

STATE OF TENNESSEE
STATE GEOLOGICAL SURVEY
GEO. H. ASHLEY, STATE GEOLOGIST

BULLETIN 4

ADMINISTRATIVE REPORT
OF
STATE GEOLOGICAL SURVEY
1910

BY GEO. H. ASHLEY,
State Geologist



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CONTENTS

	PAGE
Letter of Transmittal.....	4
Introduction.....	5
Establishment.....	5
Organization.....	5
Equipment.....	8
Purpose.....	8
Scope of work.....	9
Cooperation with federal bureaus.....	9
Work of the Survey.....	10
Office work.....	10
Administrative work.....	10
Bureau of information.....	10
Preparation of reports.....	11
Maps and illustrations.....	12
Preparation of exhibits.....	12
Publications of the Survey.....	12
Field work.....	14
How conducted.....	14
Cooperative field work and study.....	15
Field work in 1910. By State Geologist.....	15
Stratigraphic and structural geology.....	16
Coal.....	16
Iron.....	17
Marble.....	17
Oil and gas.....	18
Phosphate.....	18
Zinc.....	18
Clays.....	18
Copper.....	18
Drainage reclamation.....	19
Water resources.....	19
Road building.....	20
Forestry.....	20
Financial Statement.....	21
Program and Recommendations for 1911.....	22
Appendices.....	32
Appendix "A"—Statement concerning forest conditions in Tennessee by U. S. Forest Service.....	33
Appendix "B"—Press bulletins giving synopsis of reports published....	37
Appendix "C"—Types of miscellaneous bulletins, special papers and ad- dresses.....	41
(a) The Geological Survey and the Coal Men.....	41
(b) State Geological Survey and the Farming Interests.....	41
Appendix "D"—Exhibits.....	55
Exhibit at Appalachian Exposition, Knoxville, September 12 to Octo- ber 12, 1910.....	55
State Geological Exhibit at Nashville.....	57

MARCH 20, 1911.

To the Members of the Fifty-seventh General Assembly, of Tennessee:

In accordance with the Act creating the State Geological Survey there is submitted for your investigation the report of the State Geologist, covering a period from May 1, 1910, when he took charge of his office, to December 19, 1910. We bespeak your careful consideration of the report, showing the extensive field already occupied by the Survey and the work done by it during the few months of its existence.

Respectfully submitted,

BROWN AYRES,

Secretary of the Commission.

BEN W. HOOPER, Governor,

Chairman of the Commission.

LETTER OF TRANSMITTAL.

NASHVILLE, TENN., December 15, 1910.

To His Excellency, the Governor, and Members of the Geological Commission:

GENTLEMEN—I have the honor to transmit herewith my report as State Geologist, as the law requires, for the term ending December 19, 1910. The report recounts the establishment of the Survey, its organization May 1, 1910, reviews the work accomplished during the seven and one-half months of its existence and the present condition of the Survey, and makes certain recommendations looking toward the future work of the Survey.

Very respectfully,

GEO. H. ASHLEY,
State Geologist.

INTRODUCTION.*

Establishment.—The State Geological Survey of Tennessee was created by an Act passed April 30, 1909. The Act creating the Survey designated an *ex-officio* commission to have charge of the work and specified their duties; it provided for the appointment of a State Geologist, and specified his duties; it described the object and conduct of the Survey, and allotted \$15,000 a year for its carrying on. The Act specified that the funds should not be available until May 1, 1910.

Organization.—On March 16, Mr. Geo. H. Ashley, then of the U. S. Geological Survey, was appointed State Geologist, and Prof. L. C. Glenn, of Vanderbilt University, and Prof. C. H. Gordon, of the University of Tennessee, associate geologists, the same to take effect May 1, 1910.

As at present organized, the Geological Survey's force consists of the State Geologist, two associate geologists on per diem, and one clerk or stenographer. Three temporary field assistants are or have been employed and three temporary draftsmen. One unskilled assistant cares for the State geological exhibit, runs the mimeograph, etc. In addition, three experts in the State have cooperated in the preparation of special reports; two members of the Geologic Branch of the U. S. Geological Survey, three members of the Topographic Branch of that Survey, two members of the Drainage Investigations Division of the U. S. Department of Agriculture, and two members of the U. S. Forest Service have cooperated in areal and special work in Tennessee. In addition six topographic assistants, obtained locally, have been on the Survey's pay roll in connection with the topographic work in West Tennessee.

The following list contains the names of the Geological Commission and all of those engaged in the work, either directly for the Survey or in cooperation with it:

*The establishment, organization, purpose, scope and work of the Survey have been quite fully explained in Bulletin 1-A, published soon after the establishment of the Survey. Copies of this bulletin can be obtained on request.

COMMISSIONERS.

GOV. BEN W. HOOPER, Chairman.
COL. JOHN THOMPSON (State Commissioner of Agriculture).
R. A. SHIFLETT (State Mine Inspector).
PRESIDENT BROWN AYRES (University of Tennessee), Secretary.
CHANCELLOR J. H. KIRKLAND (Vanderbilt University).
VICE CHANCELLOR WILLIAM B. HALL (University of the South).

ADMINISTRATIVE AND OFFICE WORK.

GEO. H. ASHLEY, State Geologist.
ELIZABETH COCKRILL, Clerk.
B L. DePIERRI, Draftsman.

GEOLOGICAL SECTION.

PROF. L. C. GLENN (Vanderbilt), Associate Geologist. Coal, water resources.
PROF. C. H. GORDON (University of Tennessee), Associate Geologist. Appalachian Expositon.
MR. WILBUR A. NELSON (Nashville), Assistant Geologist. Clays.
PROF. R. P. JARVIS (University of Tennessee), Cooperating Geologist. Iron.
DR. W. C. PHALEN (U. S. Geological Survey), Cooperating Geologist. Areal survey, coal.
MR. M. J. MUNN (U. S. Geological Survey), Cooperating Geologist. Oil and gas.
MR. LUCIUS P. BROWN (State Chemist), Cooperating Geologist. Phosphate.
MR. S. W. OSGOOD (Knoxville, Tenn.), Cooperating Engineer. Zinc.
PROF. J. A. SWITZER (University of Tennessee), Cooperating Engineer. Water powers.
MR. HENRY H. HART (Chattanooga), Field Assistant. Areal surveys.
MR. JOHN H. AGEE (LaFollette), Field Assistant. Phosphate, soil surveys.

FORESTRY SECTION.

MR. R. CLIFFORD HALL (U. S. Forest Service), Cooperating Forester.
MR. W. W. ASHE (U. S. Forest Service), Cooperating Forester.
MR. ERNEST D. CLARK (U. S. Forest Service), Cooperating Forester.

TOPOGRAPHICAL SECTION.

MR. E. L. McNAIR (U. S. Geological Survey), Topographer.
MR. A. F. McNAIR (U. S. Geological Survey), Junior Topographer.
MR. J. M. RAWLS (U. S. Geological Survey), Topographic Aid.
MR. M. W. GRAY, Recorder.
MR. ROBT. L. TAYLOR, JR., Chainman.
MR. EDMOND C. KAIN, Chainman.
MR. L. E. PECK, Rodman.
MR. H. H. DICK, Rodman.
MR. BRUCE REED, Rodman.

DRAINAGE SECTION.

MR. ARTHUR E. MORGAN (U. S. Department of Agriculture), Drainage Engineer.

MR. S. H. MCCRORY (U. S. Department of Agriculture), Drainage Engineer.

MR. J. V. PHILLIPS (U. S. Department of Agriculture), Drainage Engineer.

Geological work in cooperation with the U. S. Geological Survey has been under the personal supervision of Mr. David White, who gave the greater part of a month to the supervision in the field of the cooperative work being done in this State. The topographic work done under cooperation has been under the supervision of Mr. Frank Sutton; the drainage investigations under Mr. C. G. Elliott, and the forestry work under Mr. J. G. Peters, all of whom have visited the State during the progress of the work. The large topographic parties engaged in the survey of the stream bottoms of West Tennessee, that do not appear on the pay roll of this Survey, are not included in the preceding list. The topographers in charge of this work have been Messrs. C. Hartmann, Jr., S. P. Floore, J. DePuy, W. H. Griffin and J. M. Rawls. Nor do the names appear of several who were employed for short periods for stenographic, drafting and other work. The preceding list also does not include the names of members of the U. S. Geological Survey and others engaged in geologic, topographic or other scientific work in the State to which the State Survey did not contribute.

The work of the Survey has been divided into three parts, or as they may be termed bureaus: (*a*) bureau of administration; (*b*) bureau of survey; (*c*) bureau of information and publication.

The bureau of administration work involves: (*a*) plans and estimates; (*b*) bids, purchases, contracts; (*c*) property and equipment; (*d*) correspondence; (*e*) records; (*f*) accounts; (*g*) supervision. This includes the internal machinery of the Survey.

