possible. Point Barrow was reached September 3, and supplies and party proceeded, September 5, in an open boat along the coast to the coal mines near Cape Lisburne, a distance of about 350 miles, arriving September 18. Here a steamer was found bound for Nome, at which point the party arrived on September 26. At Nome passage was secured on one of the regular steamers, and the party was disbanded at Seattle on October 19.

The total length of linear surveys was 432 miles, the area mapped including 2,640 square miles. While the area actually mapped by this expedition is small, its results are of great importance, as they throw light on the geographic features of a large unexplored region in northwestern Alaska. Between latitudes 67° 10′ and 68° 25′ the expedition traversed a rugged mountain range, about 80 miles in width, with altitudes ranging up to 6,000 feet. These mountains consist chiefly of Paleozoic and pre-Paleozoic sediments which are much faulted. North of the range is a plateau 2,000 feet in height which is made up of Upper and Lower Cretaceous beds. The

Arctic coastal plain, where traversed by the expedition, has a width of about 80 miles and is underlain by Tertiary beds several hundred feet in thickness. The valleys of the mountain range were found to be glaciated, and evidence of glaciation was found on the Cretaceous plateau nearly 100 miles north of the front of the range.

Placer mining on the Upper Koyukuk, where about 260 people wintered, was found to be in a prosperous condition, the yield of gold during the last season having been upward of $200,000. The placer gold seems to have its source in quartz-mica-schists and quartz-mica-slates of Paleozoic age or older. These rocks also carry sulphides of iron, copper, and antimony, the latter occurring as stibnite associated with the vein quartz in the schists. South of these schists is a belt of metamorphic limestone and mica-schists which carry galena, iron sulphides, and some copper sulphides.

Where the Colville River enters the coastal plain there are abundant exposures of lignitic coal, apparently of Tertiary age. The Corwin coal mines, near Cape Lisburne, were hastily examined. This coal is of a semibituminous character and probably of Mesozoic age. Mr. Schrader has presented the results of this expedition in a report entitled, "Preliminary report of a reconnaissance in northern Alaska from the Koyukuk Basin to the Arctic Coast," which will be published as a professional paper.

ORGANIZATION OF PARTIES FOR SEASON OF 1902.

Mr. Goode and Mr. Brooks, after full conferences with the geologists and topographers connected with the Alaskan surveys, suggested plans for the season of 1902, which were accepted by the Director and approved by the Secretary of the Interior.

Since 1897 the mineral production of Alaska has increased from $2,500,000 to $8,000,000, and its white population has nearly doubled. The result of this is that many demands are being made on the Geological Survey for investigations and surveys in Alaska. With the present appropriation of $60,000 it is impossible to meet all these demands, for this sum is only

adequate to put four, or at most five, parties in the field. At this rate it will take twenty-five years to complete the preliminary work.

The area to be mapped, both topographically and geologically, includes nearly 600,000 square miles. The mineral resources include gold, silver, copper, lead, zinc, tin, nickel, marble, coal, and possibly petroleum. Each one of these mineral products should be the subject of special investigation, but up to the present time the Geological Survey has been able to make only the most general reconnaissances.

It has been thought best to spend about half the appropriation of this year in the Copper River region. It is hoped that at the close of this season the reconnaissance of the basin will be completed, when more detailed and systematic work can be undertaken. The most important problem is the investigation of the two copper belts of the region and the Chistochina gold field. Mr. F. C. Schrader, geologist, will have charge of the party in the northern half of the region and Mr. D. C. Witherspoon will accompany him as topographer.

The southern party will be in charge of Mr. T. G. Gerdine, topographer, with Mr. Walter C. Mendenhall as geologist. Each party will be equipped with ten or fifteen horses and will include five or six camp hands. The provisions were transported across the Coast Range during the last winter, and the parties will begin work about the 1st of May.

Besides the investigation of regions of known mineral wealth, the Geological Survey is attempting the reconnaissance of unexplored regions. This is for the purpose of obtaining general geographic and topographic data, and, if possible, of finding new mineral-producing areas. For this purpose a party will be sent, in charge of Mr. Brooks, to explore the northwest slope of the Alaskan Range. The region lying between the headwaters of the Kuskokwim and the Tanana is the largest unexplored area south of the Yukon. Mr. Brooks's party will include Mr. D. L. Reaburn, topographer; Mr. L. M. Prindle, geologic assistant, and four camp hands, and will be equipped with twenty horses. It will land at Tyonok about the 1st of May, and go northwestward to the

Skwentna Pass, then cross to the Kuskokwim waters, from which point it will extend its mapping in a northeasterly direction to the Tanana. Time permitting, the gold field of the Chena River and Baker Creek will be mapped.

As the accessible timber along the Yukon becomes exhausted the coal resources of this region become important. This will be the subject of a special investigation by Mr. Arthur J. Collier, who will study the Yukon section from the international boundary to the mouth of the river. Mr. Collier will pay special attention to the coal deposits, but will also visit such of the placer fields as are accessible from his route of travel. It is expected that the results of this investigation will throw considerable light on the general geologic problems of the region.

In southeastern Alaska, where the vein mining requires large investments of capital, the surveys must be of an entirely different character from those of the interior. Maps must be of a high degree of accuracy to serve the purposes of the miner. On account of the timbered conditions of the coast regions such surveys are very expensive. The Geological Survey will begin this work by surveying the important mining region lying adjacent to Juneau. Mr. W. J. Peters will have charge of this mapping, which will be done on a scale of an inch to the mile.

The five parties described above have taken the field and are now engaged in carrying out the plans here briefly outlined. Since they are in part or entirely beyond mail com munication their work for the entire season will be described in the next annual report.

DIVISION OF MINING AND MINERAL RESOURCES.

The new work of collecting the statistics of precious metals, separating the gold that comes from placer mines from that which comes from deep mines, mentioned in the Twenty-second Annual Report, was organized, and the report on the Mineral Resources of the United States for 1901, now in press, contains the results of this investigation.

The endeavor to acquire more complete knowledge of the mineral resources of the country and more intimate acquaint-

ance with the methods of occurrence of minerals of economic importance led to investigations into the occurrence of platinum on the Pacific coast and of petroleum at Beaumont, Tex., and in adjacent States.

The following work outlined in the last report was completed, and the information has been or soon will be given to the public: Mr. George H. Eldridge's investigation of the occurrence and distribution of asphaltum, published in the Twenty-second Annual Report, Part I; Mr. M. R. Campbell's work on the borax deposits of Death Valley and Mohave Desert, published as Bulletin No. 200; and the work of this division and the Division of Economic Geology on the coal fields of the United States, published in the Twenty-second Annual Report, Part III.

The work of Messrs. E. W. Parker and Jefferson Middleton for the Twelfth Census—the preparation of reports on coke, petroleum refining, salt, and clay products—was completed within the fiscal year, and the reports on these subjects were published.

In addition to the various agents and field assistants who have aided in the work, Dr. David T. Day, geologist in charge, was assisted by Mr. Edward W. Parker and Mr. Jefferson Middleton, statisticians; Miss Evangeline E. Crowell, Miss Helen M. Hough, Mrs. Lotta L. Kimball, Mrs. Mary M. Raborg, Miss Helen L. Stoddard, and Miss Laura E. Thorwarth, clerks; Miss Belle W. Bagley, Miss Altha T. Coons, Miss Julia M. Corse, Mr. Theodore Johnson, statistical experts, and Miss Elizabeth A. Balloch, stenographer.

For the second time in our history, as shown by the statistics of mineral production collected by the Division of Mining and Mineral Resources, the value of the mineral products of the United States exceeded $1,000,000,000, the exact figures being $1,086,529,521, as compared with $1,063,620,548 in 1900 and with $972,152,208 in 1899, a gain in 1901 over 1900 of $22,908,973, or 2.15 per cent, and a gain in 1901 over 1899 of $114,377,313, or 11.77 per cent. Although this gain is not so great, either actually or proportionally, as that in 1899, when the gain over 1898 was $273,601,810, or 39.17

per cent, it is sufficient to show that the growth of the mineral industries keeps pace with the national prosperity.

The notable gains and losses of the last two decades are as follows: The largest actual gain was that of 1899 over 1898, $273,601,810, or 39.17 per cent; next, that of 1900 over 1899, $91,468,340, or 9.41 per cent; then the gain of 1895 over 1894, which was $94,215,822, or 17.88 per cent; next, the gain of 1887 over 1886, $74,927,880, or 16.81 per cent; then the gain of 1901 over 1900, $22,908,973, or 2.15 per cent. In other years than those mentioned between 1880 and 1898, the gains were not noteworthy, and in some years, notably in 1884, the production decreased, the decrease in that year being $40,451,968, or nearly 9 per cent. During the industrial depression of 1892–1895 it was to be expected that the production would decline, as it did, going from $648,895,031 in 1892 to $574,464,724 in 1893, to $527,079,225 in 1894, and then rising to $621,295,047 in 1895, and not reaching the output of 1892 until 1898.

As heretofore, iron and coal are the most important of our mineral products. The value of the former in 1901 was $242,174,000 and of the latter $348,910,469. All of the important metals decreased in both output and value, with the exception of pig iron and zinc, and among the less important metals the most remarkable increase, both in quantity and in value, was made in platinum, the production of which was 1,408 ounces, valued at $27,526, as compared with 400 ounces, valued at $2,500, in 1900, a gain of 1.001 per cent in value. The fuels increased from $406,359,351 in 1900 to $442,395,304 in 1901, a gain of $36,035,953, or 8.87 per cent. Every variety of fuel increased in value except petroleum, which showed an increase in quantity of 5,768,665 barrels, but a decline in value of $9,571,978, due largely to the less valuable character of the increased product of the new petroleum fields as compared with that of the older fields. Anthracite coal increased 9,021,207 long tons in output and $26,746,169 in value. The average price of anthracite coal per ton at the mine was $2.05, the highest figure obtained since 1888, as compared with $1.85 in 1900 and $1.80 in 1899; and the

average price per ton for bituminous coal at the mine was $1.047, about the same as in 1900. The gain of $22,908,973 is due entirely to the increase in the nonmetallic products, since the metallic products showed a decline from $550,425,286 in 1900 to $518,268,377 in 1901, a loss of $32,156,909, whereas the nonmetallic products increased from $512,195,216 in 1900 to $567,261,144 in 1901, a gain of $55,065,882. To these products should be added estimated unspecified products, including the rare minerals lithium, tungsten, vanadium, uranium, etc., bismuth, and crystalline quartz, valued at $1,000,000, making the total mineral production for 1901, $1,086,529,521.

For the first time since 1885 the production of bismuth in the United States is noted in this report. In 1901 the manufacture of arsenious oxide was taken up for the first time in the United States by the Puget Sound Reduction Company, at Seattle, Wash., when an output of 300 short tons was placed on the market. For the first time also the production of rutile on a large scale was realized, by the American Rutile Company, from the deposits in Nelson County, Va., the output amounting to about 40,000 pounds.

METALS.

Iron and steel.—The record-breaking output of pig iron in 1899, 13,620,703 long tons, valued at $245,172,654, was exceeded in 1900, the output then being 13,789,242 long tons, valued at $259,944,000, and this has now been exceeded by the production of 1901, which was 15,878,354 long tons, valued at $242,174,000. This is an increase of 2,089,112 long tons, or 15.15 per cent, and a decline of $17,770,000 in value, or 6.84 per cent, as compared with 1900. This gain, however, like the gain made in 1900 over 1899, is slight when compared with the gain of 1899 over 1898. In 1899 the production increased 15.69 per cent and the value 110.35 per cent over 1898. The average price per ton of pig iron increased from $18 in 1899 to $18.85 in 1900, and the price in 1901 was $15.25. The maximum price so far is $19, which was reached in 1887. The average price per long ton in recent years has been as follows: 1897, $9.85; 1896, $10.47; 1895, $11.14; 1894, $9.76; 1893, $11.90.

Iron ores.—The production of iron ores in the United States during 1901 amounted to 28,887,479 long tons, as compared with 27,553,161 long tons in 1900, a gain of 1,334,318 long tons, or 5 per cent, as compared with a gain of 12 per cent in 1900 over 1899. The total value at the mines of the ore mined in 1901 was $49,256,245, or a mean value of $1.71 per ton, an apparent decrease of 71 cents, or 29 per cent, from the 1900 figures of $2.42 per ton. The total value of the iron ore mined in 1901 shows a decrease of 26 per cent, as compared with the total value, $66,590,504, of the ore produced in 1900. As in 1898, 1899, and 1900, the production of iron ores in 1901 has never been equaled by any other country, the nearest approach to our output being in 1900 by the German Empire, when 18,664,772 long tons were produced.

Copper.—The activity of 1899 and 1900 in the copper industry showed a slight falling off during 1901. The production decreased from 606,117,166 pounds in 1900 to 602,072,519 pounds in 1901, a loss of 4,044,647 pounds, or 0.67 per cent, as compared with an increase of 6.59 per cent in 1900; and the value decreased from $98,494,039 in 1900 to $87,300,515 in 1901, a decrease of $11,193,524, or 11.36 per cent, from 1900, and a decrease of $13,922,197 from 1899, when the value was $101,222,712.

Lead.—The large increase in the production of lead in 1900 over 1899 was not repeated in 1901, the production of 270,700 short tons in 1901 being 124 short tons less than in 1900, and the value of the product, $23,280,200, being $281,488 less than in 1900.

Zinc.—The production of zinc in 1901 showed a marked increase in quantity over both 1900 and 1899; and the value of the product in 1901 showed an increase as compared with 1900 and a decrease as compared with 1899. The production in 1901 amounted to 140,822 short tons, as compared with 123,886 short tons in 1900, an increase of 16,936 short tons, or over 13 per cent, and an increase of 11,771 short tons, or 9 per cent, over 1899. The value of the zinc product in 1901 was $11,265,760, as compared with $10,654,196 in 1900 and with $14,840,865 in 1899.

Gold.—The gold production decreased in 1901, falling from 3,829,897 fine ounces in 1900 to 3,805,500 fine ounces in 1901; and the value decreased from $79,171,000 in 1900 to $78,666,700 in 1901. In 1899 the product was valued at $71,053,400.

Silver.—The coining value of the silver product in 1901 was $71,387,800, as compared with $74,533,495 in 1900. The production in 1901 was 55,214,000 fine ounces, as compared with 57,647,000 fine ounces in 1900. The commercial value of the product in 1901 was $33,128,400, as compared with $35,741,140 in 1900, a decrease of $2,612,740, or 7.31 per cent.

Quicksilver.—The production of quicksilver in 1901 showed an increase of 1,410 flasks of 76½ pounds net over 1900, or 29,727 flasks as against 28,317 flasks in 1900. The production of 1901 was still 727 flasks below the production of 30,454 flasks in 1899. The value of the quicksilver produced in 1901, $1,382,305, exceeded that of the output of 1900 by $79,719, and fell below the value of the product of 1899 by $70,440.

Aluminum.—The Pittsburg Reduction Company, operating under the Hall patents, continues to be the only producer of metallic aluminum in the United States. The production in 1901 was 7,150,000 pounds, the same as in 1900, and exceeded by 650,000 pounds the production of 1899; and the value of the product of 1901, $2,238,000, increased $318,000 over that of 1900, and $522,000 over that of 1899.

Antimony.—The amount of antimony obtained from ores of domestic production in 1901 was 50 short tons, valued at $10,250; the antimony obtained from the smelting of foreign imported ores was 364 short tons, valued at $74,620; and the antimony obtained from hard or antimonial lead produced from foreign and domestic lead ores was 2,235 short tons, valued at $457,150; a total production for 1901 of 2,649 short tons, valued at $542,020. The estimated total amount of antimony available for consumption in 1901 was 4,486 short tons, including 1,837 short tons of imported antimony regulus, as compared with 6,053 short tons, including 1,827 short tons of imported antimony regulus, in 1900. The decrease in the

total quantity of antimony estimated to have been consumed in the United States in 1901 as compared with 1900 was due to the large overimportation of antimony ore, and, to a less extent, of antimony regulus, in 1900.

Manganese ores.—The production of manganese ores increased slightly, from 11,771 long tons, valued at $100,289, in 1900 to 11,995 long tons, valued at $116,722, in 1901, an increase in quantity of 224 tons, or almost 2 per cent, and in value of $16,433, or over 16 per cent. The average price per ton was $9.73, as compared with $8.52 in 1900 and $8.28 in 1899.

Nickel.—The production of nickel continued to decline from 22,541 pounds in 1899 to 9,715 pounds in 1900 and to 6,700 pounds in 1901. The value of the product decreased from $8,566 in 1899 to $3,886 in 1900 and $3,551 in 1901. As heretofore noted, all of the domestic product was obtained as a by-product in the smelting of lead ores at Mine Lamotte, Mo.

Platinum.—The production of crude platinum in 1901 showed a remarkable increase, although the amount produced still remains small. In 1901 the production was 1,408 ounces, as compared with 400 ounces in 1900, 300 ounces in 1899, 225 ounces in 1898, and 150 ounces in 1897, an increase for 1901 over 1900 of 1,008 ounces, or about 252 per cent. The value of the product obtained in 1901 was $27,526, as compared with $2,500 in 1900 and $1,800 in 1899, an increase of $25,026, or 1,001 per cent, of the 1901 product over that of 1900.

Bismuth.—The production of bismuth ore in the United States in 1901 amounted to 318.6 short tons, as compared with 220 short tons in 1900. Colorado supplied the entire output. All of the ore contained gold and silver values, for which the producers were paid. As nearly as can be ascertained, the value of the product was $25,488, or an average of $80 per ton, charges for transportation and treatment being deducted.

FUELS.

Coal.—The aggregate production of anthracite and bituminous coal in the United States in 1901 amounted to 293,298,-

516 short tons, valued at $348,910,469, as compared with 269,682,827 short tons, valued at $306,671,364, in 1900, an increase of 23,615,689 short tons, or 8.76 per cent, in quantity, and of $42,239,105, or 13.8 per cent, in value. The increase in 1900 over 1899 was 15,942,835 short tons in quantity and $50,593,930 in value.

The production of Pennsylvania anthracite showed a phenomenal increase, from 51,221,353 long tons, or 57,367,915 short tons, in 1900, to 60,242,560 long tons, or 67,471,667 short tons, in 1901. This represented a gain of 17.5 per cent, the largest percentage of gain made by the anthracite trade in twenty years. Part of this increase in 1901 was due to the decreased output of anthracite in 1900, as, owing to the strike in 1900, the output of that year was reduced by over 2,500,000 long tons. The production of 1901 shows an increase over 1899 of 6,297,913 long tons, and but for the strike of 1900 would have shown an increase over that year of 4,5 0,000 long tons, or about half the increase actually made. The increase in the value of the anthracite product is still more striking, the amount received at the mines in 1901 showing a gain of $26,746,169, or more than 31 per cent, over that of 1900. The average price for the marketed anthracite coal (exclusive of the colliery consumption, which amounted to about 10 per cent of the total) was $2.05, the highest figure obtained since 1888.

The production of bituminous coal, lignite, cannel coal, etc., including small amounts of anthracite from Colorado and New Mexico, increased from 212,314,912 short tons in 1900 to 225,826,849 short tons in 1901, a gain of 13,511,937 tons, or about 6 per cent. The value of this product amounted to $236,406,449, as compared with $220,913,513 in 1900, an increase of $15,492,936, or a little more than 7 per cent. The price of the bituminous product did not show any material advance in 1901, the average price being about 0.8 per cent higher than in 1900.

The preliminary report issued by the inspectors of mines for Great Britain shows that the production of coal in the United Kingdom last year was 219,046,945 long tons, a decrease of 6,134,355 long tons from 1900. Reducing the

production of the United States to the same unit, we find that it amounted to 261,873,675 long tons, 42,826,730 long tons (nearly 20 per cent) more than that of Great Britain. The coal output of her colonies and dependencies, including India, aggregated in 1900 about 17,000,000 long tons, so that, taking all of the British Empire as one producer, her output still falls short of the coal product of the United States in 1901 by over 20,000,000 long tons.

Our coal production last year was nearly 75 per cent larger than Germany's, nearly 7 times that of Austria-Hungary, and more than 8 times that of France.

Coke.—The total production of coke in the United States in 1901, including the output from 1,165 retort or by-product ovens, was 21,795,883 short tons, valued at $44,445,923, as compared with 20,533,348 short tons, valued at $47,443,331, in 1900, and with 19,668,569 short tons, valued at $34,670,417, in 1899. The increase in production in 1901 over 1900 was 1,262,535 short tons, or 6.15 per cent; the value of the product, however, showed a decrease of $2,997,408, or 6.3 per cent.

Petroleum.—The total production of crude petroleum in the United States in 1901 was 69,389,194 barrels, being larger than that of any previous year. It was larger by 5,768,665 barrels, or 9 per cent, than the production of 1900. The increase in the production of 1900 over 1899 was 6,549,679 barrels, or 11 per cent, and the increase in 1899 over 1898 was 3 per cent, making an average gain of 7.7 per cent for the last three years. The value of the product in 1901 was $66,417,335, as compared with $75,989,313 in 1900, a decrease of $9,571,978, or about 12.6 per cent. The largest number of barrels marketed in the States outside of the Appalachian and the Lima-Indiana fields was in California, although when the proportionate quantity produced but not sold is considered the State of Texas takes precedence. The gain in new production from these two States alone shows over 8,000,000 barrels, and when the increased yield in Kansas and Colorado is added the percentage of the total petroleum produced outside of the older fields above named is shown to rise from 8.60 per cent in

1900 to nearly 20 per cent in 1901. This is a difference of 11.40 per cent, and indicates that a rapid change is taking place in the localities from which the increased supply of petroleum is to be obtained in the future.

The quality of the petroleum produced from these new sections is generally much inferior to that produced in the older fields, the quantity of first-class illuminating oil and other valuable derivatives being very much less. The greater part, however, is valuable as fuel in its natural state, or after some of the more volatile products have been removed, and is particularly acceptable as such in the absence of deposits of coal in the Southwest and West.

The average price per barrel for all the petroleum marketed in the United States during 1901 was 95.7 cents, as compared with $1.194 in 1900, $1.132 in 1899, and $0.798 in 1898. This is a decrease as compared with 1900 of $0.237 per barrel, the lowest average price since 1898.

A noteworthy feature of the year, due particularly to the oil excitement in Texas and California, was the formation of 1,578 oil companies, with an acknowledged and estimated capitalization of $669,083,000.

Natural gas.—The value of the natural gas product increased in 1901 to $27,067,500, as compared with $23,698,674 in 1900 and $20,074,873 in 1899. This is a gain of $3,368,826, or 14 per cent, in 1901 over 1900.

STRUCTURAL MATERIALS.

Stone.—The value of all kinds of building stone produced in the United States during 1901 amounted to $55,615,926, as compared with $44,321,345 in 1900 and $44,090,670 in 1899, an increase of $11,294,581, or over 25 per cent, in 1901 over 1900. The decline in exports of slate which was noted in this report for last year has continued. The value of the exports decreased from $1,363,617 in 1899 to $950,543 in 1900 and to $898,262 in 1901.

Clays.—The activity in all branches of the clay-working industries in 1899 and 1900 continued during 1901. The value of all clay products in 1901, as reported to this office,

was $110,211,587, as compared with $96,212,345 for 1900, a gain of $13,999,242, or 14.55 per cent. The brick and tile products in 1901 were valued at $87,747,727, as compared with $76,413,775 in 1900, a gain of $11,333,952, or 14.83 per cent. The pottery products were valued in 1901 at $22,463,860, as compared with $19,798,570 in 1900, a gain of $2,665,290, or 13.46 per cent.

The clay mined and sold in 1901 by those not manufacturing the product themselves was valued at $2,576,932, as compared with clay valued at $1,840,377 sold in 1900.

Cement.—The total production of cement in the United States in 1901 was 20,068,737 barrels, compared with 17,231,150 barrels in 1900, an increase of 2,837,587 barrels, or about 15 per cent. The value increased from $13,283,581 in 1900 to $15,786,789 in 1901, a gain of $2,503,208, or 11.17 per cent.

ABRASIVE MATERIALS.

Carborundum.—In 1901 the total production of carborundum was 3,838,175 pounds, worth from 8 to 10 cents a pound, as compared with 2,634,900 pounds in 1900, with 1,741,245 pounds in 1897, with 52,200 pounds in 1894, and with 15,200 pounds in 1893.

Corundum and emery.—The combined production of corundum and emery in 1901 amounted to 4,305 short tons, valued at $146,040, as compared with 4,305 short tons, valued at $102,715, in 1900, an increase in value of $43,325, or 42 per cent.

Crushed steel.—The production of crushed steel by the Pittsburg Crushed Steel Company in 1901 was 690,000 pounds, 10,000 pounds less than in 1900. Crushed steel is quoted on the market at 5½ cents per pound f. o. b. Pittsburg. The annual production has varied little since 1898.

Crystalline quartz.—The production of crystalline quartz in 1901 was 14,050 short tons, valued at $41,500, as compared with 14,461 tons, valued at $40,705, in 1900. The entire product was from Connecticut.

Garnet.—The amount of abrasive garnet produced in 1901 was 4,444 short tons, valued at $158,100, as compared with

3,185 short tons, valued at $123,475, in 1900, an increase in quantity of 1,259 tons, or about 40 per cent, and in value of $34,625, or about 28 per cent.

Grindstones.—The total value of the production of all kinds of grindstones in 1901 was $580,703, a decrease of $129,323 from the production of 1900, which was $710,026.

Infusorial earth and tripoli.—The production of infusorial earth and tripoli increased from 3,615 short tons, valued at $24,207, in 1900 to 4,020 short tons, valued at $52,950, in 1901, an increase of 405 tons, or over 11 per cent, in amount, and of $28,743, or over 118 per cent, in value. This large increase is due partly to the large production of the American Tripoli Company of Seneca, Mo.

Millstones and buhrstones.—The production of millstones in 1901 was valued at $57,179, as compared with $32,858 in 1900 and with $28,115 in 1899, an increase in 1901 over 1900 of $24,321, or a little more than 74 per cent.

Oilstones and whetstones.—The value of the oilstones and whetstones made in the United States in 1901 amounted to $158,300, as compared with $174,087 in 1900 and $208,283 in 1899, a decrease in 1901 of $49,983, or 24 per cent, as compared with 1899. The production of 1899 was the largest in the history of the industry.

CHEMICAL MATERIALS.

Arsenious oxide.—In 1901 the manufacture of arsenious oxide was begun by the Puget Sound Reduction Company at Seattle, Wash., and an output of 300 short tons was placed on the market.

Borax.—The production of borax in 1901 consisted of 17,887 short tons of crude and 5,344 short tons of refined, with a total value of $1,012,118, as compared with 24,235 short tons of crude and 1,602 tons of refined, valued at $1,018,251, in 1900.

Bromine.—The production of bromine in 1901 amounted to 552,043 pounds, valued at $154,572, as compared with 521,444 pounds, valued at $140,790, in 1900. The bromine is obtained from the mother liquor made in the salt works in Michigan, Ohio, and West Virginia.

Fluorspar.—The production of fluorspar in 1901 amounted to 19,586 short tons, valued at $113,803, as compared with 18,450 short tons, valued at $94,500, in 1900.

Gypsum.—The production of gypsum, particularly for the manufacture of calcined plaster, continues to show a remarkable gain. The output of crude gypsum in 1901 amounted to 659,659 short tons, valued, in its first marketable condition, at $1,577,493, as compared with 594,462 short tons, valued at $1,627,203, in 1900, an increase in quantity of 65,197 short tons, or 10.97 per cent, and a decrease in value of $49,710. The production in 1899 was 486,235 short tons, and in 1898 it was 291,638 short tons. The greatly increased production of the last three years is attributable to the substitution of plaster of paris for ordinary lime mortar in the manufacture of wall plaster in large buildings; also to the manufacture of staff for temporary buildings.

Phosphate rock.—The production of phosphate rock decreased slightly, from 1,491,216 long tons in 1900 to 1,483,723 long tons in 1901, and the value decreased from $5,359,248 in 1900 to $5,316,403 in 1901.

Pyrite.—During 1901 the production of pyrite, used in the manufacture of sulphuric acid, was stimulated to the largest yearly quantity yet recorded, amounting to 234,825 long tons, valued at $1,024,449, as compared with 204,615 long tons, valued at $749,991, in 1900, an increase in quantity of 30,210 long tons, or 14.76 per cent, and in value of $274,458, or 36.60 per cent. The greater part of the output was derived from Virginia, Colorado, Massachusetts, and New York, named in the order of production.

Salt.—The salt product includes the salt in brine used in the manufacture of soda ash, caustic soda, etc., at chemical works in Michigan, New York, and Pennsylvania. The production of salt in the United States during 1901 was 20,566,661 barrels of 280 pounds net, a decrease of 302,681 barrels, or 1.45 per cent, from the production in 1900, which was 20,869,342 barrels. The value of the salt produced in 1901 was $6,617,449, a decrease of $327,154 from the 1900 value of $6,944,603. The production of salt in the United States dur-

ing 1900 and 1901 was the greatest for any two individual years yet recorded.

Sulphur.—The quantity of sulphur produced in the United States has always been insignificant as compared with the total consumption of the country. During 1901 the production of sulphur in the United States was 7,690 short tons, valued at $223,430, as compared with 3,525 short tons, valued at $88,100, in 1900, an increase during 1901 of 4,165 tons in quantity, or about 118 per cent, and of $135,330 in value, or nearly 154 per cent. It is worthy of note that during 1901 Nevada and Oregon reentered the list of producing States, along with Utah and Louisiana.

PIGMENTS.

Barytes.—The output of crude barytes in 1901 was 49,070 short tons, valued at $157,844, a decrease of 18,610 tons from the production of 1900, which was 67,680 tons, valued at $188,089. In 1901, however, the average price per ton was $3.22, as compared with $2.78 in 1900, an increase accounted for by the fact that a better grade of barytes was put on the market.

Cobalt oxide.—The production of cobalt oxide in 1901 was 13,360 pounds, valued at $24,048, as compared with 6,471 pounds, valued at $11,648, in 1900, an increase of over 100 per cent in both quantity and value. All of the cobalt-oxide product was obtained as a by-product in smelting lead ores at Mine Lamotte, Mo.

Mineral paint.—The production of mineral paints in 1901 amounted to 61,460 short tons, valued at $789,962, as compared with 72,222 short tons, valued at $881,363, in 1900.

Zinc white.—The production of zinc white in 1901 showed a slight decline, from 48,840 short tons in 1900, to 46,500 short tons in 1901, a decrease of 2,340 tons, or 4.79 per cent. The value of the product, however, increased from $3,667,210 in 1900 to $3,720,000 in 1901, a gain of $52,790, or 1.44 per cent.

MISCELLANEOUS.

Asbestos.—As in 1900, nearly the entire product continued to come from the Sall Mountain mines in White County, Ga.,

with small additions from California and Massachusetts. The production in 1901 was 747 short tons, valued at $13,498, as compared with 1,054 short tons, valued at $16,310, in 1900. The production promises to be considerably greater in 1902.

Asphaltum.—Under this title are included all the numerous varieties of bitumens or hydrocarbons occurring in the United States and not discussed in the chapter on petroleum. The production in 1901 was greater than that of 1900, though less than that of preceding years as far back as 1895. The amount was 63,134 short tons, valued at $555,335, as compared with 54,389 short tons, valued at $415,958, in 1900, and with 75,085 short tons, valued at $553,904, in 1899.

Bauxite.—The production of bauxite continued to decrease in 1901, when it amounted to 18,905 long tons, valued at $79,914, as compared with 23,184 tons, valued at $89,676, in 1900, and with 35,280 tons, valued at $125,598, in 1899.

Chromic iron ore.—Since 1896, when the output of 786 long tons, worth $6,667, was obtained, there was very little production of chromite in the United States until 1901, when California produced 368 long tons, valued at $5,790.

Feldspar.—The production of feldspar in 1901 showed a notable increase in quantity, 34,741 short tons, as against 24,821 short tons in 1900; also a marked increase in value, $220,422, as against $180,971 in 1900.

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 a makeweight in the manufacture of medium grades of paper. The production in 1901, 69,200 short tons, valued at $483,600, is the largest yet recorded, though the value is less than in 1900.

Flint.—The production of flint in 1901 amounted to 34,420 short tons, an increase of 1,925 tons over 1900, and was valued at $149,297, an increase of $62,946 over 1900.

Fuller's earth.—The production of fuller's earth in 1901 showed an increase over the production of 1900, being 14,112 short tons, valued at $96,835, as compared with 9,698 short tons, valued at $67,535, in 1900. The maximum production of fuller's earth was in 1897, when the output was 17,113 short tons.

Graphite.—The production of graphite in 1901 amounted to 3,967,612 pounds of crystalline graphite and 809 short tons of amorphous, as compared with 5,507,855 pounds of crystalline graphite and 611 short tons of amorphous graphite in 1900. The total value of the product in 1901 was $167,714; in 1900 it was $197,579. The production of artificial graphite was 2,500,000 pounds, valued at $119,000.

Limestone for iron flux.—The amount of limestone used for fluxing in blast furnaces in 1901 was 8,540,168 long tons, valued at $4,659,836, as compared with 7,495,435 long tons, valued at $3,687,394, in 1900.

Lithium.—The production of lithium minerals in 1901, amounting to 1,750 tons, valued at $43,000, was more than three times the production of 1900, about 520 tons.

Magnesite.—This product comes entirely from California. The production in 1901 amounted to 13,172 short tons, valued at $43,057, as compared with 2,252 short tons, valued at $19,333, in 1900, the maximum production up to that date.

Mica.—There was an important increase in the production of sheet mica in 1901, particularly in the small sizes, which have been found available for the manufacture of electric insulators. The total production of sheet mica in 1901 amounted to 360,060 pounds, valued at $98,859, as compared with 456,283 pounds, valued at $92,758, in 1900, and with 108,570 pounds of sheet mica, valued at $70,587, in 1899. The scrap mica produced in 1901 amounted to 2,171 short tons, valued at $19,719, as compared with 5,497 short tons, valued at $55,202, in 1900, and with 1,505 short tons, valued at $50,878, in 1899.

Mineral waters.—The amount of commercial natural waters sold in 1901 was, as it was also in 1900, about 8,000,000 gallons more than in the preceding year, but unlike 1900 there was a very considerable gain in value in 1901. In 1901 55,771,188 gallons were sold, valued at $7,586,962, as compared with 47,558,784 gallons, valued at $6,245,172, in 1900, a gain of $1,341,790 in 1901.

Molybdenum.—The production of molybdenite in the United States in 1901 probably did not exceed 10 to 15 tons. The

production of 1902 will probably greatly exceed that of 1901.

Monazite.—The production of monazite in 1901 amounted to 748,736 pounds, valued at $59,262, as compared with 908,000 pounds, valued $48,805, in 1900, an increase of $10,457 in value and a decrease of 159,264 pounds in amount, both increase and decrease being probably caused by the improved condition in which the crude material was marketed.

Precious stones.—The value of the gems and precious stones found in the United States in 1901 was $289,050, as compared with $233,170 in 1900 and with $185,770 in 1899. The principal features connected with this industry in 1901 were the increased mining of the fine blue sapphires in Fergus County, Mont.; the extensive working of a deposit of rhodolite-garnet in Cowee Valley, Macon County, N. C.; the active working of the tourmaline deposits at Mesa Grande, San Diego County, Cal., and the discovery of a new nearby deposit; the formation of several new turquoise companies for mining in New Mexico; the finding of one diamond in Lee County, Ga.; and the finding of magnificent epidote crystals in Prince of Wales Island, Alaska.

Pumice stone.—No pumice was produced in 1901.

Rutile.—The production of rutile in 1901 rose from 300 pounds, valued at $1,300, in 1900, to 44,250 pounds, valued at $5,710, in 1901. This great increase in the production of cheap rutile was due to the development of the deposits in Nelson County, Va.

Soapstone.—Exclusive of the production of fibrous talc from Gouverneur, N. Y., the production of soapstone and talc amounted in 1901 to 28,643 short tons, valued at $424,888, as compared with 27,943 short tons, valued at $383,541, in 1900. The output for 1901 was the largest on record, exceeding that of 1900, the year of previous largest production, by 700 short tons in amount and $41,347 in value, as 1900 had exceeded 1899 by 3,178 short tons in amount and $52,736 in value.

Tungsten.—The production of tungsten ore in 1901 amounted to 179 short tons, concentrated from 1,221 short tons of crude ore, and was valued at $27,720, an average price of $154.86 per ton.

Uranium and vanadium.—The production, confined chiefly to Colorado, of the minerals containing uranium and vanadium in 1901 amounted to about 375 short tons. The value of this product is difficult to estimate, some of the crude ore selling for $150 per ton and some of the uranium oxide selling for $1.20 per pound.

DIVISION OF HYDROGRAPHY.

This division was continued in charge of Mr. Frederick H. Newell, whose assistants in various lines of investigation included Messrs. Arthur P. Davis, Charles H. Fitch, N. H. Darton, Cyrus C. Babb, H. A. Pressey, Edwin G. Paul, Gerard H. Matthes, Jeremiah Ahern, and Charles R. Olberg. In addition, there were employed in the field a number of assistants designated resident hydrographers, whose names are given below.

Mr. Arthur P. Davis continued and completed investigations of the storage of water on Verde River and on Salt River, Arizona, and prepared a detailed report on both projects, including the designing of dams, with the necessary adjuncts. He also started a reconnaissance investigation of the Lower Colorado River. A portion of his time was taken by work which he did as a member of the board of engineers to report on the water-storage projects in the Truckee River Basin, in California and Nevada. In the Arizona work he was assisted by Mr. Charles R. Olberg.

Mr. Charles H. Fitch, in charge of investigations in the Northwest, supervised work in Colorado, including the tunnel diversion of the Gunnison River; in Montana, the storage and diversion of the St. Mary River; in Idaho, the diversion of the Upper Snake River; and in Wyoming, storage on Crow Creek.

Mr. N. H. Darton continued field work in the subhumid region, mainly in the Black Hills, South Dakota, and later eastward on the Great Plains. His investigations related largely to the occurrence of underground waters, and hence were of a geologic nature.

Mr. Cyrus C. Babb had charge of the St. Mary River survey

in northern Montana, which project contemplates storage on this stream and its diversion to Milk River, the adjoining basin eastward, where the waters can be more advantageously used for irrigation purposes.

Mr. H. A. Pressey continued to direct the work in the Atlantic coast drainage. He made special investigations of the water powers of Maine and of the water supply of New York City and vicinity, completed the report on the Southern Appalachian area, and made a study of hydraulic conditions as affected by turbidity and color of streams.

Mr. Edwin G. Paul continued in charge of the instrument equipment and the rating of meters, and in addition filled the position of resident hydrographer in Pennsylvania and Maryland.

Mr. Gerard H. Matthes was principal assistant on the St. Mary Canal survey, and later in the office was in charge of the computations of the flow of streams for the detailed annual progress report of the division.

In response to a demand for more complete information concerning the quality of natural waters, steps have been taken to develop this side of the investigation somewhat more fully than in the past. It is not sufficient for many industrial purposes to know merely the quantity of the water, but certain facts must be ascertained concerning its quality, or the foreign substances carried in suspension or solution. A complete analysis of these from the chemical and bacteriological standpoints is very expensive and requires considerable time, so that it is usually possible to examine only one or two samples of water from a given source. To make a general examination in this way of water from most of the important streams of the country would be impracticable. The attempt has been made, therefore, to select from the many possible analyses or determinations a few which are most important and which require least apparatus and time.

Of the many possible ways in which water might be examined there are a few which yield valuable results when made in the field. Others require expensive laboratory apparatus. As the work of this division is almost wholly in the field,

there have been selected for examination such subjects as yield results by the field methods. The most important of these are color and turbidity. After conference with Messrs. Allen Hazen and George W. Whipple, a system of examination and a scheme of recording results have been devised. A full description has been given in Circular No. 8, devoted to this subject.

Measurements of color and turbidity have been carried on at a few river stations, particularly in the East, and sufficient figures have been obtained to show the general relation between river flow and quality of water at certain places. The experience thus gained justifies the continuation of field work in other parts of the country.

For the more thorough examination of the quality of water, such as requires laboratory apparatus, dependence is placed mainly upon cooperation with individual chemists or with State boards of health, universities, and similar institutions. It has been found important to secure approximate uniformity in the methods of examination and in the statements of results, so that these will be comparable. For this purpose Circular No. 9 has been prepared by Mr. Marshall O. Leighton, who has acted as expert in such matters, this circular being in conformity with the recommendations made by the committee on standard methods of water analysis of the American Public Health Association. It is hoped that not only can the quantity of water and its distribution be shown, but also the comparative quality of natural waters, and changes which occur in these through geologic agencies, particularly through the influences introduced by increase of population.