The bureau of survey covers the obtaining of data whether in the field, the laboratory or the library. This covers the bulk of the work and expense of the Survey to date.

The bureau of information covers the giving of information, informally or formally. It includes: (*a*) informal communications and correspondence; (*b*) newspaper items and press bulletins; (*c*) special articles and addresses; (*d*) bulletins (the regular publications of the

Survey); (*e*) maps and illustrations; (*f*) exhibits; (*g*) educational work.

Equipment.—The Survey office is at present on the second floor of the Capitol Annex. The State Geological exhibit occupies the whole of the east side of that building on the third floor, and the other rooms on the third floor are used in connection with the preparation of that exhibit. The office has been equipped with the usual office furniture, and in addition to the usual files, are map cases, specimen cases, index cases, well record cases, drawing tables, etc., with their equipment of index cards and maps, record cards for filing information, files for manuscripts, note books, etc. The best business methods of recording, filing and cross referencing correspondence has been followed. The mimeograph has been used in preparing press bulletins, circulars, etc. The office also contains the Survey library, which has been started, and the geological library of the State Geologist of several thousand volumes and pamphlets upon which dependence will be placed until the Survey library has been built up.

The exhibit at Nashville occupies twelve glass floor cases, four table wall cases, five drawer cases, over one hundred feet of step shelving and six ten-leaf hanging wall cases for maps and photographs.

Purpose.—*The purpose of the Survey may be briefly stated: The Geological Survey of Tennessee exists to obtain and publish accurate, definite and unbiased information on the State's natural resources for the purpose of increasing the wealth and well-being of the State and its citizens through a larger and better use of those resources.

*The following statement from Bulletin 1-A, page 10, explains the purpose and value of the Survey more fully:

“The Survey will be of direct value to the State in several ways: (1) by serving as the State's expert in determining the value, etc., of the State's present large holdings of mineral lands, or of any proposed additional purchases or sales; (2) by supplying the facts and information necessary to intelligent legislation concerning the State's resources; (3) by conserving the State's resources through leading to better methods of obtaining and using them; (4) by helping to bring into the State new capital for investment and the immigration of new citizens; (5) by keeping money in the State through aiding in the establishment of local industries to supply local needs, and by bringing additional money in by enlarging the output of farms, mines, and factories; (6) by leading to added sources of income for the State.

“The Survey will be of indirect value to the State through its value to the individual citizens for whose welfare the State exists.

"It is of value to the landowner by showing what ores, minerals, rocks, or other resources underlie his land; their depth, volume, character, and value, and to that extent it affects the possible sale value of his land; and, second, by suggesting such use of his land as will make it yield the largest possible return. It is of value to those having capital to invest by supplying unbiased information upon which investments may be made or industries established. It is of value to transportation interests by increasing the volume of both crude and manufactured materials to be moved, through an increased production and an increased demand. It is of value to the purchasing public, which includes most of us, by reducing costs through the production in the State of things that must otherwise be obtained from without, and through increasing the supply of those things. It is of value to the man without work by increasing the demand for labor through the starting of new or enlarging of old industries.

"In so far as the Survey may aid in the abating of the smoke nuisance in the cities, in obtaining cheaper light and power through a larger use of our water powers, in aiding and making effective plans for the drainage of bottom lands, in converting poor farm lands into good farm lands, and in a thousand other ways, it may make it possible for all citizens to have more of the comforts and luxuries of life."

Scope of Work.—*The Survey is primarily a bureau of information on certain subjects. This implies, first, the collecting of the information; second, the study, systematizing, filing, or preparation of that information; and, third, the supplying of that information.

The subjects on which the Survey is to serve as a bureau of information have already been outlined in Section 5 of the Act under which the Survey is established. They may be grouped as follows:

1. General Geology, mineralogy, physics, and chemistry, so far as they relate to the natural resources of this State.
2. Geography of the State.
3. Metals and their ores.
4. Fuels and fertilizers.
5. Structural materials and materials used in the arts.
6. Water and water power.
7. Soils.
8. Reclamation of land.
9. Forests, roads, etc.
10. Miscellaneous materials and products.

Cooperation with Federal Bureaus.—To secure the largest returns for the money available, cooperation has been carried on with a number of bureaus and departments of the United States Government, as well as with other departments of the State Government. In these co-

* This subject is more fully explained in Bulletin 1-A, pages 12-21.

operative agreements, as a rule, experts of the Federal Government have done the work, and the State Survey has borne half of the expenses and published the reports. In some cases the State Survey furnished assistants, paying their salary and field expenses. In this way the State has had the benefit of work by men of large experience, such as it could hardly afford to employ for the short time they are needed with the funds at its command. Again, in many cases, these men bring to the work in Tennessee a wide acquaintance with the conditions in adjoining States, and not infrequently they have already had a greater or less experience in this State in the line of the particular subject involved.

WORK OF THE SURVEY.

OFFICE WORK.

Administrative Work.—The administrative work has consisted of making plans for the work, correspondence and conference relating to their carrying out, the obtaining of bids for the purchase of equipment and supplies, the making of contracts, especially of cooperative agreements, the care of the Survey equipment and property, the conduct or supervision of work while in progress, and of the reports when the work is completed, and the distribution of the reports, the administration of the finances of the Survey, the classification and filing of information needed for reference or for reports in progress or contemplated.

In the preparation and obtaining of this information, it has been found necessary to prepare a rather complete card index to all of the publications and also by the usual means followed in business houses to get the data available in such shape that it can be readily referred to. Among other things this has involved the preparation of maps of the State, on which can be shown by different colored tacks the location of deposits of various kinds, the mines, quarries and plants where these resources are being obtained and worked up.

Bureau of Information.—A large share of the time of the State Geologist has gone into the work of answering personal and written inquiries of all kinds regarding the mineral resources of the State. These come from landowners, investors, railways, cities, towns, commercial associations, teachers and pupils, and, in fact, from all classes of people, both within and without the State. The aggregate number is very large, and the number of inquiries per day is constantly increasing. This work is believed to be an important function of the Survey, though it necessarily hampers the larger and systematic study of the

State's resources. At present it is often necessary to write long replies describing the occurrence and character of resources about which inquiries are made. It is hoped that with the publication of the preliminary bulletins, many of the inquiries can better be answered by sending such bulletins. In addition, the Survey has been ever mindful of opportunities to advertise the State's resources and many letters have been sent out to those who might be interested in examining further into the opportunities this State offers for investment and the building up of new enterprises.

In order to give the results of the Survey's work the widest publicity, the distribution of each bulletin has been accompanied with a press bulletin, giving the principal facts contained in the bulletin. These have been sent to all of the newspapers in the State, and to all of the technical journals in the country, in the lines involved. As a matter of fact these press bulletins have been very liberally used by such outside journals, possibly more so than by the smaller local newspapers in the State. In some cases the technical journals have used considerable extracts from the bulletins themselves, and in one or two cases have requested the use of plates used in the bulletins to accompany their extracts. A large part of the outside inquiries may be traced directly to these notices. In addition to the press notices accompanying the bulletins issued, others have been issued from time to time, explaining the work or calling attention to economic conditions found in the progress of the work.

Besides the general articles referred to, a number of articles have been specially written for the technical journals both inside and outside of the State, and a number of addresses have been prepared on various subjects and given in various parts of the State.

Preparation of Reports.—After the completion of any given piece of field work, a large amount of office work is necessary, digesting, systematizing and boiling down the information gathered, the study and analysis of specimens collected, the preparing of maps, cross sections and other drawings, the writing of the report, the critical review of the manuscript by other members of the Survey or others, the proof reading of the report in press, and later its distribution. During this first year many of the publications prepared have involved a very full review of all papers and reports previously published on that subject, many of which are now out of print or rare. During the year Bulletins 1-A, 2-A, 3-A and 4 were prepared in the Nashville office printed and distributed. Bulletin 1-B has been prepared and is in press. Bulletins 5, 6, 7 and 2-B are in preparation.

Maps and Illustrations.—Considerable time has been given in the office to preparing a new geological map of the State, using all of the information available. There has been no large scale map of the State published in many years, and the work has developed many problems, some of which will have to be worked out in the field.

In the field many photographs have been taken, part of which will be used in the reports, part in cases in the exhibits and a part for lantern slides to use later in talks on the resources of the State. As most of the bulletins are accompanied by especially prepared maps, the preparation of these has formed no small part of the office work.

Preparation of Exhibits.—This work includes the care of specimens received from the field, or as donations, the planning of suitable rooms, cases and mountings, the arranging of exhibits, their labeling, their exhibition or explanation to teachers and others. Two such exhibits have been prepared this year, one at Knoxville in connection with the Appalachian Exposition, the second the beginning of a permanent exhibit at Nashville. These exhibits are described more in detail in Appendix E.

Publications of the Survey.—The formal publications of the Survey are issued in the form of bulletins. This Survey has departed, to some extent, from the method adopted by many of the State surveys of issuing an annual report. On the contrary, as soon as any paper or report, complete in itself, has been ready, it has been printed and issued. In some cases where these papers are very short and two or more are under preparation or in anticipation along closely related lines, they are gathered into one bulletin, and the separate papers are designated by the letters, A, B, C, etc. Each paper, however, is printed as soon as ready, without reference to the others which may later be combined with it, to form that bulletin. These bulletins have been distributed over the State to all those known to be professionally interested in the subject with which they deal, or who have requested information on that subject, to all boards of trade or corresponding bodies in the State, and the principal bodies of that nature in adjoining States as far north as New York and west as far as North Dakota, to the libraries of the State, including the school libraries of secondary or grammar grades, to State, city and scientific libraries outside of the State, to members of the State Legislature and other State and county officials. With the exception of five hundred copies of each edition, the bulletins are sent free upon request accompanied by postage. Five hundred copies of each edition are held to be sold at the cost of printing in order that late comers, and especially those who may

have a financial interest in the subject involved, may have an opportunity of getting such reports. The following list shows the bulletins already issued or in preparation:

Bulletins Nos. 1-A, 2-A, 2-E, 2-G and 3, issued.

- Bulletin No. 1. Geological Work in Tennessee (Part A issued).
- A. The establishment, purpose, object and methods of the State Geological Survey; by Geo. H. Ashley; 33 pages, issued July, 1910; postage 2 cents.
 - B. Bibliography of Tennessee Geology and related subjects; by Elizabeth Cockrill (in press).
 - C. History of Geological Work in Tennessee; by L. C. Glenn (in preparation).
- Bulletin No. 2. Preliminary Papers on the Mineral Resources of Tennessee, by Geo. H. Ashley and others. (Parts A., E. and G. issued.)
- A. Outline Introduction to the Mineral Resources of Tennessee, by Geo. H. Ashley, issued September 10, 1910; postage 2 cents.
 - B. The coal fields of Tennessee, by Geo. H. Ashley (in preparation).
 - C. The Iron Ores of Tennessee, by R. P. Jarvis (in preparation).
 - D. The marble of East Tennessee, by C. H. Gordon (in press).
 - E. Oil Development in Tennessee, by M. J. Munn (issued); postage 2 cents.
 - F. The Phosphate Deposits of Tennessee, by Lucius P. Brown (in preparation).
 - G. The Zinc Deposits of Tennessee, by S. W. Osgood (issued); postage 1 cent.
 - H. Preliminary Geological Map of Tennessee (in preparation).
- Bulletin No. 3. Drainage Reclamation in Tennessee; 74 pages, issued July, 1910; postage 3 cents.
- A. Drainage Problems in Tennessee, by Geo. H. Ashley; pp. 1-15; postage 1 cent.
 - B. Drainage of Rivers in Gibson County, Tennessee, by A. E. Morgan and S. H. McCrory; pp. 17-43; postage 1 cent.
 - C. The Drainage Law of Tennessee; pp. 45-74; postage 1 cent.
- Bulletin No. 4. Administrative Report of the State Geologist for 1910.
- Bulletin No. 5. Clays of West Tennessee, by Wilbur A. Nelson (in press).
- Bulletin No. 6. Road Building in Tennessee, by Geo. H. Ashley (in preparation).
- Bulletin No. 7. Water Resources of Tennessee, by L. C. Glenn (in preparation).
- Bulletin No. 8. Utilization of small water powers in Tennessee, by J. A. Switzer and Geo. H. Ashley (in press).
- Bulletin No. 9. Economic Geology of the Dayton-Pikeville Region, by W. C. Phalen (in preparation).

- Bulletin No. 10. Studies of the Forests of Tennessee.
- A. An Investigation of the Forest Conditions in Tennessee, by R. Clifford Hall (in press).
 - B. A Study of the Growth of the Second Growth Hardwoods, by W. W. Ashe (in preparation).
- Bulletin No. 11. The Marbles of East Tennessee, illustrated with colored plates, by C. H. Gordon (in preparation).
- Bulletin No. 12. Preliminary Report on Copper Deposits of Polk County, by W. H. Emmons (in preparation).

In appendix "C" are given copies of the press bulletins issued in connection with the distribution of the bulletins so far issued. They are given in this report to give a synopsis of those bulletins.

FIELD WORK.

How Conducted.—The manner of conducting field work has been quite fully explained in Bulletin 1-A, pages 27 *et seq.* Briefly the main part of the field work will consist of a personal, detailed study and mapping of the State's various resources, in the field, mile by mile, to determine the position, character, quality and quantity of each resource, soil, rock formation or other subject of study. This work, to obtain facts of value that will be thoroughly reliable, will require, in most areas, the work of one man for two months for every one hundred square miles studied. That rate assumes the existence of adequate topographic maps on which to work. On account of the cost of such work the cooperation of the U. S. Geological Survey has been obtained, as far as possible, in its prosecution, and that Survey has indicated its willingness to cooperate in such work. Two hundred and fifty square miles in Rhea, Bledsoe, Van Buren and Cumberland counties were so surveyed this past year. After the first year or two it is hoped to increase the areas covered each year. For the first year or two much of the field work will have to be of a reconnoissance nature, necessary for the preparation of preliminary bulletins to meet the need of immediate information. In addition the State Geologist has made many special trips to investigate special conditions, reported occurrences of new materials, etc., etc. In addition to the regular field work on geological and related subjects, the Survey had cooperated in the preparation of topographic and drainage maps and studies. In this work again cooperation has been had with the U. S. Geological Survey and other bureaus.

The primary object of the Survey is to obtain and give information. This can be done most efficiently by obtaining the information through

carefully planned work carried on systematically to a definite conclusion and the results then carefully digested and published in as great detail as possible. But in the beginning of any work, such as that inaugurated by this Survey, the need and demand for immediate information make it necessary to spend much time in obtaining and disseminating general information, delaying for the time being the prosecution of the detailed, systematic work. Where, as in this State, a large amount of previous geologic work has been done, much of this desired general information can be obtained from the published reports of that work, though in nearly all cases it has been found necessary to supplement such information with some field examinations. Accordingly a large part of the work of the Survey for the first year has been absorbed in general preliminary studies of the State's resources, and the preparation of preliminary and general papers on those resources.

Cooperative Field Work and Study.—Since May 1 cooperative agreements have been entered into with the Geological Branch of the U. S. Geological Survey for detailed work in the coal fields of Tennessee, the area surveyed being the Pikeville special atlas sheet in Bledsoe, Rhea, Van Buren and Cumberland counties; for a preliminary study of the oil and gas deposits of the State. In addition that bureau has had work in progress in the copper district of Polk County, the preliminary results of which have been kindly placed at the disposal of the Survey. The U. S. Survey has also carried on some general studies in accordance with its usual custom, and the results of such studies redound to the benefit of the State. The Topographic Branch of the same survey has cooperated in topographic work in West Tennessee, and has done some work independently in Middle Tennessee and East Tennessee. The Water Resource Branch of the U. S. Survey has cooperated in a study of the water resources of the State, by Prof. Glenn. The Survey has cooperated with the U. S. Department of Agriculture through its Division of Drainage Investigations of the Experiment Stations, the Bureau of Soils, the Bureau of Public Roads and the Forest Service.

In addition to the bureaus with which cooperative agreements were made, much information has been furnished by other bureaus of the National Government, and by other departments of the State Government. In all cases requests of the State Survey for cooperation or for information have been met more than half way.

Field Work in 1910. By State Geologist.—The State Geologist has visited the parties engaged in the several lines of work in progress, spending from two days to a week or more with each party.

He has made independent trips to nearly all parts of the State, examining deposits and getting specimens and photographs. He has attended farmers' conventions in East and Middle Tennessee, a miners' convention in Knoxville and a good roads convention in the same city, the Southern Conservation Congress in Atlanta and a conference with the State Geologists of other States, and with the officials of the federal bureaus in Washington. The preparation of the several preliminary reports (Bulletins 1-A, 2-A, 2-B, 3-A, 4 and 6) and the necessary proof-reading and other matters connected with their publication, has prevented his giving as much time to the field work as he hopes to be able to give after the completion of these bulletins. As stated elsewhere, the preparation of these bulletins has been urgently needed to save time in answering correspondence and supplying information.

Stratigraphic and Structural Geology.—A knowledge of the stratigraphy and structure of the State is fundamental to a study of its economic geology. Taking advantage of the work in those subjects previously done, an outline statement of those subjects for this State was early prepared and included in Bulletin 2-A. No larger studies of the stratigraphy and structure of the State were undertaken this year, though several trips by the State Geologist, David White and others, had for their primary object the securing of data on those subjects. Independently of the work of the State Survey, studies of the Silurian fossils were made by Mr. Ray Bassler, of the U. S. National Museum, and of the Tertiary plants of West Tennessee by Edward W. Berry, of the U. S. Geological Survey, and of the fossils of the Pikeville region by Mr. T. E. Willard, of the U. S. National Museum.