The movement of water beneath the surface, especially in pervious sands and gravels, is a matter concerning which little is known other than that such movement does occur and at varying rates. Many attempts have been made to measure the so-called underflow, and during the last year Prof. Charles S. Slichter, of Madison, Wis., succeeded in making an apparatus which apparently will be helpful in the quest for information on this subject. His device is based upon a method of putting an easily soluble electrolyte, such as ammonium

chloride, into one well, and measuring by a suitable electrical device the resistance between this well and another sunk to the same level, this resistance decreasing as the salt in solution reaches the lower well. The results attained lead to the hope that during the next year field operations can be conducted on a considerable scale, and light be thrown on obscure points in the movement of water beneath the surface in its progress toward wells or underflow channels.

STREAM MEASUREMENT.

In addition to the special work above mentioned, systematic measurements of the streams of the United States were continued, the results being shown in Water-Supply Papers Nos. 75 and 76. The field data obtained at the various stations during 1901 are given in Water-Supply Papers Nos. 65 and 66.

There are given in the list below, arranged by States, names of resident hydrographers in charge of stream measurements, and persons cooperating in various localities:

California: J. B. Lippincott, civil engineer, Los Angeles.

Colorado: A. L. Fellows, civil engineer, Denver.

Georgia and Alabama: Prof. B. M. Hall, civil engineer, Atlanta, Ga.; Prof. W. S. Yeates, State geologist, Atlanta, Ga.; Prof. Eugene A. Smith, State geologist, Tuscaloosa, Ala.

Idaho: D. W. Ross, State engineer, Boise; N. S. Dils, civil engineer, Caldwell.

Kansas: W. G. Russell, Russell.

Maine: Prof. N. C. Grover, Maine State College, Orono.

Maryland: Prof. William B. Clark, State geologist, Baltimore.

Montana: Prof. Samuel Fortier, Bozeman; J. L. Rhead, Bozeman.

Nebraska: Prof. O. V. P. Stout, State University, Lincoln.

Nevada: L. H. Taylor, civil engineer, Reno.

New Jersey: G. B. Hollister, Rutherford.

New Mexico: P. E. Harroun, civil engineer, Albuquerque.

New York: R. E. Horton, civil engineer, Utica; W. W. Schlecht, New York.

North Carolina and South Carolina: Prof. J. A. Holmes, State geologist, Chapel Hill, N. C.; assisted by E. W. Myers.

North Dakota and Minnesota: Prof. C. M. Hall, Fargo, N. Dak.

Ohio: B. H. Flynn, engineer State board of health, Columbus.

Rhode Island: Prof. John E. Hill, Brown University, Providence.

Texas: Prof. Thomas U. Taylor, State University, Austin.

Utah: Prof. George L. Swendsen, Logan.

Virginia and West Virginia: Prof. D. C. Humphreys, Washington and Lee University, Lexington, Va.

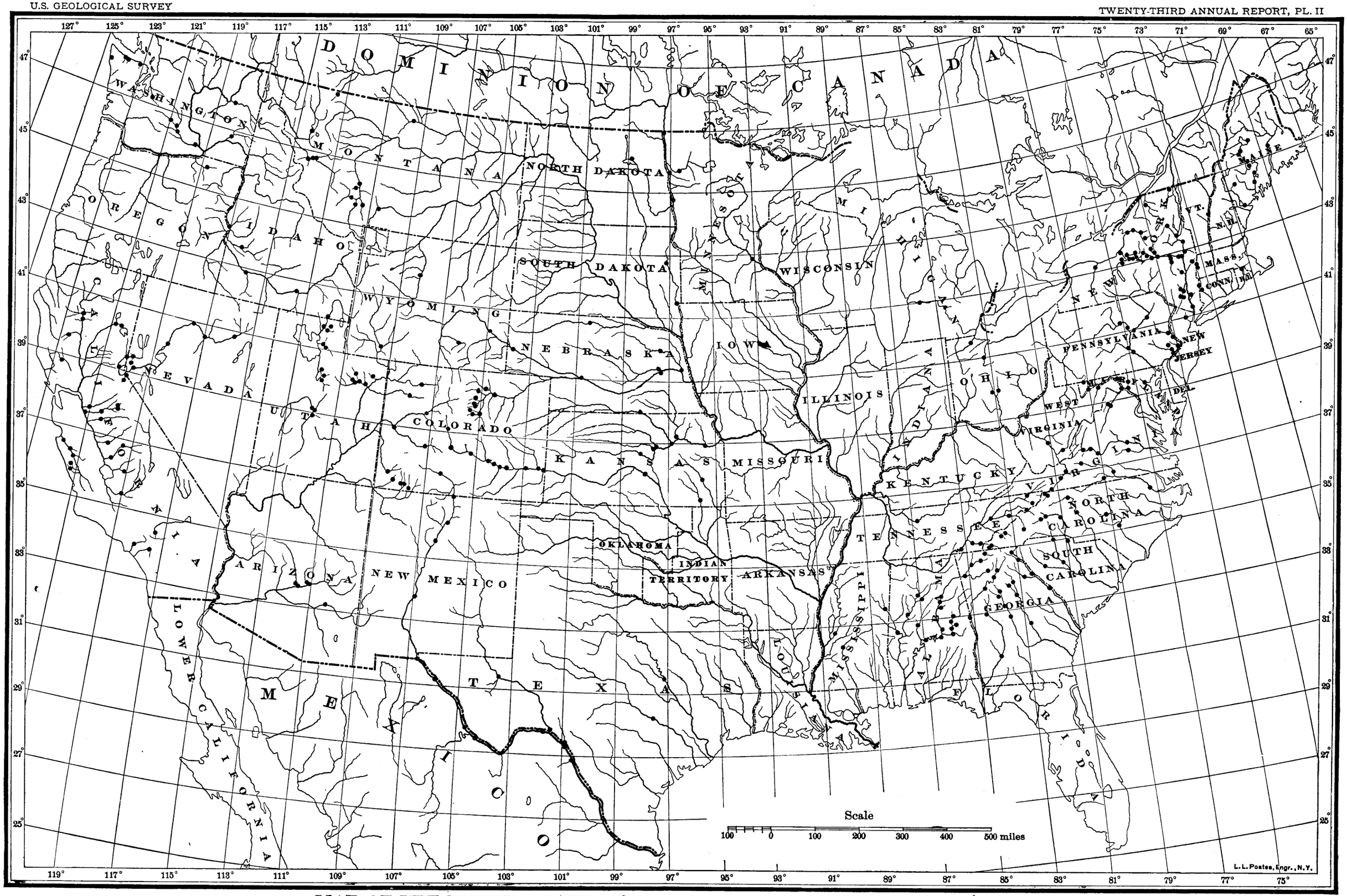
Washington: Sydney Arnold, civil engineer, North Yakima.

Wyoming: A. J. Parshall, civil engineer, Cheyenne.

Cooperation was also extended at a number of points by the United States Weather Bureau and by various private organizations.

The following list, arranged by States, and the map, Pl. II, show the points at which the principal gaging stations were maintained:

River.	Station.
ALABAMA.	
Alabama	Montgomery.
Do	Selma.
Big Sandy Creek	Dadeville.
Black Warrior (Mulberry Fork of).	Cordova.
Black Warrior	Tuscaloosa.
Cahaba	Centerville.
Coosa	Lock No. 4.
Do	Riverside.
Hillabee	Alexander.
Talladega	Nottingham.
Tallapoosa	Milstead.
Do	Sturdevant.
Do	Susanna.
Tombigbee	Epes.
ARIZONA.	
Colorado	Yuma.
Gila	San Carlos.
Salt	Livingston.
Do	McDowell.
Tonto Creek	Livingston.
Verde	McDowell.
CALIFORNIA.	
Arroyo Seco	Piney.
Do	Soledad.
Cache Creek	Lower Lake.
Eleanor Creek	On trail.
CALIFORNIA—cont'd.	
Kern	Bakersfield.
Kings	Red Mountain.
Los Angeles	Narrows.
Merced	Merced Falls.
Mohave	Victorville.
Mokelumne	Electra.
Nacimiento	Bryson.
Sacramento	Jellys Ferry.
Salinas	Salinas.
San Antonio	Jolon.
San Gabriel	Azusa.
San Lorenzo	King City.
Santa Ana	Warm Springs.
San Joaquin	Herndon.
Stanislaus	Oakdale.
Stony Creek	Fruto.
Susan	Susanville.
Truckee	Tahoe.
Do	Mystic.
Tule	Porterville.
Tuolumne	Hetch Hetchy Valley.
Do	Lagrange.
West Fork Carson	Woodfords.
Willow Creek	Standish.
COLORADO.	
Animas	Durango.
Arkansas	Barton.



MAP OF THE UNITED STATES, SHOWING LOCATION OF RIVER STATIONS.

River.	Station.
COLORADO—continued.	
Arkansas	Canyon.
Do	Granite.
Do	Granada.
Do	Nepesta.
Do	Prowers.
Do	Pueblo.
Do	Rockyford.
Do	Salida.
Bear Creek	Morrison.
Big Thompson	Arkins.
Boulder Creek	Boulder.
Clear Creek	Forks Creek.
Dolores	Dolores.
Florida	Durango.
Grand	Glenwood Sp'gs.
Gunnison	Iola.
Do	Whitewater.
Los Pinos	Ignacio.
Mancos	Mancos.
Rio Grande	Cenicero.
Do	Del Norte.
South Boulder Creek	Marshall.
South Platte	Denver.
Do	Kersey.
St. Vrain	Lyons.
White	Meeker.
Yampa	Craig.
CONNECTICUT.	
Housatonic	Gaylordsville.
GEORGIA.	
Apalachee	Buckhead.
Alcovy	Covington.
Broad	Carlton.
Chattahoochee	Buford.
Do	Gainesville.
Do	Oakdale.
Do	West Point.
Coosawattee	Carters.
Coosa	Rome.
Etowah	Canton.
GEORGIA—continued.	
Flint	Albany.
Do	Woodbury.
Middle Oconee	Athens.
Oconee	Barnett Shoals.
Do	Dublin.
Ocmulgee	Flovilla.
Do	Macon.
Oostanaula	Resaca.
Savannah	Augusta.
Tallulah	Tallulah Falls.
Toccoa	Blueridge.
Towaliga	Juliette.
Yellow	Almon.
IDAHO.	
Bear	Battle Creek.
Boise	Boise.
Bruneau	Grandview.
Weiser	Weiser.
Snake	Montgomery Ferry.
KANSAS.	
Arkansas	Hutchinson.
Blue	Manhattan.
Kansas	Lecompton.
Neosho	Iola.
Republican	Junction.
Saline	Salina.
Smoky Hill	Ellsworth.
Solomon	Niles.
Verdigris	Liberty.
MARYLAND.	
Antietam Creek	Sharpsburg.
Monocacy	Frederick.
Patapsco	Woodstock.
Potomac	Point of Rocks.
Youghiogheny	Friendsville.
MINNESOTA.	
Devils Lake	Devils Lake.
Mississippi	St. Paul.
Red Lake River	Crookston.
Red River	Moorhead.

River.	Station.
MISSISSIPPI.	
Pearl	Jackson.
Tombigbee	Columbus.
Yazoo	Yazoo City.
MONTANA.	
Bitterroot	Missoula.
Blackfoot	Bonner.
Crow Creek	Radersburg.
Flathead Lake	Polson.
Gallatin	Logan.
Jefferson	Sappington.
Madison	Redbluff.
Milk	Havre.
Missoula	Missoula.
Missouri	Townsend.
St. Mary	Main.
West Gallatin	Salesville.
Yellowstone	Livingston.
NEBRASKA.	
Elkhorn	Arlington.
Do	Norfolk.
Loup	Columbus.
North Platte	Mitchell.
Do	North Platte.
Niobrara	Valentine.
Platte	Columbus.
Republican	Superior.
NEVADA.	
Carson	Empire.
East Fork Carson	Gardnerville.
Humboldt	Elko.
Do	Golconda.
Do	Oreana.
S. F. Humboldt	Mason's ranch.
Steamboat Creek	Steamboat Springs.
Truckee	Vista.
NEW HAMPSHIRE.	
Connecticut	Orford.
NEW JERSEY.	
Delaware	Lambertville.
Passaic	Two Bridges.
Pompton	Do.
NEW MEXICO.	
Rio Grande	Embudo.
Do	Rio Grande.
Do	San Marcial.
NEW YORK.	
Black	Felts Mills.
Cayadutta Creek	Johnstown.
Chenango Creek	Binghamton.
Chittenango Creek	Bridgeport.
Do	Chittenango.
Croton	Croton dam (old).
East Canada Creek	Dolgeville.
Esopus Creek	Kingston.
Fishkill Creek	Glenham.
Hudson	Fort Edward.
Do	Mechanicsville.
Indian Creek	Indian Lake dam.
Kinderhook Creek	East Nassau and Wilson's dam.
Mohawk	Dunsback Ferry.
Do	Little Falls.
Moose	Mooseriver.
Normanskill Creek	French's mill.
Oneida	Brewerton.
Oneida Creek	Kenwood.
Oswego	Fulton.
Do	High Dam.
Do	Minetto.
Raquette	Hannawa Falls.
Richelieu	Fort Montgomery.
Rondout	Honk Falls.
Saquoit Creek	New York Mills and Yorkville.
Schoharie Creek	Fort Hunter dam.
Do	Mill Point Aqueduct.

River.	Station.
NEW YORK—cont'd.	
Seneca	Baldwinsville.
Susquehanna	Binghamton.
Tenmile River	Dover Plains.
Wallkill	New Paltz.
West Branch Fish Creek.	McConnellsville.
West Canada Creek	Middleville.
NORTH CAROLINA.	
Cape Fear	Fayetteville.
Catawba	Catawba.
Deep	Cumnock.
French Broad	Asheville.
Hiwassee	Murphy.
Little Tennessee	Judson.
Nottely	Ranger.
Roanoke	Neal.
Tuckasegee	Bryson.
Yadkin	Salisbury.
NORTH DAKOTA.	
Red	Grand Forks.
Do	Pembina.
OHIO.	
Maumee	Waterville.
Olentangy	Columbus.
Sandusky	Mexico.
Do	Fremont.
Sciota	Columbus.
OREGON.	
Umatilla	Gibbon.
PENNSYLVANIA.	
Juniata	Newport.
Susquehanna	Danville.
Do	Harrisburg.
Susquehanna, West Branch.	Allenwood.
Do	Williamsport.
Susquehanna, North Branch.	Wilkesbarre.
RHODE ISLAND.	
Blackstone	Berkeley.
SOUTH CAROLINA.	
Broad	Alston.
Catawba	Rock Hill.
Savannah	Calhoun Falls.
Saluda	Waterloo.
Tugaloo	Madison.
SOUTH DAKOTA.	
Big Sioux	Sioux Falls.
Do	Watertown.
TENNESSEE.	
Cumberland	Nashville.
Hiwassee	Charleston.
Do	Reliance.
Tennessee	Chattanooga.
Do	Knoxville.
South Fork of Holston.	Bluff City.
TEXAS.	
Brazos	Waco.
Colorado	Austin.
Devils River	Devilsriver.
Pecos	Moorhead.
Do	Pecos.
Rio Grande	El Paso.
Do	Below Presidio.
Do	Eagle Pass.
Do	Langtry.
Do	Above Presidio.
Do	Devilsriver.
Do	Fort Hancock.
UTAH.	
American Fork	American Fork.
Ashley Creek	Vernal.
Bear	Collinston.
Blacksmith Fork	Hyrum.
Duchesne	Price Bridge.
Lake Creek	Near mouth.

River.	Station.
UTAH—continued.	
Logan	Logan.
Ogden	Ogden.
Provo	Provo.
Salina Creek	Salina.
Sanpitch	Gunnison.
Sevier	Do.
Spanish Fork	In canyon.
Uinta	Fort Duchesne.
Do	Ouray School.
Do	Whiterocks.
Weber	Uinta.
Whiterocks	Whiterocks.
VIRGINIA.	
Appomattox	Mattoax.
Dan	South Boston.
James	Buchanan.
Do	Cartersville.
James (North of)	Glasgow.
James	Holcomb Rock.
New	Oldtown.
Do	Radford.
Roanoke	Roanoke.
Shenandoah, North Branch.	Riverton.
Shenandoah, South Branch.	Front Royal.
VIRGINIA—continued.	
Staunton	Randolph.
WASHINGTON.	
Dungeness	Dungeness.
Elwha	McDonald.
Kalawa	Forks.
Naches	North Yakima.
Palouse	Hooper.
Soleduck	Quillayute.
Spokane	Spokane.
White	Buckley.
Yakima	Kiona.
Do	Union Gap.
WEST VIRGINIA.	
Greenbrier	Alderson.
New	Fayette.
Potomac, North Branch.	Piedmont.
Potomac, South Branch.	Springfield.
Shenandoah	Millville.
WYOMING.	
Bighorn	Thermopolis.
Green	Greenriver.
Medicine Bow	Medicine Bow.
North Platte	Guernsey.

OPERATIONS, IN GEOGRAPHIC ORDER.

There are given below, in general geographic order, descriptions of the operations in the various States or groups of States, and also the names of the engineers or resident hydrographers under whose charge the work was done.

HUMID REGION.

Maine.—Measurements of the rivers at various points were continued through cooperation with the State, the field work having been placed in charge of Prof. N. C. Grover.

Rhode Island.—Measurements on the Blackstone River were

continued in cooperation with Brown University, the field work being carried on by the students of Prof. John E. Hill.

Connecticut.—Measurements were continued on certain small streams in connection with a study of the water supply for the city of New York.

New York.—Systematic measurements, through cooperation with the State, were continued under the direction of Mr. Robert E. Horton. Additional work, mainly in the Catskill region, in connection with the water supply of New York City, was carried on by Mr. W. W. Schlecht. The investigations as to the relative accuracy of various forms of current meters under different conditions, made by Prof. E. C. Murphy at the hydraulic laboratory of Cornell University, Ithaca, were completed, and the results were published in Water-Supply Paper No. 64.

New Jersey.—Occasional measurements of streams were made in the southern part of this State, the work being under the charge of Mr. George B. Hollister, of Rutherford, who gave particular attention to the preparation of short reports designed to call public attention to the results of the work of this division.

Pennsylvania.—Systematic measurements of Susquehanna and Delaware rivers were carried on by Mr. Edwin G. Paul, in order that data might be available for a discussion of the development of water power and of the influence of forests on the streams.

Maryland.—The study of the streams of this State was continued through the assistance rendered by Prof. William B. Clark, State geologist, in connection with the geological survey of the State.

Virginia and West Virginia.—Measurements of a number of the important rivers of these States were continued by Prof. D. C. Humphreys, of Lexington, Va.

North Carolina and South Carolina.—The work in these States was continued, under the direction of Prof. J. A. Holmes, by Mr. E. W. Myers, particular attention being given to the streams which issue from the western part of the State, within the area of the proposed national forest reserve, and also to

certain streams on which plans are being made for the development of hydraulic power.

Georgia.—Through cooperation with the State geologist, Prof. W. S. Yeates, and with the United States Weather Bureau, continued investigations were possible, the work being carried on by Prof. B. M. Hall and Mr. Max Hall.

Alabama.—Gaging stations in this State were continued, with the addition of a few others, the work being carried on through cooperation with the State geologist, Prof. Eugene A. Smith.

Tennessee.—A portion of the streams of the northeast corner of the State were measured by Mr. E. W. Myers in connection with the proposed national park; and other rivers by Mr. B. M. Hall, in connection with related work in Georgia and Alabama.

Ohio.—Cooperation was continued with the State board of health, the field work having been placed in charge of Mr. Benjamin H. Flynn, engineer of the board.

Minnesota.—A few gaging stations were established in this State on the recommendation of Prof. C. M. Hall, of the State Agricultural College at Fargo, N. Dak., as an extension of similar work in North Dakota.

SUBHUMID REGION.

North Dakota.—Through cooperation with the Agricultural College, hydrographic work in this State was extended, an appropriation for this purpose having been made by the State legislature. Prof. C. M. Hall, professor of geology at the State College, had charge of the work.

South Dakota.—Mr. N. H. Darton, geologist, continued his examination of the artesian conditions in the vicinity of the Black Hills. Later his work was extended eastward to the Great Plains. Stream measurements in the State were maintained by Prof. O. V. P. Stout, of Lincoln, Nebr.

Nebraska.—Systematic measurements of the rivers of this State were continued by Prof. O. V. P. Stout and his assistants, cooperation being had with Mr. Adna Dobson, State engineer.

Kansas and Oklahoma.—Work in this area was continued by Mr. W. G. Russell, of Russell, Kans., as in former years.

Texas.—Measurements of a number of important rivers in connection with irrigation studies were made by Prof. Thomas U. Taylor, of the State University. Measurements at various points along the Rio Grande were made by the engineers of the International (Water) Boundary Commission, and through their courtesy the results have been furnished to this Survey.

ARID REGIONS.

The organization of the Division of Hydrography came about through a desire for information regarding the flow of streams in the arid West in connection with the irrigation development of the country, and, as in former years, the greater portion of the appropriation for hydrographic investigations was devoted to that section. Stream measurements were continued and various reservoir sites were surveyed, and examinations were made of the possibility of diverting the large rivers.

Appreciation of the results of this work is clearly shown by the numerous requests and petitions coming to this office for an extension of the work. It has, however, been impossible to comply with all of them on account of the limited funds available.

Arizona.—Two notable engineering projects were investigated in detail and reports on them were prepared by Mr. Arthur P. Davis, hydrographer, viz, the possibility of storing water on Verde River and on Salt River.

The former project contemplates the construction of a rock-fill dam 2 miles above the mouth of the river. Test borings for the depth of bed rock were made, and the greatest depth found was 90 feet. The upper 30 feet consisted generally of sand and gravel, below which was a compact cemented gravel. It is proposed to have a concrete core wall extend from bed rock up through the cemented gravel, and to construct the rock fill above this, excavating all the loose sand and gravel over the site of the dam. A concrete wall will be placed at the heel of the dam, above which will extend a rubble masonry wall 20 feet thick at bottom and 5 feet thick at top, constituting the upper face of the dam. Against its downstream side

will be built the mass of rock fill. On the water side will be placed I beams and a web of steel plate dipped in asphalt and riveted together to form a water-tight skin over the entire upper side of the dam. The available reservoir capacity for a dam 190 feet above the lowest foundation is 186,000 acre-feet. The cost of construction is placed at $1,624,871, or $8.74 per acre-foot stored.

The Salt River project contemplates the construction of a high masonry dam in the canyon of the river about 45 miles above the mouth of the Verde and a short distance below the mouth of Tonto Creek. The greatest depth to bed rock at the chosen site was found to be about 30 feet. The height of the dam is to be 217 feet above the bed of the river, and it is to store water at a maximum depth of 190 feet. The reservoir capacity at this spillway height is 847,745 acre-feet. The foundation and abutments, of hard, tough, fine-grained sandstone, are all that could be desired. A large amount of cement will be required for the construction of the dam, and it is proposed to manufacture this material on the ground, as the proper natural constituents have been found in place near by.

It is planned to develop a hydraulic power at the dam. The proposed canal for the plant would head some distance above the reservoir, following above its water line and finally discharging just below the dam with an available head of 180 feet. It is designed to deliver 100 second-feet and develop a net energy of 1,200 horsepower, 300 of which is to be used at the cement mill and 900 at the dam during construction. The cost of the entire Salt River project is placed at $1,908,387, or $2.27 per acre-foot of water stored.

California.—Hydrographic investigations in this State were under the general direction of Mr. J. B. Lippincott, as in former years, and special studies of the storage possibilities in Salinas Valley were made.

The problem of providing water for the Salinas Valley has been exceedingly difficult, as the conditions are highly unfavorable for water storage, and the cost of fuel for pumping water is high. A systematic examination of all the conditions has been made under Mr. Lippincott's direction by

Mr. Homer Hamlin, and the results are being prepared for publication in the Water-Supply series. Not merely have the reservoir sites been examined, but every available fact concerning the opportunities of obtaining water from underground has been sought, and the question of a cheaper supply of fuel, such as natural petroleum, has been examined.

Work was continued also on Stony Creek, a tributary of Sacramento River, which enters from the west side. The storage possibilities on the main stream and on the tributaries were examined and a report has been completed, to be published in the Water-Supply series. It is believed that by the use of the reservoir sites examined it will be possible to build up a densely populated community.

Colorado.—Mr. A. L. Fellows continued systematic measurements of the streams in this State, and, in addition, undertook an investigation of the practicability of diverting the water of Gunnison River, by means of a tunnel, to the Uncompahgre River Valley. In this work he was assisted by Mr. Jeremiah Ahern.

There are in the Uncompahgre Valley 100,000 acres of arable land, approximately 60,000 acres of which have been filed upon, the remaining 40,000 acres being Government land. Owing to the deficient water supply, only about 30,000 acres are at present under cultivation. The investigation shows that it is feasible to divert the Gunnison River through a tunnel to this valley. The tunnel will be 4 miles long and is designed to carry 1,000 second-feet. It will have a cross section 12 by 12 feet and a fall of about 15 feet to the mile. Two miles of the main tunnel will be through Cretaceous shales, and it will be necessary to line this portion with concrete. The remainder of the tunnel will be through impervious granite. The entire cost of the project is placed at $750,000, not including the canal distribution system in the Uncompahgre Valley. The latter has not yet been surveyed, but the cost will approximate $100,000.

Idaho.—Stream measurements at a number of points in the State were continued by Mr. N. S. Dils.

Through cooperation with the State, an investigation of water conservation in Upper Snake River Valley was commenced, under the direction of D. W. Ross, State engineer. Three reservoir sites were surveyed—Henry Lake, Flat Rock, and Island Park sites. The present area of Henry Lake is 3,760.5 acres; by the construction of a dam to a height of 20 feet above the present lake level the area will be increased to 7,000 acres, with a capacity of 104,370 acre-feet. The cost of an earthen dam here, with outlet tunnel and gate house, would approximate $30,000.

Flat Rock reservoir site is on Henry Fork a few miles below Henry Lake, the site of the dam being at the head of Coffeepot Rapids. A survey was made for a dam 35 feet above the bed of the river, and the capacity of the reservoir was found to be 35,000 acre-feet. The discharge of the river at the time of the survey, during a low stage, was 350 second-feet. The dam would be 170 feet long on the bottom, 350 feet on top, and about 42 feet above bed rock. The cost of a timber-and-rock structure here is placed at $40,000.

Island Park site is on Henry Fork 6 miles below the mouth of Buffalo Creek. The survey was for a dam 33 feet high, and the capacity was found to be 18,000 acre-feet. The river was discharging at the time of measurement, during a low stage, 600 second-feet. This site should be developed on bolder plans—that is, for a greater height of dam—but the surveys could not be made at this season on account of the inclement weather.

An investigation was also made of the feasibility of diverting Henry Fork just below Henry Lake, conducting the waters eastward over Sheridan Pass and turning them into the head of Camas Creek, to be used in the vicinity of Mud Lake. The controlling point was Sheridan Pass, and a canal survey was run backward from here on an ascending grade and came out 41 feet above the lake level. A dam 50 feet in height would be required to lift the water to this elevation, but there is no suitable dam site. If the water were diverted without the use of the dam, the cut through Sheridan Pass would be over 65

feet and more than 6 miles long, while through another pass a few miles south another cut, 15 feet deep and from 2 to 4 miles in length, would be necessary, the greater portion being in solid rock. For these reasons the project is not considered feasible.

Montana.—Stream measurements were continued in this State, the field work being carried on by Mr. J. L. Rhead.

The investigation of the storage of water on St. Mary River and its diversion to the adjacent basin eastward—that of Milk River—was continued under the immediate charge of Mr. Cyrus C. Babb. This project is designed to store flood waters in the St. Mary Lakes, in the northern portion of the State, and conduct them easterly by a canal cut through the ridges to the head of Milk River.

It is proposed to build a low storage dam at a point about three-fourths of a mile below the present outlet of Lower St. Mary Lake. This dam will have a maximum elevation of 50 feet above the bottom of the river and will form a reservoir with a capacity of 250,000 acre-feet. The head of the diversion canal will be on the right-hand, or eastern, side of the river. The canal has been planned to carry 1,200 cubic feet per second, and the extent of the area to be reclaimed is estimated at 120,000 acres of public land, which would have a probable value of $35 per acre, or $4,200,000, and would sustain a population of 20,000. By storage in the Lower Milk River Valley the area of reclaimed land, including the use of Milk River, can be increased to 300,000 acres. The length of the proposed canal from its head to the North Fork of Milk River is 27.4 miles, and the cost of construction, including dam and head gates and the drop at the North Fork, will be $687,000.

The extension of the canal from the North Fork to the South Fork and its diversion into the latter stream will have certain advantages over the plan for stopping the canal at the North Fork. The total cost of the canal from the head to the South Fork of Milk River will be $1,173,000, and its length will be 43.8 miles.

The canal from the South Fork could be carried around the

ridge between the basin of this stream and that of the Marias drainage, and after running for a distance of about 46 miles from the South Fork it could be turned into Cutbank Creek. The water could then be allowed to continue down the natural channel of this stream and the Marias for 100 miles or more, when it could be diverted from the latter near the mouth of Willow Creek, and, after a course of about 75 miles, turned into Big Sandy Creek, a tributary of Lower Milk River. This plan keeps the canal in United States territory for its entire course until it reaches Lower Milk River, where the water can be more advantageously used.

Plans have also been considered for a secondary system of storage reservoirs in the Lower Milk River Basin.

If the plan of turning the water of St. Mary Lake into the South Fork of Milk River is adopted, allowing it to continue down through Canada and then utilizing it through the secondary storage system in Lower Milk River Valley, 300,000 acres can be reclaimed, at an estimated cost of from $7 to $9 per acre. By the complete development of the system, including the utilization of St. Mary and Marias waters, and the construction of the secondary storage systems, about 500,000 acres can be reclaimed, at a cost not to exceed $10 per acre.

Nevada.—Stream measurements and special water-storage problems were carried on by Mr. L. H. Taylor. A study of water storage in Carson River Basin is now in progress. Five reservoir sites have been surveyed and estimates of cost prepared for their development, as given below. The first three, Silver King, Diamond Valley, and Mud Lake sites, are in the upper portion of the basin, and if employed to supplement the low-water flow of the streams, their capacity is sufficient to irrigate 70,000 acres. The two larger reservoirs farther down the stream, Alkali Flat and Lower Carson reservoirs, have sufficient capacity to impound all the surplus water over and above the requirements of the upper part of the basin. Their waters will be used on the lands in the vicinity of old Fort Churchill and in the Carson Sink Valley. The following table shows the capacity, the total cost, and the cost per acre-foot of water stored at the five reservoirs.

Carson River reservoirs.

Reservoir.	Capacity in acre-feet.	Cost.	Cost per acre-foot.
Silver King	22,555	$128,040	$5.68
Diamond Valley	23,280	126,500	5.43
Mud Lake	8,370	39,050	4.66
Alkali Flat	136,500	303,000	2.22
Lower Carson	83,595	138,000	1.65

Surveys of two reservoir sites in the basin of Humboldt River were made by Mr. Jeremiah Ahern. One was on the South Fork, in Elko County, where the capacity, with a 70-foot dam, was found to be 23,026 acre-feet. The second site was on the North Fork above Beaver Creek, Elko County, where the capacity, with a 100-foot dam, is 113,414 acre-feet.

A detailed investigation of the storage in the Truckee Basin was completed, and the report will be published as Water-Supply Paper No. 68. In all, ten reservoir sites were surveyed, and a number of miles of main canal line were run. It has been found that 230,000 acres of land can be irrigated. The following table gives the gross and net capacity and the cost of the various storage reservoirs in the system:

Capacity and cost of Truckee River reservoirs.

Reservoir.	Gross capacity.	Net quantity which can be annually drawn.	Cost, complete.
	Acre-feet.	*Acre-feet.*	
Lake Tahoe	745,400	200,000	$21,402
Donner Lake	26,900	26,900	82,672
Independence Lake	11,750	11,700	31,802
Webber Lake	10,450	10,400	50,463
Squaw Creek	1,600	1,600	7,920
Twin Valley	3,480	3,400	20,125
Little Truckee No. 1	20,540	20,500	62,215
Henness Pass Valley	17,000	16,000	40,365
Little Truckee No. 2	6,500	6,500	28,750
Dog Valley	5,785	5,500	17,037
Total	849,405	352,500	362,751

New Mexico.—A few stations along the Rio Grande were maintained by Mr. P. E. Harroun, and data were also obtained from the International (Water) Boundary Commission, through the courtesy of the chairman of the commission, Gen. Anson Mills, and the consulting engineer, Mr. W. W. Follett.

Oregon.—Measurements of the rivers in this State were continued in connection with similar work in the State of Washington.

Utah.—Measurements of streams in this Territory were continued by Prof. George L. Swendsen, of Logan.

A final report on the water supply of the Uinta Indian Reservation was prepared by Mr. Cyrus C. Babb, which shows that the 830 Uinta and Whiterocks Indians will require water for 33,200 acres when the reservation is open, and that the 550 Uncompahgres already allotted lands will require water for 22,000 acres, a total of 55,200 acres. The average water supply is sufficient for 100,000 acres, while for a minimum year there will be enough for 80,500 acres. The report recommends that permission be given to private parties to divert the Whiterocks River, to be used on lands outside of the reservation.

Washington.—Hydrographic work was continued in this State by Mr. Sidney Arnold, of North Yakima, and Mr. W. J. Ware, of Port Angeles.

Wyoming.—Mr. A. J. Parshall continued stream measurements at various points, and also made a detailed examination of a storage project on Crow Creek for an increased water supply for the city of Cheyenne. It was recommended that a dam of rubble masonry laid in Portland-cement concrete be constructed in the canyon of the creek. It will be 90 feet high, with a top length of 420 feet, and the cubical contents will be 10,900 cubic yards. The reservoir capacity is 7,367 acre-feet. As soon as the surveys were completed the city of Cheyenne commenced the construction of the work.

VACANT PUBLIC LAND.

In the discussion of the utilization of the water resources of the country it has been found necessary to make an inventory of the vacant public lands, and to prepare maps of the West-

ern States showing the land in private ownership. This work was undertaken in a general way in 1894, and published in a paper in the Sixteenth Annual Report, Part II, on "The public lands and their water supply," by F. H. Newell. Through cooperation of the General Land Office a more complete examination of public records has been made, and maps have been prepared bringing up to date the information given in this earlier volume. A preliminary edition of photolithographic maps has been issued for the States and Territories of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Work has been begun on the map of California, and also on the maps of the States of the semiarid region—North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma

RESULTS.

In former years the results of the work of the division were published in two series. The data obtained at the various gaging stations appeared from year to year in the Water-Supply series, while the conclusions drawn from the field work and the results of special investigations were published in the hydrography volume of the Annual Report. Owing to a change in the law regarding publications, all progress reports as well as special papers will hereafter appear in the Water-Supply and Irrigation series. The 100-page limit for these papers has been removed, which is an additional advantage.

The data obtained by field work during the year 1901 have been published in Water-Supply Papers Nos. 65 and 66. The progress report on the hydrographic surveys for the same year, including the computations resulting from the field work, will appear in Water-Supply Papers Nos. 75 and 76.

During the last fiscal year Water-Supply Papers Nos. 56 to 71 were sent to the printer. Of these, No. 56 is on methods of stream measurements as developed by the engineers and hydrographers of the division; No. 57 is a list of deep borings in the United States (Part I), by Mr. N. H. Darton; No. 58 gives the results of a detailed examination of water storage in the Kings River Basin, California, under the general direction of Mr. J. B. Lippincott; Nos. 59 and 60 (Parts I and II) are

on the development and application of water in southern California, by Mr. J. B. Lippincott; No. 61 is Part II of deep borings in the United States, by Mr. N. H. Darton; Nos. 62 and 63 (Parts I and II) are on the hydrography of the southern Appalachian region, by Mr. H. A. Pressey, and give a detailed description of the investigation of that region in connection with the establishment of the proposed national park; No. 64 is on the accuracy of stream measurements, by Prof. E. C. Murphy, and is the result of his experimental work at Cornell University; Nos. 65 and 66, as has been noted above, give results of operations at river stations for 1901; No. 67 is on the motion of underground waters, by Prof. Charles S. Slichter; No. 68 shows the results of a detailed investigation of water storage in the Truckee Basin in California and Nevada, by Mr. L. H. Taylor; No. 69 is on the water powers of the State of Maine, by Mr. H. A. Pressey; in No. 70, Dr. George I. Adams treats of the geology and water resources of the Patrick and Goshen Hole quadrangles in Wyoming and Nebraska, and in No. 71 Prof. Thomas U. Taylor describes the irrigation systems of Texas.

Among a number of water-supply papers not yet sent to the printer are the following: "Water pollution of metropolitan areas near New York City," by M. O. Leighton; "Water storage on Salt and Verde rivers, Arizona," by A. P. Davis; "Water resources of Colorado," by A. L. Fellows; "Water resources of Salinas Valley, California," by J. B. Lippincott; "Mississippi River," by William Starling; "The flow of rivers near New York City," by H. A. Pressey.

DIVISION OF PHYSICAL AND CHEMICAL RESEARCH.

During the last fiscal year the scientific force of this division was increased by the appointment on July 23 of Mr. C. E. Van Orstrand as assistant physicist; otherwise it remained unchanged.

In the chemical laboratory 183 quantitative analyses and 490 qualitative analyses were made. The quantitative analyses comprise rocks, ores, minerals, waters, coals, etc., sent in by officers of the Survey and approved by the committee on

Chemical Analyses. Among the interesting substances investigated are volcanic sands and pumice from the islands of Martinique and St. Vincent.

The chemical laboratories were enlarged and in part refitted during the year, causing unavoidable delays in analyses and investigations. The new assay laboratory has been in operation since March 1.

In the physical laboratory much difficulty has been experienced in obtaining apparatus of special designs needed for the investigations proposed. On account of these delays some of the physical researches planned a year ago have unavoidably been postponed, though not abandoned, the labors of the force being expended on problems the facilities for which were at hand.

The special occupations of the members of the force were as follows:

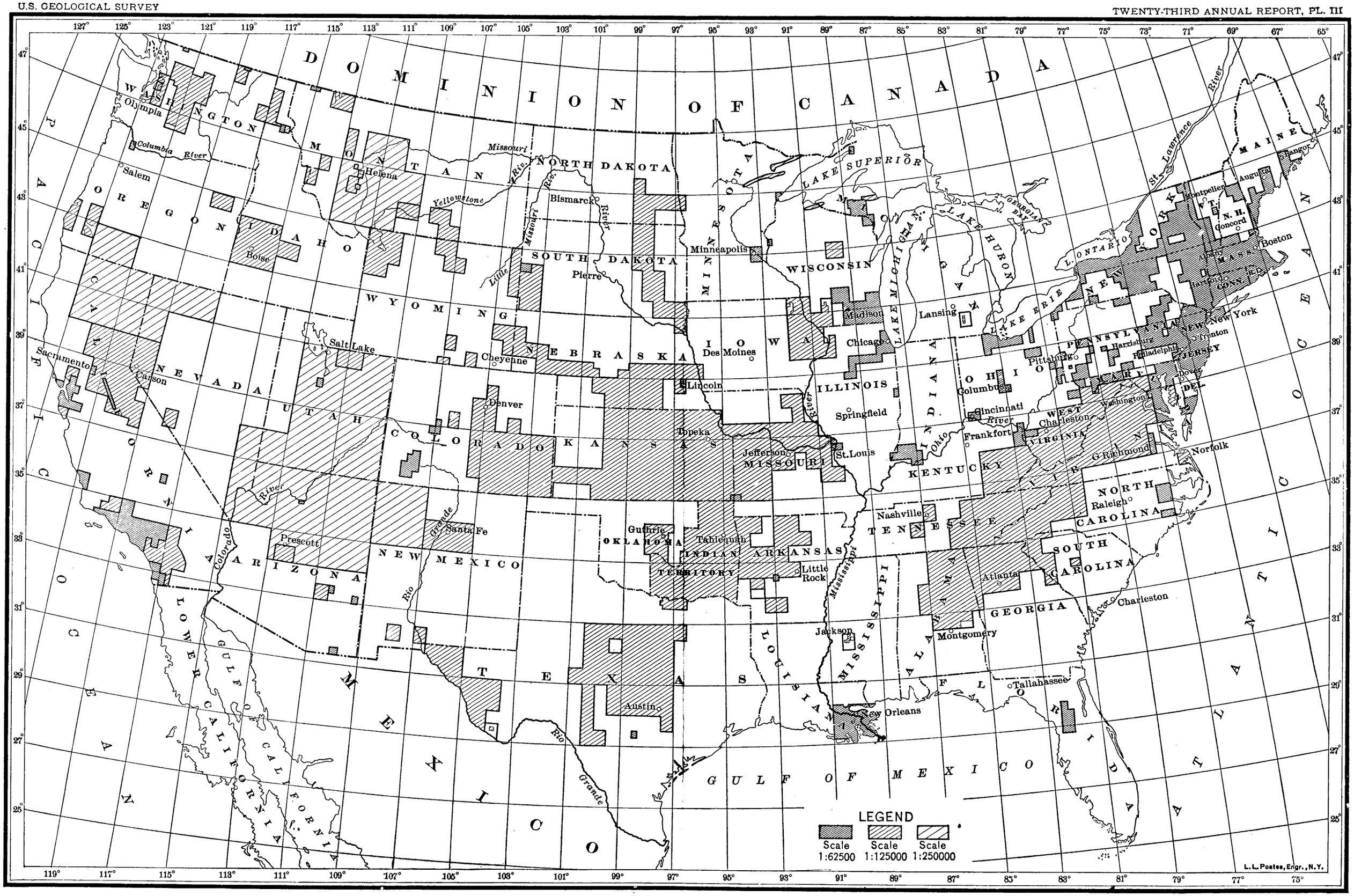
During the early part of the year the time of the geologist in charge was occupied in preparing a memoir on the dynamic geology of the Mother Lode of California, and later by work on physical problems in geology.