In addition to these special studies all of the economic work has necessarily involved more or less study of the stratigraphy and structure of the region under study. As one of the first things necessary in connection with the successful prosecution of the work was to learn what was known about the geology of the State and its resources, a card catalogue of all reports and papers, dealing with the geology of the State, has been prepared, and from these Miss Cockrill has prepared a bibliography of the State as far as these subjects go, which is now in press.

Coal.—It was hoped when the Survey started that Prof. Glenn would devote the major part of the summer to a reconnaissance study of the coal field of the State, as he was already familiar with many parts of that field. The completion of some work in Kentucky, upon which he has been engaged for several years, however, required the

whole summer, and he was not able to give any of the summer to the work in this State. Detailed work in the coal field was done in cooperation with the U. S. Geological Survey in what is known as the "Pikeville Special" quadrangle. This comprises the southeast quarter of the old Pikeville topographic atlas sheet of the U. S. Geological Survey series. An up-to-date topographic map of the region surveyed was prepared only two years ago, and on that basis Mr. W. C. Phalen, assisted by Mr. Henry G. Hart, made a detailed map of the formations and coals and a study of the stratigraphy, structure and economic geology of that region. A preliminary report on the economic geology is being prepared by Mr. Phalen and will be published by the Survey during the coming spring. In addition, the State Geologist is preparing a preliminary report on the coal field as a whole, using such data as was obtained by Safford, and by the U. S. Geological Survey in connection with its folios covering that territory, supplemented by additional information in the field and by correspondence.

Partial arrangements have been made with the U. S. Bureau of Mines for a cooperative study in the use of coal, looking primarily to its more efficient use, but having in view as secondary results the obtaining of facts that may have a large bearing on the smoke problem of the cities of the State. It is hoped the study may be started in January.

Iron.—It had been hoped to undertake a detailed study of the iron ore resources of the Chattanooga district in cooperation with the U. S. Geological Survey and the Chattanooga Chamber of Commerce. Conditions, however, made it necessary to postpone that work until 1911, when it is hoped that such a study may be undertaken and also a study of the iron resources of western Middle Tennessee. Samples of iron have been collected from many parts of the State and Prof. Jarvis, of the University of Tennessee, is engaged in a preliminary field study of the iron resources of the State. His report will be published during the spring.

Marble.—As stated elsewhere a very handsome exhibit of the marbles of the Knoxville district was shown at the Appalachian Exposition, and Prof. Gordon has prepared a short bulletin describing the occurrence and character of those marbles. He also has in progress a more detailed report on the marbles of East Tennessee to be illustrated with plates in color showing the actual appearance of the marbles now on the market. The marble producers have cooperated in the preparation and expense of those plates. As fine marbles are reported from many parts of the State, it is hoped in the near future to under-

take a systematic examination of all such deposits as seem to offer commercial building stone.

Oil and Gas.—In cooperation with the U. S. Geological Survey a comprehensive preliminary study of the oil and gas resources of the State was made by Mr. M. J. Munn, of the federal bureau. This included a visit to nearly all of the counties of Middle and West Tennessee. Information was obtained in regard to all wells drilled for oil or gas that could be learned of. A preliminary report on those resources in this State forms Bulletin 2-E.

Phosphate.—Aside from some preliminary studies on the phosphate field, the principal work done has consisted in a detailed tracing of the horizon of the blue phosphate through Williamson County, by Mr. John H. Agee, and the collection and examination of specimens of the phosphate bed, wherever exposed. In addition, Mr. Lucius P. Brown, who has had many years' experience, both in the field and laboratory with Tennessee phosphates, has in hand the preparation of a preliminary bulletin on that subject. As some additional field work is still needed, the appearance of that bulletin will be delayed until late in the spring.

Zinc.—Though no field work has been done by members of the Survey on the zinc deposits of the State, advantage has been taken of the knowledge of that field by Mr. S. W. Osgood to have a preliminary bulletin prepared by him on the industry in this State.

Clays.—Mr. Wilbur A. Nelson has spent most of the fall in a fairly detailed study of the clays and clay resources of West Tennessee. These clays are now being extensively shipped north and east for use in a variety of high grade clay products. Mr. Nelson has collected samples of most of the clays as well as samples of the wares being made in that section. In addition, the several outside companies using Tennessee clay have contributed samples of the ware made by them, which with the clays collected by Mr. Nelson; are now on exhibition in the Geological exhibit. A report on the results of this work will appear during the spring. In addition, considerable attention has been given to the clays found in Middle and East Tennessee. It is hoped that by another season a systematic study of the clays of Middle Tennessee may be undertaken similar to that carried on this year in West Tennessee.

Copper.—The U. S. Geological Survey recently completed a large scale topographic map of the copper district of Polk County. During 1910 Mr. W. H. Emmons, of that Survey, has been engaged in a close study of the geology and resources of that area. Through the liberality

of the Federal Survey, the State Survey hopes to be able to publish a preliminary economic paper, giving the results of Mr. Emmons' study.

Drainage Reclamation.—Probably the most important single piece of work done by or under the auspices of the State Survey has been in connection with the drainage reclamation of the little river bottoms of West Tennessee. At the time the Survey started drainage surveys were in full progress in Obion County. Two drainage districts in Gibson County had filed petitions for surveys and organization, and districts on streams in that and other counties had or have since taken the first steps toward the formation of such drainage districts. In cooperation with the Drainage Investigations Division of the U. S. Department of Agriculture, a preliminary study was made of the conditions on the Rutherford Fork of Obion River and on the North and Middle Forks of the Forked Deer River. This work was done by Messrs. A. E. Morgan and S. H. McCrory, drainage engineers from the federal bureau. Upon the completion of their work a report with recommendations was filed, which was printed by the Survey. Following that an arrangement was made with the U. S. Geological Survey for the topographic mapping of the river bottoms. As it was necessary in connection with such mapping to obtain accurate lines of levels and of horizontal control, and as such levels and control would be necessary and of value to all proposed drainage districts in Obion, Weakley, Gibson and adjoining counties, a cooperative agreement was made with the U. S. Survey to extend a net work of levels over all of that territory to which later the drainage surveys of the immediate river bottoms would be tied. This work occupied most of the summer, and was sufficiently completed by October 1, so that topographic parties could take up the work in the river bottoms. Such work was completed on the Rutherford Fork of the Obion River in Gibson County, and on the North Fork of the Forked Deer River in Gibson County. It is probable that by another season similar surveys will be requested on the Middle Fork of the Obion River in Weakley County, the Middle Fork of Forked Deer River in Gibson and Crockett Counties, and the North Fork of Forked Deer River in Dyer County as far down as Dyersburg. With the beginning of the rainy season, late in December, cooperation was again had with the Drainage Investigations Division for a study of run-off, sand wash and other problems, data upon which will be necessary to complete the engineering plans for the reclamation of these valleys.

Water Resources.—In 1903 and following years, Prof. Glenn, Asso-

ciate Geologist of the Survey, made a detailed study of the underground water resources of West Tennessee, which was published by the Water Resources Branch of the U. S. Geological Survey. At present Prof. Glenn is engaged in extending that study in a less detailed way over Middle and East Tennessee. This study will take some time, but it is possible that a report may be prepared early in 1911. This will include a study of present sources of water supply, possible sources of water supply, water power and mineral springs.

Road Building.—A beginning has been made in the study of road-building materials, and of the conditions affecting road-building in various parts of the State. Some of the quarries have been visited from which road material is obtained, samples and photographs have been gotten, and some studies made on the wearing and other qualities of completed roads using these materials. A bulletin on the building of the roads in Tennessee is in preparation.

Forestry.—Among the duties assigned to the State Geological Survey by the General Assembly in the bill establishing that Survey is the following: "An investigation of the forests, . . . with special reference to their conservation and development for industrial enterprises." In accordance with this provision, the Geological Survey secured the cooperation of the Forest Service of the U. S. Department of Agriculture, in a preliminary examination of forest conditions in this State, and in a brief study of the rate of growth of second growth hardwood. The object of the preliminary examination which is being made by Mr. R. Clifford Hall is to collect as much information as is possible in the very limited period of time available, with a view to recommending a progressive forest policy for the State. A statement of the conditions found and recommendations made is given in Appendix A.

The study of the second growth hardwoods, which is being made by Mr. W. W. Ashe, is taken as an example of the scientific investigations that should be carried on by the State in order to get at facts of value in managing timber lands on a conservative basis. As usual in such cooperative agreements, the Forest Service pays one-half the cost of this work, and the State Survey publishes the reports, which should be ready to be issued in April.

On the following page is given a table, showing the expenditures by the Survey between May 1, 1910, and December 19, 1910, a period of seven and a half months.

FINANCIAL STATEMENT.

CLASSIFICATION OF EXPENDITURES BY THE TENNESSEE GEOLOGICAL SURVEY FOR THE FISCAL YEAR ENDING
DECEMBER 19, 1910.

	SALARIES				Equipment	Supplies	Field Expenses and Travel	Printing and Engraving	Service	Total
	Office	Field	Drafting							
Nashville office.....										
Administration.....	\$ 616 62	\$ 75 00		\$ 221 43	\$339 15		\$285 10			\$ 845 68
Bureau of Information.....	700 00						5 25			788 77
General studies.....	150 00	95 00								700 00
Preparing Bulletin 1-A.....	225 00						104 50			245 00
Bibliography.....	75 00									329 50
Mineral resources.....	181 50									75 00
Coal work, general.....	100 00		\$ 31 10							181 50
State maps.....			25 00							131 10
State exhibit.....	167 50			644 50						25 00
Library.....				36 00						812 00
Knoxville office and work.....	706 00	50 00	7 25	39 01		67 00				36 00
Field work.....				524 11			5 25			869 26
Drainage work.....	112 50	790 00				814 36				529 36
Pikeville areal work.....		255 00				92 64				347 64
Oil and gas work.....			144 50			166 87				311 37
Phosphate work.....		88 07				167 20				255 27
Clay work.....		81 00				112 96				193 96
Forestry work.....						157 00				157 00
Iron work.....						37 04				37 04
Zinc work.....							50 00			50 00
Postage.....								\$125 00		125 00
Telephone.....									36 80	36 80
Transportation of property.....									42 00	42 00
Miscellaneous.....									20 55	20 55
Total.....	\$3,034 12	\$1,434 07	\$207 85	\$1,465 05	\$339 15	\$1,706 97	\$693 90	\$224 35		\$9,105 46

The above table shows the expenses of the Survey practically to December first. In addition to the amount shown there will be the usual expenses of the Survey during December, including expenses for several parties still at work in West Tennessee, but the principal additional expense, which it is estimated will take up all of the remainder of the first year's allotment or more, will be the engraving of maps and printing of the reports now being prepared.

In addition to the amount shown above as expended by the State Survey, the figures at hand show that the cooperating bureaus have already expended over \$6,000 and will expend much more before the completion of the cooperative work now in progress. It may be safe to say that the cooperative work in Tennessee will have cost the cooperating surveys close to \$10,000, if not more, so that when all of the work now on hand has been completed and published the Survey will have had the benefit of \$25,000 worth of service.

PROGRAM AND RECOMMENDATION FOR 1911.

In planning field work from season to season regard is paid to two factors—first and foremost to the body of requests for information along any given line, and, second, information obtained about resources that would seem to offer opportunities for development. Thus, there is hardly a day that does not bring at least one request for information about the coal fields of Tennessee; therefore, any plans should evidently include work on the coal fields in order to obtain the information necessary to answer these inquiries. As an example of resources that may prove of large value, it is known that the horizon of the famous Bedford oölitic limestone of Indiana runs through Tennessee. This stone is probably more used as a building stone than any other stone in the United States. At present Tennessee is using large quantities of that stone obtained at Bowling Green, Kentucky. But it is reported that the Bowling Green quarries are nearing commercial exhaustion. The locating and describing of good stone at that horizon in Tennessee would therefore possibly lead to the establishment of a large new industry in this State.

Based on the two factors just mentioned the following are some of the lines of work for which there appears to be more or less urgent demand.

FIELD WORK ON FUELS.

- Coal.*—(a) Preliminary reconnoissance survey of the whole field;
(b) continuation of detailed study of coal field in Crossville area, based

on the new detailed topographic map of the Crossville area made in 1910.

Oil and Gas.—(a) Study of conditions in the field of former production (Fentress, Overton and Scott counties, etc.); (b) study of the conditions in southwest corner of State where active drilling is now being done.

Lignite.—Recent work of the Federal Mining Bureau has shown that lignite used in the producer gas engine will yield as much power per ton as the best bituminous or anthracite coal when used in the ordinary steam engine. There are known to be beds of lignite in West Tennessee that might prove of large value to local industries. Their location and value should be determined.

BUILDING MATERIALS.

Marble.—(a) The area of the Hawkins marble of East Tennessee has been mapped by the U. S. Geological Survey, but that Survey made no study of its commercial or economical aspects. The whole of the outcrop should be studied to determine the character of the bed at all points, whether lying so that it could be quarried, etc., etc. (b) There are known to be many other marbles in Tennessee besides the one now being so extensively quarried. They should be examined and mapped.

Oölitic Limestone.—The possibility of locating sites for quarries of oölitic limestone in Tennessee should be undertaken at once. The whole outcrop should be examined to determine the location of high-grade stone and points where it could be economically quarried.

Cement Material.—There have been many inquiries in regard to suitable sites for the location of cement plants. It is known that Tennessee has suitable materials, but much study will be required to determine just where the several materials occur near each other, and under favorable commercial conditions as regards transportation, etc.

Sandstone and Limestone.—Notwithstanding the large use of cement, there is still much demand for sandstone and limestone for structural purposes. The Survey should have information as to where these materials can best be obtained.

Granite.—For certain classes of structural work granite will always be in demand. The granite deposits of Tennessee have never been studied from the commercial standpoint.

Slate.—The slate industry is one of the new industries of this State. Field studies might show deposits of much value.

Clay.—(a) Preliminary study of the clays of Middle Tennessee, similar to that made in 1910 of the clays of West Tennessee; (b) similar study of the clays in East Tennessee.

Shale.—Examination of shales for use in the manufacture of paving brick, tile, etc.

FERTILIZERS.

Phosphate.—During the past year many specimens of phosphate rock have been sent to the Survey office, suggesting a much wider distribution of the phosphate rocks than has usually been suggested. (a) Reconnaissance study of scattered points from which phosphatic rocks have been obtained; (b) detailed mapping and examination of horizon of the blue phosphate around the north end of the basin in Middle Tennessee. (c) Similar study of the blue phosphate horizon around the south end of the basin of Middle Tennessee; (d) general study of the brown phosphates, with detailed mapping; (e) general study of white phosphates.

Green Sand.—The recent activity of Germany in stopping the exportation of potash has created a large interest in the native potash deposits. The green sands of West Tennessee are known to carry considerable amounts of potash. They should be studied both in the field and laboratory.

METALLIC ORES.

Iron.—Next to the studies in the coal field the iron ores rank second in interest and importance. The following studies should be made in the very near future: (a) Detailed study of iron ores of the Chattanooga district (in cooperation with the U. S. Geological Survey and Chattanooga Chamber of Commerce); (b) general study of the iron ores of the western part of Middle Tennessee; (c) general study of the iron ores of the eastern part of East Tennessee. It will be necessary in some of this work to supplement the ordinary field work with some prospecting.

Zinc.—East Tennessee has extensive belts of zinc-bearing rocks. A great difference of opinion exists as to the exact extent and value of those deposits. They should be thoroughly studied and their exact value determined as well as can be done without actual prospect drilling.

Lead.—Many undeveloped lead prospects are known. These should be examined to determine if any of them are of value.

Gold.—Much interest has recently been aroused in the possibility of finding gold in Tennessee. The known gold fields of the State should be studied to determine their extent, probable future value, etc.

There are many other metallic ores, such as bauxite, pyrite, manganese, etc., that should be studied in the near future.

MATERIALS USED IN THE ARTS.

Barytes.—The deposits of barytes should be mapped and their value determined.

Fluorspar.—Fluorspar is known to occur at many points in the State. These should be studied to determine if any of the deposits are of commercial size and value.

Glass Sand.—Glass sands are doubtless abundant in this State. Their position and value should be determined.

Paint Materials.—There is a variety of paint materials in the State—ochres, oxides of iron and zinc, etc. Deposits of these should be examined to determine their extent, quality and value.

ROAD MATERIALS.

The State is at present making great strides in the building of good roads, and is doubtless to do much more in the coming years. That the best and most economical results be obtained, definite information should be had of the nearest available materials, of their relative value, of how best used, etc. To determine all these matters with certainty will require much study, and that study should be undertaken at once.

SOILS.

Soil Surveys.—The study of the soils of this State is one of the largest objects before the survey. The immediate work should be a general study of the soils of the State, and detailed studies of the soils of selected areas, including studies as to their use, the special treatment they need, the crops to which they are best adapted, etc., etc. The detailed work will be undertaken in cooperation with the National Bureau of Soils.

Hillside Wash.—Preliminary studies should be made of the causes and remedies of hillside washing.

WATER RESOURCES.

Underground Waters.—Studies of the underground water resources of (a) Middle and (b) East Tennessee, similar to that already made by Mr. Glenn in West Tennessee.