Much of Professor Clarke's time was consumed by work connected with the expositions at Buffalo and Charleston, on behalf of the Department of the Interior. This avocation, it is believed, is practically at an end.

In addition to the routine work of analysis, Dr. Hillebrand discovered a new mineral, plumbojarosite, and reanalyzed a rare species, yttrialite, in order to determine its composition. At the request of the New York section of the Society of Chemical Industry, Dr. Hillebrand investigated and reported on the best methods for analyzing Portland cement, as well as on the best methods for analyzing copper slag.

Dr. Stokes, in the time not occupied by routine work, made valuable researches into the solution and reprecipitation of metallic sulphides, thereby throwing much light on the concentration of ores in veins.

Dr. Allen investigated the use of certain organic bases as precipitants in analytical separations. This work is still incomplete.



MAP OF THE UNITED STATES, SHOWING AREAS COVERED BY TOPOGRAPHIC SURVEYS

AND THE VARIOUS SCALES EMPLOYED FOR EACH AREA.

Scale

100 0 100 200 300 miles

1902

Messrs. Clarke and Steiger continued and practically completed their research into the action of ammonium chlorides upon silicates. About twenty minerals in all have been studied, and much light has been thrown upon their rational constitution by this investigation. Mr. Steiger also prepared substitution products of analcite and other zeolites in which the alkali or lime of the mineral is replaced by silver, thus elucidating certain points in the constitution of these important minerals.

Dr. A. L. Day and Mr. Van Orstrand were employed in perfecting the equipment of the physical laboratory, in numerous experiments on the linear force exerted by growing crystals, and on the elastic properties of solids dealt with in a novel manner; but these investigations are not concluded.

The following is a list of the papers published or prepared within the year by members of the division:

By F. W. Clarke: The development of chemistry, in Journal of American Chemical Society, Vol. XXIV, No. 2; The calculation of atomic weights, in American Chemical Journal, Vol. XXVII, No. 5; Ninth annual report of the committee on atomic weights, determinations published in 1902, in Journal American Chemical Society, Vol. XXIV, No. 3.

By F. W. Clarke and George Steiger: The action of ammonium chloride upon silicates, Bulletin No. 207 of the United States Geological Survey.

By W. F. Hillebrand: Common errors in the determination of silica, in Journal of American Chemical Society, Vol. XXIV, No. 4, p. 362; The composition of yttrialite, with a criticism of the formula assigned to thalenite, in American Journal of Science, Vol. XIII, p. 145; On cement analysis, report to the committee on uniformity in analysis of materials for the Portland cement industry, of the New York section of the Society of Chemical Industry, in the Journal of the Society of Chemical Industries, Vol. XXI, 1902.

By H. N. Stokes: On pyrite and marcasite, Bulletin No. 186 of the United States Geological Survey.

By E. T. Allen and V. H. Gottschalk: Researches on the oxides of tungsten, in American Chemical Journal for May, 1902.

By George Steiger and E. T. Allen: A new Government laboratory and its work, in Engineering and Mining Journal, Vol. LXXIII, No. 9.

By J. S. Diller and George Steiger: Volcanic dust and sand from St. Vincent, caught at sea and the Barbados, in Science for June 13, 1902.

TOPOGRAPHIC BRANCH.

Organization and Summary.

The organization of the Topographic Branch remained the same as in the previous year. For purposes of administration there were four sections, viz: Atlantic section, Mr. H. M. Wil-

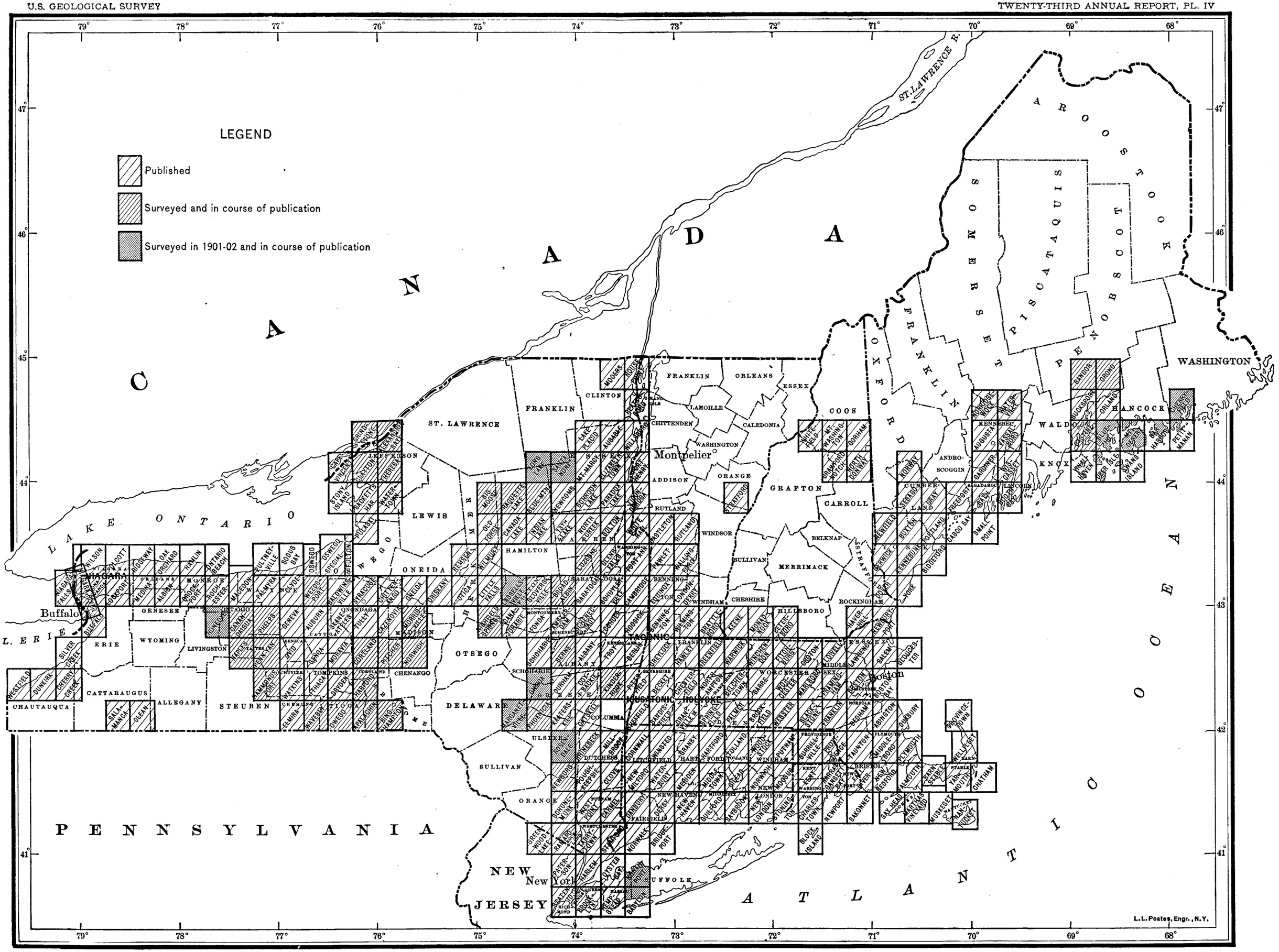
son, geographer in charge; Central section, Mr. John H. Renshawe, geographer in charge; Rocky Mountain section, Mr. E. M. Douglas, geographer in charge; Pacific section, Mr. Richard U. Goode, geographer in charge. Mr. Goode continued to serve as chairman of the Topographic Committee, composed of the above-mentioned geographers.

Changes in the topographic corps were the appointment and resignation of Mr. Charles L. Hoopes, assistant topographer, and the appointment of Messrs. Ernest G. Hamilton, Eugene L. McNair, James M. Whitman, jr., and T. Foster Slaughter, assistant topographers.

Cooperative agreements were arranged with ten States, $22,500 being allotted by the State engineer and surveyor of New York, $15,000 by the State survey commission of Pennsylvania, $15,000 by the State geologist of West Virginia, $25,000 by the governor of Ohio, $2,500 by the State survey commission of Maine, $10,000 by the governor of North Carolina, $1,000 by the State geologist of Alabama, $2,000 by the State geologist of Michigan, $1,000 by the Mississippi experiment station of Mississippi, and about $2,500 by the University of Texas mineral survey. Thus $96,500 was added by the States mentioned to the Federal appropriation for topographic work.

In connection with the topographic surveys, the surveys of forest reserves, Alaskan surveys, and the survey of the Northwest boundary, the following results were obtained:

One base line was measured; primary azimuth observations were made at 5 triangulation stations; 1 meridian line was established; 213 triangulation stations were occupied or located; 2,002 miles of primary traverse were run; 31,798 square miles were covered by detailed topographic mapping, this area being distributed through 28 States and Territories; 16,782 miles of levels were run, and 1,560 permanent bench marks were established, these bench marks being iron posts, bronze or aluminum tablets, or copper or aluminum plugs. In Alaska about 4,950 square miles were mapped topographically and about 1,600 linear miles of traverse were run. Of the boundary of the Bighorn Reserve of Wyoming 117 miles were surveyed and marked by 80 special iron posts, and 42



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

miles were surveyed and tentatively marked by iron posts along the boundary between the United States and Canada west of the Rocky Mountains.

The condition of topographic work to April 30, 1902, distinguished as to scale, is shown on the general map of the United States, Pl. III, and the detailed distribution of this work in the various States and Territories, including Alaska, is shown on the twenty-three accompanying maps (Pls. IV–XXV). On the latter are indicated the published sheets to June 30, 1902, the sheets in course of publication, and the areas surveyed in 1901–2 to April 30.

The following tables give the details relating to topography and spirit leveling for the fiscal year:

Topographic surveys of the United States Geological Survey in 1901–2 to April 30, including levels run and permanent bench marks established.

State or Territory.	Contour interval.	Scale of publication.		Total area surveyed.	Levels.	
		1:62500.	1:125000.		Distance run.	Number of bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	50	.....	782	782	138	13
Arizona	20–50–100	231	530	[a] 776	291	95
Arkansas	50	.....	428	428	117	13
California	10–25–50–100	1,258	2,705	[b] 3,967	1,213	289
Colorado	25–100	187	.....	[c d] 198	42	13
Delaware	20	63	.....	63	.....	.....
Idaho	50–100	202	142	344	57	11
Illinois	20	40	.....	40	3	2
Indiana	20	1,133	.....	1,133	637	28
Iowa	20	.....	520	520	246	19
Maine	20	665	.....	665	130	7
Michigan	20	.....	110	110	292	5
Mississippi	20	.....	198	198	109	.....
Missouri	20	.....	1,039	1,039	319	26
Montana	50–100	.....	1,977	[b] 2,057	407	116
New Mexico	.....	.....	.....	.....	90	24
New York	20	2,665	.....	2,665	1,183	69

[a] 15 square miles in Arizona and 32 square miles in Utah on scale of 1:12000.

[b] 4 square miles in California; 80 square miles in Montana; 18 square miles in Texas, and 84 square miles in Washington on scale of 1:45000.

[c] 8 square miles in Colorado and 502 square miles in Wyoming on scale of 1:90000.

[d] 3 square miles in Colorado on scale of 800 feet to 1 inch.

Topographic surveys of the United States Geological Survey in 1901–2 to April 30, including levels run and permanent bench marks established—Continued.

State or Territory.	Contour interval.	Scale of publication.		Total area surveyed.	Levels.	
		1:62500.	1:125000.		Distance run.	Number of bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
North Carolina	10–100	1,467	128	1,595	808	60
Ohio	10–20	3,715	.....	3,715	6,019	148
Oregon	100	.....	600	600	179	24
Pennsylvania	20	1,758	.....	1,758	637	63
South Carolina	20	.....	238	238	258	61
South Dakota	50	.....	79	79	.....	.....
Tennessee	50–100	.....	908	908	345	25
Texas	10–50	83	1,804	[a] 1,905	723	182
Utah	50–100	.....	310	[b] 342	194	44
Washington	100	.....	2,103	[a] 2,187	543	102
West Virginia	20	1,192	.....	1,192	1,236	47
Wisconsin	20	560	438	998	383	20
Wyoming	50–100	.....	794	[c] 1,296	183	54
Total	.....	15,219	15,833	31,798	16,782	1,560

[a] 4 square miles in California; 80 square miles in Montana; 18 square miles in Texas, and 84 square miles in Washington on scale of 1:45000.

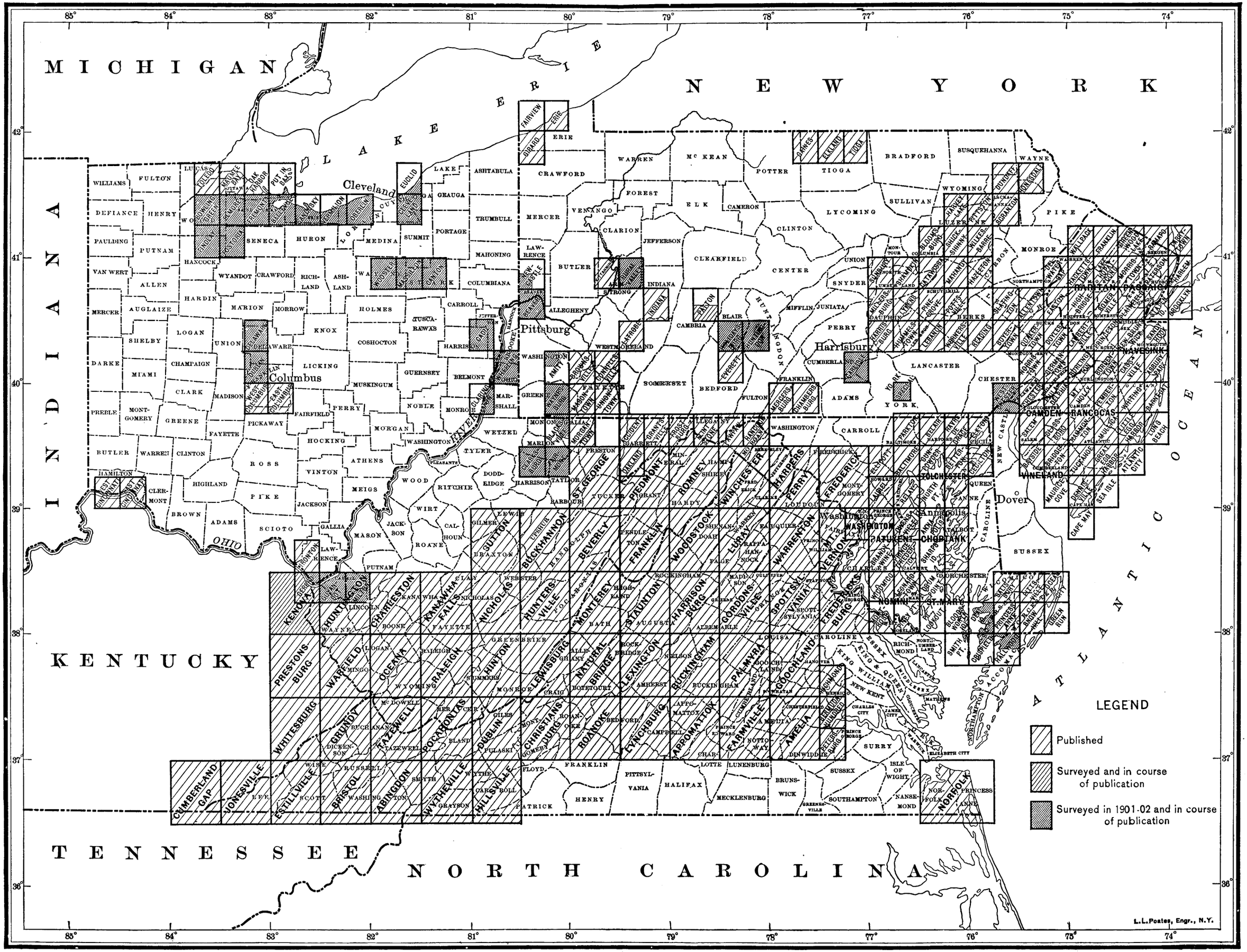
[b] 15 square miles in Arizona and 32 square miles in Utah on scale of 1:12000.

[c] 8 square miles in Colorado and 502 square miles in Wyoming on scale of 1:90000.

Present condition of topographic surveys and the new areas surveyed in 1901–2.

[Areas which were resurveyed are not included in this table.]

State or Territory.	Total area.	Area surveyed in 1901–2.	Area surveyed to Apr. 30, 1902.	
	Square miles.	*Square miles.*	*Square miles.*	*Per cent.*
Alabama	52,250	782	17,333	33
Arizona	113,020	246	59,367	53
Arkansas	53,850	428	18,882	35
California	158,360	3,967	61,816	39
Colorado	103,925	91	34,367	33
Connecticut	4,990	.....	4,990	100
Delaware	2,050	63	818	40
District of Columbia	70	.....	70	100
Florida	58,680	.....	1,821	3
Georgia	59,475	.....	14,522	24
Idaho	84,800	344	14,369	17
Illinois	56,650	40	4,525	8



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

Present condition of topographic surveys and the new areas surveyed in 1901–2—Continued.

State or Territory.	Total area.	Area surveyed in 1901–2.	Area surveyed to Apr. 30, 1902.	
	Square miles.	*Square miles.*	*Square miles.*	*Per cent.*
Indian Territory	31,400	.....	30,885	99
Indiana	36,350	664	2,123	5
Iowa	56,025	520	9,205	16
Kansas	82,080	.....	62,806	77
Kentucky	40,400	.....	11,527	29
Louisiana	48,720	.....	7,492	15
Maine	33,040	665	5,432	16
Maryland	12,210	.....	10,307	84
Massachusetts	8,315	.....	8,315	100
Michigan	58,915	110	2,074	4
Minnesota	83,365	.....	3,512	4
Mississippi	46,810	198	227	.....
Missouri	69,415	919	32,926	47
Montana	146,080	2,057	40,278	27
Nebraska	77,510	.....	26,228	35
Nevada	110,700	.....	28,949	26
New Hampshire	9,305	.....	2,396	26
New Jersey	7,815	.....	7,815	100
New Mexico	122,580	.....	27,777	23
New York	49,170	2,655	28,157	57
North Carolina	52,250	1,467	13,719	26
North Dakota	70,795	.....	6,327	9
Ohio	41,060	3,715	5,579	14
Oklahoma	39,030	.....	4,146	11
Oregon	96,030	600	15,413	16
Pennsylvania	45,215	1,758	12,543	28
Rhode Island	1,250	.....	1,250	100
South Carolina	30,570	238	4,138	14
South Dakota	77,650	79	17,222	22
Tennessee	42,050	670	19,351	46
Texas	265,780	1,905	60,332	23
Utah	84,970	.....	64,280	76
Vermont	9,565	.....	2,844	30
Virginia	42,450	.....	29,227	69
Washington	69,180	1,759	10,920	16
West Virginia	24,780	742	18,306	73
Wisconsin	56,040	873	10,313	18
Wyoming	97,890	1,271	18,452	19
Total	3,024,880	30,148	895,673	29

Division of Triangulation.

ATLANTIC SECTION.

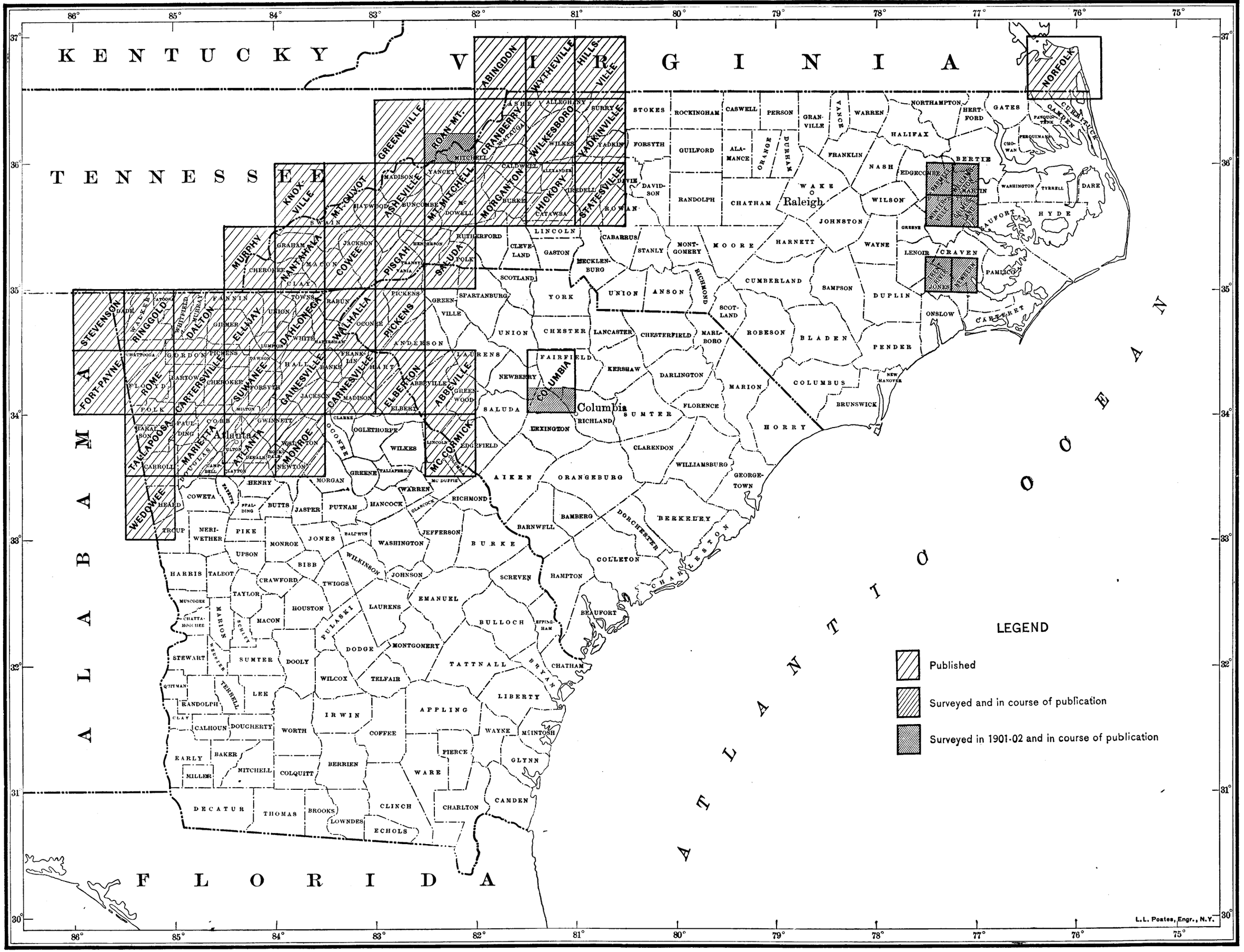
Mr. S. S. Gannett, geographer, continued to exercise general supervision of the primary control executed during the season in this section, under the general direction of Mr. Wilson, geographer in charge.

Primary triangulation was in progress at various times during the season by four parties, and primary traverse by two of the same parties. This work was distributed over portions of six States—New York, Pennsylvania, Maryland, West Virginia, North Carolina, and Ohio. The total area covered by this primary control was 11,200 square miles, of which 3,200 square miles were controlled by primary traverse. The result of this control was to make available forty-nine additional quadrangles in which to prosecute future topographic surveys. In the progress of this work 117 triangulation stations were permanently marked and their geodetic positions determined.

New York.—Mr. E. L. McNair, topographer, was engaged during the first half of the season in extending triangulation over the southern portion of the Adirondack region, and during the remainder of the season over the northwestern portion of the same region. He established and marked the positions of 35 stations, so located as to control nine 15-minute quadrangles in the counties of Franklin, Fulton, Hamilton, St. Lawrence, Saratoga, and Warren. He also established and marked a meridian line at Johnstown.

Pennsylvania.—Triangulation in the central portion of the State was extended from the vicinity of Altoona and Ebensburg so as to control seven 15-minute quadrangles in Cambria, Clearfield, and Jefferson counties. Twenty-two stations were occupied, and 4 secondary points were located by Mr. Gannett. Connection was also made with the work of 1899 in Indiana County, and a circuit of 370 miles in length was thus completed.

West Virginia.—Mr. Sledge Tatum, topographer, extended triangulation from the vicinity of Morgantown southward to



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

Clarksburg, thence westward to Parkersburg. During the season he established and monumented 28 stations, controlling eleven 15-minute quadrangles in the counties of Monongalia, Marion, Taylor, Harrison, Gilmer, Lewis, Braxton, Doddridge, Pleasants, Ritchie, and Wood.

Ohio.—Prof. A. H. Thompson, geographer, was engaged throughout the season in extending triangulation over the southeastern portion of the State, between Cadiz, Ohio, and Parkersburg, W. Va., connecting with the work of Mr. Tatum near the latter place. As a result of this work 28 stations were established for the control of eight 15-minute quadrangles, covering portions of the counties of Carroll, Harrison, Belmont, Guernsey, Noble, Monroe, and Washington.

During the month of October Mr. Tatum controlled, by means of 140 miles of primary traverse, four 15-minute quadrangles in the northern-central portion of the State, in the counties of Lorain, Huron, Medina, Richland, Ashland, and Wayne.

North Carolina.—Early in the spring of 1902 Mr. Tatum controlled, by means of 254 miles of primary traverse, eight 15-minute quadrangles in North Carolina, lying east of Raleigh, in the counties of Nash, Franklin, Wake, Johnston, Wayne, Greene, Pitt, and Wilson.

Maryland.—Two 15-minute quadrangles, covering portions of the counties of Baltimore, Carroll, and Howard, were controlled by 80 miles of traverse in April, 1902, by Mr. McNair.

CENTRAL SECTION.

Control in this section was obtained exclusively by primary traverse. Detached areas in eleven States were thus controlled during the field season, and with the exception of a portion of the work in central Ohio, this work was carried on by Mr. George T. Hawkins, topographer.

Alabama.—The Dadeville and Opelika 30-minute quadrangles, in Talledega, Coosa, Tallapoosa, Lee, Macon, and Montgomery counties, were controlled by a line starting from the Coast and Geodetic Survey triangulation station Kahatchie and following the route of the Central of Georgia Railway to

Opelika, thence along the Western Railway of Alabama to the State capitol at Montgomery, the total distance traversed being 151 miles.

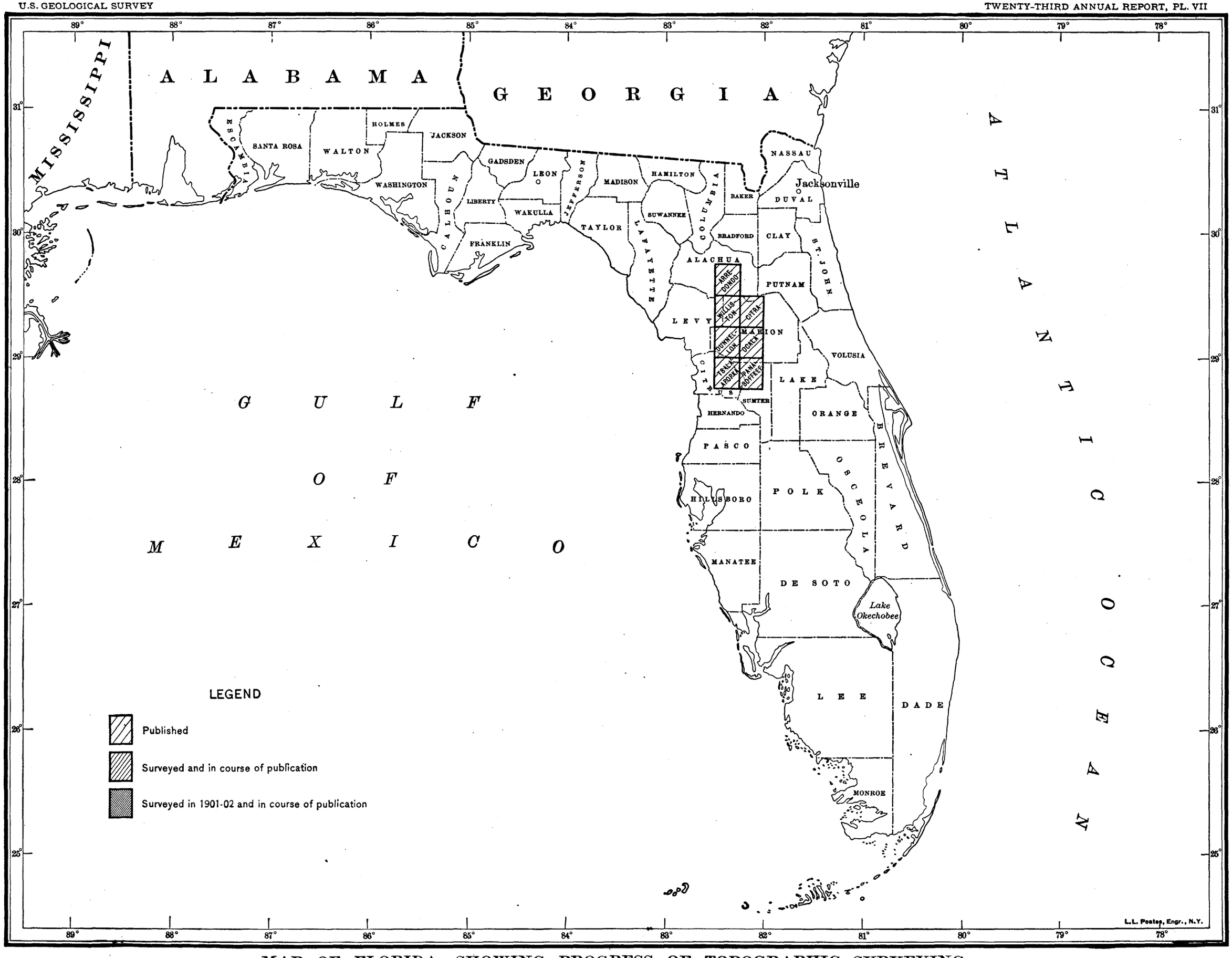
Arkansas.—Partial control for the Caddo Gap 30-minute quadrangle, in Clark, Pike, and Howard counties, was obtained by running a traverse line westward from Gurden station 64 miles to the southwest corner of the quadrangle.

Ohio.—Twenty 15-minute quadrangles, covering portions of Williams, Fulton, Lucas, Wood, Hancock, Henry, Putnam, Defiance, Paulding, Allen, Hardin, Wyandot, Seneca, Crawford, Marion, Delaware, Union, and Logan counties, in the northwestern part of the State, were controlled by 160 miles of primary traverse along railways by Mr. Hawkins, supplemented by 400 miles of traverse run by Mr. J. R. Ellis, traverseman, along highways, upon meridians and parallels as nearly as possible.

Indiana.—Three 15-minute quadrangles in southern Indiana, in Gibbon, Knox, Vanderburg, and Posey counties, were controlled by a line 135 miles in length between Evansville and Vincennes, carried along the Evansville and Terre Haute Railroad, with an additional line run from Princeton along the air-line railroad to Mount Carmel, Ill., and thence by the Louisville and Nashville Railroad to Evansville.

Missouri.—The Palmyra and Shelbyville 30-minute quadrangles, in northeastern Missouri, in Adair, Schuyler, Scotland, and Clark counties, were controlled by 112 miles of traverse along the Wabash, the Hannibal and St. Joseph, and the Missouri, Kansas and Texas railways. The line started at Kirkville and was connected with the Mississippi River Commission triangulation station Hannibal.

Iowa.—The Decorah 30-minute quadrangle, in northeastern Iowa, in Winnesheik and Allamakee counties, was controlled by 62 miles of traverse, which started from Postville and followed the Chicago, Milwaukee and St. Paul Railway to the county line 2 miles east of Cresco, thence north on highways to the Iowa–Minnesota State line. A spur line started from Calmar and followed the Dakota division of the same railroad to Jackson Junction.



MAP OF FLORIDA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Nebraska.—One 30-minute quadrangle in southeastern Nebraska, in the counties of Cass, Otoe, and Lancaster, was controlled by 126 miles of traverse along the Missouri Pacific and the Burlington and Missouri railways, based upon triangulation tations of the Missouri River Commission.

Michigan.—The Ann Arbor and Detroit 30-minute quadrangles, in Lenawee, Washtenaw, Livingston, and Wayne counties, were controlled by 120 miles of traverse carried along the Lake Shore and Michigan Southern, the Ann Arbor, and the Pere Marquette railways.

Wisconsin.—A traverse line of 37 miles along the Chicago and Northwestern Railway, from the court-house dome at Milwaukee to the north line of Ozaukee County, furnished control for the Milwaukee and Port Washington 15-minute quadrangles.

ROCKY MOUNTAIN SECTION.

Texas.—In April and May, 1901, Mr. W. M. Beaman, topographer, ran a line of primary traverse across the Fredericksburg and Boerne quadrangles, a linear distance of 61 miles, in the counties of Gillespie and Kendall.

Colorado.—Late in the season Mr. R. H. Chapman, topographer, located by secondary triangulation and the three-point method many mines, shaft houses, tunnel mouths, etc., for the control of the Leadville special quadrangle.

Wyoming–Colorado.—Three 30-minute quadrangles in Carbon County, Wyo., and two in Routt County, Colo., were controlled by Mr. Frank Tweedy, topographer, in May and June, 1901. A base line 4.6 miles in length was measured near the Wheeler astronomic station at Fort Steele and connected therewith. From this base triangulation was extended southward into Colorado. Twelve primary and 4 secondary stations were occupied and numerous high points were located by intersections.

PACIFIC SECTION.

California.—Triangulation control for the three 15-minute quadrangles south and east of Mount Diablo was based upon Mocho and Diablo stations of the Coast and Geodetic Survey.

In addition to these, 7 other stations were occupied and 3 points were located by intersection in Alameda and Contra Costa counties by Mr. C. F. Urquhart, topographer.

The Fair Oaks 15-minute quadrangle was controlled by Mr. Urquhart by 100 miles of primary traverse, which was run around the borders of and diagonally across the quadrangle. This work was based upon the geodetic position of the dome of the State capitol.

FOREST RESERVES.

ROCKY MOUNTAIN SECTION.

Arizona–New Mexico, Gila River Reserve.—Triangulation in southern-central Arizona was extended eastward into New Mexico by Mr. Chapman in November and December, 1901. Three 30-minute quadrangles in Graham County, Ariz., and two in Grant and Socorro counties, N. Mex., were controlled by the occupation of 5 new and 6 old stations.

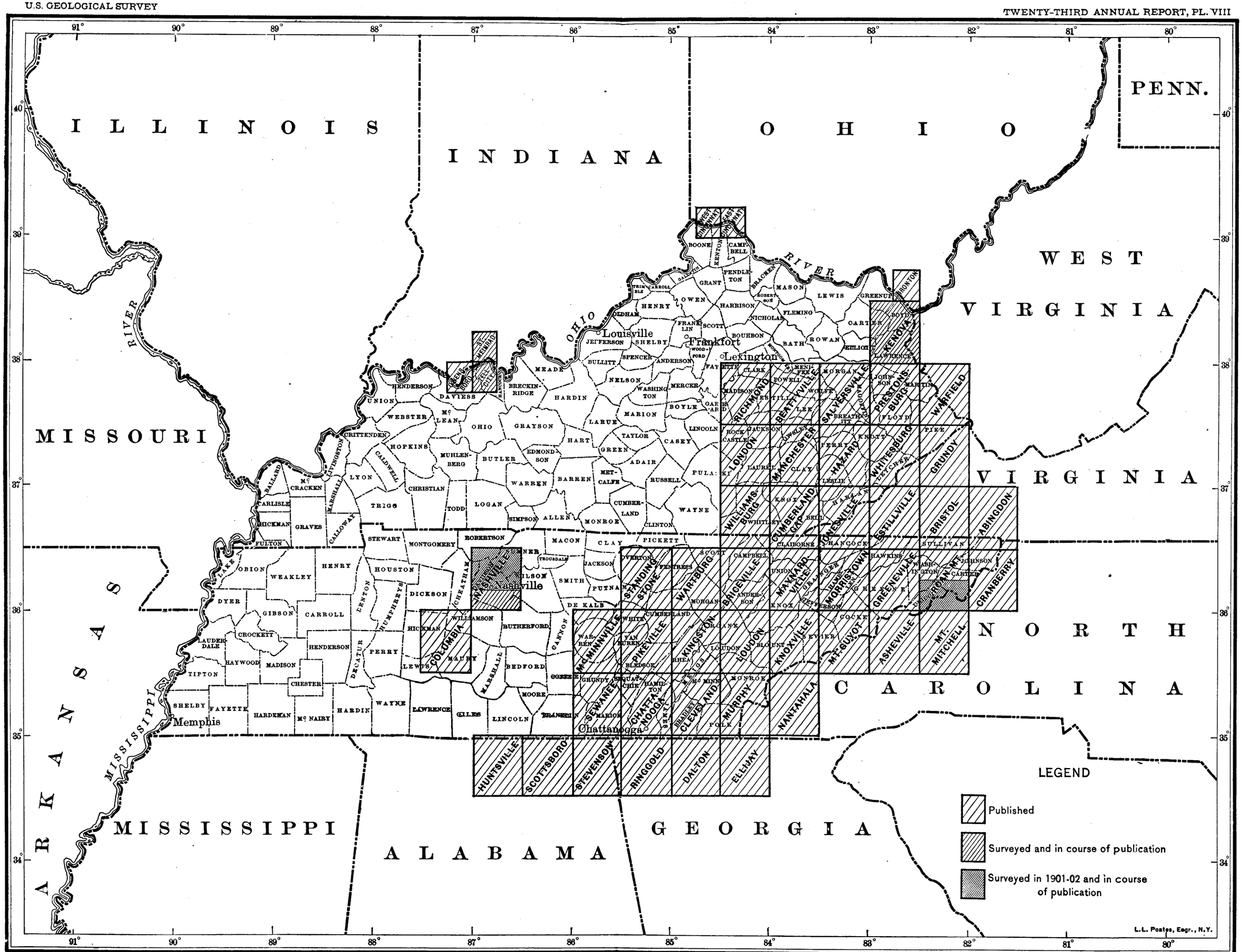
Arizona; Prescott, San Francisco Mountain, and Grand Canyon reserves.—In the spring of 1902, Mr. H. L. Baldwin, jr., topographer, extended trigonometric control over portions of these three reserves in Yavapai County, based upon former work in the Prescott Reserve.

Montana; Flathead, and Lewis and Clarke reserves.—Messrs. Baldwin and Chapman continued the extension of triangulation over these reserves and into adjacent areas, covering portions of Flathead and Teton counties. Twenty-one stations were occupied and numerous high peaks were located, thus establishing the control of five 30-minute quadrangles.

PACIFIC SECTION.

Oregon, Cascade Range Reserve.—Mr. Urquhart made a reconnaissance along the western slope of the Cascade Mountains between Eugene and Mount Hood, in Linn, Marion, and Clackamas counties. Fifteen stations, located in six 30-minute quadrangles, were selected and signals were erected, but owing to the difficulties encountered and the shortness of the season no stations were occupied.

California, Sierra Reserve.—Mr. E. T. Perkins, topographer,



MAP OF KENTUCKY AND TENNESSEE, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

extended the belt of triangulation commenced by him during the previous year southward along the high Sierra to Tehachapi Pass. In addition to reoccupying 2 stations, he built and occupied 11 new stations, some of which were formerly located by the Wheeler survey, thus forming a basis of comparison between the two surveys. This work was further extended and connected with that in southern California by Mr. Urquhart in December, 5 new stations being reoccupied, the net result being the control for six 30-minute quadrangles in Tulare and Kern counties.

Division of Topography.

ATLANTIC SECTION.

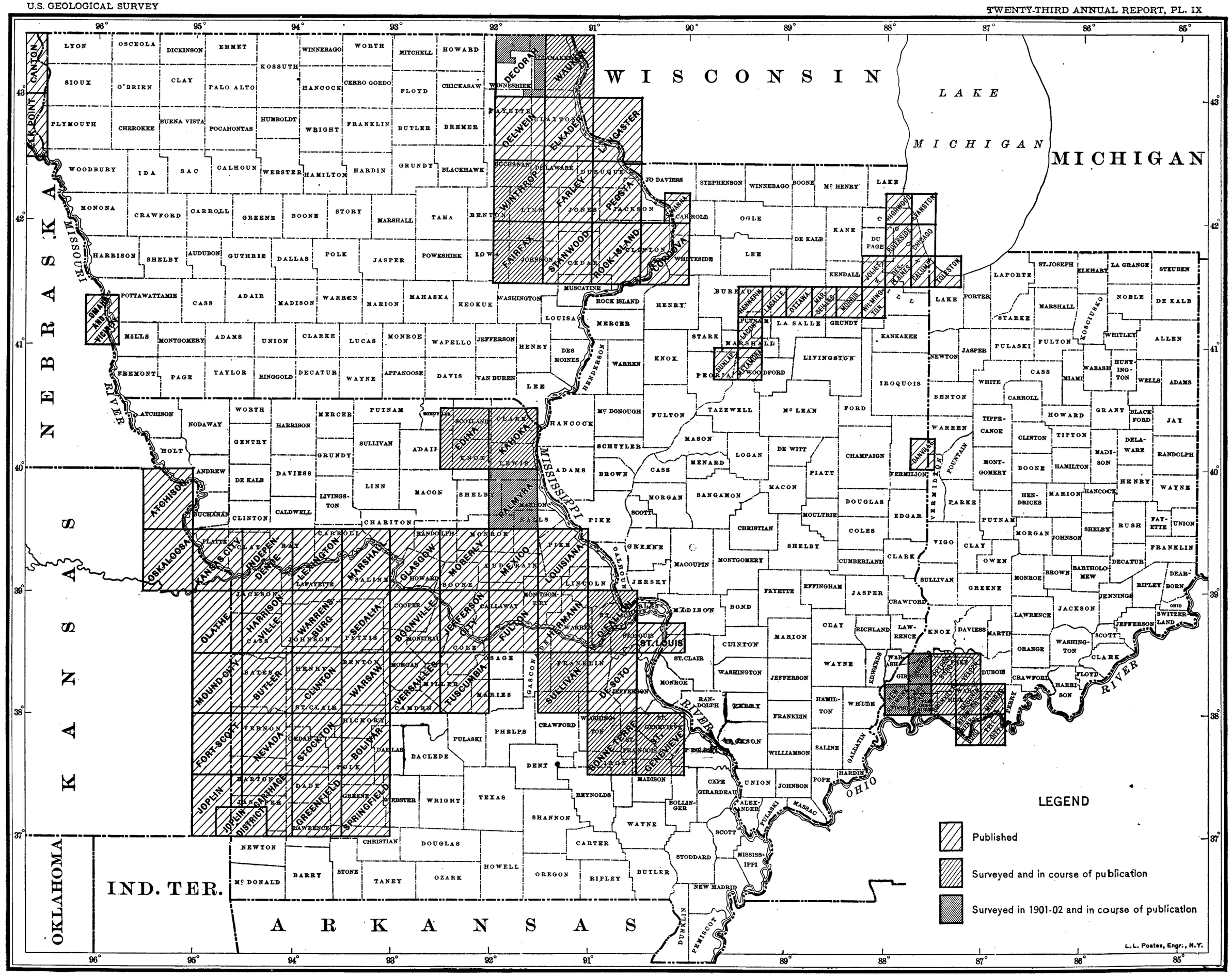
Topographic work was carried on during the season by twenty-four parties working in eight States — New York, Pennsylvania, West Virginia, Ohio, Maine, North Carolina, South Carolina, and Tennessee. The survey of forty-eight quadrangles was completed, twenty-eight were partially surveyed, and a special map was made in the vicinity of York, Pa. The total new area surveyed was 9,770 square miles, of which 8,862 square miles were for publication on the scale of 1:62500, and 908 square miles were for publication on the scale of 1:125000. In addition, 826 square miles were resurveyed, of which 460 square miles were on the scale of 1:62500, and 366 square miles were on the scale of 1:125000. Levels were run over 6,099 linear miles, resulting in the establishment of 402 permanent bench marks.

New York.—Work was carried on under an agreement with the State engineer and surveyor of New York, approved by the Director of the United States Geological Survey May 27, 1901, whereby the terms of the cooperative agreement of March 25, 1889, were continued in force for the fiscal year ending June 30, 1902. By the terms of this agreement the State of New York allotted $19,500 and the Director of the United States Geological Survey allotted a like amount to the topographic survey of the State. In July this sum was increased by $3,000 offered by the State engineer and by an

equal amount allotted by the Director, thus making the allotments $22,500 each, or a total of $45,000.

There were maintained on topographic work in New York during the season eleven parties. Mr. J. H. Jennings, topographer, was placed in charge of a group of three parties and was aided by Messrs. Oscar Jones and D. H. Baldwin, assistant topographers, and by Gilbert Young, field assistant. Mr. C. C. Bassett, topographer, was in charge of the completion of the mapping of a group of quadrangles adjacent to those on which Mr. Jennings was working. During the season these combined parties completed the mapping of eight quadrangles — the Gilboa, Rosendale, Margaretville, Honeoye, Binghamton, Apalachin, Pitcher, and Harford, in Scoharie, Delaware, Greene, Ulster, Monroe, Ontario, Livingston, Broome, Tioga, Cortland, Madison, and Chenango counties. They were also engaged in procuring partial secondary control of four other quadrangles—the Hobart, Richmondville, Wayland, and Boonville, in Scoharie, Delaware, Otsego, Livingston, Steuben, Lewis, and Oneida counties. Mr. Glenn S. Smith, topographer, was placed in general charge of a group of five parties, headed by himself and Messrs. George H. Guerdrum, T. G. Basinger, J. M. Whitman, jr., and E. G. Hamilton, assistant topographers. These parties completed the mapping of four quadrangles—the Babylon and Northport, on Long Island, in Suffolk and Queens counties; and the Santanoni and Big Moose, in Franklin, Essex, Herkimer, and Hamilton counties, in the Adirondacks. They also completed the secondary control and partial mapping of the Long Lake and St. Regis quadrangles, in Franklin and Hamilton counties. Messrs. A. C. Roberts and W. H. Lovell, topographers, assisted by Mr. C. L. Hoopes, assistant topographer, were in charge of two parties and completed the mapping of the Lassellsville and Gloversville quadrangles, in Herkimer, Hamilton, and Fulton counties.

All of the parties in New York commenced field work early in April and disbanded in October. The total area surveyed was 2,655 square miles, for publication on the scale of 1:62500, with a contour interval of 20 feet. In connection with this work 1,063 miles of primary levels were run and 56 perma-



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

nent bench marks were established. In addition to the above Mr. Lovell revised 10 square miles of the Fort Ann and Whitehall quadrangles, in Washington and Richmond counties.

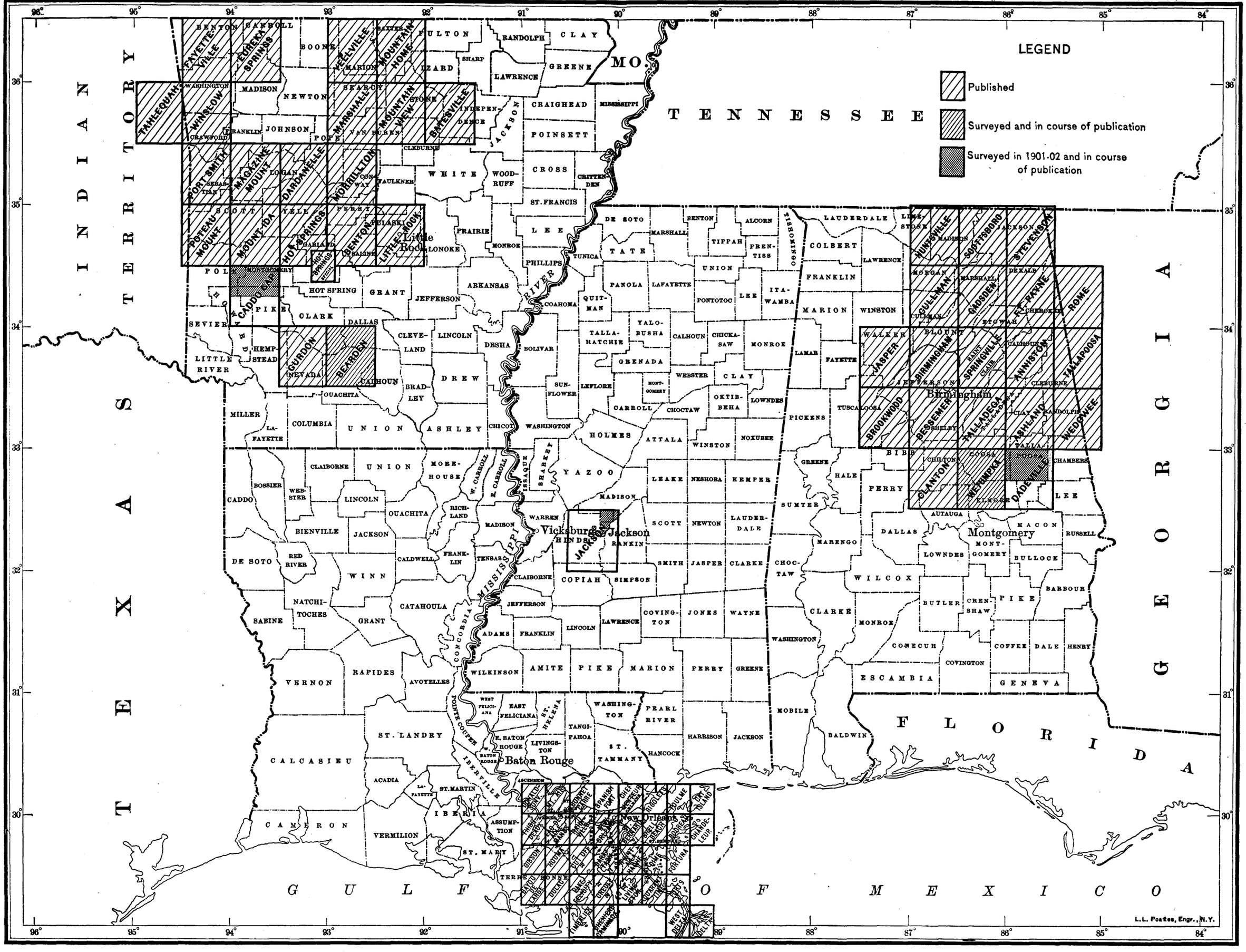
During July, August, and September Mr. Baldwin executed precise leveling over routes as follows: A circuit was first run in Utica to connect the lines of the Deep Waterway Commission, Barge Canal, and New York State levels, which also make connection with the Army Engineer line of 1875 near Herkimer; leveling was then continued from Utica southward along the Delaware, Lackawanna and Western Railroad to Richfield Junction, thence along the Unadilla Valley Railway to New Berlin and along the New York, Ontario and Western Railway to Sidney, closing on a bronze tablet 2.7 miles east of Bainbridge, the elevation of which was determined by precise leveling run in 1899 between Albany and Dunkirk by Mr. McNair. From Sidney the line was continued along the New York, Ontario and Western Railway via Walton and Cadosia to Hancock, where a closure was made with the line of precise levels brought down from Binghamton in 1900 by Mr. C. H. Semper, levelman, thus concluding two more links in the precise-level net. Another line was then started at the Lake Survey bench mark on the lighthouse at Charlotte and continued along the New York Central and Hudson River Railroad (branch) to Rochester, where connections were made with the Barge Canal and New York State levels, and thence along the Western New York and Pennsylvania Railway to Genesee Junction, where the line was discontinued. The total of the precise leveling comprised the running of 120 miles of duplicate rodded lines and the establishment of 13 permanent bench marks.

Pennsylvania–Delaware.—Work was prosecuted under an arrangement with the State survey commissioners of Pennsylvania, proposed on July 31, 1901, and accepted by the Director of the United States Geological Survey on August 10, 1901, whereby each party agreed to devote $15,000 to topographic work. This arrangement was to be governed by the terms of the agreement signed by the members of the survey commission of Pennsylvania and by the Director of the United States Geological Survey on July 12, 1899.

Field work was commenced by all parties early in April and was discontinued in October and November. Seven parties were maintained on such work during the season. Mr. Frank Sutton, topographer, was placed in general charge of a group of three parties, headed by himself and Messrs. E. B. Clark, topographer, and J. D. Forster, field assistant. During the season these parties completed the mapping of three quadrangles, the Waynesburg, Rural Valley, and Beaver, in Greene, Armstrong, Indiana, Allegheny, and Beaver counties; the secondary control and partial mapping of the Newcastle and Barnesboro quadrangles, in Clearfield, Cambria, and Indiana counties; and the partial secondary control of the Elders Ridge quadrangle, in Armstrong, Indiana, and Westmoreland counties. Mr. A. M. Walker, topographer, aided by Mr. E. S. Ela, assistant topographer, was in charge of a group of two parties which completed the mapping of the Huntingdon and Hollidaysburg quadrangles, in Blair and Huntingdon counties. Mr. Walker also secured the partial secondary control of the Johnstown, Patton, and Ebensburg quadrangles, in Cambria, Somerset, Indiana, Westmoreland, Clearfield, Blair, and Bedford counties. Mr. J. H. Wheat, topographer, completed the mapping of the Carlisle and Westchester quadrangles, in the counties of Cumberland, Chester, and Delaware, Pa., and Newcastle County, Del. Mr. Wheat also procured the partial secondary control of the Lancaster quadrangle, in Lancaster and Lebanon counties. Mr. A. H. Bumstead, assistant topographer, procured secondary control for the partial mapping of the Amity quadrangle, in Washington County. In addition to the above, Mr. Clark completed the mapping of the York Special quadrangle, in York County.

The total area surveyed in Pennsylvania and Delaware was 1,818 square miles, for publication on the scale of 1:62500, with a contour interval of 20 feet. In connection with this work, 635 miles of spirit levels were run and 57 permanent bench marks were established.

West Virginia–Ohio–Pennsylvania.—Work was prosecuted under a cooperative agreement signed by the State geologist of West Virginia March 7, 1901, and by the Director of the



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

United States Geological Survey March 6, 1901, as provided for under appropriation bill passed by the State legislature February 21, 1901, whereby $15,000 was to be expended by each of the parties from the date of the agreement to June 30, 1902. The portions of Pennsylvania and Ohio mapped in connection with the filling out of the quadrangles were surveyed at the expense of and in cooperation with those States.

Five parties were maintained on field work during portions of the season, which was commenced in April. Mr. W. Carvel Hall, topographer, assisted by Mr. Walter R. Harper, assistant topographer, was in charge of a group of two parties which completed the mapping of the Fairmont and Wheeling quadrangles, in Marion, Taylor, Harrison, Ohio, Marshall, and Brooke counties, W. Va.; Jefferson and Belmont counties, Ohio; and Washington County, Pa. Mr. W. N. Morrill, topographer, completed the mapping of the Guyandot quadrangle, in Cabell and Wayne counties, W. Va., and Lawrence County, Ohio. Mr. W. N. Brown, topographer, completed the mapping of the Milton quadrangle, in Cabell, Lincoln, Putnam, Mason, and Wayne counties. Messrs. Morrill and Brown also completed the Clarksburg quadrangle, in Marion, Wetzel, and Harrison counties. Mr. Morrill, assisted by Mr. Robert Coe, assistant topographer, procured secondary control for the Weston quadrangle, in Harrison, Lewis, Upshur, and Barbour counties. Messrs. Hall and Morrill were likewise engaged on the Philippi quadrangle, in Harrison, Taylor, Upshur, and Barbour counties. Messrs. Hall, Bumstead, and Harper were engaged in procuring the secondary control and partial mapping of the Blacksville quadrangle, in Marion and Monongalia counties, W. Va., and Greene County, Pa. The Clarington quadrangle, in Marshall County, W. Va., and Belmont and Monroe counties, Ohio, was partially mapped by Mr. Bumstead; and the Ceredo quadrangle, in Wayne County, W. Va., Lawrence County, Ohio, and Boyd and Greenup counties, Ky., was partially mapped by Mr. Morrill. The parties of Messrs. Bumstead and Brown were disbanded in August and those under Messrs. Hall, Morrill, and Harper in November.

The total area surveyed in the above States was 1,299 square

miles, for publication on the scale of 1:62500, with a contour interval of 20 feet. The spirit leveling aggregated 1,310 linear miles, in connection with which 53 permanent bench marks were established.

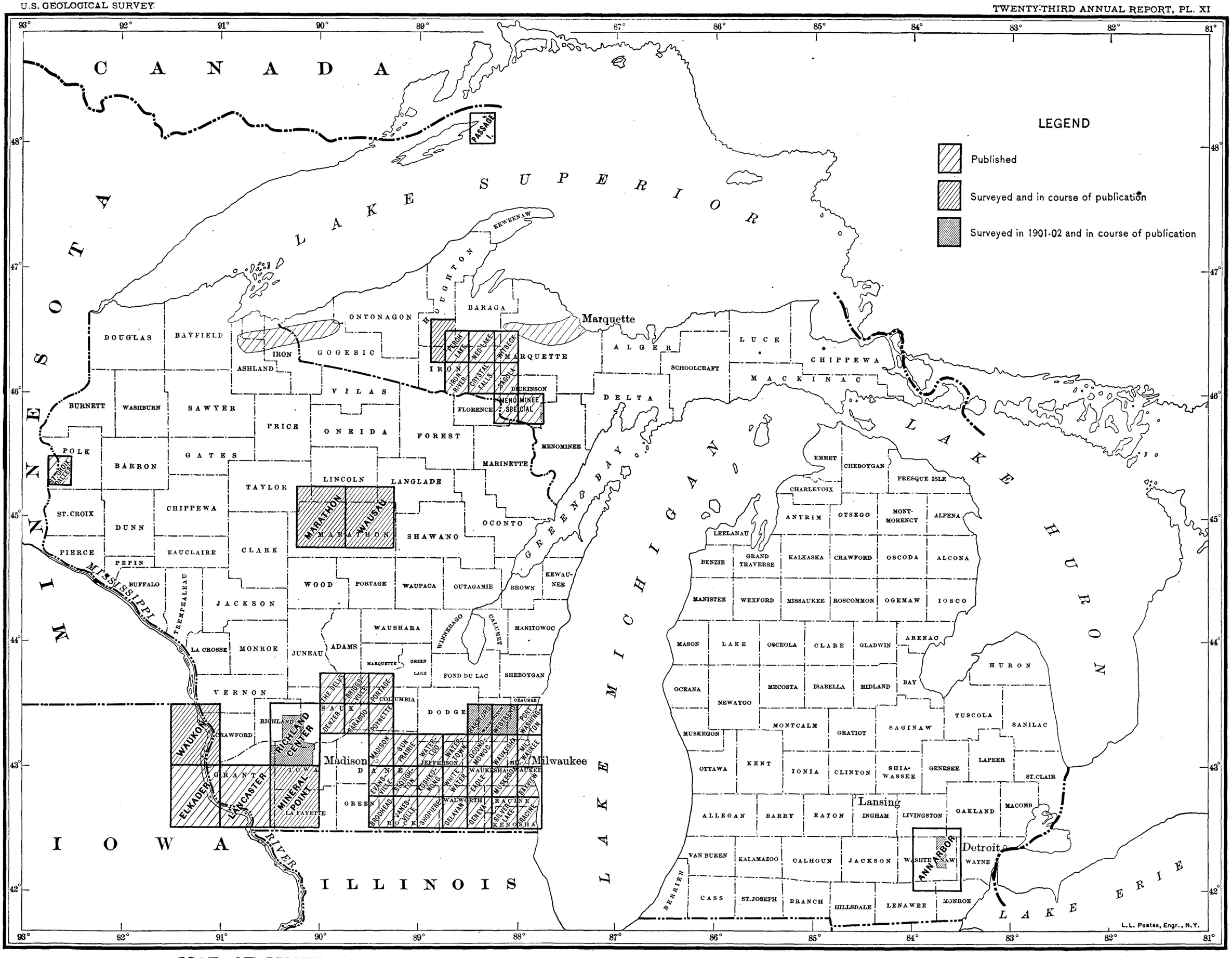
Ohio.—Work was prosecuted under the cooperative agreement signed by the governor of Ohio November 24, 1900, and by the Director of the United States Geological Survey November 26, 1900, whereby $25,000, appropriated by the State of Ohio, was met by a like sum by the Director of the United States Geological Survey. Of this, $12,500 each, or $25,000 in all, was allotted to the Atlantic section of topography, a like sum being allotted to the Central section.

Three parties were maintained in Ohio from April to October, and were under the charge of Messrs. W. T. Griswold, Hersey Munroe, and R. D. Cummin, topographers. Mr. Griswold completed the mapping of the Cadiz quadrangle, in Jefferson, Carroll, and Harrison counties. Mr. Munroe completed the mapping of the Wooster, Massillon, and Canton quadrangles, in Wayne, Summit, and Stark counties. Mr. Cummin completed the mapping of the Euclid, Cleveland, and Oberlin quadrangles, in Cuyahoga, Medina, Summit, and Lorain counties. Messrs. Griswold, Cummin, and Munroe were further engaged in procuring the partial secondary control for the Scio quadrangle, in Harrison and Carroll counties; the Berea quadrangle, in Cuyahoga and Lorain counties, and the partial leveling of the Medina quadrangle, in Medina County.

The above work comprised 1,408 square miles of completed topography, for publication on the scale of 1:62500, with a contour interval of 20 feet, in connection with which 1,430 linear miles of spirit levels were run and 70 permanent bench marks were established.

Maine.—Work was prosecuted under an agreement between the Director of the United States Geological Survey and the State commissioners of Maine, dated May 25, 1899, which was continued in force to cover the expenditure of $2,500 appropriated by the State for the years 1901–2, and a like sum by the Director of the United States Geological Survey.

Field work was commenced in May by a party under Mr.



MAP OF MICHIGAN AND WISCONSIN, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Lovell, and was discontinued in September. This party completed the mapping of the Deer Isle, Blue Hill, Swan Island, Vinal Haven, Mount Desert, Bar Harbor, and Petite Manan quadrangles, and the secondary control and partial mapping of the Cherryfield quadrangle. These quadrangles cover portions of Hancock, Washington, Waldo, and Knox counties, and represent 665 square miles of topography, for publication on the scale of 1:62500, with a contour interval of 20 feet. In connection with this work 130 linear miles of spirit levels were run and 7 permanent bench marks were established.

North Carolina.—Work was prosecuted under an agreement between the governor of North Carolina and the Director of the United States Geological Survey, whereby the total appropriation of $20,000, made by the State board of agriculture of North Carolina for topographic work for the two years 1901 and 1902, was met by a like sum by the Director of the United States Geological Survey.

One large party under Mr. Albert Pike, topographer, was engaged from March until December in procuring complete secondary control of the Trent River, Newbern, Ayden, Vanceboro, Grimesland, Winterville, Williamston, and Parmele quadrangles, lying in Edgecombe, Martin, Pitt, Craven, Bertie, Jones, Beaufort, and Greene counties; also the partial secondary control of the Tarboro and Rocky Mount quadrangles, in Edgecombe and Nash counties. In the fall, under the general direction of Mr. Pike, the Trent River, Winterville, and Grimesland quadrangles were completed by Messrs. Morrill, Hoopes, and Hamilton; and Mr. Pike, assisted by Mr. Basinger, completed the Newbern, Williamston, and Parmele quadrangles, the above covering portions of Edgecombe, Martin, Beaufort, Pitt, Craven, Bertie, and Jones counties. The total area surveyed was 1,467 square miles, for publication on the scale of 1:62500, with a contour interval of 10 feet, in connection with which 669 linear miles of spirit levels were run and 55 permanent bench marks were established.

Tennessee.—Mr. W. L. Miller, topographer, assisted by Messrs. Coe and Harper, resumed the mapping of the Nashville quadrangle, in Davidson, Williamson, Robertson,

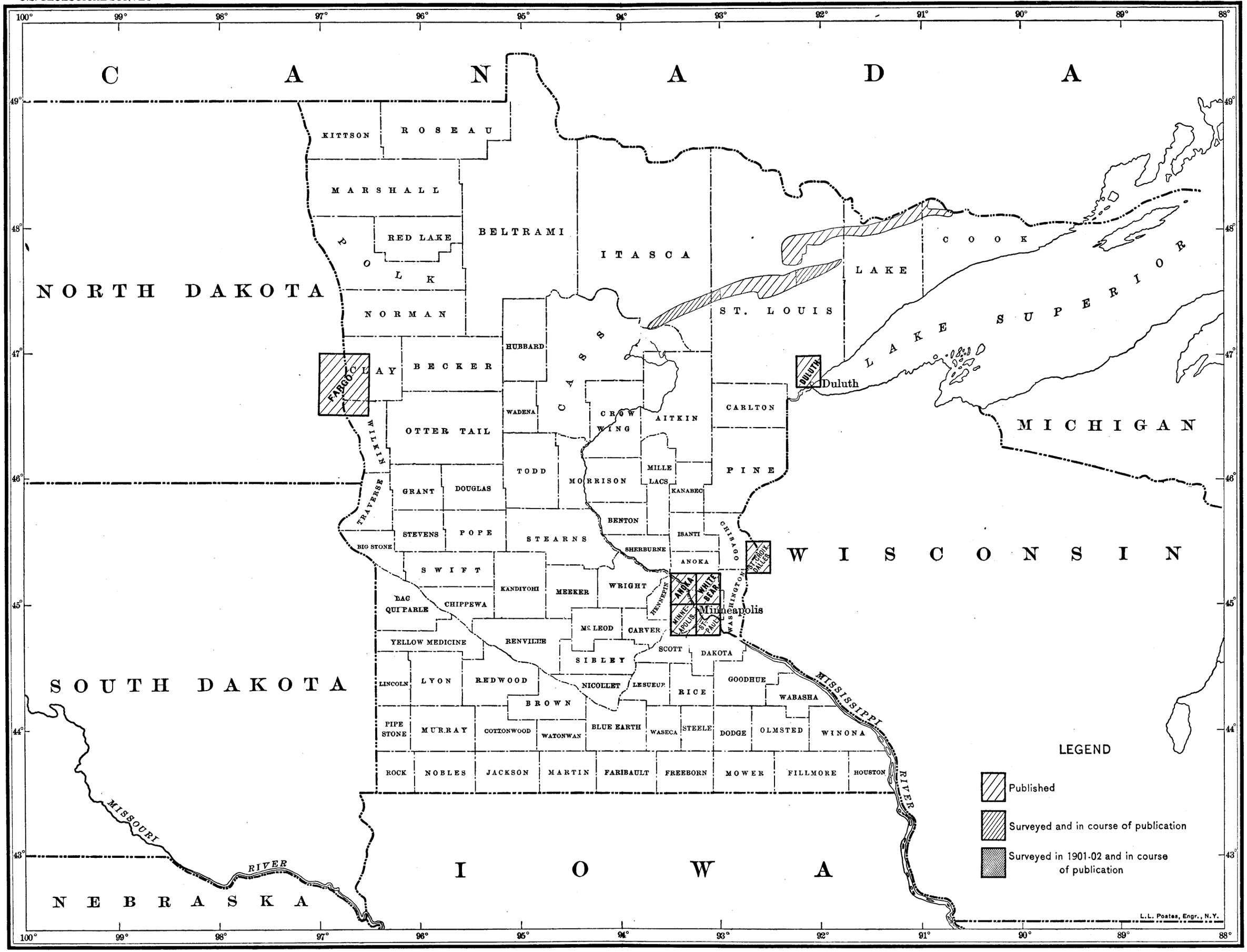
Cheatham, Rutherford, and Sumner counties, in April and completed the same in October. This work represents 670 square miles of finished topography, for publication on the scale of 1:125000, with a contour interval of 50 feet, in connection with which 250 linear miles of levels were run and 14 permanent bench marks were established.

South Carolina.—Mr. Pike, during August and September, and Mr. Jones, during October and November, were in charge of a large party engaged in procuring the secondary control and the partial mapping of the Columbia quadrangle, in Richland, Fairfield, Newberry, Lexington, and Saluda counties. From December to March Mr. H. M. Wilson, geographer, was engaged in the partial mapping of the same quadrangle, the total area mapped aggregating 238 square miles, for publication on the scale of 1:125000, with a contour interval of 20 feet. In connection with this work 258 linear miles of levels were run and 61 permanent bench marks were established.

North Carolina–Tennessee.—Mr. Miller, from April to August, and Mr. Brown, from September to October, were in charge of a party engaged in the resurvey of the Roan Mountain quadrangle, in Mitchell and Yancey counties, N. C., and Sullivan, Carter, Washington, and Unicoi counties, Tenn. The total area surveyed was 366 square miles, for publication on the scale of 1:125000, with a contour interval of 100 feet, in connection with which 234 linear miles of levels were run and 16 permanent bench marks were established.

CENTRAL SECTION.

During the season 12 topographic parties were employed in the States of Ohio, Indiana, Alabama, Arkansas, Missouri, Iowa, Wisconsin, Michigan, and Mississippi. Seventeen complete quadrangles and portions of eight others were surveyed. In addition, revision of cultural features was done on the Port Washington, Petersburg, and Boonville 15-minute quadrangles and on the Bonneterre 30-minute quadrangle, covering an area of 714 square miles. The total new area surveyed was 6,737 square miles, of which 3,342 square miles were for publication on the scale of 1:62500 and 3,395 square miles were for pub-



MAP OF MINNESOTA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

lication on the scale of 1:125000. Spirit levels were carried over 6,761 linear miles, from which 204 permanent bench marks were established.

Ohio.—As previously stated, work in Ohio was prosecuted under the cooperative agreement between the governor of Ohio and the Director of the United States Geological Survey. The amount allotted to the Central section from the appropriation of the State was $12,500, which was met by a like sum from the Federal funds, making the total allotment $25,000.

Mr. Charles E. Cooke, topographer, began field work about the middle of March and continued until the early part of October, during which time he completed the Fostoria, Bowling Green, Findlay, and Elmore quadrangles, lying in parts of Wood, Ottawa, Hancock, Seneca, and Sandusky counties, and comprising an area of 939 square miles. In connection with this work 1,670 miles of levels were run and 28 permanent bench marks were established. This work adjoined that which had been done in previous seasons in the vicinity of Toledo.

Mr. Nat. Tyler, jr., topographer, began work in the latter part of March and continued until the end of September, completing the Fremont, Bellevue, Sandusky, and Put-in-Bay quadrangles, lying in parts of Ottawa, Sandusky, and Erie counties, and comprising an area of 673 square miles, exclusive of water area. In connection with this work 1,057 miles of levels were run and 22 permanent bench marks were established.

Mr. Basil Duke, topographer, began work about the middle of June and continued until the end of September, when the Delaware quadrangle was completed, lying in parts of Delaware, Marion, and Morrow counties. The area surveyed consists of 228 square miles, in connection with which 746 miles of levels were run and 11 permanent bench marks were established.

Mr. W. H. Griffin, topographer, began work about the first of July and continued until the end of October, when he completed the Dublin quadrangle, lying in parts of Delaware, Union, Franklin, and Madison counties. The Dublin quadrangle embraces an area of 228 square miles, and in connec-

tion with its survey 516 miles of levels were run and 7 permanent bench marks were established.

Mr. C. W. Goodlove, topographer, after the completion of his work in southern Indiana, began the survey of the Vermilion quadrangle, about August 15, and completed the same about the end of September. This quadrangle lies in parts of Lorain, Erie, and Huron counties and embraces 135 square miles, exclusive of water area; and in connection with its survey 528 miles of levels were run and 10 permanent bench marks were established.

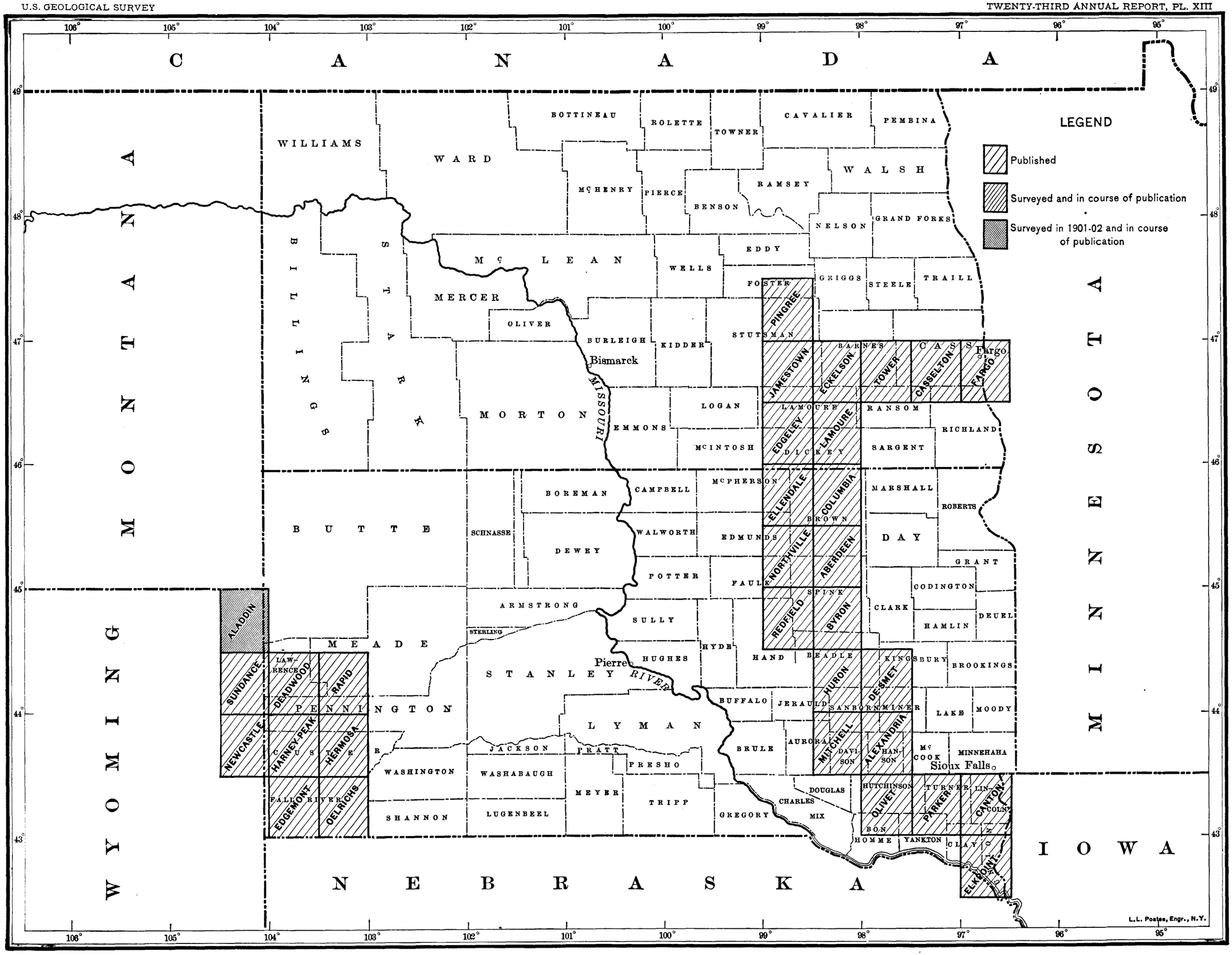
All of the above work in Ohio was for publication on the scale of 1:62500, with a contour interval of 10 feet.

Indiana–Illinois.—Mr. Goodlove commenced field work in this district April 1 and continued until August 15, completing the Princeton, New Harmony, and Haubstadt quadrangles, lying in parts of Gibson, Vanderburg, Posey, and Knox counties, Ind., and White and Wabash counties, Ill. This region was mapped for publication on the scale of 1:62500, with a contour interval of 20 feet, and comprised an area of 704 square miles, in connection with which 640 miles of levels were run and 30 permanent bench marks were established.

Indiana.—Mr. H. B. Blair, topographer, after the close of his field season in Arkansas in the early part of September, was transferred to Indiana for the purpose of resurveying and revising a portion of the Boonville and Petersburg quadrangles, in Pike, Gibson, and Warrick counties. He was engaged on this work for about two weeks, during which time he surveyed 72 square miles. On April 1, 1902, Mr. Blair resumed work in this locality, and completed the two quadrangles about June 14, the total area revised being 469 square miles, for publication on the scale of 1:62500, with a contour interval of 20 feet.

Alabama.—The agreement with the State geologist of Alabama was continued, by which he contributed $1,000 from the State appropriation, to be expended in cooperation with the United States Geological Survey.

Work was commenced by a party under Mr. Robert Muldrow, topographer, by Mr. J. T. McCoy, field assistant, on



MAP OF NORTH DAKOTA AND SOUTH DAKOTA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

April 1, Mr. Muldrow taking the field May 15, and was continued until September 1. During the time work was in progress the Wetumpka quadrangle, which had been commenced in the season previous, was completed and also the north half of the Dadeville quadrangle, the total area surveyed being 782 square miles, for publication on the scale of 1:125000, with a contour interval of 50 feet, in Coosa, Elmore, and Tallapoosa counties. In connection with the above, 138 miles of levels were run and 13 permanent bench marks were established.

Arkansas.—Mr. Blair commenced field work in Arkansas in the early part of May and continued until the end of September, when the north half of the Caddo Gap quadrangle, consisting of 428 square miles in Montgomery, Polk, and Pike counties, was completed. This work was mapped for publication on the scale of 1:125000, with a contour interval of 50 feet, and in connection with it 117 miles of levels were run and 13 permanent bench marks were established.

Missouri.—Field work in Missouri was commenced about the middle of June by Mr. Paul Holman, topographer, and was continued until September 10, when the Palmyra quadrangle, in Marion, Shelby, Monroe, and Ralls counties, was completed. The area surveyed consisted of 919 square miles, for publication on the scale of 1:125000, with a contour interval of 20 feet, in connection with which 223 miles of levels were run and 26 permanent bench marks were established.

Mr. Duncan Hannegan, topographer, began work about August 1, on the resurvey of the Bonneterre 30-minute quadrangle and continued work in this vicinity until September 10. During this time 120 square miles were completed, in connection with which 96 miles of levels were run.

Iowa.—Mr. M. Hackett, topographer, began field work in Iowa on May 19 and continued until September 15, when the north half of the Decorah quadrangle, in Winnesheik and Allamakee counties, was completed. This work embraced an area of 520 square miles, for publication on the scale of 1:125000, with a contour interval of 20 feet, in connection with which 246 miles of levels were run and 19 permanent bench marks were established.