Water Powers.—The bill providing for the establishment of the Appalachian Park, recently passed by Congress, required the examining of the territory involved, by the U. S. Geological Survey before any lands are purchased, such purchases being upon its recommendations. In a recent conference with Mr. Leighton, Chief of the Water Resource Branch of that Survey, it was learned that if the State were prepared to cooperate in that work in the near future, it would be possible to obtain information desired by the State on its water powers, etc., at probably not more than one-third to one-fourth of what it would cost the State to do the same work by itself. It would seem wise, therefore, that the State Survey should be prepared to cooperate to as large an extent as may be necessary in order to take full advantage of this opportunity now before it. Such a study should include stream gauging, to determine the largest, smallest and average flow of water in the many streams, surveys to determine the fall of the streams, where the fall is greater, where suitable sites exist for the location of dams, the probable amount of power obtainable at the different seasons of the year, etc.

Drainage.—The experience of the year just passed in the drainage reclamation of the stream valleys of West Tennessee has shown the need of engineering assistance, and supervision by the State. It has been apparent that the Survey should have one or more thoroughly trained drainage engineers, who could study the special problems involved, who could confer with the engineers in charge of the several districts to insure that plans made by them are adequate for the purposes intended, and that such plans, when carried out, will not affect adversely those owning lands in other drainage districts on the same stream, and who could, in special cases, be designated by the county courts to have supervisory charge of drainage projects, when so desired by the petitioners for any drainage district. In such a case, they would serve as the engineer required by law, thus giving small drainage districts the benefit of a thoroughly trained engineer as well as the large districts, that are large enough to employ a competent engineer.

FORESTRY.

The passage of the Appalachian Park bill by the United States Congress, opens a new chapter in the forest development of the

southern United States. Among other things the bill provides a definite sum to be used by the Secretary of Agriculture to cooperate with the several States in preserving the forests from fires, etc., and calls on the States for cooperation to such an extent that it would seem desirable that this State organize a special bureau to handle that work. Furthermore, while the State Geological Survey will gladly continue such studies of the forests of the State as are now in progress or have been made during the past year, it is felt that the magnitude of the lumber and timber interests in this State warrant a larger recognition from the General Assembly, and I would therefore recommend that, without cutting into the other appropriations just named, the General Assembly provide for the establishment of a distinct bureau of forestry. The needs in this case and a fuller explanation of the recommendation is given in Appendix A, in a statement prepared at my request by the U. S. Forest Service after a preliminary study of the conditions made in this State.

In brief, the recommendation is made that there be created a board of seven (7) members, in part, state officers *ex officio*, and in part, practical lumber men; the appointment of a State Forester. The recommendation suggests the authority and duties of the board and State Forester, principally by the transfer of powers and duties conferred by the present law to that board and provides a definite appropriation to make effective the purposes of the act, and suggests coöperation by the counties, both physically and financially.

EDUCATIONAL BULLETINS.

In addition, if time and money will permit, there are planned four educational bulletins, describing the general, physiographic and economic geology of the four principal divisions of the State, including (1) the valley of East Tennessee, (2) the Cumberland Plateau region, (3) the basin of Middle Tennessee and Highland Rim, and (4) West Tennessee; and in particular the geology and economic development around (1) Knoxville, (2) Chattanooga and Sewanee-Monteagle region, (3) Nashville, and (4) Memphis. Those places are chosen partly because they are centers of population, and partly because of the large numbers of visiting students and teachers. Thus, at Knoxville in addition to the University, the summer

school is attended by about 2,500 teachers from all over the State; Monteagle is attended by many thousand teachers and others, and Nashville is reported to give instruction each year to over 10,000 visiting students.

These bulletins will not only illustrate the geology of the areas mentioned, but will also show the extent and manner of using the resources of those regions, thus serving not only for the instruction and entertainment of those residing or attending there, but furnishing data for the information of those living elsewhere, who may be seeking to know more about Tennessee.

TOPOGRAPHIC MAPPING.

So long as the work of the State Geological Survey is of a preliminary reconnoissance nature, it can use such maps as are available, supplemented by compass meanders and other rough surveys where no maps exist. Such maps will necessarily show only the large features. For the detailed studies, which it is proposed to undertake, it will be necessary to have larger scale detailed topographic maps.

The following extract from Bulletin 1-A, page 14, explains the value and cost of making topographic maps:

"The making of maps will form no small part of the work of the Survey. These will range from small scale maps of the State, showing only the county seats, to large scale detailed maps of small areas, showing all of the roads, trails, houses, streams, the exact shape of the hills and valleys, the location of the mines, quarries, springs, etc. Some of the more detailed maps will show every five-foot change of level in the ground. These maps may be published simply as geographical maps for the use of engineers, surveyors, travelers, landowners, prospectors, or other people; or they may form a basis on which are placed facts about the geology, or soils, or timber, the roads, water supply, markets, or any one of those things with which the Survey is to deal.

"High-grade, plain, geographic maps, showing the topography, are much studied and used, where they exist, for the location of steam and electric railways, of State and county highways, of schools, telegraph and telephone lines, for the laying of water pipes, aqueducts and sewerage systems, for the drainage or irrigation of land, for the position of county and township lines, for selecting the best routes for automobile tours or for tramps, in planning maneuvers of the National Guard, in connection with the purchase or sale of land, in gaining exact knowledge of the country, elevation of places, distances and directions between places, and for a multitude of other uses.

"In the early days the geologists made their own maps as they went, and in reconnoissance work that is often still necessary; but where detailed work is to be done, requiring topographic maps on which to publish the geologic results, it has been found much more economical to train men for the specific purpose of map making. To obtain such maps, there is required accurate

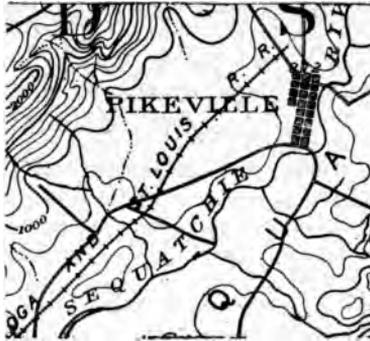


FIG. A. Fragment of Pikeville Topographic Atlas Sheet
 Date, 1886-1890. Scale, 1 inch = 2 miles.
 Same area as figure B.

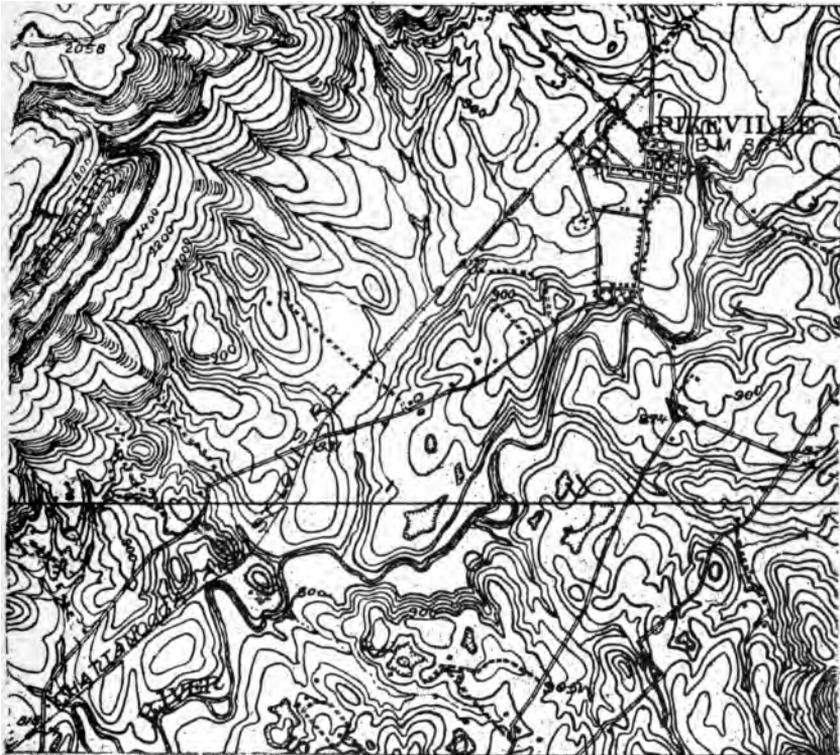


FIG. B. Fragment of Pikeville Special Atlas Sheet
 From photograph of field drawing, contours in escarpment west of Pikeville not all shown.
 Date, 1908-1909. Scale, 1 inch = 1 mile.
 Same area as figure A.