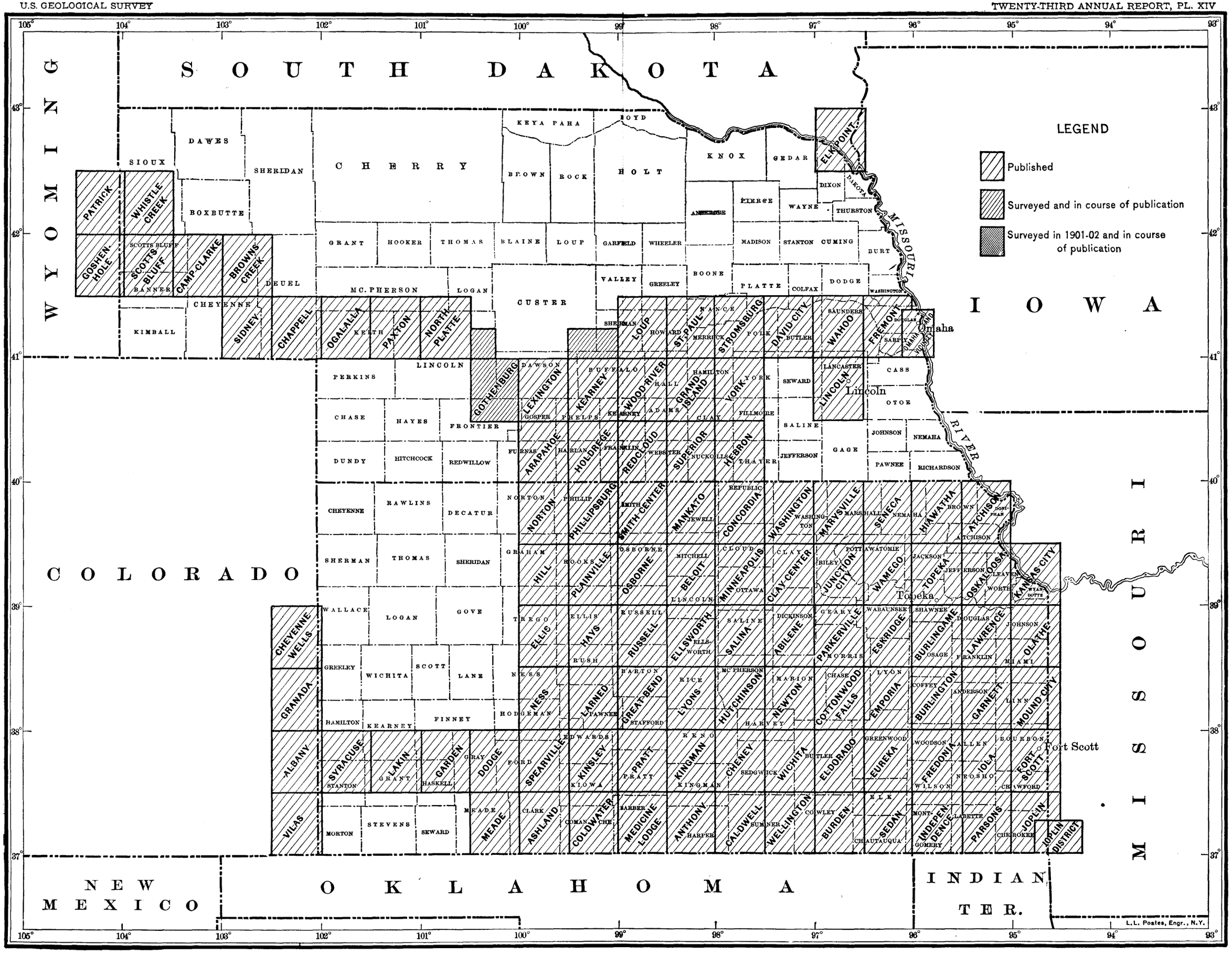
Wisconsin.—Mr. R. C. McKinney, topographer, began work in the southwestern part of Wisconsin in the latter part of April and continued until September 15, when he completed the south half of the Richland Center quadrangle, in Richland, Iowa, and Sauk counties. The area surveyed consisted of 438 square miles, for publication on the scale of 1:125000, with a contour interval of 20 feet, in connection with which 157 miles of levels were run.

Mr. E. C. Bebb, topographer, commenced operations in the southeastern part of Wisconsin the latter part of May, where he continued until the end of October, completing the survey of the Hartford and West Bend quadrangles, in Dodge, Washington, and Ozaukee counties. This work was for publication on the scale of 1:62500, with a contour interval of 20 feet, and embraced an area of 435 square miles, in connection with which 226 miles of levels were run and 20 permanent bench marks were established. During his field season Mr. Bebb also revised and readjusted the Port Washington 15-minute quadrangle, consisting of 125 square miles, exclusive of water area.

Michigan.—An arrangement was entered into between the Director of the United States Geological Survey and the State geologist of Michigan by which the latter contributed $2,000 from his appropriation, which was met by the same amount from the funds of the Geological Survey.

Mr. Muldrow commenced work on the Ann Arbor quadrangle, in Washtenaw County, about the 10th of September, after the completion of his work in Alabama, and continued in the field until the latter part of November, when 110 square miles were completed. This work was mapped for publication on the scale of 1:125000, with a contour interval of 20 feet, in connection with which 292 miles of levels were run and 5 permanent bench marks were established.

Mississippi.—Work in Mississippi was begun under an agreement with the director of the Mississippi experiment station, by the terms of which he allotted $1,000 for cooperative topographic work, which was met with a like amount by the Director of the United States Geological Survey.



MAP OF NEBRASKA AND KANSAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Mr. Hackett commenced field work the middle of October and continued until December 15, when 198 square miles of the Jackson quadrangle, in Hinds and Madison counties, were completed. This work was mapped for publication on the scale of 1:125000, with a contour interval of 20 feet, in connection with which 109 miles of levels were run.

ROCKY MOUNTAIN SECTION.

Topographic work was carried on during the year by ten parties working in South Dakota, Wyoming, Montana, Utah, Colorado, Texas, and Arizona. Six regular quadrangles and five special areas were mapped, and the survey of three other regular quadrangles and one special area was commenced. The total new area surveyed was 3,594 square miles, of which 2,654 square miles were for publication on the scale of 1:125000, 394 were for publication on the scale of 1:62500, and 546 were on special scales. In addition to this, 164 square miles were resurveyed. In connection with this work 1,050 miles of levels were run and 275 permanent bench marks were established.

South Dakota–Wyoming–Montana.—Mr. W. H. Herron, topographer, commenced the survey of the Aladdin quadrangle on May 20 and completed the same on October 25. The greater part of this quadrangle lies in Crook County, Wyo., the remaining portion being in Butte County, S. Dak., and Custer County, Wyo. The total area surveyed was 850 square miles, for publication on the scale of 1:125000, with a contour interval of 50 feet. In connection with this work a resurvey was made of 25 square miles of the north edge of the Sundance quadrangle.

Wyoming–Colorado.—On April 10 Messrs. E. W. Glafcke and Goyne Drummond, levelmen, commenced leveling at a bench mark in Laramie established by the Coast and Geodetic Survey on the transcontinental level line, and ran a duplicate line southeastward to Encampment to secure control for the Encampment special map. After the line reached Encampment Mr. Donnell Miller, levelman, took up the work and completed the vertical control for the quadrangle, extending the work

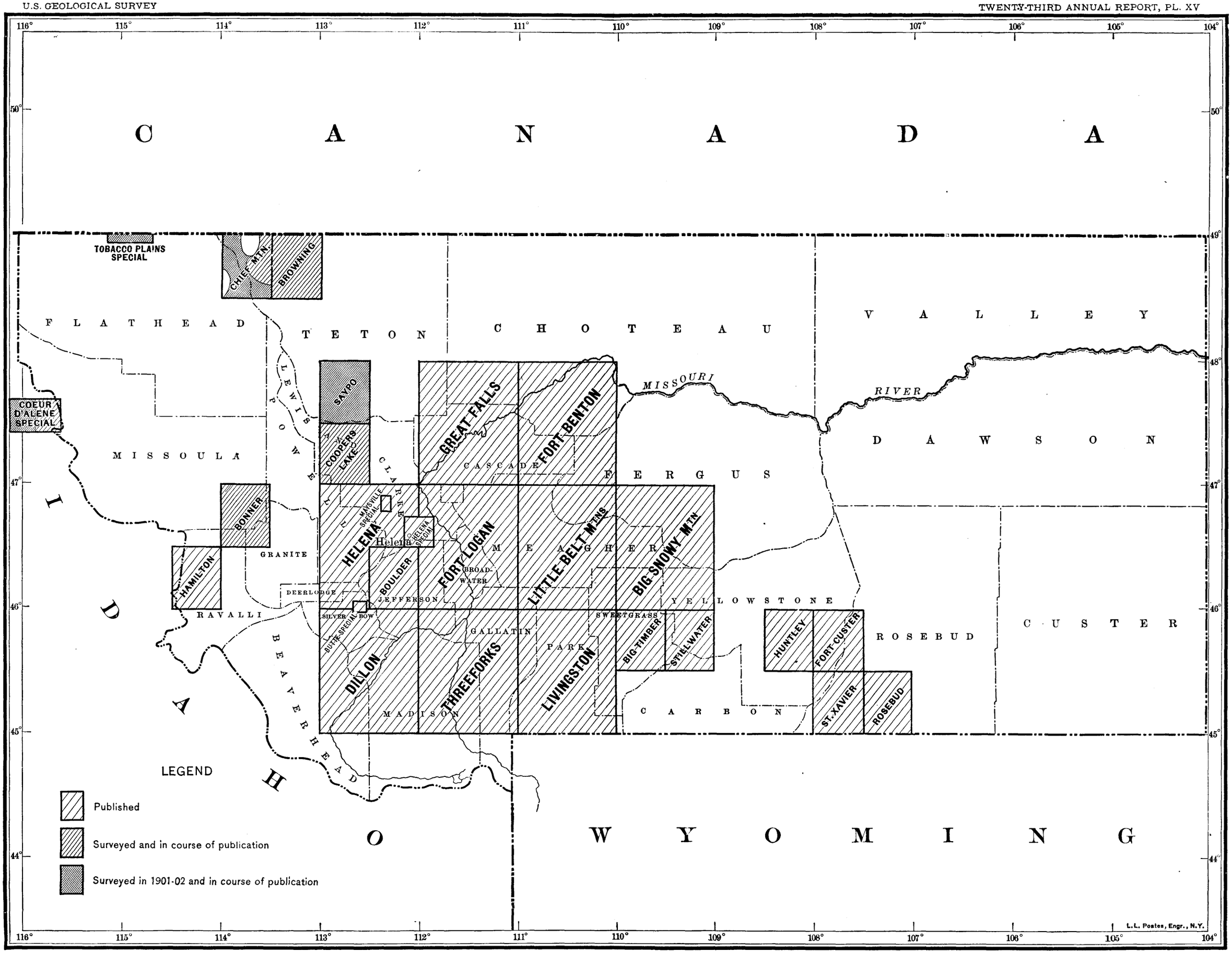
southward into Colorado. The total number of miles run was 183, in connection with which 54 permanent bench marks were established.

Wyoming.—Mr. Frank Tweedy, topographer, having finished the triangulation to which reference has been made, on July 12 began the survey of the Encampment mining district, in Carbon County. The party remained in the field until October 15, when 510 square miles were completed, for publication on the scale of 1:125000, with a contour interval of 100 feet.

Colorado.—On July 1 Mr. W. M. Beaman, topographer, commenced the survey of the Ouray quadrangle, in Ouray, Gunnison, and Hinsdale counties, and continued until July 16, when he, with Mr. Arthur Stiles, topographer, as assistant, was placed in charge of the resurvey of the Silverton quadrangle, in San Juan, Ouray, and Hinsdale counties. The Silverton quadrangle, embracing an area of 107 square miles, was completed early in August, when the whole party resumed work on the Ouray quadrangle, Mr. Stiles continuing until September 23 and Mr. Beaman until October 10, the area surveyed being 80 square miles. Both quadrangles were surveyed for publication on the scale of 1: 62500, with a contour interval of 100 feet, in connection with which 42 miles of levels were run and 13 permanent bench marks were established.

Mr. R. H. Chapman, topographer, was detailed in September to make geographic locations of the principal mines at Leadville and to partially revise the "Tenmile district" quadrangle, which includes the city and mining district of Leadville. Over 3 square miles of new area were added to the map, for publication on the scale of 800 feet to 1 inch, with a contour interval of 25 feet, and nearly 800 new locations of mines, shafts, tunnels, and other important points were made.

Texas.—At the close of the last annual report (April 30, 1901) work had just been commenced on the Gainesville quadrangle, in Montague and Cook counties, by Mr. Stiles, aided by Mr. R. H. Sargent, assistant topographer. Work in this locality was discontinued on June 10, taken up again on October 15 by Mr. Stiles, and completed on March 1, 1902. The total



MAP OF MONTANA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

area surveyed was 787 square miles, for publication on the scale of 1:125000, with a contour interval of 50 feet, in addition to which a survey of 18 square miles of the asphalt area about St. Jo, in Montague County, was made, for publication on the scale of 1:45000, with a contour interval of 25 feet.

The survey of the San Antonio Special quadrangle, in Bexar, Atascosa, and Wilson counties, was commenced by Mr. Herron on December 12 and continued until March 1, 1902, when 83 square miles had been mapped, for publication on the scale of 1:62500, with a contour interval of 10 feet. In connection with this work 240 miles of levels were run and 55 permanent bench marks were established.

Mr. M. S. Bright, levelman, also ran 64 miles of levels and established 15 permanent bench marks in completing the control of the Fredericksburg quadrangle, in Gillespie and Kendall counties.

Mr. W. J. Lloyd, topographer, began the mapping of the Cerro Alto quadrangle, in El Paso County, on November 1. In December he was joined by Mr. Pearson Chapman, topographer, and during the first week in March, 1902, they completed the mapping of the quadrangle, consisting of 1,017 square miles, for publication on the scale of 1:125000, with a contour interval of 50 feet. In connection with this work 134 miles of levels were run and 23 permanent bench marks were established.

Early in December an arrangement was perfected between the Director of the United States Geological Survey and Dr. William B. Phillips, director of the University of Texas mineral survey, by which the expenses of topographic surveys in the vicinity of Terlingua, Brewster County, were to be shared between the two organizations, the Texas mineral survey appropriating about $2,500. The leveling for the vertical control of this district was immediately started at Marfa, and was completed April 1, 1902, 285 miles of line having been run and 89 permanent bench marks established. On April 21 Mr. Stiles, with Mr. Fred McLaughlin as assistant, outfitted a party for the topographic work, but up to April 30 only the preliminary work had been undertaken.

Arizona.—Mr. T. M. Bannon, topographer, commenced the survey of the Bisbee quadrangle, in Cochise County, on November 20 and completed the same on February 12, 1902, having surveyed 161 square miles, for publication on the scale of 1:62500, with a contour interval of 50 feet. A special map of the area about the principal mines, consisting of 8 square miles, was also completed, for publication on the scale of 1:12000, with a contour interval of 20 feet. The leveling for this area consisted of 61 miles of line, in connection with which 18 permanent bench marks were established.

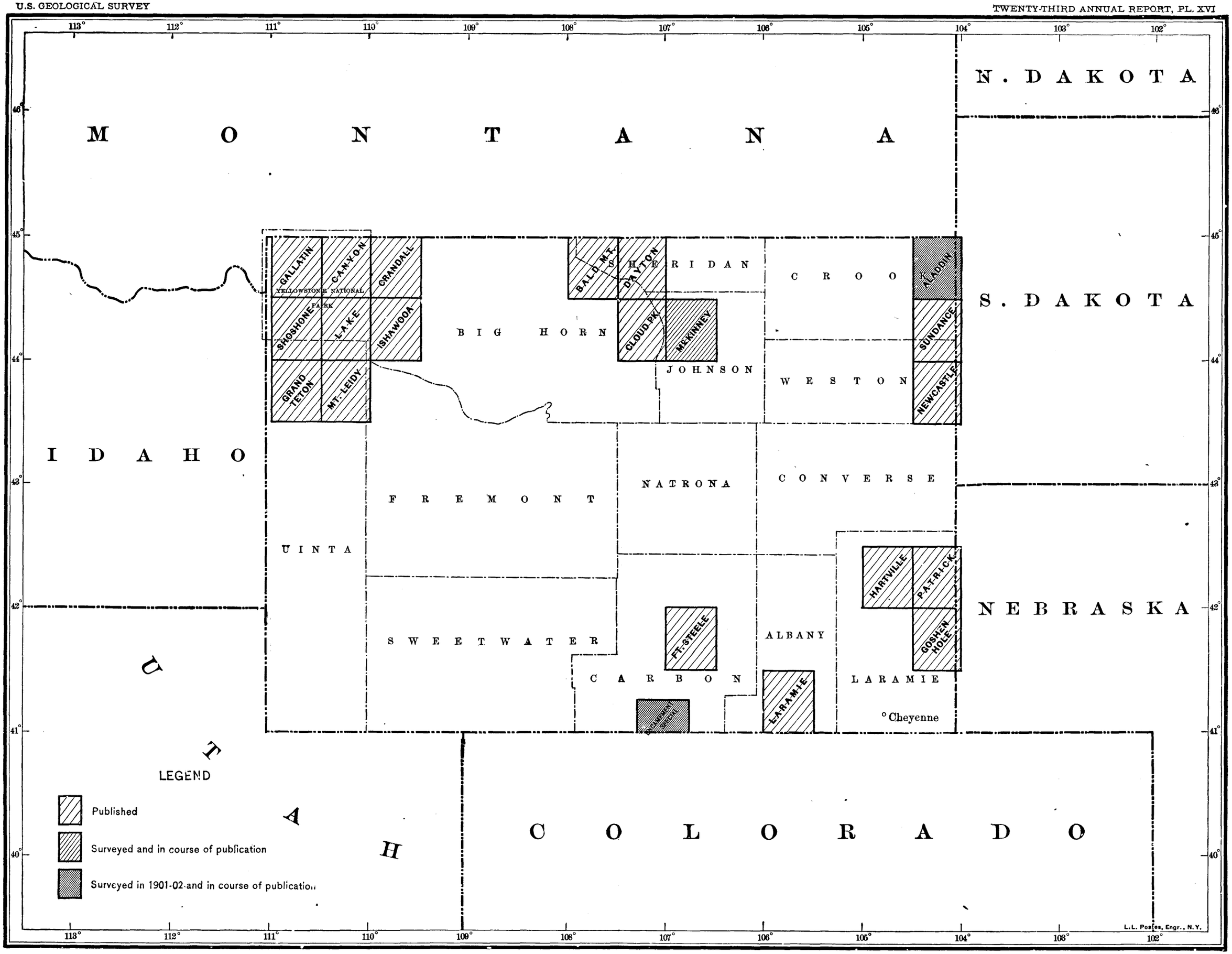
During the last week in June Mr. J. F. McBeth, field assistant, commenced work on the Globe Special map, and completed the same the latter part of August. The area surveyed was 6 square miles, for publication on the scale of 1:12000, with a contour interval of 20 feet.

During May and June the survey of the Clifton quadrangle, in Graham County, was completed by Mr. Jeremiah Ahern, topographer. An area of 70 square miles was surveyed, for publication on the scale of 1:62500, with a contour interval of 100 feet. An area of 1 square mile about Shannon Mountain was also surveyed, for publication on the scale of 1:12000, with a contour interval of 20 feet.

Utah.—Early in July the survey of the Park City Special area was commenced by Mr. Pearson Chapman and was completed on November 30. The area surveyed was 30 square miles, for publication on the scale of 1:21120, with a contour interval of 50 feet. A survey of 2 square miles of the Silver King mining district, included within the limits of this map, was made by Mr. McBeth, for publication on the scale of 1:12000, with a contour interval of 50 feet. In this vicinity 41 miles of levels were run and 8 permanent bench marks were established.

PACIFIC SECTION.

Topographic work was prosecuted by five parties in Washington, Montana, Idaho, Oregon, and California. The survey of four quadrangles was completed, two were partially completed, and three special areas along the Northwest boundary were surveyed. The total area mapped was 2,380 square miles,



MAP OF WYOMING, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

of which 1,531 square miles were for publication on the scale of 1:125000; 685 square miles were for publication on the scale of 1:62500; and 164 square miles were for publication on the scale of 1:45000. Levels were run over 889 linear miles, in connection with which 187 permanent bench marks were established, 4 of which were by vertical angulation.

Idaho.—Mr. Van. H. Manning, topographer, was detailed to resume work on the western half of the Cœur d'Alene special quadrangle, a portion of which was mapped during the previous field season. He began on May 5, and continued in the vicinity until September 27, when he was forced to stop on account of an accident to himself in the mountains. An area of 202 square miles, for publication on the scale of 1:62500, with a contour interval of 50 feet, was mapped, thus completing the quadrangle; also an area of 142 square miles of the Cataldo quadrangle, for publication on the scale of 1:125000, with a contour interval of 100 feet. In connection with this work 57 miles of levels were run and 11 permanent bench marks were established, 4 of the latter being by vertical angulation. The area surveyed was in Shoshone and Kootenai counties.

Oregon.—Mr. A. B. Searle, topographer, with Mr. A. F. Hassan, assistant topographer, was assigned to the Riddles quadrangle. Field work was commenced the 1st of July and continued until the end of December, during which time 600 square miles in Douglas, Josephine, and Jackson counties were mapped. Of the above, 300 square miles were mapped by a subparty under Mr. J. G. Hefty, field assistant. This work was for publication on the scale of 1:125000, with a contour interval of 100 feet, in connection with which 179 miles of levels were run and 24 permanent bench marks were established.

Washington.—Mr. L. C. Fletcher, topographer, was detailed for the survey of the Republic quadrangle, in Ferry and Okanogan counties. Field work progressed from May 5 to October 6, during which time the mapping of the quadrangle, consisting of an area of 789 square miles, was completed. This work was for publication on the scale of 1:125000, with

a contour interval of 100 feet, in connection with which 150 miles of levels were run and 27 permanent bench marks were established.

In addition to the above, Mr. E. M. Fry, levelman, ran 241 miles of levels and established 45 permanent bench marks in this general locality.

Mr R. A. Farmer, topographer, had charge of a level party from April 15 to May 12, during which time he ran a line from Deer Park to Meyers Falls, along the Spokane Falls and Northern Railroad, a distance of 69 miles, and established in connection therewith 11 permanent bench marks.

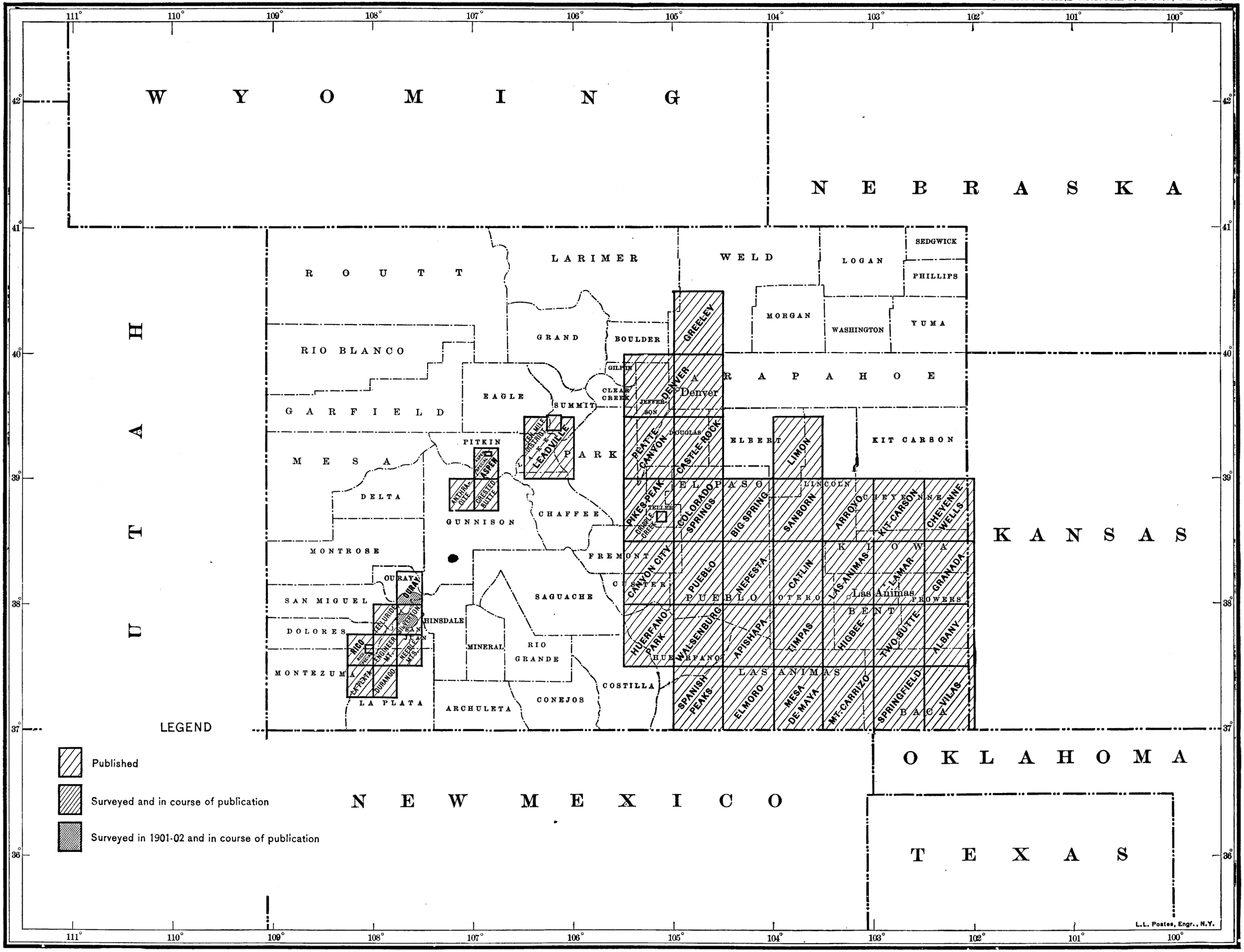
California.—Mr. J. E. Rockhold, assistant topographer, commenced operations on the La Jolla quadrangle, in southern California, about July 1, and continued work until the end of the succeeding February, when the area assigned him, embracing 250 square miles in San Diego County, was completed. This work was for publication on the scale of 1:62500, with a contour interval of 25 feet, in connection with which 75 miles of levels were run and 12 permanent bench marks were established.

Mr. A. E. Murlin, topographer, upon the completion of his work in Washington, hereafter referred to, was ordered to California and began work on the Fairoaks quadrangle, in Sacramento and Placer counties, on October 1, completing the same the latter part of December. The area surveyed was 233 square miles, for publication on the scale of 1:62500, with a contour interval of 10 feet, in connection with which 86 miles of levels were run and 13 permanent bench marks were established.

In addition to the above, Mr. L. D. Ryus, levelman, ran 32 miles of levels in Marin and Sonoma counties and 44 miles in Santa Cruz and Monterey counties.

NORTHWEST-BOUNDARY SURVEY.

At the request of the Department of State, Mr. E. C. Barnard, topographer, was detailed to make certain surveys and investigations of the land portion of the boundary between the United States and Canada extending westward from the sum-



LEGEND

- Published
- Surveyed and in course of publication
- Surveyed in 1901-02 and in course of publication

L.L. Postes, Engr., N.Y.

MAP OF COLORADO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

mit of the Rocky Mountains. Mr. Barnard was to act in cooperation with Mr. C. H. Sinclair, assistant on the Coast and Geodetic Survey, the object of the work of the joint parties being twofold:

1. To clearly define and temporarily mark the boundary line in three localities in which there was considerable uncertainty relating to the line. These portions were in the Mount Baker mining district, Washington; the Midway and Grand Forks district, Washington; and the Tobacco Plains district of Montana.

2. In conjunction with three geologic parties, to make an examination of the whole line and to report upon its existing conditions.

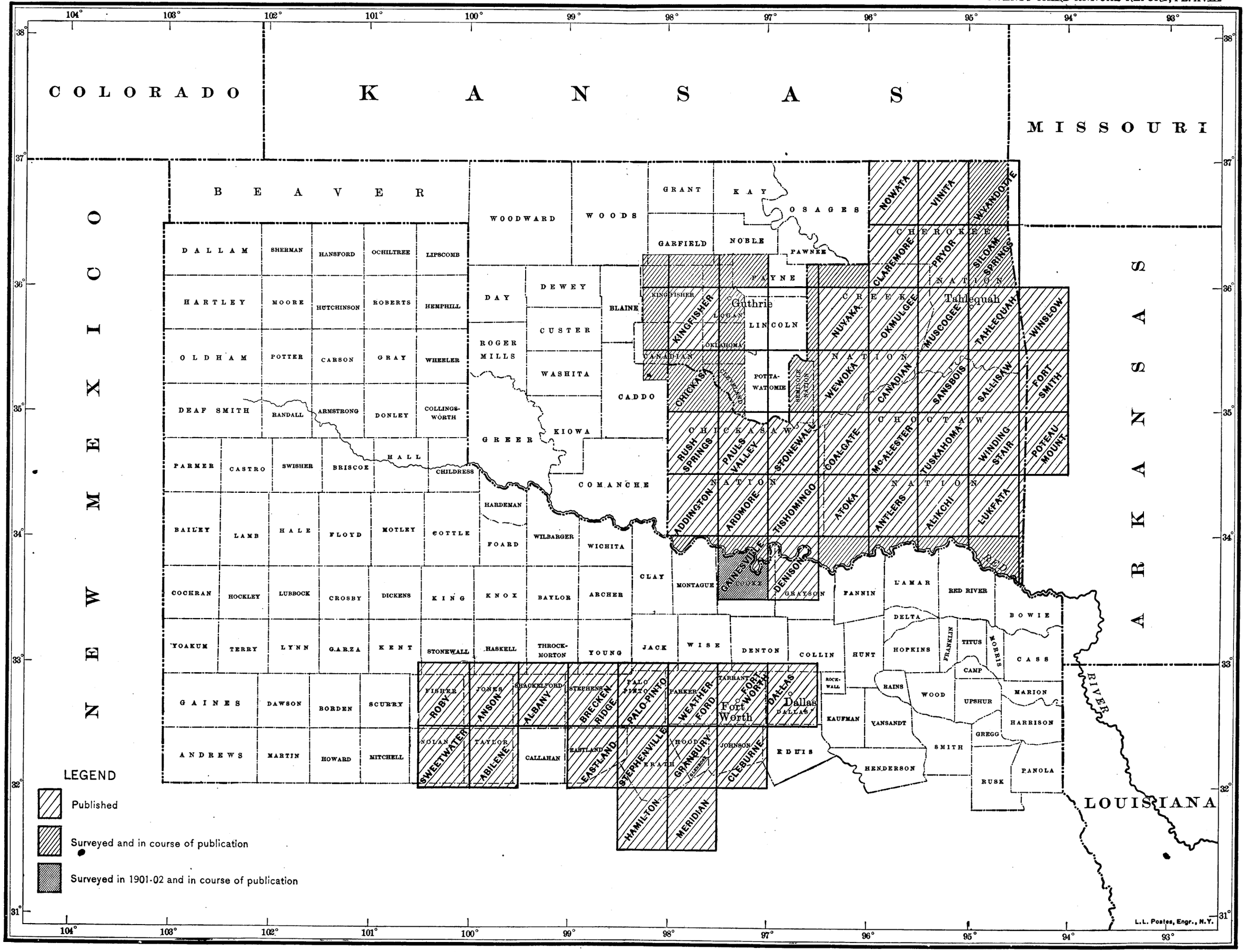
It was agreed that work should be begun in the Mount Baker district; then that the combined parties should proceed to Midway and Grand Forks, and finally to Tobacco Plains.

Mount Baker district, or Silicia Creek.—Mr. Barnard left Washington, D. C., about May 1, and after supplying himself with the necessary outfit in Seattle reached Chilliwack, British Columbia, a station on the Canadian Pacific Railroad, on May 18. From this point the boundary line at Silicia Creek was distant by road and trail 32 miles, and was much more accessible than from any point south of the boundary line. The party left Chilliwack for Silicia Creek on May 22, the outfit being taken in by 20 pack horses which had been hired, and camp was established in the vicinity of the latter place on the 24th. An old astronomic observatory post, used by the Northwest Boundary Commission of 1856–1860, was readily identified, the latitude observations by Mr. Sinclair verifying those obtained by the old Boundary Commission. From this point a careful transit line was run southward a distance of about three-quarters of a mile to the supposed position of the boundary line, and after diligent search an old mound of stones near Silicia Creek was discovered, which was identified as a boundary monument erected by the Commission. The identification was made certain by the discovery of a mark cut into an adjacent rock, the distance and bearing of which from the monument corresponded with those given in the records of the

Boundary Commission. Accepting the latitude of the astronomic point as determined by the Commission, the measurements made by Messrs. Sinclair and Barnard give the position of the rock mound as about 7 feet north of the forty-ninth parallel. An azimuth was observed by Mr. Sinclair at the rock mound, and points were established on the tangent east and west. The boundary line was then located by offsets from the tangent, and vistas were cut through the forest, iron posts marking the line being established on spur ridges 3,800 feet east, 6,300 feet east, and 4,000 feet west from the identified monument. Thus a distance along the line of about 2 miles was cut out and marked. An iron post was set at the astronomic post and the old mound was restored, the latter being witnessed by an iron post set on the line closely adjacent thereto. The line thus defined passed through the entire locality in which there were any disputes. As the snow lay deep on the summits to the east and west, it was not practicable to extend the line farther. Photographs were taken of all old marks and all new monuments, and a topographic map was made, on the scale of 1:45000, of about 20 square miles embracing the territory adjacent to the surveyed line. On the maps all the monuments were carefully located. The party returned to Chilliwack on June 24.

A party of Canadian boundary surveyors under Mr. McArthur was also in this vicinity. They were engaged principally in building trails to various points on the boundary line, and later proposed to cut out portions of the line, but would set no posts or permanent marks.

Midway and Grand Forks.—The combined parties left Chilliwack on June 26 and arrived, via the Canadian Pacific Railway, at Midway on the 27th. On the 28th Messrs. Barnard and Sinclair visited a Canadian boundary party camped in the vicinity, under Mr. O'Hara. The latter stated that he was instructed to open the boundary line between existing monuments from Midway westward and also to make a topographic map, including a strip of territory 10 miles in width on the Canadian side of the line. It had been previously arranged that the work of the United States parties should extend westward from Midway.



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

In this locality two lines had been defined by the old Boundary Commission—the astronomic parallel and the mean parallel. The astronomic parallel was originally cut out and monuments erected, but afterwards the United States and English Commissioners agreed to adopt the mean parallel from Similikameen to Cascade, a distance of about 69 miles. The mean, or adopted, parallel was cut out only on the ridges and in the localities where new monuments were placed. The monuments which had been erected on the astronomic parallel were torn down, the material, however, being left on the ground, and other monuments were built near by on the mean parallel. Thus, under the conditions left by the old Commission, there was one line defined by monuments but only partially cut out, and another line cut out but on which the monuments had been torn down, though not removed; hence the confusion that arose as to the actual location of the boundary. This uncertainty was removed by clearly and distinctly cutting out the line defined by the monuments on the mean parallel.

The results accomplished were that the boundary line from Midway to Grand Forks, a distance of about 16 miles, was surveyed and cut out, and the monuments were inspected 6 miles farther, to Cascade. Photographs of all monuments were obtained and an area of 64 square miles adjacent to the line was topographically mapped. Mr. Sinclair observed for latitude at three points—Midway, Carson, and Cascade. This work was completed on August 12.

Tobacco Plains.—On the completion of the work above referred to, the combined party left Grand Forks, via the Canadian Pacific Railway, for Elko, British Columbia, and from this point reached Phillips, British Columbia, a point on the boundary line, traveling by wagon and arriving on August 14.

A monument on the boundary near Phillips was identified and the line was surveyed and cut out therefrom to Wigwam, another station of the old boundary survey, a distance of 13 miles. Four iron monuments were established, marking this portion of the line. Later the portion of the line surveyed by the commission of 1857–1861 from Phillips to a

point about 4 miles west of the Kootenai River was cut out, one iron post being set midway between Phillips and the Kootenai River. An area of about 80 square miles in this vicinity adjacent to the line was mapped. Mr. Sinclair determined the latitude of five points on the boundary in this vicinity—at Phillips, Wigwam, Kootenai River, Columbia River, and an old astronomic station of the Boundary Commission near Wigwam.

Field work was completed by Mr. Barnard on October 14, and he, with his assistant, Mr. Dunaway, proceeded to Washington for office work.

SUMMARY OF RESULTS.

The combined parties of Messrs. Sinclair and Barnard accomplished the following results during the field season of five and a half months:

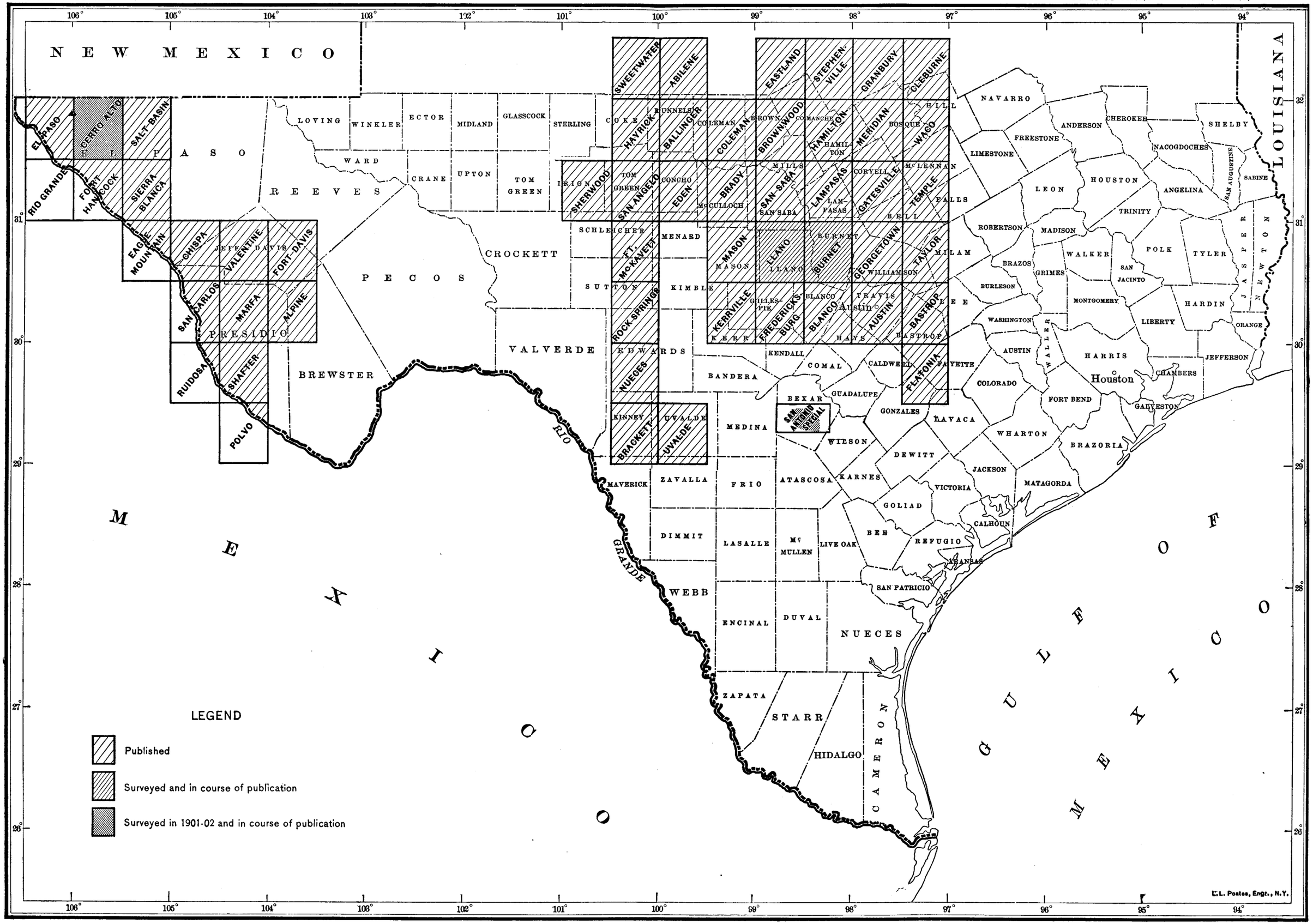
The latitudes of 9 stations were determined and meridian lines were established in connection therewith. The boundary line was surveyed and cut out for a distance of 42 miles. Five monuments that had been torn down were rebuilt and 9 iron posts were set to mark the line where it had not been previously surveyed, and an area of 164 square miles along the axis of the line in the various localities visited was mapped.

FOREST RESERVES.

The organization continued as heretofore, the topographic survey of certain reserves being assigned to the Rocky Mountain section, under Mr. E. M. Douglas, geographer, and that of the remaining reserves being assigned to the Pacific section, under Mr. Richard U. Goode, geographer. Mr. Henry Gannett, geographer, was continued in charge of the forest examinations.

ROCKY MOUNTAIN SECTION.

Topographic surveys were carried on in the Lewis and Clarke and Flathead reserves, Montana; the Uinta Reserve, Utah; the Gila River Reserve, New Mexico, and the Prescott and Grand Canyon reserves, Arizona. The marking of the boundary line of the Bighorn Reserve, Wyoming, was con-



MAP OF SOUTHERN TEXAS, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

tinued. The survey of three quadrangles was completed and three were partially surveyed. A total new area of 1,975 square miles was mapped and a resurvey of 840 square miles was completed, for publication on the scale of 1:125000. In connection with this work 880 miles of levels were run, 253 permanent bench marks were established, and 117 miles of boundary line were marked.

Wyoming, Bighorn Reserve.—The surveying and marking of the boundary line of this reserve was continued by a party under the charge of Mr. W. H. Thorn, United States surveyor, from July 1 to November 23. During this time 117 miles of line were surveyed and marked by 80 special iron posts.

Montana, Lewis and Clarke Reserve.—Mr. Bannon, between May 13 and October 27, surveyed the Saypo quadrangle, covering an area of 730 square miles, including the east-central part of this reserve, in Lewis and Clarke and Teton counties. This work was for publication on the scale of 1:125000, with a contour interval of 100 feet. Leveling for this and adjoining areas covered 220 miles, in connection with which 65 permanent bench marks were established.

Montana, Flathead Reserve.—Mr. H. L. Baldwin, jr., topographer, began work June 20, and during the season mapped 718 square miles of the Browning quadrangle, in Teton County. Messrs. François E. Matthes and R. H. Sargent, topographers, mapped 527 square miles of the Chief Mountain quadrangle, which covers portions of Flathead and Teton counties. All of this work was for publication on the scale of 1:125000, with a contour interval of 100 feet. The leveling for this reserve consisted of 187 miles of line, in connection with which 51 permanent bench marks were established.

Utah, Uinta Reserve.—Mr. Lloyd surveyed 310 square miles of the Hayden Peak quadrangle, in Summit and Wasatch counties, thereby completing the same, for publication on the scale of 1:125000, with a contour interval of 100 feet. This work was commenced the last week in June and the party disbanded October 12, and in connection with it 153 miles of levels were run and 36 permanent bench marks were established.

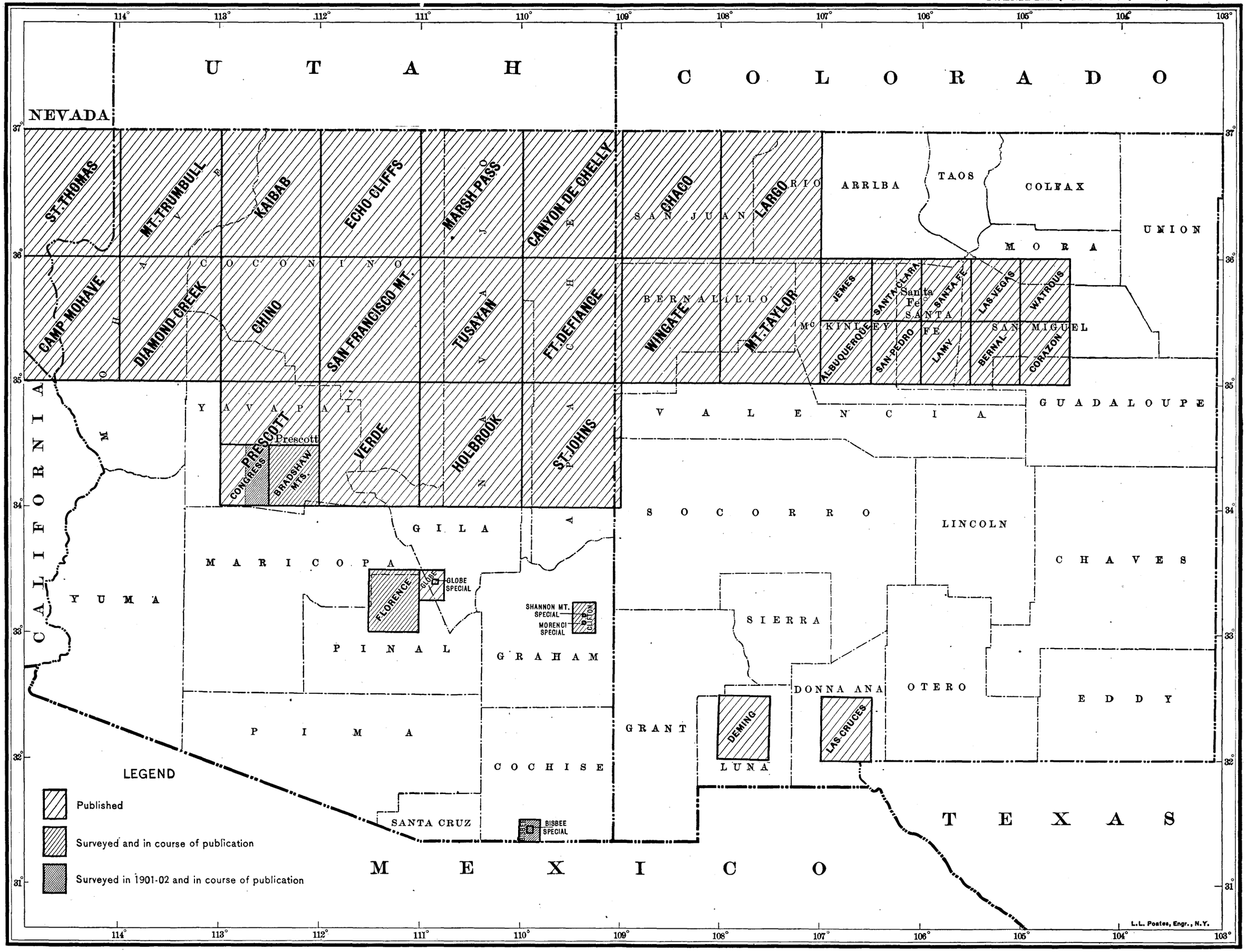
New Mexico–Arizona, Gila River Reserve.—Leveling for this reserve was commenced at a bench mark near Duncan, Ariz., by Mr. Chester Irvine, levelman, on February 15, and on April 1 he reported that 90 miles of line had been run and 24 permanent bench marks established, in Graham County, Ariz., and Grant County, N. Mex.

Arizona, Prescott Reserve.—Mr. Sargent outfitted a party on October 1 for the survey of the western part of this reserve, being the eastern part of the Congress quadrangle, in Yavapai County. The party remained in the field until March 12, 1902, when 530 square miles had been surveyed, for publication on the scale of 1:125000, with a contour interval of 100 feet. Leveling for the unsurveyed parts of this reserve, including the carrying forward of a checked line for the control of the San Francisco Mountain Reserve, was commenced October 15 by Mr. John T. Stewart, levelman. Prior to March 12, when the party was disbanded, 230 miles of line were run and 77 permanent bench marks were established.

Arizona, Grand Canyon Reserve.—On March 20, 1902, Mr. Matthes organized a party for the survey of two quadrangles within this reserve, in Coconino County, but previous to April 15 only the preliminary work had been undertaken.

PACIFIC SECTION.

Topographic work was prosecuted in and adjacent to the following reserves: Washington, Mount Rainier, Pine Mountain and Zaca Lake, Sierra, Santa Ynez, and San Jacinto. The survey of nine quadrangles was completed, three were partially surveyed, and a small special area in the Fresno Big Trees Grove was mapped. The total new area mapped was 4,370 square miles, of which 3,591 square miles were for publication on the scale of 1:125,000, 775 square miles were for publication on the scale of 1:62,500, and 4 square miles were for publication on the scale of 1:45,000. In addition 428 square miles were resurveyed. In connection with the above, 1,103 miles of levels were run and 239 permanent bench marks were established, 7 of the latter being by vertical angulation.



MAP OF ARIZONA AND NEW MEXICO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Washington, Washington Reserve.—Mr. Farmer resumed work on the Chiwaukum (formerly designated Leavenworth) quadrangle, in Chelan and Kittitas counties, about May 15, and completed the same on October 5. An area of 332 square miles was mapped, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 39 miles of levels were run and 11 permanent bench marks were established. An area of 186 square miles was also mapped within the Stehekin quadrangle.

Washington, Mount Rainier Reserve.—Mr. Murlin resumed work on the resurvey of the Snoqualmie quadrangle on June 6, and was so engaged until the latter part of September, when the quadrangle was completed. An area of 428 square miles was mapped, in Kittitas and King counties.

Mr. A. H. Sylvester, topographer, who had remained in the field throughout the winter, was ordered from California to the State of Washington to resume operations on the Mount Aix quadrangle, in Yakima and Kittitas counties. He commenced work about June 5 and continued until about October 15, when an area of 368 square miles was completed, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 44 miles of levels were run and 8 permanent bench marks were established.

California, Sierra Reserve.—Mr. R. B. Marshall, topographer, was assigned to the charge of a party in this reserve, and commenced work the first part of July. He contined until near the end of September, when about half of the Kaiser Peak quadrangle, consisting of 430 square miles, in Fresno County, was completed. This work was surveyed for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 87 miles of levels were run and 20 permanent bench marks were established, 7 of the latter being by vertical angulation.

In addition Mr. Marshall mapped an area of 4 square miles on the scale of 1:45,000, including the Fresno Big Trees Grove, within the Ahwanee quadrangle, in Madera County.

In order to connect the leveling above referred to, which was based on elevations furnished by the Southern Pacific

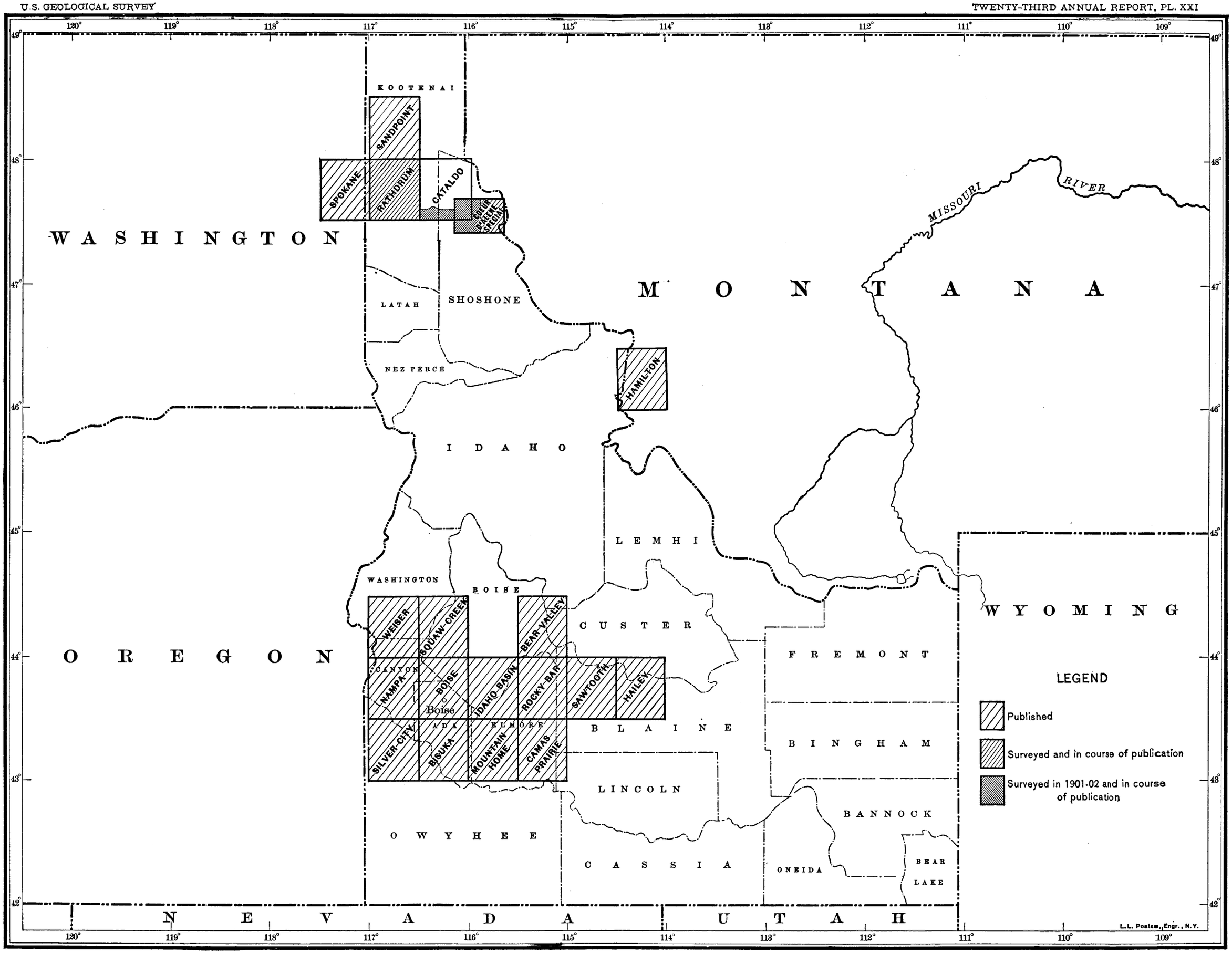
Railroad, with mean sea level, and for the control of future work in the forest reserves, Mr. C. H. Semper, levelman, about October 1 began a precise line with duplicate rods at Benicia. This work was based on a tidal bench mark established by the Coast and Geodetic Survey. The line was carried along the Southern Pacific Railroad, via Sacramento, through the San Joaquin Valley and across the Tehachapi Mountains to the vicinity of Mohave. The distance run was 391 miles, and 127 permanent bench marks were established.

California, Pine Mountain and Zaca Lake Reserve.—Mr. W. T. Turner, topographer, resumed charge of the party in this reserve, which had been continued throughout the winter under Mr. S. N. Stoner, field assistant, commencing work on May 5. He continued in this vicinity until the end of January, 1902, when he completed the mapping of the Mount Pinos quadrangle, consisting of 683 square miles, and of 234 square miles of the Santa Ynez quadrangle, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This work lies in Ventura, Los Angeles, Kern, and Santa Barbara counties.

On the completion of his work in Washington, Mr. Sylvester was ordered to California to resume work. He commenced about October 22, and continued until March 10, 1902, when the Ventura quadrangle, in Ventura County, was completed. The area surveyed was 174 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

Mr. Marshall, on the completion of work heretofore referred to, resumed operations in the Santa Paula quadrangle, in Ventura County, about the 1st of October. He continued in this vicinity until November 9, when the quadrangle was completed, the area mapped being 99 square miles. During the previous spring Mr. J. G. Hefty, field assistant, mapped 82 square miles in this quadrangle, which was not included in the last annual report. This work was mapped for publication on the scale of 1:62,500, with a contour interval of 50 feet.

California, Santa Ynez Reserve.—After completing the Santa Paula quadrangle, Mr. Marshall was engaged on the survey of the Santa Barbara and Goleta quadrangles, in Santa Barbara



MAP OF IDAHO, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

County, until February 9. The area mapped was 222 square miles, for publication on the scale of 1 : 62500, with a contour interval of 50 feet.

For the vertical control of the work in the Pine Mountain and Zaca Lake and the Santa Ynez reserves, Mr. H. S. Crowe, levelman, during the period from May 1, 1901, through the following January, ran 387 miles of levels, in connection with which 53 permanent bench marks were established.

California, San Jacinto Reserve.—Mr. A. I. Oliver, field assistant, began work in this reserve early in May, in Riverside and San Diego counties, and continued until the end of December, when 900 square miles of the Indio Special quadrangle were completed. This work was surveyed for publication on the scale of 1 : 125000, with a contour interval of 100 feet.

Mr E. T. Perkins, topographer, on the completion of his triangulation work, took up the survey of the Cuyamaca quadrangle, adjoining the San Jacinto Forest Reserve on the south. He commenced work in this vicinity November 1, and continued until the end of February, when the eastern half of the Cuyamaca quadrangle, consisting of 458 square miles, in San Diego County, was completed. This work was for publication on the scale of 1 : 125000, with a contour interval of 100 feet, in connection with which 77 miles of levels were run and 7 permanent bench marks were established.

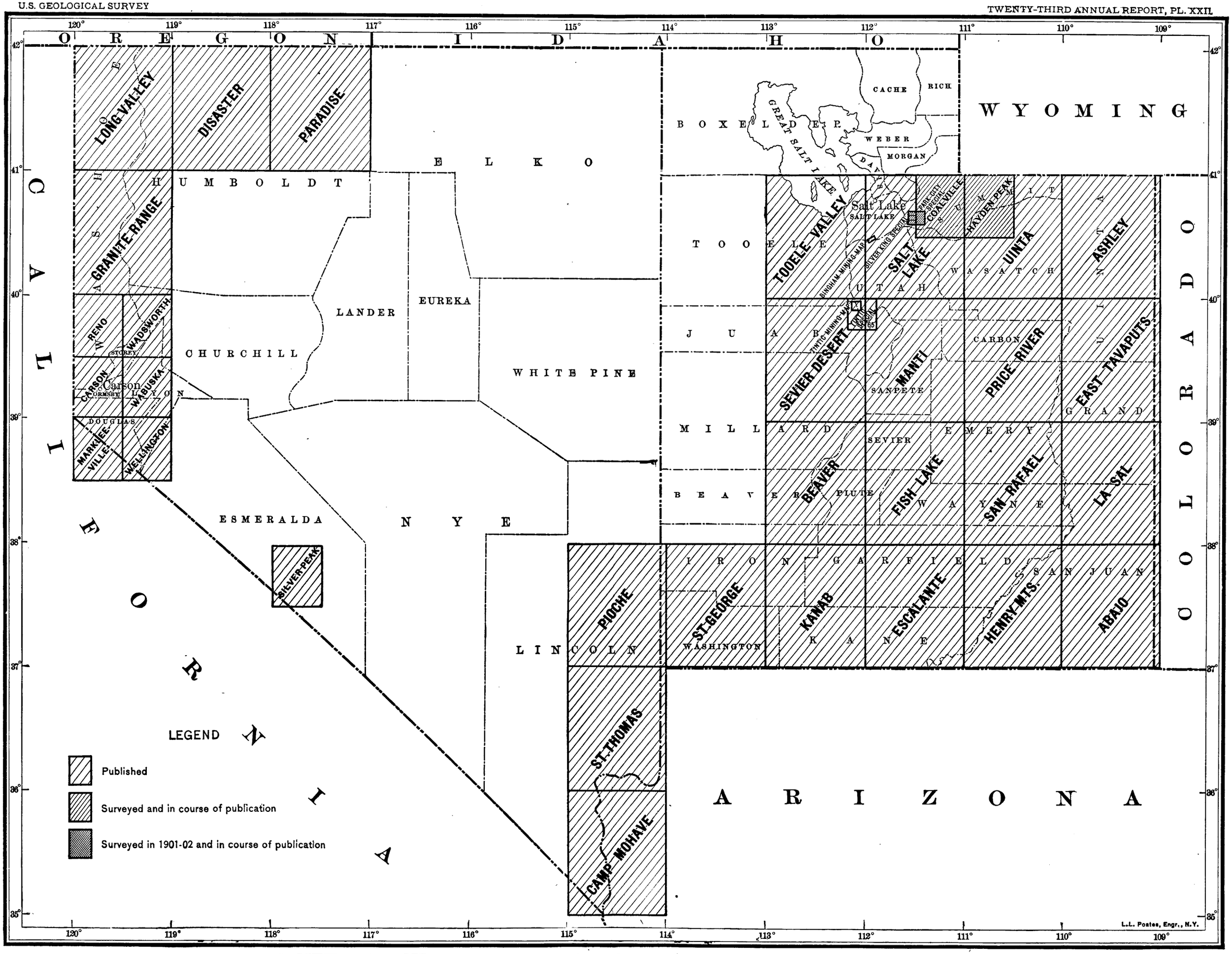
Mr. Perkins, with the assistance of Mr. Oliver, also completed the Jamul quadrangle, in San Diego County, consisting of an area of 198 square miles, the work being for publication on the scale of 1 : 62500, with a contour interval of 25 feet, in connection with which 78 miles of levels were run and 13 permanent bench marks were established.

Office Work.

The table herewith shows the atlas sheets, numbering 108, the drawing of which was completed in the office during the year.

Topographic sheets completed in office during 1901–2.

State and sheet.	Scale.	Contour interval.
		Feet.
ALABAMA:		
Wetumka	1:125000	50
ALASKA (see end of list).		
ARIZONA:		
Bisbee	1:62500	50
Bisbee Special	1:12000	20
Clifton	1:62500	100
Shannon Mountain Special	1:12000	20
Globe Special	1:12000	20
CALIFORNIA:		
Cuyamaca	1:125000	100
Fairoaks	1:62500	10
Goleta	1:62500	50
Hueneme	1:62500	50
Indio Special	1:125000	100
Jamul	1:62500	25
La Jolla	1:62500	25
Mount Pinos	1:125000	100
Santa Barbara	1:62500	50
Santa Paula	1:62500	50
Ventura	1:62500	50
COLORADO:		
Silverton	1:62500	100
IDAHO:		
Cœur d'Alene Special (western sheet)	1:62500	50
INDIANA:		
Boonville (revision)	1:62500	20
Haubstadt	1:62500	20
Petersburg (revision)	1:62500	20
INDIANA–ILLINOIS:		
Princeton	1:62500	20
New Harmony	1:62500	20
MAINE:		
Bar Harbor	1:62500	20
Blue Hill	1:62500	20
Deer Isle	1:62500	20
Mount Desert	1:62500	20
Petite Manan	1:62500	20
Swan Island	1:62500	20
Vinal Haven	1:62500	20



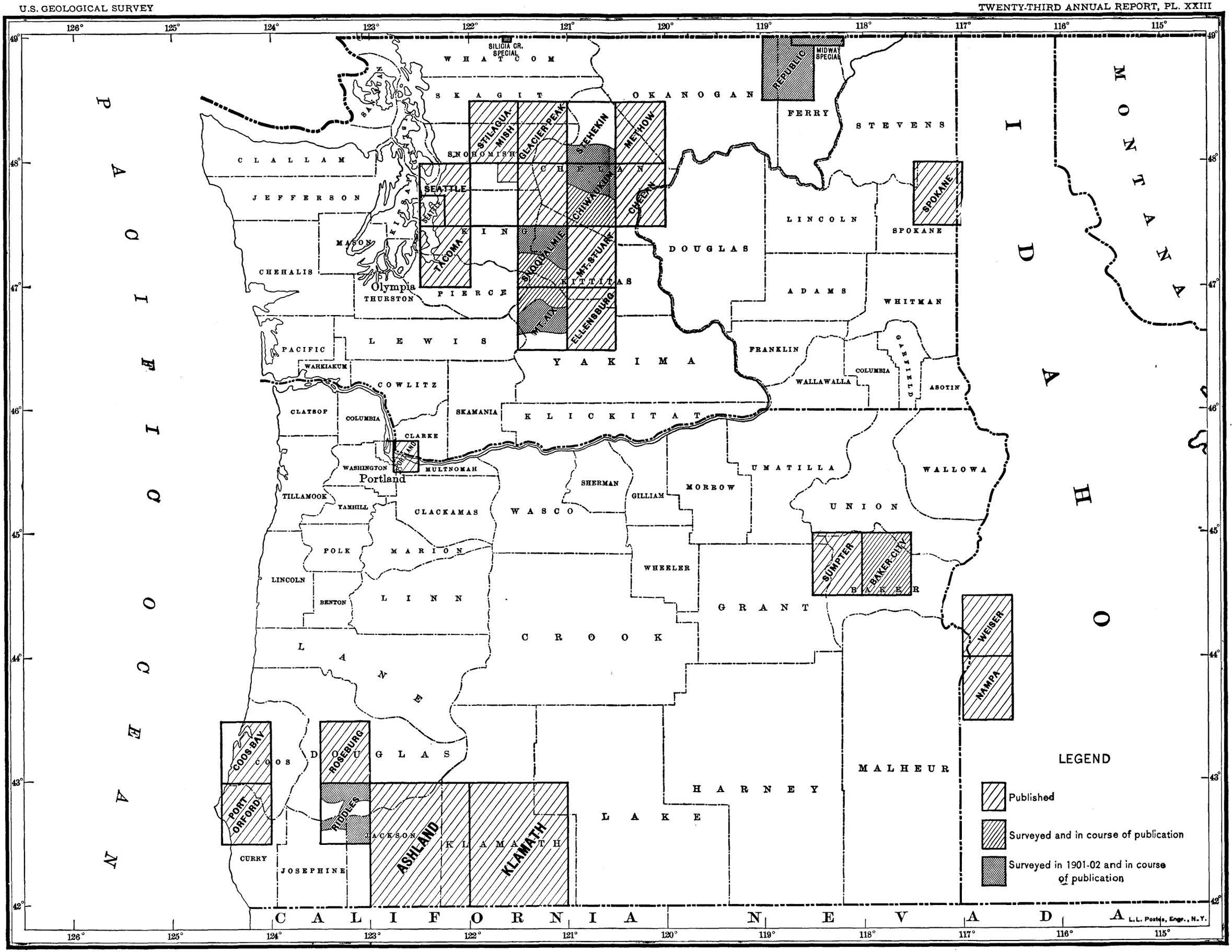
MAP OF NEVADA AND UTAH, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Topographic sheets completed in office during 1901–2—Continued.

State and sheet.	Scale.	Contour interval.
		Feet.
MISSOURI:		
Edina	1:125000	20
Palmyra	1:125000	20
MISSOURI-ILLINOIS:		
Kahoka	1:125000	20
MONTANA:		
Browning	1:125000	100
Saypo	1:125000	100
Tobacco Plains Special	1:45000	100
NEW YORK:		
Apalachin	1:62500	20
Babylon	1:62500	20
Big Moose	1:62500	20
Binghamton	1:62500	20
Gilboa	1:62500	20
Gloversville	1:62500	20
Harford	1:62500	20
Honeoye	1:62500	20
Lasellsville	1:62500	20
Margaretville	1:62500	20
Northport	1:62500	20
Pitcher	1:62500	20
Rosendale	1:62500	20
Santanoni	1:62500	20
NORTH CAROLINA:		
Grimesland	1:62500	10
Newbern	1:62500	10
Parmele	1:62500	10
Trent River	1:62500	10
Williamston	1:62500	10
Winterville	1:62500	10
OHIO:		
Bellevue	1:62500	10
Bowling Green	1:62500	10
Cadiz	1:62500	20
Canton	1:62500	20
Cleveland	1:62500	20
Delaware	1:62500	10
Dublin	1:62500	10
Elmore	1:62500	10
Euclid	1:62500	20

Topographic sheets completed in office during 1901–2—Continued.

State and sheet.	Scale.	Contour interval.
		Feet.
OHIO—Continued.		
Findlay	1:62500	10
Fostoria	1:62500	10
Fremont	1:62500	10
Massillon	1:62500	20
Oberlin	1:62500	20
Put in Bay	1:62500	10
Sandusky	1:62500	10
Vermilion	1.62500	10
Wooster	1:62500	20
PENNSYLVANIA–DELAWARE:		
Beaver	1:62500	20
Carlisle	1:62500	20
Hollidaysburg	1:62500	20
Huntingdon	1:62500	20
Rural Valley	1:62500	20
Waynesburg	1:62500	20
Westchester	1:62500	20
York Special	1:62500	20
TENNESSEE:		
Nashville	1:125000	50
TEXAS:		
Cerro Alto	1:125000	50
TEXAS–INDIAN TERRITORY:		
Gainesville	1:125000	50
UTAH:		
Hayden Peak	1:125000	100
Park City Special	1:21120	50
WASHINGTON:		
Chiwaukum	1:125000	100
Midway Special	1:45000	100
Republic	1:125000	100
Snoqualmie	1:125000	100
Silicia Creek Special	1:45000	100
WASHINGTON–IDAHO–MONTANA:		
General map of Northwest boundary	1:130080	250
WEST VIRGINIA–OHIO–PENNSYLVANIA:		
Clarksburg	1:62500	20
Fairmont	1:62500	20



MAP OF WASHINGTON AND OREGON, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Topographic sheets completed in office during 1901–2—Continued.

State and sheet.	Scale.	Contour interval.
		Feet.
WEST VIRGINIA–OHIO–PENNSYLVANIA—Continued.		
Guyandot	1:62500	20
Milton	1:62500	20
Wheeling	1:62500	20
WISCONSIN:		
Hartford	1:62500	20
Port Washington (revision)	1:62500	20
West Bend	1:62500	20
WYOMING:		
Encampment Special	1:90000	100
WYOMING–SOUTH DAKOTA–MONTANA:		
Aladdin	1:125000	50
ALASKA:		
General map of Alaska	1:2500000	1,000
Fort Yukon to Kotzebue Sound	1:625000	100
Koyukuk River to mouth of Colville River	1:625000	100
Northwestern part of Seward Peninsula	1:250000	100

In addition to the usual office work by the various topographers in completing their field sketches, Mr. William Stranahan, assistant topographer, during March and April, 1902, completed the plotting of the topographic field work of the Indian Territory portions of four quadrangles—the Seminole and Hominy, Indian Territory–Oklahoma, and the Bonham and Paris, Texas–Indian Territory—and also revised the drawing of the Indian Territory general map.

Mr. S. A. Aplin continued in charge of topographic records and the purchase and repair of instruments.

During the year about 2,500 notebooks, constituting the original records of triangulation, topographic, and leveling parties, were filed and catalogued under the existing system. In addition, the miscellaneous field material relative to the various quadrangles was separately filed.

Repairs to instruments were made, as far as practicable, by Mr Ernest Kübel, mechanician of the Survey, and the follow-

ing list shows the number of instruments handled by him up to May 16:

22 telescopic alidades.
39 Y levels.
2 transits.
62 level tripods.
115 Johnson movement tripods.
6 theodolite tripods.
94 traverse tripods.
3 transit tripods.
1 protractor.
12 pocket compasses.
10 tapelines.
38 sight alidades.
52 P. T. B. plates.
11 circular hand levels.
32 box compasses.
2 rod levels.
1 aneroid barometer.

Other repairs which could be more economically made by outside shops were made by Mr. G. N. Saegmüller, of Washington, D. C., and Messrs. W. and L. E. Gurley, of Troy, N. Y.

The stock of instruments has been increased during the year by the purchase of two 6-inch transits, 12 telescopic alidades, 1 special telescopic alidade with micrometer for use in Alaska, 1 telescopic alidade with micrometer for use in the Adirondacks, and other instruments necessary to replace those rendered defective by the ordinary wear and tear of the service.

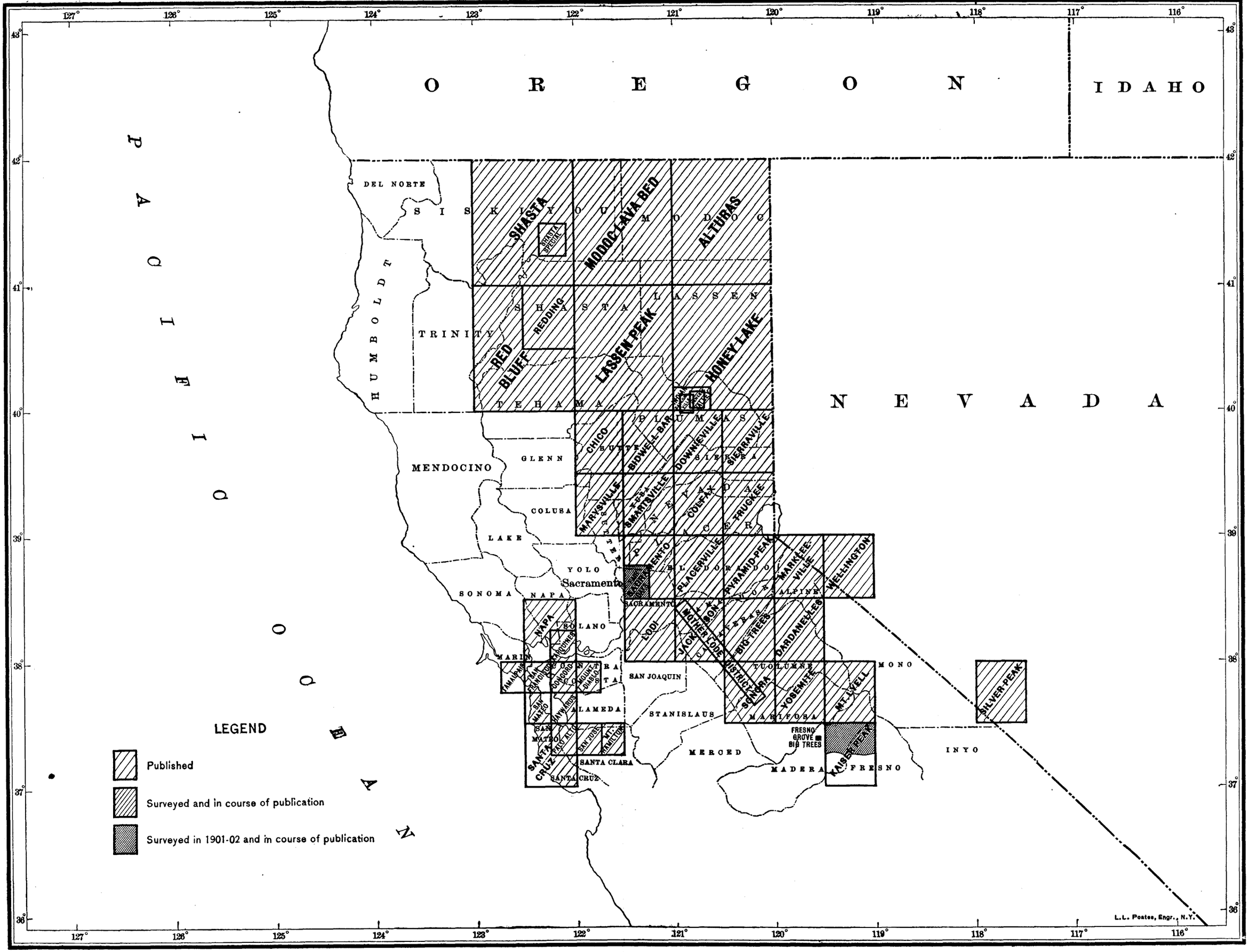
Assistance during the year in the work under Mr. Aplin's charge was ably rendered by Mr. Powell P. Withers.

The office computation of the triangulation and primary traverse was under the charge of Mr. S. S. Gannett, as heretofore. The results of this work have been summarized and will be published as Bulletin No. 201. The office adjustment of level circuits was made by Messrs. D. H. Baldwin and L. C. Fletcher, under the general supervision of Mr. Gannett, and a manuscript list of the bench marks established by spirit leveling was prepared for publication, but it will not be published until final adjustments are made.

Division of Geography and Forestry.

Mr. Henry Gannett, geographer, continued in charge of this division.

The principal field work carried on was the examination of the forests of the Cascade Range Forest Reserve, excluding the southern portion, which was examined by Mr. Leiberg in 1899. The area examined was in the neighborhood of 6,000



MAP OF NORTHERN CALIFORNIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

square miles. This area was divided among three parties, Mr. H. D. Langille taking the northern portion of the reserve, Mr. F. G. Plummer the middle portion, and Messrs. Arthur Dodwell and Theodore F. Rixon the southern portion. In addition to examining the forest and obtaining subsidiary data relating thereto, these men prepared a rough reconnaissance map, suitable for publication on the scale of 4 miles to the inch, of the entire area. Many photographs and illustrations of the character of the country and conditions of the forest were taken. The reports have been prepared and will be published in the Professional Paper series.

Mr. J. B. Leiberg undertook the detailed examination by sections of the San Francisco Mountain Forest Reserve, in Arizona. The character of these examinations made progress slow, so that at the close of the season he had completed only about half the area of the reserve. The examination included the railway sections as well as the Government sections. The area examined lies mainly north of the Santa Fe road.

Examinations of the forests of the southern Appalachian Mountain region, in North Carolina and adjoining States, were continued during the season by Messrs. H. B. Ayres and W. W. Ashe, with a view to the purchase by the Government of lands in this region and the creation of an Appalachian Forest Reserve. Thus far the examinations have been carried over an area of between 10,000 and 11,000 square miles, including all the mountainous region of the State and portions of adjoining States. A report on the regions examined has been prepared, with map and photographic illustrations, and is ready for publication.

Mr. Gannett devoted the months of July and August to an examination of the Cascade Range Forest Reserve, with a view to familiarizing himself with the character of the country and of the timber, in order that he might intelligently revise the reports of his assistants on this region. Most of September he spent in Arizona, in the Grand Canyon Forest Reserve, where he mapped the outline of the yellow-pine forest, and in the southern part of the San Francisco Mountain Reserve, making brief visits to the Sacramento Mountains in New Mexico on his way east.

Besides the preparation of the reports above noted, the work in the office consisted in the preparation of gazetteers of Porto Rico and Cuba, which have been published as Bulletins 183 and 192, respectively, and of Texas, Virginia, West Virginia, and Delaware, which will be published at an early date; the completion of a folio on glaciers, and the preparation of a contribution to the origin of place names in this country, which has just been published as Bulletin 197. In addition, much work was done in connection with the establishment, change of boundaries, etc., of forest reserves, which involved a great deal of study and correspondence.

PUBLICATION BRANCH.

Editorial Division.

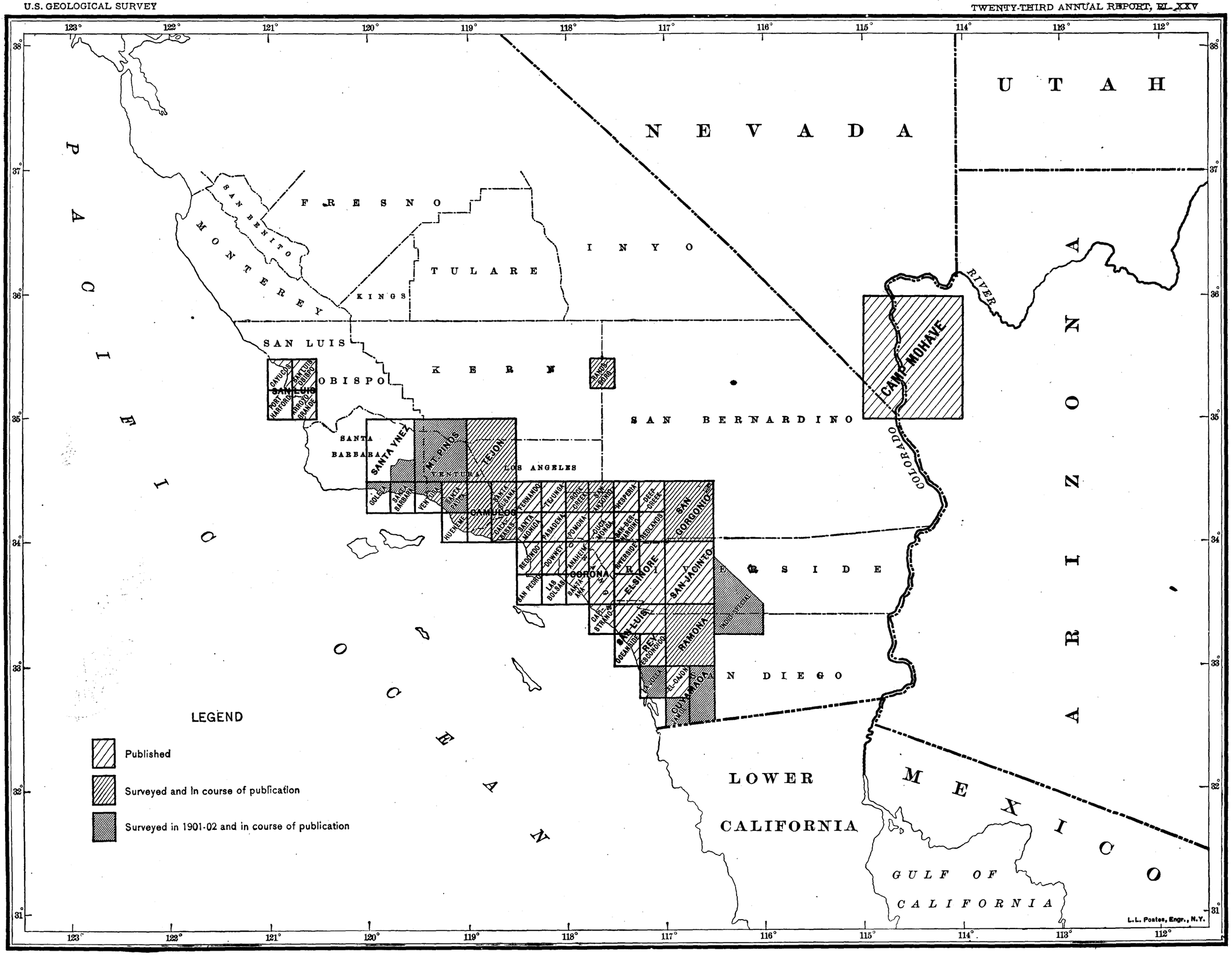
TEXTUAL PUBLICATIONS.

Mr. Philip C. Warman remained in charge of this section. He was assisted throughout the year by Messrs. George M. Wood and L. F. Schmeckebier. In the early part of the year, when the work was heavy, assistance was rendered by Mrs. Annie B. Wood; and since May 1, 1902, Mr. Charles A. Mansuy has been connected with the section.