Figures showing contrast between earlier topographic maps (1890) and recent topographic maps. The figures show scale of publication. The area in each is the same.

primary and secondary triangulation, traverses, and leveling work. The preparation of such maps is expensive, costing from \$4 to \$50 per square mile, according to the scale of the map and the character of the country. It has been the practice of most of the States needing such maps to ask the cooperation of the Topographic Branch of the United States Geological Survey, which stands ready within the limits of its funds to make such maps where requested, the State and National governments sharing alike in the cost of the field and office work, but the National Government assuming the entire cost of engraving and printing the maps. At present forty-eight per cent of Tennessee, mostly in the eastern and central parts of the State, has been covered by such mapping, which, in most cases, has been followed by geologic mapping. The early maps, both topographic and geologic, were done rapidly and at small cost. Gradually the grade of such work has been improving, until today the United States Government frankly labels later editions of the early maps as 'reconnaissance' maps. As the grade of geologic work has risen, it has been found necessary to have better and better topographic maps in order to adequately represent the geologic facts obtained. This has continued until today the older topographic maps are entirely inadequate for the representation of geologic facts as obtained by modern methods. The first step in geologic work has, therefore, been the securing of adequate topographic maps.

"Fortunately, for the beginning of the new work in Tennessee, a few of such up-to-date topographic maps have been made in this State within the last few years. The recent topographic maps on hand will suffice for the geologic work for the first season or two, but soon active steps must be taken to secure similar good maps of other areas on which the Survey desires to do work. Efforts to secure additional modern topographic maps in Tennessee by the United States Geological Survey will be made.

"The present funds of the Geological Survey of Tennessee do not warrant seeking such cooperation, except to a very limited extent. It is hoped in the future that more funds will be available for that specific object."

The difference between the early maps and those at present being made can best be illustrated by taking out a small piece of the old Pikeville topographic atlas sheet and comparing it with the modern Pikeville special sheet, covering just the same area. As will be noted, the scale of the new map is double that of the old, but of even greater importance is the accuracy of the new map, and the amount of detail shown. It will be noted that the part of the new map shown is from a photograph of the field drawing, and therefore, does not always represent all of the contour lines as the complete engraving will do. The engraved lines will also be finer than those of the photograph from which the cut is made.

A comparison of the two maps will readily show the difference in the possibility of locating one's self with accuracy.

Aside from the gradual resurveying of that part of the eastern part of the State which was surveyed in the early days of that work

much of Middle and all of West Tennessee remains to be mapped. As the State Survey desires to do a large amount of detailed work in both of these subdivisions of the State, it is going to be necessary to delay such work until such maps can be made.

During the past year \$2,000 of the Survey's funds were devoted to the inauguration of topographic mapping in West Tennessee. From what was stated in the preceding paragraphs, it is evident that much more must be set aside for that work if the mapping is to keep pace with the future needs of the Survey.

DISCUSSION OF PRECEDING PROGRAM.

It is a general belief that in the decade beginning with the year 1911, the whole South is going to make a greater advance than ever before in her history, and many believe a greater proportional advance than any other section of the nation. As Governor Woodrow Wilson expressed it at the Southern Commercial Congress at Atlanta, recently, the South is tense with unused power and strength waiting for the word go; and all over the South the word is being given. In the cities millions of dollars are being spent in improvements that will put them on a par with any cities of the world in matters of health, education, streets, lighting and safety, and hundreds of thousands of dollars are being spent by the cities in learning of their resources and advertising them to the nation and to the world. Nor are the cities of this State behind in this matter. Memphis is spending \$50,000 a year in national advertising. Nashville has just decided to increase her advertising fund from \$100,000 to \$200,000. It required a two-page pamphlet to merely list the new enterprises, enlargements and improvements in Bristol, as the result of a six months' campaign. Chattanooga and Knoxville and other cities are using the same methods with the same results—a large increase in industrial plants, the raising of the value of real estate, a gain in population and all of the attending advantages.

In this forward movement, the States are also going to take an active part. During the ten years from 1900 to 1910, Tennessee stood next to last of the Southern States in advancement as expressed in the gain in population. That standing should not be repeated in the ten years just beginning, but if it is not to be true for the coming ten years, the State must do just as any business firm or corporation

would do—learn her resources and advertise them as do other States. The State Geological Survey is peculiarly the agency for doing that work.

In preceding paragraphs there have been outlined suggested lines of work. This is only the beginning of work that must be done before the State will know the extent and value of her natural resources. But to do the work outlined in those paragraphs adequately, and with such accuracy as to warrant definite assertions, would require not less than \$100,000 a year, in fact it may be doubted if the present allotment for the Survey work would pay for the printing and distribution of the reports when prepared.

In view of these facts, in view of the unequalled resources of this State, in view of the conscious effort on the part of all of the States of the South to advance their physical development, in view of the fact that this State has been behind all of the other States in acquiring knowledge of her own resources, and in view of the opportunity now before the State, I recommend that for the work of this Survey a sum of not less than \$25,000 a year be appropriated to be immediately available in addition to any balance that may remain from the present appropriation. In this connection it should be remembered that even with \$25,000 a year it will not be possible to do more than one-fourth of the work outlined in the program given in preceding pages. With such an appropriation, however, it would be possible to more adequately meet the pressing demands now being made on the Survey for information that should lead to the State's advancement.

APPENDICES.

In the preceding pages have been given a brief resume of the work of the Survey for the partial year of 1910. In the following pages are given in less condensed form: (a) A statement relating to the future forest policy of the State; (b) samples of press bulletins describing some of the work and some of the results of the Survey's work; (c) two addresses, describing the relation of the Survey to the coal men and to the farming interests of the State; and (d) descriptions of two exhibits prepared by the Survey.

APPENDIX A.

As a result of a cooperative study of the forest conditions in Tennessee, and at the request of the State Geologist, the U. S. Forest Service have prepared the following statement of the conditions found in this State, and have made certain recommendations for strengthening the present forest law:

(Statement of the U. S. Forest Service.)

The field work on the examination of forest conditions in Tennessee was begun the first of November, and has been carried to such a point that the chief needs of the State in regard to forest legislation are apparent. Therefore it is deemed advisable to prepare a brief preliminary statement as a part of the administrative report of the State Geologist.

The recent movement for the conservation of natural resources has brought to the attention of all thoughtful men the evils resulting from too great a depletion of the timber supply. The loss from this cause would be especially heavy in Tennessee, where the wood-using industries are of great importance and value. In addition to the immense annual lumber production (1,224,000,000 feet in 1909), the large output of hewed ties, posts, mine timbers, wood, tan bark, and miscellaneous forest products adds enormously to the wealth of the State. Many large factories of various kinds, dependent chiefly on local wood supplies, afford profitable investment for capital and a good livelihood for thousands of workmen. The mountainous districts of the State, in particular, depend on the forests, and if the forests are destroyed, there is an impairment or destruction of one of their chief sources of income—practically the only source where coal or other minerals are lacking. The protective value of the forests located on the headwaters of streams in regulating the flow of water is also well understood, as well as their scenic value in making the country more attractive as a summer resort, and benefiting those who come from the cities of the State for recreation or health.

In twenty years, practically all of the timber that is now either virgin or lightly culled will be cut over. A few large manufacturers claim a supply for their sawmills that will last thirty to forty years, but these cases are exceptional. Even now there are no virgin tracts of any extent outside of six or eight counties, most of which are on the North Carolina line. A large part of the timberland now being lumbered consists of small bodies previously culled of the high grade trees, and the operations are usually by small portable sawmills. Consumers of high-grade stock, such as manufacturers of tight staves, of hubs and spokes, and of furniture, report a growing scarcity of timber suitable for their purposes. All indications point to a continued supplanting of higher grade timber with lower grades, as far as this is possible, and to a period of scarcity and greatly restricted production in the not far distant future.

The exhaustion of the virgin timber, however, is not in itself a disadvantage. It is even necessary that mature and decadent timber be cut to prevent

loss and to allow younger trees room for development. The great evil lies in the fact that little or no attention is paid to securing a valuable second growth. There is a great deal of land in the rougher parts of Tennessee that will yield little or nothing in any other crop than forest trees. Yet in the face of the growing scarcity of timber, these lands are being allowed to become unproductive through neglect. If all of the valuable trees large enough to bear seed are cut off and much of the young growth smashed down in logging, it can not be expected that the forest will renew itself with commercially valuable species. If fires are allowed to burn over the ground every year, removing the fertilizing and moisture conserving mat of leaves and litter, and giving insect and fungus enemies a chance to enter the trunks of trees that are too large to be killed directly, it cannot be expected that the young growth will develop rapidly into timber of quality, or that the fertility of the soil will be maintained. If timber lands are to remain in a productive state, they must be treated intelligently. No one expects to grow any other crop without attention, and yet no crop matures as slowly as the forest crop or requires as long a period of time for the rectifying of mistakes in management.

The forest land of Tennessee is practically all held by private individuals, and the greater part of this land will continue to be so held, even if Congress sees fit to establish by purchase a National Forest in the Southern Appalachians. If forestry principles are to be applied in order that the woodlands may continue productive, it must be done by these private owners. Most of them will do little or nothing along this line unless the State shows them the need and advantage, and assists them in using proper forest methods. At the same time, the State should help in giving these landowners protection from fire. There is now a very thorough fire law on the statute books; it provides penalties for setting forest fires carelessly or wilfully, but the machinery for enforcing it needs strengthening. In addition, an educational campaign to show the damage that results from surface fires in woodland is greatly needed and will do more to protect the forests from this danger than any amount of legislation. It is now recognized by many States that it is to their advantage to promote better methods of forestry just as they are encouraging improvement in agriculture. Sixteen States employ one or more trained foresters in such work.