The work consists chiefly of three classes—preparation of manuscripts, correction of proofs, and making of indexes—and these classes consume approximately equal amounts of time. Following are lists of the manuscripts prepared, proofs read, and indexes made during the year:

Manuscripts edited during the year 1901–2.

Publication.	Pages (usually type-written).
Twenty-second Annual Report (in part)	1,889
Monograph XLI	1,358
Monograph XLII	220
Professional Paper No. 1	313
Professional Paper No. 2	170
Professional Paper No. 3	303
Professional Paper No. 4	65
Professional Paper No. 5	88
Professional Paper No. 6	65



MAP OF SOUTHERN CALIFORNIA, SHOWING PROGRESS OF TOPOGRAPHIC SURVEYING.

Manuscripts edited during the year 1901–2—Continued.

Publication.	Pages (usually type-written).
Professional Paper No. 7	192
Professional Paper No. 8	287
Professional Paper No. 9	640
Bulletin No. 185	473
Bulletin No. 186	69
Bulletin No. 187	1,536
Bulletin No. 188	1,457
Bulletin No. 189	469
Bulletin No. 190	558
Bulletin No. 191	991
Bulletin No. 192	274
Bulletin No. 193	108
Bulletin No. 194	82
Bulletin No. 195	24
Bulletin No. 196	172
Bulletin No. 197	914
Bulletin No. 198	57
Bulletin No. 199	275
Bulletin No. 200	47
Bulletin No. 204	325
Bulletin No. 205	75
Water-Supply Paper No. 56	90
Water-Supply Paper No. 57	496
Water-Supply Paper No. 58	151
Water-Supply Papers Nos. 59–60	185
Water-Supply Paper No. 61	240
Water-Supply Paper No. 62	221
Water-Supply Paper No. 63	212
Water-Supply Paper No. 64	161
Water-Supply Paper No. 65	671
Water-Supply Paper No. 66	520
Water-Supply Paper No. 67	182
Water-Supply Paper No. 68	212
Water-Supply Paper No. 69	292
Water-Supply Paper No. 70	98
Water-Supply Paper No. 71	172
Water-Supply Paper No. 73	116
Geologic Folio No. 74	87
Geologic Folio No. 75	57
Geologic Folio No. 76	88

Manuscripts edited during the year 1901–2—Continued.

Publication.	Pages (usually type-written).
Geologic Folio No. 77	86
Geologic Folio No. 78	99
Geologic Folio No. 79	110
Geologic Folio No. 80	47
Geologic Folio No. 81	146
Geologic Folio No. 82	303
Mineral Resources for 1900 (in part)	1,332
Mineral Resources for 1901 (in part)	1,574
Abstract of letters requesting topographic surveys	300
Explanation for cover of geologic folios	20
Circular No. 9, Divison of Hydrography (analyses of water)	10
Total number of manuscript pages edited	21,774

Proof sheets read and corrected during the year 1901–2.

Publication.	Final printed pages.
Twenty-second Annual Report	3,051
Monograph XLI	828
Bulletin No. 179	868
Bulletin No. 180	112
Bulletin No. 182	281
Bulletin No. 184	66
Bulletin No. 185	219
Bulletin No. 186	51
Bulletin No. 187	446
Bulletin No. 188	717
Bulletin No. 189	337
Bulletin No. 190	162
Bulletin No. 191	448
Bulletin No. 192	113
Bulletin No. 193	101
Bulletin No. 194	51
Water-Supply Paper No. 56	63
Water-Supply Paper No. 57	60
Water-Supply Paper No. 58	133
Water-Supply Paper No. 59	99
Water-Supply Paper No. 60	52

Proof sheets read and corrected during the year 1901–2—Continued.

Publication.	Final printed pages.
Water-Supply Paper No. 61	67
Water-Supply Paper No. 62	120
Water-Supply Paper No. 63	134
Water-Supply Paper No. 64	103
Water-Supply Paper No. 65	324
Geologic Folio No. 74	6
Geologic Folio No. 75	7
Geologic Folio No. 76	10
Geologic Folio No. 77	11
Geologic Folio No. 78	8
Geologic Folio No. 79	10
Geologic Folio No. 80	5
Mineral Resources for 1900 (in part)	847
Mineral Resources for 1901 (in part)	300
Abstracts of letters requesting topographic surveys	67
Circulars	150
Total number of pages of proof (including plates) read and corrected.	10, 427

The correcting of the proof sheets of the publications tabulated above required the examination of 4,133 galleys and 21,450 page proofs.

Indexes prepared during the year 1901–2.

Publication.	Pages indexed.
Twenty-second Annual Report, Part I	510
Twenty-second Annual Report, Part II	970
Twenty-second Annual Report, Part III	816
Twenty-second Annual Report, Part IV	755
Monograph XLI	828
Bulletin No. 180	112
Bulletin No. 182	281
Bulletin No. 184	66
Bulletin No. 185	219
Bulletin No. 186	51
Bulletin No. 193	101
Bulletin No. 194	51
Water-Supply Papers Nos. 47–52 (joint index)	575

Indexes prepared during the year 1901–2—Continued.

Publication.	Pages indexed.
Water-Supply Papers Nos. 53–54 (joint index)	141
Water-Supply Paper No. 55	75
Water-Supply Paper No. 56	63
Water-Supply Paper No. 58	133
Water-Supply Papers Nos. 59–60 (joint index)	151
Water-Supply Papers Nos. 62–63 (joint index)	154
Water-Supply Paper No. 64	103
Mineral Resources for 1900	905
Cape Nome and Norton Bay report	222
Total number of pages indexed	7,282

In addition to the foregoing, work on the general index of Survey publications, supplemental to Bulletin No. 177, was continued as opportunity permitted, and Dr. Schmeckebier made a general index of the publications of the Hayden, King, Powell, and Wheeler surveys. The results of both of these lines of work are accessible in manuscript form, and they will probably be offered for publication in due time.

The Division of Hydrography and the Division of Mines and Mineral Resources have continued to render special assistance in the editorial work.

GEOLOGIC MAPS.

This section continued in charge of Mr. George W. Stose, who was assisted throughout the year by Messrs. O. A. Ljungstedt, H. S. Selden, and H. V. Leménager.

Mr. Stose devoted his time chiefly to editing the folio manuscripts. The descriptive texts were read by Mr. Willis and by some one in the textual section of the Editorial Division, where the proofs of the texts were also read and corrected. The increased number of folios prepared by nonresident members of the Survey has added to the labor of editing and unifying the publications and has entailed considerable correspondence with the authors. Besides the administrative work in connection with the section, Mr. Stose served on the com-

mittee on Map Editing and Printing and on the committee on Geologic Names, acting as chairman of the latter in the absence of Mr. Willis from Washington. During the field season of 1901 Mr. Stose was engaged in geologic work in the Cumberland Valley of southern Pennsylvania, details of which are given in his report on field work (see p. 58).

Mr. Ljungstedt continued geologic drafting for the folios and supervised the general drawing and proof reading of the section. Messrs. Selden and Leménager drew sections and illustrations for the folios, prepared original maps for engraving, and did most of the proof reading.

During the year 24 folios were in process of publication. Of these, 7 (Nos. 73–79, inclusive) were completed and the editions were delivered. The list of published folios is as follows:

Geologic folios published to June 30, 1902.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia, Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston[a]	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga[a]	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte.[a]	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry[a]	Virginia, West Va, Maryland	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia, Kentucky, Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland, Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia, West Va	79°–79° 30′	38°–38° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee, N. Carolina	83° 30′–84°	35° 30′–36°	925	25
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	California	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama, Georgia, Tennessee	85° 30′–86°	34° 30′–35°	980	25

[a] Out of stock.

Geologic folios published to June 30, 1902—Continued.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	Tennessee	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	Tennessee	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland, Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	Loudon	Tennessee	84°–84° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia, West Va	81°–81° 30′	37°–37° 30′	951	25
27	Morristown	Tennessee	83°–83° 30′	36°–36° 30′	963	25
28	Piedmont	Maryland, West Va	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City:					
	Nevada City	California	121° 00′ 25″–121° 03′ 45″	39° 13′ 50″–39° 17′ 16″	11.65	50
	Grass Valley	California	121° 01′ 35″–121° 05′ 04″	39° 10′ 22″–39° 13′ 50″	12.09	50
	Banner Hill	California	120° 57′ 05″–121° 00′ 25″	39° 13′ 50″–39° 17′ 16″	11.65	50
30	Yellowstone National Park:					
	Gallatin	Wyoming	110°–111°	44°–45°	3,412	75
	Canyon	Wyoming	110°–111°	44°–45°	3,412	75
	Shoshone	Wyoming	110°–111°	44°–45°	3,412	75
	Lake	Wyoming	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California	120°–120° 30′	44°–45°	932	25
32	Franklin	Virginia, West Va	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36°–36° 30′	963	25
34	Buckhannon	West Va	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California	120° 30′–121°	39° 30′–40°	919	25
38	Butte Special	Montana	112° 29′ 30″–112° 36′ 42″	45° 59′ 28″–46° 02′ 54″	22.80	50
39	Truckee	California	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California	121°–121° 30′	39° 30′–40°	918	25
44	Tazewell	Virginia, West Va	81° 30′–82°	37°–37° 30′	950	25
45	Boise	Idaho	116°–116° 30′	43° 30′–44°	864	25
46	Richmond	Kentucky	84°–84° 30′	37° 30′–38°	944	25
47	London	Kentucky	84°–84° 30′	37°–37° 30′	950	25
48	Tenmile District Special.	Colorado	106° 8′–106° 16′	39° 22′ 30″–39° 30′ 30″	55	25
49	Roseburg	Oregon	123°–123° 30′	43°–43° 30′	871	25
50	Holyoke	Mass., Conn	72° 30′–73°	42°–42° 30′	885	50
51	Big Trees	California	120°–120° 30′	38°–38° 30′	938	25
52	Absaroka:					
	Crandall	Wyoming	109° 30′–110°	44°–44° 30′	1,706	25
	Ishawooa	Wyoming	109° 30′–110°	44°–44° 30′	1,706	25
53	Standingstone	Tennessee	85°–85° 30′	36°–36° 30′	963	25
54	Tacoma	Washington.	122°–122° 30′	47°–47° 30′	812	25

Geologic folios published to June 30, 1902—Continued.

No.	Name of folio.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
55	Fort Benton	Montana	110°–111°	47°–48°	3,273	25
56	Little Belt Mts	Montana	110°–111°	46°–47°	3,295	25
57	Telluride	Colorado	107° 45′–108°	37° 45′–38°	236	25
58	Elmoro	Colorado	104°–104° 30′	37°–37° 30′	950	25
59	Bristol	Virginia, Tennessee	82°–82° 30′	36° 30′–37°	957	25
60	La Plata	Colorado	108°–108° 15′	37° 15′–37° 30′	237	25
61	Monterey	Virginia, West Va	79° 30′–80°	38°–38° 30′	938	25
62	Menominee Special	Michigan	(a NW.-SE. area, about	22 m. long, 6½ wide)	150	25
63	Mother Lode	California	(a NW.-SE rectangle,	70 m. long, 6½ wide)	455	50
64	Uvalde	Texas	99° 30′–100	29°–29° 30′	1,040	25
65	Tintic Special	Utah	111° 55′–112° 10′	39° 45′–40°	229	25
66	Colfax	California	120° 30′–121°	39°–39° 30′	925	25
67	Danville	Illinois, Indiana	87° 30′–87° 45′	40°–40° 15′	228	25
68	Walsenburg	Colorado	104° 30′–105°	37° 30′–38°	944	25
69	Huntington	West Va, Ohio	82°–82° 30′	38°–38° 30′	938	25
70	Washington	D. C, Virginia, Maryland	76° 45′–77° 15′	38° 45′–39°	465	50
71	Spanish Peaks	Colorado	104° 30′–105°	37°–37° 30′	950	25
72	Charleston	West Va	81° 30′–82°	38°–38° 30′	938	25
73	Coos Bay	Oregon	124°–124° 30′	43°–43° 30′	871	25
74	Coalgate	Ind. Ter	96°–96° 30′	34° 30′–35°	980	25
75	Maynardville	Tennessee	83° 30′–84°	36°–36° 30′	963	25
76	Austin	Texas	97° 30′–98°	30°–30° 30′	1,030	25
77	Raleigh	West Va	81°–81° 30′	37° 30′–38°	944	25
78	Rome	Georgia, Alabama	85°–85° 30′	34°–34° 30′	986	25
79	Atoka	Ind. Ter	96°–96° 30′	34°–34° 40′	986	25

During the year twelve folios were transmitted to this section for publication, viz:

Brownsville–Connellsville, Pa.
Columbia, Tenn.
Elkland–Tioga, Pa.
Ellensburg, Wash.
Fayetteville, Ark.
Gaines, Pa.
Masontown–Uniontown, Pa.
Newcastle, Wyo.
Port Orford, Oreg.
Silver Peak, Nev.–Cal.
Tishomingo, Ind. T.
Yosemite, Cal.

Fifteen folios are now in process of engraving. The following list gives their names and stages:

Name.	Stage.
Alexandria, S. Dak	Plate engraved.
Camp Clarke, Nebr	Color stones in preparation.
Chicago, Ill.–Ind. (comprising Chicago, Riverside, Desplaines, and Calumet maps).	Maps completed.
Cranberry, Tenn	Plate engraved.
Ellensburg, Wash	Engraving begun.
Hartville, Wyo	Transferred to stone.
Masontown–Uniontown, Pa. (comprising Masontown and Uniontown maps).	Maps completed.
Mitchell, S. Dak	Plate engraved.
New York City, N. Y.–N. J. (comprising Paterson, Harlem, Staten Island, and Brooklyn maps).	Maps completed.
Norfolk, Va.–N. C	Nearly completed.
Oelrichs, S. Dak.–Nebr	Maps being printed.
Olivet, S. Dak	Color stones in preparation.
Parker, S. Dak	Do.
Port Orford, Oreg	Engraving begun.
Scotts Bluff, Nebr	Color stones in preparation.

From the above list it will be seen that two folios, New York City and Chicago, each equivalent to four ordinary folios, and the Masontown-Uniontown, equivalent to two ordinary folios, are almost ready to be issued. This accounts in part for the few folios (seven) actually issued during the year. The output next year will be correspondingly increased.

The New York City and Chicago folios are of special interest to students in the schools and universities in these cities, and an extra large edition has been printed to meet the demand. The Masontown–Uniontown area is a great coal-producing region, and the folio contains data of great value to the operator and landowner. The Coos Bay, Coalgate, Atoka, and Raleigh folios include descriptions of coal fields in Oregon, Indian Territory, and West Virginia. The Rome folio treats of valuable deposits of bauxite and iron in Tennessee.

TOPOGRAPHIC MAPS.

Mr. S. J. Kübel was continued in charge of the editing of topographic maps. He was assisted in this work by Messrs. James McCormick, H. W. Elmore, and J. W. Brashears.

The work of this section consisted, as heretofore, of the editing of new topographic atlas sheets, the correction of published maps, the examination of manuscript maps with regard to their completeness for publication, especially in the matter of geographic nomenclature, and the supervision and safekeeping of all the manuscripts of the published and unpublished maps of the Survey.

Mr. McCormick, besides superintending the work of Messrs. Elmore and Brashears, critically examined and edited all manuscript maps transmitted by the topographers, and inspected the manuscript maps, sketches, plans, etc., with reference to the correctness of geographic details, especially the spelling of geographic names, which were prepared for book or other text illustration. Messrs. Elmore and Brashears were engaged in proof reading and in keeping the records.

In Group I, on pages 178 to 180, are enumerated the new topographic atlas sheets which were edited and proof read during the year, while the two lists "new editions" and "sheets corrected" enumerate the atlas sheets corrections to which were edited and proof read.

Much time was consumed in editing the manuscript maps prepared for the various publications of the Survey. The following list shows the number of drawings of this class examined:

Twenty-second Annual Report	180
Bulletins Nos. 171, 182, 184, 190, 192, 193, 194, 196, 198, 199	59
Monograph XLI	22
Water-Supply and Irrigation Papers Nos. 57, 61, 70, 71, 72, 73, 75, 76, 77	72
Professional Paper No. 1	9
Total	342

No little time is devoted by this section to the preparation of circulars concerning the progress made by the Survey in publishing the topographic maps and geologic folios. The general plan adopted last year for these circulars has been followed, and the results seem to warrant its continuance.

Division of Illustrations.

The Division of Illustrations remained in charge of Mr. John L. Ridgway, who was assisted by Messrs. H. Chadwick Hunter, H. Hobart Nichols, F. W. von Dachenhausen, D. W. Cronin, J. H. Pellen, Paul Morris, Misses Frances Wieser and Mary M. Mitchell, and Mr. L. B. Jay, aid. The work of these assistants has been highly satisfactory. Mr. Hunter, in addition to his regular work of drafting, assisted in the administrative work of the division, while Mr. Nichols was employed more particularly on artistic work. Methods of preparation have changed but little. The greatly increased number of photographs submitted reduced to a considerable extent the number of drawings to be prepared, but the total amount of work done in the division was no less, because the total amount of material received was larger than in previous years.

There were prepared during the year 2,419 drawings (miscellaneous work is not included), classified as follows:

	Number.
Geologic and topographic maps	165
Paleontologic drawings	1,416
Photographs prepared for reproduction	416
Diagrams and sections	391
Landscapes	25
Lithologic drawings	6
Total	2,419

Illustrations were transmitted to accompany the following manuscripts:

Bulletins Nos. 176 (reprint), 184 (reprint), 186, 190, 192, 193, 194, 195, 196, 198, 199, 200.
Monographs XLI, XLII.
Water-Supply and Irrigation Papers Nos. 56, 58, 59, 62, 63, 64, 67, 68, 69, 70, 71, 72.
Extract from the Twenty-first Annual Report, Part IV (reprint).
Twenty-second Annual Report Part I.
Twenty-second Annual Report Part II.
Twenty-second Annual Report Part III.
Twenty-second Annual Report Part IV.

Following is a list of the processes of reproduction employed during the year, with the number of drawings reproduced by each:

	Number.
Chromolithography	164
Photolithography	2
Photogelatin	5
Zinc etching	537
Wax engraving	270
Half-tone engraving	422
Three-color process	3
From previously engraved plates	236

Proofs to the number of 1,628 were received and examined critically. An examination was also made of all illustrations delivered at the Government Printing Office, under contract, for reports of the Survey. As a result of this examination, 13,220 copies were found imperfect and rejected.

During the year 68 requests for electrotypes from outside publishers were filled, the number of cuts represented in these orders being 690, and several hundred letters concerning illustrations were written.

Photographic Laboratory.

The photographic laboratory was continued under the direction of Mr. Norman W. Carkhuff, who was assisted by Messrs. John Erbach, Charles A. Ross, Nelson H. Kent, Ernest A. Shuster, jr., and Ed. F. Wahl.

The increase of work performed by this division was very marked, there being made 1,949 negatives and 9,997 prints more than last year.

The photographic reproduction of maps received very careful consideration. This work was done with promptness, and the quality was of a high order.

The photographing of fossils and other geologic specimens showed improvement, thus saving a considerable expense in their illustration.

The printing and indexing of the Survey collection of negatives is practically completed and consists of 13,317 indexed negatives.

Progress was made on an illustrated catalogue of the 3,500 slides belonging to the Survey. As in previous years, several schools made use of this collection for educational purposes.

The chief photographer gave considerable time to the members of the Survey doing field work with the camera, and

there is reason to believe that, as a consequence of the instruction thus given, the photographic results this year will average better than for some years past.

Following is a tabulated statement of the work of the laboratory for the year:

Work of the photographic laboratory for the year 1901–2.

Month.	Negatives.			Slides.	Prints.				Prints mounted.	Prints bleached.	Slides labeled.
	Wet.	Dry.	Total.		Map.	Glossy.	Matte.	Total.			
1901.											
July	108	394	502	1	360	372	.....	732	....	....	....
August	86	355	441	....	230	572	.....	802	....	3	....
September	42	414	456	....	125	363	12	500	....	2	....
October	72	993	1,065	20	225	938	703	1,886	....	30	....
November	223	985	1,208	34	114	964	36	1,114	....	....	....
December	189	495	684	82	592	1,597	60	2,249	27	....	....
1902.											
January	110	554	664	31	409	2,033	21	2,463	....	....	....
February	173	259	432	47	522	2,403	192	3,117	....	....	....
March	268	28	296	80	413	2,020	224	2,657	47	....	1
April	170	32	202	118	573	1,887	16	2,476	17	....	....
May	117	184	301	38	616	1,393	228	2,237	....	....	....
June	176	348	524	....	919	2,971	730	4,620	175	14	235
Total	1,734	5,041	6,775	451	5,098	17,513	2,222	24,833	266	49	236

Sizes of negatives and prints made in 1901–2.

Size.	Negatives.	Prints.
28 by 34	359	1,604
22 by 28	125	558
20 by 24	392	1,624
14 by 17	192	585
11 by 14	517	944
8 by 10	367	1,198
6½ by 8½	641	3,023
5 by 7	1,608	8,024
4 by 5	1,575	4,948
3¼ by 4¼	999	2,325
Total	6,775	24,833

Division of Engraving and Printing.

Mr. S. J. Kübel was continued in charge of this division as chief engraver, and was assisted by Mr. H. C. Evans as foreman of copperplate engravers until September 20, 1901, and after that date by Mr. L. P. Daniel; F. P. Droney, foreman of the press room; O. Schleichert, foreman of stone engravers; and R. H. Payne, foreman of transferrers.

On July 1, 1901, there were on hand, ready for publication, manuscript atlas sheets and other maps to the number of 132. Three of these, the Bonneterre and Ste. Genevieve, Mo., and the Morenci Special, Ariz., have since been withdrawn, the first two for additional field work and the last for publication in different form, leaving 129. During the year 110 new maps, in manuscript, were received from the Topographic Branch, and two others, the Mettawee, N. Y.–Vt., and the Nantucket, Mass., were made from atlas sheets heretofore published. This gives a total of 238 atlas sheets and other maps, which are listed below in three groups:

Group I comprises 72 sheets which were published during the year or were in press at the close of the year. (Double sheets counted as one.)

Group II comprises 18 sheets which were in process of engraving at the close of the year.

Group III comprises 148 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 166 unpublished atlas sheets and special maps, and that the engraving of 18 of these was in various stages of progress.

GROUP I.—*Topographic atlas sheets and other maps engraved and printed, or in press, during the fiscal year 1901–2.*

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′		
Anoka, Minn	45	00	93	15	20	1:62500
Baker City, Oreg	44	30	117	30	100	1:125000
Belair, Md.–Pa	39	30	76	15	20	1:62500
Boyertown, Pa	40	15	75	30	20	1:62500
Broadalbin, N. Y	43	00	74	00	20	1:62500
Brownsville, Pa	40	00	79	45	20	1:62500
Capistrano, Cal	33	00	117	30	100	1:125000
Chambersburg, Pa	39	45	77	30	20	1:62500
Clyde, N. Y	43	00	76	45	20	1:62500
Connellsville, Pa	40	00	79	30	20	1:62500
Corona, Cal	33	30	117	30	100	1:125000
Deep Creek, Cal	34	15	117	00	50	1:62500
Denzer, Wis	43	15	89	45	20	1:62500
De Soto, Mo	38	00	90	30	50	1:125000
Edgemont, S. Dak	43	00	103	30	50	1:125000
Elkader, Iowa–Wis	42	30	91	00	20	1:125000
Elk Point, S. Dak.–Nebr.–Iowa	42	30	96	30	20	1:125000
Eureka Springs, Ark.–Mo	36	00	93	30	50	1:125000
Everett, Pa	40	00	78	15	20	1:62500
Florence, Ariz	33	00	111	00	100	1:125000
Geneva, N. Y	42	45	76	45	20	1:62500
Genoa, N. Y	42	30	76	30	20	1:62500
Globe, Ariz	33	15	110	45	50	1:62500
Globe Special, Ariz	----------		----------		20	1:12000
Greeley, Colo	40	00	104	30	20	1:125000
Gunpowder, Md.[a]	39	15	76	15	20	1:62500
Hancock, Md.–W. Va.–Pa	39	30	78	00	20	1:62500
Hesperia, Cal	34	15	117	15	50	1:62500
Indiana, Pa	40	30	79	00	20	1:62500
Indian Territory	----------		----------		100	1:500000
Joplin District, Mo.–Kans.[b]	----------		----------		10	1:62500
Kittanning, Pa	40	45	79	30	20	1:62500
Latrobe, Pa	40	15	79	15	20	1:62500
Lukfata, Ind. T	34	00	94	30	50	1:125000
Marysville Special, Mont	----------		----------		50	1:31250
Mercersburg, Pa	39	45	77	45	20	1:62500
Millbrook, N. Y.–Conn	42	45	73	30	20	1:62500

[a] Resurvey. [b] Double sheet.

GROUP I.—*Topographic atlas sheets and other maps engraved and printed, or in press, during the fiscal year 1901–2*—Continued.

Quadrangle and State.	Position of SE. corner.				Contour interval.	Scale.
	Latitude.		Longitude.			
	°	′	°	′		
Morgantown, W. Va.–Pa.	39	30	79	45	20	1:62500
Morrisville, N. Y	42	45	75	30	20	1:62500
Mount Mitchell, N. C.–Tenn.[a]	35	30	82	00	100	1:125000
Nantucket, Mass.[b]	----------		----------		20	1:125000
Napa, Cal	38	00	122	00	100	1:125000
Navesink, N. J	40	00	74	00	20	1:125000
Needle Mountains, Colo	37	30	107	30	100	1:62500
North Platte, Nebr	40	00	100	30	20	1:125000
Ocean City, Md.–Del	38	15	75	00	10	1:62500
Oelwein, Iowa	42	30	91	30	20	1:125000
Owensboro, Ind.–Ky	37	45	87	00	20	1:62500
Parkton, Md.–Pa	39	30	76	30	20	1:62500
Pauls Valley, Ind. T	34	30	97	00	50	1:125000
Pittsville, Md.–Del	38	15	75	15	10	1:62500
Portage, Wis.[a]	43	30	89	15	20	1:62500
Poynette, Wis	43	15	89	15	20	1:62500
Princess Anne, Md.–Va	38	00	75	30	10	1:62500
Pultneyville, N. Y	43	15	77	00	20	1:62500
Redding, Cal	40	30	122	00	100	1:125000
Rush Springs, Ind. T	34	30	97	30	50	1:125000
Salisbury, Md.–Del	38	15	75	30	10	1:62500
Santa Cruz, Cal	37	00	122	00	100	1:125000
Saratoga, N. Y	43	00	73	45	20	1:62500
Schunemunk, N. Y	41	15	74	00	20	1:62500
Silverton, Colo.[a]	37	45	107	30	100	1:125000
Slatington, Pa	40	30	75	30	20	1:62500
Snow Hill, Md.–Va	38	00	75	15	10	1:62500
Sodus Bay, N. Y	43	15	76	45	20	1:62500
Southern California[b]	----------		----------		250	1:250000
Sumpter, Oreg	44	30	118	00	100	1:125000
Sundance, Wyo.–S. Dak.[a]	44	00	104	00	50	1:125000
Tioga, Pa	41	45	77	00	20	1:62500
Wedowee, Ga.–Ala	33	00	85	00	50	1:125000
Wernersville, Pa	40	15	76	00	20	1:62500
White Bear, Minn	45	00	93	00	20	1:62500

[a] Resurvey. [b] Double sheet.

Résumé by States.

Alabama	1	Nebraska	2
Arizona	3	New Jersey	1
Arkansas	1	New York	10
California	8	North Carolina	1
Colorado	3	Oregon	2
Connecticut	1	Pennsylvania	16
Delaware	3	South Dakota	3
Georgia	1	Tennessee	1
Indiana	1	Virginia	2
Indian Territory	4	West Virginia	2
Iowa	3	Wisconsin	4
Kansas	1	Wyoming	1
Kentucky	1		
Maryland	9	Total	92
Massachusetts	1	Deducting sheets counted in more than one State	20
Minnesota	2		
Missouri	3		
Montana	1	Balance	72

GROUP II.—*Topographic atlas sheets and other maps in process of engraving, 1901–1902.*

Bisbee Special, Ariz.
Bisbee, Ariz.
Clarksburg, W. Va.
Clifton, Ariz.
Edina, Mo.
Fairmont, W. Va.
Gainesville, Tex.–Ind. T.
Gothenburg, Nebr.
Guyandot, W. Va.–Ohio.
Mettawee, N. Y.–Vt.
Milton, W. Va.
O'Fallon, Mo.–Kans.
Phelps, N. Y.
San Gorgonio, Cal.
Sullivan, Mo. (formerly called Union).
Waverly, N. Y.
Weedsport, N. Y.
Wheeling, W. Va.–Ohio–Pa.

GROUP III.—*New topographic atlas sheets awaiting editorial examination before approval for engraving, 1901–2.*

Aladdin, Wyo.–S. Dak.–Mont.
Alexandria Bay, N. Y.
Apalachin, N. Y.
Babylon, N. Y.
Bangor, Me.
Bar Harbor, Me.
Bastrop, Tex.[a]
Beaver, Pa.
Bellevue, Ohio.
Berne, N. Y.
Big Moose, N. Y.
Binghamton, N. Y.
Bloodsworth Island, Md.
Blue Hill, Me.
Blue Mountain, N. Y.
Bonner, Mont.
Booneville, Ind.
Boston, Mass.[a]
Boston Bay, Mass.[a]
Bowling Green, Ohio.
Bradshaw Mountains, Ariz.
Briggsville, Wis.
Browning, Mont.
Burnet, Tex.[a]
Cadiz, Ohio.
Calabasas, Cal.
Camden, Ark.
Camulos, Cal.
Canandaigua, N. Y.
Canton, Ohio.
Carlisle, Pa.
Castine, Me.

[a] Resurvey.

Cerro Alto, Tex.
Chickasha, Ind. T.–Okla.
Chiwaukum, Wash.
Clayton, N. Y.
Cleveland, Ohio.
Coalville, Utah.
Coeur d'Alene Special, Idaho–Mont.[a]
Coopers Lake, Mont.
Cortland, N. Y.
Crisfield, Md.–Va. (Md. portion only).
Cuyamaca, Cal.
Dahlonega, Ga.–N. C.[b]
Deal Island, Md.
Deer Isle, Me.
Degonia Springs, Ind.
Delaware, Ohio.
Dublin, Ohio.
Elmore, Ohio.
Encampment Special, Wyo.–Col.
Euclid, Ohio.
Fairfax, Iowa.
Fairoaks, Cal.
Findlay, Ohio.
Fort McKinney, Wyo.
Fostoria, Ohio.
Fremont, Ohio.
Gilboa, N. Y.
Gloversville, N. Y.
Goleta, Cal.
Grimesland, N. C.
Grindstone, N. Y.
Hallwood, Md.–Va. (Md. portion only.)
Hammondsport, N. Y.
Harford, N. Y.
Hartford, Wis.
Haubstadt, Ind.
Hayden Peak, Utah–Wyo.
Hollidaysburg, Pa.
Hueneme, Cal.
Huntingdon, Pa.
Indio Special, Cal.
Jamul, Cal.
Kahoka, Mo.
Kenova, Ky.–W. Va.–Pa.
Kinderhook, N. Y.
La Jolla, Cal.
Lassellsville, N. Y.
Llano, Tex.[b]
Luzerne, N. Y.
Marathon Special, Wis.
Margaretville, N. Y.
Massillon, Ohio.
Mineral Point, Wis.–Ill.
Mount Desert, Me.
Mount Pinos, Cal.
Naples, N. Y.
Nashville, Tenn.[b]
Newbern, N. C.
Newburg, N. Y.
New Harmony, Ind.
Northport, N. Y.
Norwich, N. Y.
Oberlin, Ohio.
Orono, Me.
Ovid, N. Y.
Owego, N. Y.
Palmyra, N. Y.
Park City Special, Utah.
Parmele, N. C.
Penn Yan, N. Y.
Petersburg, Ind.
Petit Manan, Me.
Pitcher, N. Y.
Phoenicia, N. Y.
Port Washington, Wis.[b]
Princeton, Ind.
Put-in Bay, Ohio.
Ramona, Cal.
Randsburg, Cal.
Raquette Lake, N. Y.
Rathdrum, Idaho.
Republic, Wash.
Richfield Springs, N. Y.
Rock Creek, Cal.
Rosendale, N. Y.
Rural Valley, Pa.
St. Meinrad, Ind.
San Antonio, Cal.
Sandusky, Ohio.
Santa Barbara, Cal.
Santanoni, N. Y.
Santa Paula, Cal.
Santa Susana, Cal.
Saypo, Mont.
Siloam Springs, Ind. T.–Ark.
Smith Point, Md.–Va. (Md. part only.)
Snoqualmie, Wash.
Swan Island, Me.
Tejon, Cal.
Tell City, Ky.–Ind.
Theresa, N. Y.
Trent River, N. C.
Velpen, Ind.
Ventura, Cal.
Vermilion, Ohio.
Vinal Haven, Me.

[a] Double sheet.

[b] Resurvey.

Wausau Special, Wis.
Waukon, Iowa-Wis.
Waynesburg, Pa.
West Bend, Wis.
West Chester, Pa.-Del.
Wetumka, Ala.
Williamston, N. C.
Winterville, N. C.
Winthrop, Iowa.
Wooster, Ohio.

The progress in the publication of maps on the scale of 1:125000 by the reduction and combination of those originally published on the scale of 1:62500 is shown in the following table:

Progress in publication of maps on scale 1:125000 by reduction and combination.

Name of sheet, scale 1:125000.	Names of sheets, scale 1:62500, reduced and combined.	Stage of progress in publication.
Holyoke, Mass.-Conn ...	Chesterfield, Granville, Northampton, Springfield.	Published previous to July, 1898.
Nomini, Md.-Va.....	Leonardtown, Montross, Piney Point, Wicomico.	Do.
Housatonic, Mass.-Conn.-N. Y.	Becket, Pittsfield, Sandisfield, Sheffield.	Published during fiscal year 1898-99.
Niagara, N. Y	Lockport, Niagara Falls, Olcott, Tonawanda, Wilson.	Do.
Patuxent, Md.-D.C	Brandywine, East Washington, Owensville, Prince Frederick.	Do.
Raritan, N. J.....	Hackettstown, Highbridge, Lake Hopatcong, Somerville.	Published during fiscal year 1899-1900.
Passaic, N. J.-N. Y	Morristown, Paterson, Plainfield, Staten Island.	Do.
San Luis, Cal.....	Arroyo Grande, Cayucos, Port Harford, San Luis Obispo.	Do.
Camden, N. J.-Pa.-Del..	Chester, Glassboro, Philadelphia, Salem.	Published during fiscal year 1900-1901.
Rancocas, N. J.....	Hammonton, Mount Holly, Mullica, Pemberton.	Do.
Taconic, N. Y.-Mass.-Vt.	Bennington, Greylock, Berlin, Hoosick.	Do.
Navesink, N. J.-N. Y ...	New Brunswick, Asbury Park, Cassville, Sandy Hook.	Published during fiscal year 1901-2.
Nantucket Island, Mass..	Nantucket, Muskeget, and parts of Marthas Vineyard, Barnstable, Yarmouth, and Chatham.	Do.
Mettawee, N. Y.-Vt.....	Fort Ann, Pawlet, Cambridge, Equinox.	In process of engraving.

Following is a list of 39 atlas sheets, heretofore published, which were revised, corrected, and new editions published during the year or were in press at the end of the year.

List of atlas sheets revised, corrected, and new editions printed or in press, 1901–2.

Albany and vicinity, N. Y.
Anaheim, Cal.
Auburn, N. Y.
Big Trees, Cal.
Cambridge, N. Y.–Vt.
Canajoharie, N. Y.
Chittenango, N. Y.
Cleveland, Tenn
Clove, N. Y.–Conn.
Fonda, N. Y.
Frostburg, Md.–W. Va.–Pa.
Holyoke, Mass.–Conn.
Indian Lake, N. Y.
Jackson, Cal.
Kanawha Falls, W. Va.
Karquines, Cal.
Knoxville, Tenn.
Marietta, Ga.
Marshall, Ark.
Minneapolis, Minn.
Monterey, Va.–W. Va.
Moravia, N. Y.
Mount Marcy, N. Y.
Mount Stuart, Wash.
Newcomb, N. Y.
Norfolk, Va.–N. C.
Oneida, N. Y.
Philadelphia and vicinity (Pa.–N. J.–Del.).
Rosebud, Mont.
St. Xavier, Mont.
San Bernardino, Cal.
Santa Ana, Cal.
Santa Monica, Cal.
Skaneateles, N. Y.
Tarrytown, N. Y.–N. J.
West Point, N. Y.
Whitehall, N. Y.–Vt.
Wicomico, Md.–Va.
Wilmurt, N. Y.

Corrections were also made on the following-named sheets:

Topographic sheets corrected during the fiscal year 1901–2.

Abingdon, Tenn.–Va.–N. C.
Albany, N. Y.
Albion, N. Y.
Alexandria, S. Dak.
Amsterdam, N. Y.
Asheville, N. C.–Tenn.
Baltimore, Md.
Baraboo, Wis.
Bayside, N. J.–Del.
Bear Valley, Idaho.
Betterton, Md.
Bisuka, Idaho.
Boston, Mass.
Bristol, Va.–Tenn.
Calumet, Ill.
Camp Clarke, Nebr.
Cat Island, La.
Catskill, N. Y.
Chandeleur, La.
Chester, Pa.
Chicago, Ill.
Chico, Cal.
Choptank, Md.
Colfax, Cal.
Cottonwood Falls, Kans.
Cowee, N. C.–S. C.
Cranberry, N. C.–Tenn.
Dardanelles, Cal.
Desplaines, Ill.
Diamond Creek, Ariz.
Downieville, Cal.
Dublin, Va.–W. Va.
East Delta, La.
Edgeley, N. Dak.
Ellis, Kans.
Ellsworth, Kans.
El Paso, Tex.
Fish Lake, Utah.
Fort Ann, N. Y.
Forts, La.
Fortymile, Alaska.
Fremont, Nebr.

Gainesville, Ga.
Germantown, Pa.–N. J.
Greenwood Lake, N. J.–N. Y.
Hartville, Wyo.
Havre de Grace, Md.–Pa.
Huntersville, W. Va.
Joplin, Kans.
Kaaterskill, N. Y.
Lacon, Ill.
Laramie, Wyo.
Larned, Kans.
Little Belt Mountains, Montana.
Lockport, N. Y.
Loudon, Tenn.
Macedon, N. Y.
Mankato, Kans.
Manti, Utah.
Marseilles, Ill.
Masontown, Pa.
Mitchell, S. Dak.
Morristown, N. J.
Morristown, Tenn.
Mountain View, Ark.
Mount Vernon, Va.–Md.–D. C.
Nantahala, N. C.
Norristown, Pa.
Norton, Kans.
Oconomowoc, Wis.
Oelrichs, S. Dak.
Olcott, N. Y.
Palmyra, Va.
Parsons, Kans.
Pawlet, Vt.
Pisgah, N. C.
Platte Canyon, Colo.
Pomona, Cal.
Price River, Utah.
Racine, Wis.
Raleigh, W. Va.
Red Bluff, Cal.
Redlands, Cal.
Riverside, Ill.
San Luis, Cal.
Schenectady, N. Y.
Scotts Bluff, Nebr.
Sevier Desert, Utah.
Shell Beach, La.
Sitka, Kans.
Smith Center, Kans.
Sonora, Cal.
Spanish Fort, La.
St. George, Utah.
Statesville, N. C.
Texas.
Troy, N. Y.
Truckee, Cal.
Tully, N. Y.
Uniontown, Pa.
U. S. Base (9 sheets).
Waterloo, Wis.
Watertown, Wis.

Topographic atlas sheets printed, and number of copies delivered, during the fiscal year 1901–2.

Name of sheet.	Copies.	Name of sheet.	Copies.
Abilene, Tex	650	Baltimore, Md	2,100
Abingdon, Tenn	2,118	Bayside, N. J.–Del	1,127
Albany and vicinity, N. Y	2,130	Becket, Mass	2,085
Albion, N. Y	2,113	Beattyville, Ky	1,070
Anaheim, Cal	2,646	Belair, Md.–Pa	2,565
Anoka, Minn	2,613	Bennington, Vt	2,145
Antlers, Ind. T	2,590	Bidwell Bar, Cal	2,095
Appomattox, Va	2,008	Big Trees, Cal	2,624
Ardmore, Ind. T	2,619	Bingham Special, Utah	2,555
Asheville, N. C.–Tenn	2,621	Bisuka, Idaho	1,131
Ashland, Oreg	1,082	Boston, Mass	1,637
Atlantic City, N. J	2,116	Boston Bay, Mass	607
Auburn, N. Y	2,642	Briceville, Tenn	1,085
Baker City, Oreg	2,569	Bristol, Va.–Tenn	2,615

Topographic atlas sheets printed, and number of copies delivered, during the fiscal year 1901–2—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Brownsville, Pa	2,600	Edgemont, S. Dak	2,647
Burden, Kans	564	Elcajon, Cal	2,505
Cambridge, N. Y.–Vt	2,622	Eldorado, Kans	1,069
Camden, N. J.–Pa.–Del	2,584	Elizabethtown, N. Y	2,525
Carnesville, Ga.–S. C	1,103	Elkader, Iowa–Wis	2,616
Cat Island, La	904	Elk Point, S. Dak.–Nebr.–Iowa	2,608
Cazenovia, N. Y	2,106	Ellis, Kans	1,127
Chaco, N. Mex	1,109	Ellsworth, Kans	1,098
Chandeleur, La	898	El Paso, Tex	1,075
Charleston, W. Va	2,133	Escalante, Utah	1,099
Chattanooga, Tenn	1,065	Escondido, Cal	2,577
Cheney, Kans	601	Estillville, Ky.–Va.–Tenn	1,097
Chester, Pa.–Del.–N. J	2,072	Eureka Springs, Ark	2,616
Chestertown, Md	2,588	Everett, Pa	2,670
Chico, Cal	1,094	Farmville, Va	1,101
Chittenango, N. Y	2,117	Florence, Ariz	2,662
Choptank, Md	2,185	Fonda, N. Y	2,650
Cleveland, Tenn	2,615	Fort Custer, Mont	1,092
Clove, N. Y	2,124	Fort Livingston, La	1,089
Clyde, N. Y	2,650	Forts, La	1,091
Cohoes, N. Y	2,126	Fort Smith, Ark	1,090
Connellsville, Pa	2,599	Fortymile, Alaska	1,125
Corona, Cal	2,675	Framingham, Mass	1,089
Cowee, N. C.–S. C	806	Frostburg, Md.–W. Va.–Pa	2,622
Dahlonega, Ga.–N. C	575	Geneva, N. Y	2,640
Dardanelles, Cal	2,108	Germantown, Pa.–N. J	2,109
Deep Creek, Cal	2,520	Globe, Ariz	2,536
Denison, Tex.–I. T	592	Globe Special, Ariz	2,584
Denzer, Wis	2,622	Goochland, Va	1,106
De Soto, Mo	2,613	Grass Valley Special, Cal	1,089
Diamond Creek, Ariz	1,084	Gray, Me	1,998
Dillon, Mont	1,061	Great Falls, Mont	595
Dime, La	1,069	Greeley, Colo	2,635
Downieville, Cal	2,102	Green Run, Md.–Va	2,573
Drum Point, Md	2,601	Greenwood Lake, N. J.–N. Y	2,089
Dublin, Va.–W. Va	1,104	Greylock, Mass.–Vt	2,592
Duluth, Minn	1,095	Gunpowder, Md	2,612
East Cincinnati, Ohio–Ky	2,082	Gurdon, Ark	2,601
East Delta, La	1,085	Hahnville, La	1,115
Echo Cliffs, Ariz	1,321	Hancock, W. Va.–Md.–Pa	2,611

Topographic atlas sheets printed, and number of copies delivered, during the fiscal year 1901–2—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Harlem, N. Y.–N. J	2,605	Leonardtown, Md	2,580
Harrisburg, Pa	2,150	Lewisburg, Va.–W. Va	1,125
Harrisonburg, Va	2,026	Limon, Colo	1,087
Haywards, Cal	2,055	Little Belt Mountains, Mont	2,635
Hennepin, Ill	1,051	Long Valley, Nev	1,066
Henry Mountains, Utah	1,288	Loudon, Tenn	1,308
Hesperia, Cal	2,641	Lukfata, Ind. T	2,685
Higbee, Colo	1,079	Lynchburg, Va	1,070
Hinton, W. Va	1,080	Mahanoy, Pa	1,091
Holyoke, Mass.–Conn	2,510	Manchester, Ky	1,556
Hot Springs, Ark	1,076	Mankato, Kans	1,080
Huntersville, W. Va	1,290	Manti, Utah	1,067
Independence, Mo	1,085	Marietta, Ga	2,655
Indiana, Pa	2,668	Marlboro, Mass	2,015
Indian Lake, N. Y	2,626	Marseilles, Ill	1,101
Jackson, Cal	2,609	Marshall, Ark	2,623
Joliet, Ill	1,111	Marsh Pass, Ariz	1,113
Joplin, Kans.–Mo	1,103	Marysville Special, Mont	2,576
Joplin District, Mo.–Kans. (double sheet)	2,544	Medina, N. Y	2,103
Junction City, Kans	1,101	Mercersburg, Pa	2,650
Kaaterskill, N. Y	893	Mesa de Maya, Colo	1,100
Kanab, Utah	1,109	Metamora, Ill	1,081
Kanawha Falls, W. Va	2,598	Millbrook, N. Y.–Conn	2,542
Karquines, Cal	2,613	Minneapolis, Minn	2,107
Keene, N. H.–Vt	2,095	Monterey, Va.–W. Va	2,597
Kittanning, Pa	2,639	Moravia, N. Y	2,625
Knoxville, Tenn.–N. C	2,128	Morganton, N. C	572
Lacon, Ill	902	Morristown, N. J	2,082
La Fortuna, La	912	Morristown, Tenn	1,080
Lake Hopatcong, N. J	2,046	Mountain View, Ark	1,062
Lake Placid, N. Y	2,093	Mount Carrizo, Colo	1,081
Lake Tahoe and vicinity, Cal.–Nev	1,550	Mount Leidy, Wyo	2,597
		Mount Mitchell, N. C.–Tenn	2,499
		Mount Stuart, Wash	2,636
Lamar, Colo	1,077	Mount Trumbull, Ariz	1,092
Lambertville, N. J.–Pa	2,121	Mount Vernon, Va.–Md.–D. C	2,094
Largo, N. Mex	1,080	Murphy, Tenn.–N. C	1,052
Larned, Kans	1,067	Napa, Cal	2,640
Latrobe, Pa	2,369	Navesink, N. J.–N. Y	2,527
Leadville, Colo	1,108	Needle Mountains, Colo	2,630

Topographic atlas sheets printed, and number of copies delivered, during the fiscal year 1901-2—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Nepesta, Colo	591	Pultneyville, N. Y	2,616
Nevada City Special, Cal	1,081	Raleigh, W. Va	2,639
Newcomb, N. Y	2,575	Red Bluff, Cal	1,310
Norfolk, Va.-N. C	2,680	Redding, Cal	2,591
North Platte, Nebr	2,660	Redlands, Cal	2,612
Nuyaka, Ind. T	2,617	Relay, Md	2,007
Oak Harbor, Ohio	1,190	Rhinebeck, N. Y	2,083
Ocean City, Md.-Del	2,598	Richmond, Va	2,106
Oconomowoc, Wis	910	Rigolets, La	1,106
Oelwein, Iowa	2,637	Ringgold, Tenn.-Ga	1,095
Olcott, N. Y	2,180	Roan Mountain, Tenn.-N. C	2,117
Oneida, N. Y	2,591	Rochester, N. Y	2,145
Oskaloosa, Kans.-Mo	1,062	Rock Island, Iowa-Ill	2,602
Ottawa, Ill	1,079	Rosebud, Mont	2,141
Ovid, N. Y	2,680	St. Paul, Minn	2,613
Owensboro, Ind.-Ky	2,600	St. Thomas, Nev	1,665
Palmyra, N. Y	2,657	St. Xavier, Mont	2,103
Palmyra, Va	2,126	Salem, Mass	2,093
Parkton, Md.-Pa	2,631	Salisbury, Md.-Del	2,638
Parsons, Kans	913	Saluda, N. C.-S. C	2,115
Patuxent, Md.-D. C	2,067	San Bernardino, Cal	2,603
Pawlet, Vt.-N. Y	2,124	San Jacinto, Cal	2,622
Philadelphia, Pa.-N. J	2,191	San Jose, Cal	2,094
Philadelphia and vicinity, Pa.-N. J.-Del	3,120	San Luis Rey, Cal	2,642
Pickens, S. C	1,071	San Mateo, Cal	2,101
Pinegrove, Pa	1,084	San Pedro, N. Mex	1,103
Piney Point, Md.-Va	2,596	San Rafael, Utah	995
Pisgah, N. C.-S. C	2,122	Santa Ana, Cal	2,511
Pittsville, Md.-Del	2,612	Santa Cruz, Cal	2,675
Plainfield, N. J	2,070	Santa Monica, Cal	2,544
Platte Canyon, Colo	1,085	Saratoga, N. Y	2,665
Pomona, Cal	925	Schunemunk, N. Y	2,586
Portage, Wis	2,479	Seattle, Wash	1,117
Portland, Oreg	2,145	Sedan, Kans	904
Pottsville, Pa	1,100	Sevier Desert, Utah	1,060
Poynette, Wis	2,583	Sharps Island, Maryland	610
Price River, Utah	1,048	Shasta Special, Cal	2,075
Prince Frederick, Md	2,599	Shell Beach, La	1,074
Princess Anne, Md.-Va	2,589	Shopiere, Wis	1,059
		Shoshone, Y. N. P.-Wyo	2,614

Topographic atlas sheets printed, and number of copies delivered, during the fiscal year 1901–2—Continued.

Name of sheet.	Copies.	Name of sheet.	Copies.
Silver Creek, N. Y	2,008	Tioga, Pa	2,628
Silverton, Colo	2,668	Toulme, Miss.–La	1,094
Sitka, Kans	883	Truckee, Cal	2,071
Skaneateles, N. Y	2,533	Tully, N. Y	2,142
Smith Center, Kans	890	Tusayan, Ariz	1,065
Snow Hill, Md.–Va	2,609	Verde, Ariz	1,091
Sodus Bay, N. Y	2,630	Wabuska, Nev	1,083
Sonora, Cal	2,088	Warfield, W. Va.–Ky.–Va	2,106
Southern California No. 1	2,579	Washington, D. C.–Md.–Va. (double sheet)	2,907
Springfield, Colo	893	Washington, Kans	1,099
Springfield, Mo	1,106	Waterloo, Wis	2,105
Squaw Creek, Idaho	1,596	Watertown, Wis	2,101
St. Johns, Ariz	1,090	Wedowee, Ala	2,632
Stanwood, Iowa	2,638	West Cincinnati, Ohio–Ky	2,082
Statesville, N. C	1,095	West Point, N. Y	2,580
Stevenson, Ga.–Ala.–Tenn	1,065	White Bear, Minn	2,576
Stilaguamish, Wash	2,567	Wicomico, Md.–Va	2,619
Sumpter, Oreg	2,610	Wilkesboro, N. C	1,101
Sundance, Wyo	2,615	Williamsburg, Ky.–Tenn	2,131
Syracuse, N. Y	2,124	Wilmurt, N. Y	2,568
Tacoma, Wash	2,139	Winslow, Ark	2,600
Tarrytown, N. Y.–N. J	2,599		
Tazewell, Va.–W. Va	2,106	Total	589,896
The Dells, Wis	2,615		
Thirteenth Lake, New York	2,133		

The work of engraving and printing of geologic folios continued without interruption. The following lists show the folios completed during the year, those in press at the close of year, and those in process of engraving at the close of the year:

Geologic folios completed during the year 1901–2.

No.	Name.	Copies.
79	Atoka, Ind. T	5,200
76	Austin, Tex	5,165
74	Coalgate, Ind. T	5,103
73	Coos Bay, Oreg	5,111
75	Maynardville, Tenn	5,072
77	Raleigh, W. Va	5,039
78	Rome, Ga.–Ala	5,196
	Total	35,886

Geologic folios in press June 30, 1902.

Camp Clark, Nebr.
Chicago, Ill. (quadruple folio).
Hartville, Wyo.
Masontown and Uniontown, Pa. (double folio).
New York City, N. Y.–N. J. (quadruple folio).
Norfolk, Va.–N. C. (double folio).
Oelrichs, S. Dak.–Nebr.
Olivet, S. Dak.
Parker, S. Dak,
Scotts Bluff, Nebr.

It will be observed that the New York City and Chicago folios consist each of four sheets; therefore the work on one such folio approximates that on four ordinary folios.

The Masontown–Uniontown folio and the Norfolk folio are double folios, each being composed of two atlas sheets; they therefore required the work of two ordinary folios.

The following tables need no explanation:

Miscellaneous maps, circulars, etc., printed and delivered during 1901–2.

	Copies.
Blank forms	3,750
Circular letters	9,400
Map circulars	71,147
Niagara River and vicinity (16 by 38)	20,576
Photolithographs on celluloid	171
Photolithographs on drawing paper	320
Photolithographs on map paper	9,882
Press bulletins	13,050
Signal flags	500
Special illustrations	4,260
Special copies of maps on drawing paper	270
United States base map (11 by 16)	2,118
United States contour map (18 by 28)	2,622
United States rainfall map	4,500
Total	142,566

Totals derived from the foregoing tables.

Engraving of topographic atlas sheets:	
Sheets finished (counting double sheets two)	75
Sheets partly finished	18
Sheets corrected	143
Sheets printed	311
Engraving of folios:	
Folios in hand	14
Folios completed	7
Delivered:	Copies.
Atlas sheets	589,896
Geologic folios	35,886
Miscellaneous	142,566
Grand total, all material delivered	768,348

Comparison of output for last two fiscal years.

	1900–1901.	1901–2.
	Copies.	*Copies.*
Atlas sheets	533,665	589,916
Geologic folios	63,988	35,886
Miscellaneous	131,794	142,566
Total	729,447	768,368

Other miscellaneous work.

Maps mounted	850
Transfer impressions made and sent to contracting printers	543

INSTRUMENT SHOP.

The shop was in the administrative charge of Mr. S. J. Kübel, and the direct supervision and actual work of repairing instruments, making copperplates, and electrotyping was in charge of Mr. Ernest Kübel, mechanician, assisted by two laborers. Repairs of instruments were made as follows:

Repairs of instruments in 1901–2.

Telescopic alidades	55
Wye (Y) levels	39
Transits	2
Box compasses	32
Hand levels	11
Rod levels	2
Steel tape lines	10
Sight alidades	38

Pocket compasses	18
Plane-table board plates	52
Fitting shoes on tripod legs	112
Johnson movement tripods	115
Traverse tripods	94
Level tripods	62
Theodolite tripods	6
Transit tripods	3
Protractor	1
Aneroid	1

Copperplates, electrotypes, and resurfaced plates were furnished as follows:

	Number.
New plates made	248
Plates resurfaced	25
Electrotype bassos made	32

The following work of a miscellaneous character was done in the instrument shop:

Construction of a specially designed camera stand for the photographic laboratory.
Repair of current meters for the Division of Hydrography.
Repair of machinery and instruments for the Division of Engraving and Printing.

An exact record of the nature of these repairs and of the time consumed thereon was kept.

ADMINISTRATIVE BRANCH.

Division of Disbursements and Accounts.

This division remained throughout the year in charge of Mr. John D. McChesney, chief disbursing clerk. The high degree of efficiency which has characterized the work of this division since the organization of the Survey in 1879 was maintained. A summarized statement of disbursements follows, and a detailed statement is preserved in the office.

FINANCIAL STATEMENT.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1902.

	Geological Survey, 1902.	Geological Survey, 1901 and 1902.	Geological maps of the United States, 1902.	Surveying forest reserves, 1901 and 1902.	Furnishing new addition to Hooe Building, Geological Survey, 1902.	Total.
Appropriations: Acts approved Mar. 3, 1901; Feb. 14, 1902, and Apr. 7, 1902	$290,770.00	$460,000.00	$75,000.00	$130,000.00	$7,830.00	$963,600.00
Amounts expended, classified as follows:						
A. Services	194,493.92	295,751.81	55,575.47	88,141.97	.....	633,963.17
B. Traveling expenses	13,419.46	37,174.01	60.50	6,926.57	.....	57,580.54
C. Transportation of property	933.50	6,862.80	27.53	1,051.26	.....	8,875.09
D. Field subsistence	15,184.65	37,850.88	.....	13,291.34	.....	66,326.87
E. Field supplies and expenses	17,832.76	38,521.70	.....	12,111.07	.....	68,465.53
F. Field material	5,575.95	13,578.86	.....	3,422.23	.....	22,577.04
G. Instruments	3,171.65	7,780.84	.....	1,616.92	.....	12,569.41
H. Laboratory material	4,241.41	179.50	.....	.....	.....	4,420.91
I. Photographic material	3,450.00	2,619.38	.....	485.59	.....	6,554.97
K. Books and maps	1,327.60	117.32	.....	.....	.....	1,444.92
L. Stationery and drawing material	708.02	907.44	.....	222.01	.....	1,837.47
M. Illustrations for reports	318.00	9.42	.....	.....	.....	327.42
N. Office rent	11,199.72	91.67	.....	.....	.....	11,291.39
O. Office furniture	912.50	1,280.33	.....	.....	3,635.40	5,828.23
P. Office supplies and repairs	1,702.17	1,988.75	.....	400.84	.....	4,091.76
Q. Storage	122.40	412.06	.....	241.12	.....	775.58
R. Correspondence	360.94	342.90	1.70	102.50	.....	808.04
S. Materials for engraving and printing maps	.....	.....	15,218.30	.....	.....	15,218.30

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1902—Continued.

	Geological Survey, 1902.	Geological Survey, 1901 and 1902.	Geological maps of the United States, 1902.	Surveying forest reserves, 1901 and 1902.	Furnishing new addition to Hooe Building, Geological Survey, 1902.	Total.
Amounts expended, classified as follows—Continued.						
T. Railroad account settled at United States Treasury—						
Passenger	$488.10	$1,016.48	.....	$838.75	.....	$2,343.33
Freight	37.47	599.82	.....	226.47	.....	863.76
Total expenditures	275,480.22	447,085.97	$70,883.50	129,078.64	$3,635.40	926,163.73
Balance unexpended July 1, 1902	15,289.78	12,914.03	4,116.50	921.36	4,194.60	37,436.27
Probable amount required to meet outstanding liabilities	14,546.93	12,914.03	4,116.50	921.36	4,194.60	36,693.42

Analysis of disbursements.

Opposite the following heads appear the total expenditures under the various appropriations:

1.	Salaries, office of Geological Survey	$31,647.15
2.	Salaries of scientific assistants	29,900.00
3.	Skilled laborers and various temporary employees	15,997.25
4.	Topography	245,690.01
5.	Geology	144,075.73
6.	Paleontology	9,605.40
7.	Chemical and physical researches	18,757.12
8.	Preparation of illustrations	15,810.97
9.	Mineral resources of the United States	48,400.64
10.	Books for library, etc	1,225.75
11.	Rent of office rooms, Washington, D. C	11,199.72
12.	Gauging streams, etc	92,936.22
13.	Mineral resources of Alaska	57,320.23
14.	Engraving and printing geological maps of the United States	70,883.50
15.	Surveying forest reserves	129,078.64
16.	Furnishing new addition to Hooe Building, Geological Survey	3,635.40
	Total	926,163.73

The Library.

The library of the Survey was, as in former years, in charge of Mr. Charles C. Darwin, who was assisted by Miss Julia L. McCord, Miss M. E. Latimer, and Mr. Thomas K. Gallaher.

The library ends its second decade with 50,000 volumes accessioned. During the year the books were all transferred and rearranged, and metal racks were substituted for the crowded wooden shelves. This was done without interruption to the delivery and use of the books, made possible by the careful planning and carrying out of the work by the librarian and his assistants.

The following tabulated statement shows the receipts during the year and the contents of the library on June 30, 1902:

Contents of the library June 30, 1902.

BOOKS.

On hand June 30, 1901:			
Received by exchange	34,571		
Received by purchase	13,137		
		47,708	
Received during the year:			
By exchange	1,813		
By purchase	479		
		2,292	
			50,000

PAMPHLETS.

On hand June 30, 1901:			
Received by exchange	62,279		
Received by purchase	14,748		
		77,027	
Received during the year:			
By exchange	2,593		
By purchase	80		
		2,673	
			79,700

MAPS.

On hand June 30, 1901	29,185	
Received during the year	215	
		29,400
Total		159,100

Division of Documents.

This division remained in charge of Dr. W. D. Wirt, who was assisted by Messrs H. E. Crook, H. W. Meredith, J. P. Benfer, W. J. Yaste, and J. W. Green, Miss M. E. Mullen, and Messrs. W. C. Douglas and W. R. Ennis.

The publications received were: Twenty-first Annual Report, Parts III, IV, V (with atlas), VI, and VII, and separates from same; separates from Twenty-second Annual Report, Parts I, II, and III; Bulletins Nos. 177, 180 to 189, 192, and 193; Water-Supply and Irrigation Papers Nos. 46 to 58, 61, 63, and 64; Mineral Resources of the United States for 1900, and separates therefrom; nine advance separates of chapters from Mineral Resources for 1901; six miscellaneous publications; Geologic folios Nos. 60, 70 to 79; and 315 topographic atlas sheets, the combined editions of which number 500,881 sheets.

During the year 145,837 volumes, 39,424 folios, and 416,301 maps were sent out.

The following summary indicates how large a correspondence was handled in the division during the year: Letters received, 61,928; letters sent, 78,412.

Miscellaneous Division.

The Miscellaneous Division remained in charge of Mr. A. F. Dunnington during the year, who was assisted by Dr. W. F. Morsell, appointment and correspondence clerk; Mr. J. E. Allen, property clerk, assisted by Mr. J. P. Hendley;

Mr. J. C. Gawler, mail clerk; Mr. A. B. Anderson, registered mail, express, and freight clerk; Miss Marian Thorwarth, file clerk, assisted by Mrs. E. V. M. Clarke; and Mr. Louis G. Freeman, stationery clerk, assisted by Mr. A. C. Cosdon.

During the year 19,000 letters were received, recorded, and referred (including 11,323 money letters, containing $8,287.91), and 10,750 letters were sent.

A large part of the time of the appointment and attendance clerk was required for general letter writing and for the answering of questions touching the construction of the civil service rules and of departmental practice relating to appointments, attendance, etc.

The appointment records show the following changes for the year: Original appointments made by Secretary of Interior, 104; reinstatements, 6; promotions, 124; extensions, reappointments, changes of title, etc., 88; reductions, 1. Total changes involving the issuance and recording of letters of appointment by the Secretary of the Interior, 317. Separations, 53, of which number 23 were dismissals, expirations of limited appointments, etc.; 10 were resignations and transfers to other branches of the public service; 4 were deaths, and 6 were declinations or revocations of appointments. Aggregate of changes of all kinds, 370. These figures show that the appointment work has just doubled in volume in three years. Like the work connected with appointments, that relating to attendance has expanded with the growth of the Survey. No estimate has been attempted of the number of applications for annual leave and brief absences recorded and disposed of during the year, but more than 260 applications for sick leave and 36 applications for leave without pay were recorded, sent to the Department, and granted.

Of express, freight, and registered mail, 906 pieces were received and 2,950 pieces were shipped, a total of 3,856 pieces. Accounts checked for the above, 647. Only one piece of express matter was lost during the year—a package lost in a railroad wreck. Its value was promptly recovered from the railroad company. Several freight shipments of previous years have been traced and delivery has been accom-

plished. Registered mail received, 1,264 pieces; shipped, 31,489 pieces; a total of 32,753 pieces; approximate value, $40,000. This is an increase over last year's record of 11,028 pieces, brought about in part by the use of the mail service in lieu of express service with its attendant expense.

Anthorizations for expenditures (approximating $50,000) were requested and granted by the Department to the number of 209; requisitions on Department for supplies, 356; orders drawn for open market supplies, 1,560; office requisitions received and filled, 940; bills checked for settlement, 1,320. The office property returns are practically up to date and a card catalogue is now in course of preparation covering the same.

The number of printing requisitions drawn on the Department was 434; stationery requisitions, 270; office requisitions received and filled, 4,375.

NECROLOGY.

Clarence King, the first Director of the United States Geological Survey, geologist and mining engineer, died at Phoenix, Ariz., on December 24, 1901. He was born in Newport, R. I., January 6, 1842, so that at the time of his death he had not quite completed his sixtieth year. Immediately after his death his body was brought from Arizona to New York City, where funeral services were held, and later taken to Newport for interment.

In order that the profound sorrow felt by Mr. King's colaborers in the field of geology might find proper expression, a meeting was held in the office of the Director of the Survey, at Washington, on Saturday, December 28. The meeting was presided over by the Director and was attended by all of the scientific men of the Bureau. Addresses were made by Maj. J. W. Powell, Mr. Charles D. Walcott, and Mr. S. F. Emmons. The following resolutions, offered by Major Powell and seconded by Mr. Arnold Hague, were unanimously adopted as an expression of the great loss sustained in the death of so eminent a leader of geological science:

It is with profound sorrow that we learn of the death of Clarence King, the first Director and, in a sense, the founder of the Geological Survey. In him we have lost not only a great scientific leader, but a genial and accomplished gentleman, whose personal qualities endeared him to all who knew him, and whose many acts of loving kindness have left a wide circle of friends in all walks of life to mourn his untimely death.

As organizer and, during ten years, chief of the United States Geological Exploration of the Fortieth Parallel, he set higher standards for geological work in the United States and laid the foundation of a systematic survey of the country. He gave practical recognition to the fact that a good topographical map is the essential basis for accurate geological work.

Clarence King

As first Director of the present Geological Survey he laid down the broad general lines upon which its work should be conducted and which, as followed by his able successors, have led to its present development. He established the principle that a Geological Survey of the United States should be distinguished among similar organizations by the prominence given to the direct application of scientific results to the development of its mineral wealth.

In that essential quality of an investigator—scientific imagination—no one surpassed King, and his colleagues have all profited by his suggestiveness. He was never content with the study of science as he found it, but always sought to raise the standard of geology, as well as to apply known principles to the survey of the country.

King first introduced microscopical petrography into American geology, and as early as his Fortieth Parallel work he foreshadowed the application of exact physics to questions of geological dynamics. Early in the history of the present Survey he established a physical laboratory. One result of this step was a paper on "The Age of the Earth," which takes very high rank among modern scientific memoirs. Although in his last years circumstances rendered it necessary for him to devote most of his time to other occupations, he had by no means abandoned plans for geological investigation on a scale worthy of his reputation.

In Clarence King geological science in America will miss a pioneer and a leader, the Geological Survey loses its broad-minded founder and adviser, and its older members a beloved friend.

Clarence King stood entirely alone in his world-wide reputation as a mining geologist and as the pioneer in systematic geological exploration under Government control. Just as Hayden was the great master of general reconnaissance work over great areas of the West at a time when they were almost unknown, so King stands out beyond all other explorers for his more quantitative examination of the mineral deposits of that region.

The following tribute to the memory of Mr. King was prepared by Mr. S. F. Emmons, his intimate friend and associate, and was published in connection with the foregoing resolutions in the Engineering and Mining Journal of January 4, 1902:

THE LIFE AND SCIENTIFIC WORK OF CLARENCE KING.

Among the many who have met Clarence King, there were few but have borne away from their meeting a delightful impression of the subtle charm of his personality. Of those in the most varied walks

of life, scientific, literary and artistic, who have been counted his friends, each has recognized in him, in addition to this charming personality, a wonderful grasp of mind and a clear insight into the essential principles of his own particular profession. To the members of his small circle of intimates alone has it been sometimes permitted to gain a knowledge of the great and tender heart which accompanied this remarkable intellectual development, but the recipients of his beneficence, whether of mind or purse, alone can realize with what grace and freedom he gave.

No man could ever do justice to all his varied accomplishments, for there was nothing that he touched, whether in art, literature or science, that he did not adorn. Doubtless many casual acquaintances have reasoned that one who could be brilliant in so many different lines could not have been thorough in all, and probably few, even among mining engineers, realized to what extent the present remarkable development of our mining industry is due, directly or indirectly, to the labors or influence of Clarence King. Since, therefore, in a hasty sketch like the present, it would be manifestly impossible to do justice to all the phases of his many-sided life, it will only be attempted to trace that which had to do with the mining industry.

According to the standards of the present day, King did not receive a very elaborate professional training; but, together with an instinctive faculty of grasping at once the keynote of any subject he was studying, which is generally considered characteristic of genius, he possessed the more unusual power of concentration of mind that enabled him in comparatively brief time to master all the essential details of his subject.

In his early life the bent of his mind toward the study of nature was greatly influenced by his mother, a woman of most remarkable intellectual gifts, who, left a widow when scarcely out of her teens, had devoted her life to the education of this, her only son. His professional education was completed at the Sheffield Scientific School of Yale, which he left in 1862, a member of the first class that received a degree from that institution. At college he was devoted to athletic sports, and throughout all his life was distinguished for remarkable physical vigor and energy; even up to the time of his last illness he was in the habit of enduring fatigues that would have worn out men of half his years.

The year following his graduation he set out on a horseback trip across the continent in order to study the then practically unknown Rocky Mountains, or Cordilleran system. This trip, which he and his friend, James T. Gardner, made with an emigrant train, starting from St. Joe, Mo., occupied several months, during which he first conceived the idea of the importance and feasibility of making a geological sec-

tion across this, the longest mountain system in the world, at its widest point, an idea which he succeeded in putting into practical execution five years later.

Such a trip in those days was necessarily full of incident, but space will admit of the mention of only a single one: The young explorers had left their emigrant train and stopped over at Virginia City to study the already famous Comstock lode. The night after their arrival the boarding house in which they were sleeping caught fire, and King, who was a sound sleeper, barely escaped with his life, losing everything he had with him. His loss included not only his clothing, but all his letters of credit and recommendation, and he was, therefore, obliged to go to work as an ordinary hand in one of the mills in order to earn money enough to continue his journey, for in those days it was a question of months rather than days before replies could be had to mail communications with the East.

When he finally reached California, after crossing the Sierras on foot, he attached himself as a volunteer assistant to the geological survey of the State of California, under Prof. J. D. Whitney. Among his scientific services on this survey were the first determination of the age of the auriferous slates, the exploration of the Mount Whitney group of the southern Sierras, then the highest known mountain mass in the United States, and the recognition of the glaciation of the Sierras, which his chief had, up to that time, not believed in. He was also associated in the examination of the mines of the Mariposa grant, and took part in an exploration of Arizona under General McDowell. During the latter he and his companion were once captured by the Apaches, but were fortunately rescued just as the fires were being prepared for their torture.

After the close of the civil war, when Congress, as a measure of wise public policy, had voted to subsidize the transcontinental railroads, King recognized that the time had come for carrying out his scheme of connecting the geology of the East with that of the West, and making a cross section of the entire Cordilleran system. In the winter of 1866–67 he went to Washington, and in spite of the disadvantage of his youth, and still more youthful appearance, he was so successful in impressing Congress with the importance of ascertaining the character of the mineral resources of the country about to be opened up by these railroads and affording a scientific basis for their development, that, not only was a generous annual appropriation voted for the geological exploration he had planned, but King himself was placed in absolute charge of it, subject only to the administrative control of Gen. A. A. Humphreys, Chief of Engineers.

It was characteristic of the scientific thoroughness of the man that, while all similar works under Government auspices were called surveys,

this, the only one which formed a systematic whole and constructed complete topographic maps of the area examined, was designated by him simply an exploration.

The most important result of this work, in its relation to mining, was the publication in 1870 of the economic bearing of its results in the volume of King and Hague entitled "Mining Industry," a work which marked a new departure in geological reports. It was well characterized in these columns as "by itself a scientific manual of American precious-metal mining and metallurgy, and an invaluable work of reference concerning the mode of occurrence of gold and silver." It was mainly devoted to an exhaustive study of the Comstock lode, the mining regions farther east having reached at that time but a very limited development. In the Comstock mines alone had mining methods and machinery made any distinct advance over European precedents. These advances were all illustrated by drawings made to scale with such accuracy that it is said that the well-known firm of Frazer & Chalmers later used them as working drawings in the construction of their early stamp mills and hoisting machinery.

The original plan of the exploration had contemplated only three years' field work, and it was a striking tribute to King's ability as its chief that Congress, in the summer of 1870, without any solicitation on his part and, indeed, without his knowledge, made an appropriation for its continuance, which extended its field work for another three years.

In consequence of this extension and the time required by various specialists to work up the vast amount of material gathered, ten years had elapsed ere the six quarto volumes which embodies its results were completed and King was able to undertake the final summing up of the whole. This work was published in 1878 as a volume of 803 pages, entitled "Systematic Geology." Probably no more masterly summary of the great truths of geology had been made since the publication of Lyell's Principles, and it differs from the latter in that it is not a compilation, but is based on personal, or personally directed, observations. It was well characterized by one of its more careful reviewers in the following terms: "The most satisfactory part of Mr. King's work, next to its scientific thoroughness, is the breadth of view which embraces in one field the correlation of such extended forces and the vigor of grasp with which the author handles so large a subject without allowing himself to be crushed by details. Hitherto every geological report has been a geological itinerary without generalization or arrangement. This volume is much more; it is, indeed, almost a sytematic geology in itself and might be printed in cheaper form and used as a text-book in the technological schools."

King's crowning service to geological science in this country, and through it to the development of mining industry, followed shortly

after the completion of the Fortieth Parallel work, in the conciliation of the warring elements in existing Government surveys, which seriously threatened to put a stop to all Government aid to scientific work. Probably few realize that it was mainly through his influence among the leading scientific men of the country and his tactful management of affairs in Congress that this crisis was averted. The question was referred to the National Academy of Sciences, and their recommendations, which were on lines laid down by him, were finally adopted by Congress, and early in 1879 a law was passed establishing the United States Geological Survey as a Bureau of the Interior Department. King was appointed Director of the Survey by President Hayes, with the approval of the chiefs of all the organizations which it displaced.

Although, owing to failing health, consequent upon the severe strain, both mental and physical, of nearly twenty years' strenuous work, he felt obliged to retire to private life in the second year of his directorship, he maintained the liveliest interest in the work and organization of the Survey up to the very last. In the short period of his administration he outlined the broad general principles upon which its work should be conducted, and its subsequent successes have been in great measure dependent upon the faithfulness by which these principles have been followed by his successors. His belief was that a geological survey of a great industrial country, while not neglecting the more purely scientific side of its work, should occupy itself primarily with the direct application of geological results to the development of the mineral resources of the country.

Under his direction were carried on the examinations of the Comstock, Eureka, Leadville, and other mining districts, whose importance is to be measured not solely by the accurate information which they afforded of these particular regions, but in far greater degree by their influence upon the whole body of mining engineers, in teaching them the practical importance of a study of the geological relations of ore deposits.

He also planned and supervised the collection of statistics of the precious metals for the Tenth Census, a work which has never been equaled in detail or scientific accuracy, and whose logical result was the annual collection of statistics of all the mineral resources of the United States, which has been carried on by the Geological Survey ever since the completion of the work of the Tenth Census.

While it was his work as an organizer and administrator that will have the most far-reaching results, results that will endure when the memory of him shall have become dim, his personal influence in maintaining high standards of scientific accuracy and personal integrity in the mining profession was always most potent.

In the case of the exposure of the diamond fraud of 1872, the credit of the discovery of its long-concealed location was due to his assistants,

who happened to have surveyed during the previous summer the region within which it was included. It was in the interest of pure science, and in the hope of discovering the true matrix of the diamond, that he undertook its investigation. When it was discovered that the ground had been salted, it was King's prompt action that averted the financial catastrophe that threatened to involve Europe as well as this country. By traveling night and day he outstripped all other possible means of information, and on reaching San Francisco made a peremptory demand upon the directors of the company that they should at once stop all issue and transfer of stock. To a suggestion that the announcement should be temporarily delayed, he replied: "There is not money enough in the Bank of California to induce me to delay this announcement a single hour." It was in San Francisco, where the company had started and where its stock was mainly held, that the importance of this discovery was best appreciated. With regard to it the Rev. Horatio Stebbins made the following significant utterance: "One scientific man, whose untarnished fame alone is worth all the diamonds in the world, has found occasion to prove to the world the value of science and his own great moral worth, and that result alone compensates for all the shame of this great fraud. This man, in response to the promptings of duty and responsibility as the geologist in charge of the territory where the diamond field was alleged to be located, sought out the scene of the fraud, in the service of science alone, and hastened with his undeniable proofs to those engaged in forwarding the scheme and put an end to the projected robbery of the people. To have learned that we have one such man is enough to make us look upon the whole stupendous wrong and its results as a cause of thankfulness."

In the course of his long and varied career King served as expert in many famous mining lawsuits, such as the Richmond-Eureka case in Nevada, the Dives-Pelican case in Colorado, the Center Star-Iron Mask in British Columbia, and the Anaconda and other mines in Butte, Mont., but he was never willing to accept a retainer in such service until he had satisfied himself by personal observation that the contention of the side that desired his services was in accord with his reading of the geological structure and such as he could conscientiously subscribe to. There have been cases where the entire line of argument has been changed after the inception of the case in deference to his opinion of its geological untenability.

He possessed not only a keen insight into geological structure, as developed in the underground workings of mines, that is rare even among the best and most experienced geologists, but also a remarkable grasp of its legal bearing, so that to him was commonly allotted the general conduct of the case and the determination of the line of attack or defense to be followed. This, however, did not satisfy his concep-

tion of his duty toward his client, for he was never willing to trust to the observations of another, but always verified every fact in detail by his own personal inspection. He thus obtained such thorough knowledge of his subject that the most skillful lawyers in the profession were unable to shake his testimony by their cross-examinations, which often extended over several days' time.

This class of work was, however, to King a matter of necessity rather than of predilection, although he took pleasure in it, as he did in everything that involved a contest of wits and intellect. His first preference was for investigation in pure science, and to contribute in this line permanent and substantial additions to the foundations of human knowledge was his highest ambition; in literature and art he delighted, as a mental recreation and pastime, but money making was to him merely a means to an end—necessary, but of relatively subordinate importance. That circumstances necessitated the devotion of so much of his time to the latter occupation has been a material loss to the world of science and art.

During his directorship of the Geological Survey he established a laboratory of experimental physics, defraying the expense of its costly apparatus out of his own pocket, and securing for its conduct the services of the most prominent young physicists of the day. Here were carried on under him a series of investigations into the constants of nature, with a view of testing experimentally, and if necessary revising, the existing theories upon the constitution of the earth. The results of these investigations have already constituted important contributions to the science of terrestrial physics. King's paper on "The Age of the Earth," in the American Journal, has been characterized by such men as Kelvin and Helmholtz as a most important contribution to the study of the earth. The final summing up of a new theory of the earth, though it had been formulated in his mind, was still awaiting the long-hoped-for moment of leisure when it was cut short by death. In literature he had published but little, his principal work being "Mountaineering in the Sierra Nevada," a combination of scientific descriptions and genre painting which possesses literary merit equal to that of the best literary writers of the day.

In the spring of 1901, after an unusually arduous mining campaign, he had a severe attack of pneumonia and whooping cough, and during convalescence it was discovered that he had contracted tuberculosis, the seeds of which were supposed to have been sown during a visit to the Klondike in the previous summer. From this disease he died at Phoenix, Ariz., on the 24th of December, 1901, in the sixtieth year of his age.

Besides the publications mentioned above, the following scientific papers are credited to Clarence King:

On the discovery of actual glaciers on the mountains of the Pacific slope: American Journal of Science, 3d series, Vol. I, pp. 157–161, 1871.

Paleozoic subdivisions of the fortieth parallel: American Journal of Science, 3d series, Vol. II, pp. 475–482, 1876.

Notes on the Uinta and Wahsatch ranges: American Journal of Science, 3d series, Vol. XI, p. 494, 1876.

Catastrophism and evolution: American Naturalist, Vol. XI, pp. 449–470, 1877.

Report on physical constants of rocks: Third Annual Report United States Geological Survey, pp. 3–9, 1883.

The age of the earth: American Journal of Science, 3d series, Vol. XLV, pp. 1–20, 1893; Annual Report Smithsonian Institution, 1892–93, pp. 338–352.

S. F. EMMONS.

The present Director's personal relations with Mr. King began in the winter of 1879, and continued to the time of his death. They were of the most cordial and inspiring character. Mr. King's ideals were high, and none could talk with him on any geologic or general topic without receiving valuable suggestions. All of his scientific colleagues on the Survey honored and respected him, both as a man and as a scientist.

Mr. King's greatest service consisted in implanting in the organization of which he was the first Director those high ideals which characterized his own life and work, and thus will he continue indefinitely to exert a profound and beneficent influence.

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