The following suggestions for a State forest policy seem suited to the needs and conditions of Tennessee:

A State Board of Forestry should be created consisting of the Governor, the State Commissioner of Agriculture, State Geologist, State Game Warden, Director of the Tennessee Agricultural Experiment Station, and two timberland owners to be appointed by the Governor, one of whom shall be a manufacturing lumberman. The members should serve without compensation except for necessary expenses. This board should direct the promotion of the forest interests of the State and should employ to this end a State Forester. He should be a graduate of a reputable forest school, and a man of experience and ability in his profession. His duties should include (1) educational work, such as the giving of lectures on forestry and related subjects before Farmers' Institutes and other public meetings, and the publication of bulletins; (2) the conducting of scientific investigations with a view to increasing the knowledge of the forest resources of the State and to finding out the methods of forest

management best suited to local conditions in different sections; and (3) the administration of State forests for demonstration and experimental purposes. He should be given authority to assist private owners at their request, by making plans for conservative management of woodlands and advising in regard to the execution of such plans, provided that the applicant in each case pays at least the expenses of the field work that may be necessary. He should be authorized to cooperate also with the federal government or other branches of the State government in scientific investigations when this can be done to the advantage of the State. Authority should be given him to make rules and regulations for the State forests, including the right to sell timber, with the approval of the board. In the case of sales amounting to over \$1,000 in value advertisement for bids should be required. The board should supervise and direct all the activities of the State Forester, and make a biennial report to the Legislature showing the nature and extent of the work accomplished.

The forestry law of 1907 provides for a system of fire protection under the office of the State Game Warden, giving the county, special and deputy game wardens the duties of forest fire wardens. They are authorized to take charge of fire fighting, to summon assistance, to inspect railroad rights of way, and to arrest, without warrant, offenders against the fire laws. The law has failed in effectiveness because no provision was made for funds to pay the expenses of fire fighting. Also no arrangement was made for posting warning notices, and therefore few people are acquainted with the provisions of the law. It is believed that better results would be obtained by not trying to burden the game wardens with this additional work which has little relation to their regular duties, and for which they may or may not be fitted. Therefore it is recommended that the State Forester be made State Fire Warden, and that he be empowered to request the Board of Supervisors of each county to appoint, with his approval, a county fire warden, or to appoint one himself should the county board fail to take action. The county wardens should be subject to removal by the State Forester. The powers and duties conferred upon the game wardens by the law of 1907 should be transferred, with some modifications and additions, to the fire wardens thus provided for, who should likewise be given the powers of sheriffs in enforcing the forestry laws of the State. The county wardens should also be required to report, on suitable forms, each fire to the State Forester; to post warning notices; and to patrol in danger seasons if directed to do so by the State Forester. If the State Forester deems it advisable, deputy wardens should be appointed by the county warden, with the approval of the State Forester, to work under his direction with the same powers and duties.

The forestry law of 1907 authorizes the State Game Warden to collect statistics in regard to forest conditions, to investigate the suitability of public lands for forest reserve purposes, to take charge of such reserves as might be created, and to accept gifts of land for forest reserves. These duties lie naturally within the province of the State Board of Forestry and should be transferred to that board. The sections in regard to forest reserves should be so modified as to permit the use of mineral land for this purpose, the mineral rights to be retained by the original owner, if the land is acquired by purchase or gift.

The State now owns two tracts of land that would be suitable for forest

reserve purposes: the Brushy Mountain tract in Morgan County and the Herbert Domain in Cumberland and the counties that adjoin on the southwest. The Board of Prison Commissioners, which now controls these lands, has no authority to sell timber or practice forestry. It is recommended that the surface and timber on these tracts be turned over to the Board of Forestry to administer as State forests. Thus an opportunity may be given to start at once valuable object lessons in the practice of forestry, as well as experimental investigations. It would also make it possible to stop the loss now incurred by the State through the decay of over-mature timber which cannot be sold under existing statutes. It is also recommended that the Board of Forestry be authorized to purchase, with the approval of the Governor, land for State forest purposes, at a rate not to exceed \$5.00 per acre. This authority would probably not be exercised for the present, at least, owing to lack of sufficient funds at the disposal of the board, but would be desirable in case any small tract is needed in connection with the administration of lands now owned by the State and made State forests in accordance with these recommendations.

The expense of carrying out the forest policy as outlined naturally divides itself into two parts—the cost of the State Forester's office in educational, scientific and administrative work, and the cost of fire protection. The first should be met by a State appropriation of \$10,000 per year. This would be supplemented by a State forest fund, into which all receipts from the sale of timber on the forests and fines for violations of the forestry laws would be paid. This fund should be used in the protection, improvement and extension of the State forests, or in emergency cases for fighting fire in a county which has exhausted its annual allowance for this purpose. The cost of the general fire protection system should be shared equally between the State and the individual counties in which the money is spent. This division prevents the placing of too great a burden on the more thinly populated counties, and is perfectly fair since the protection of the forests benefits indirectly the entire State, as well as the individual counties. To secure promptness in payment of fire fighters, the State should pay the accounts and collect one-half from the county in which they were incurred. The rate of compensation for fighting is fixed in the present law at \$3.00 per day. This is unnecessarily high, and would be an inducement to set fires in order to get employment in putting them out. It is recommended that the rate be changed to 20 cents per hour and that the county and deputy wardens be paid at the rate of 25 cents per hour for time actually employed in fighting fire, posting notices, making reports, or doing other official work. They should also be reimbursed for reasonable expenses for necessary equipment and transportation. All accounts, including those for wages, should be approved by the State Forester before payment. The amount to be spent for fire protection in any county in any one year should be limited to \$200.00 and in the entire State to \$10,000 per year. The total cost to the State of the forest policy recommended could not then exceed \$15,000 per year, and the cost to any one county could not exceed \$100.00 per year, while the maximum total expense per year would be \$20,000. This ex-

penditure is to be regarded as an investment, the returns to come in the form of increased productivity of the woodlands, in the saving of loss through fire, and in the maintenance of wood-using industries.

Forest conditions, problems of forest management in the different regions of the State, and questions connected with the carrying out of a State forestry policy, will be discussed in the report, which will be issued soon after the completion of the examination now being made by the Forest Service, and upon which these preliminary recommendations are based. This report will show more fully the need for a definite progressive forest policy.

APPENDIX B.

As the several papers published by the State Geological Survey have been issued at different times, and do not accompany this administrative report, copies are given beyond of the press bulletins issued at the time of their appearance in order to give a synopsis of what they contained.

PRESS BULLETIN NO. 4.

STATE GEOLOGICAL SURVEY ISSUES ITS FIRST BULLETINS.

The State Geological Survey has just issued its first bulletins. These consist of part "A" of Bulletin No. 1, on the establishment, purpose, scope and methods of the Survey, which tells what the Survey proposes to do, and how it will do it and the benefit to be derived from its work, and Bulletin No. 3, on drainage reclamation in Tennessee. Part "A" of Bulletin No. 1, is by the State Geologist. It deals, in a broad way, with the need of a State Geological Survey and the status of such a survey in the economy of the State. It gives the bill under which the Survey of this State has been established, the personnel and the facts connected with its establishment. It then takes up the objects of the Survey, and points out some of the distinct lines of service it may render to the State and to the citizens of the State. Under "Scope of the Survey" its various lines of study are outlined, and an idea is given of the information to be studied, including everything from the setting of meridian lines at the county seats to the study of the smokeless combustion of fuels; from the detailed mapping of the phosphate rocks to the reforestation of the Cumberlands. The inside workings of the Survey are explained under the heading of "Methods." The bulletin closes with a frank statement of the Survey's relation to the public. Bulletin No. 1, part "A," can be obtained upon request when accompanied with necessary postage, two cents.

STATE ISSUES A REPORT ON THE DRAINAGE OF THE BOTTOM LANDS OF
WEST TENNESSEE.

The State Geological Survey has just issued Bulletin No. 3, on "Drainage Reclamation in Tennessee." The bulletin contains three papers; the first, on drainage problems in West Tennessee, by the State Geologist, discusses the general problems and benefits involved in the drainage of the river bottoms. It points out that not only today, but all through history, the alluvial flood plains of the rivers have been the richest agricultural lands of all nations, but that to secure the use of these flooded plains, it has always been necessary to protect such lands from the floods, and that when so protected these lands are changed from worthless lands, a constant menace to health, to lands of the highest value. It cites the case of Illinois, where some of the richest lands of the State today were continuous swamps when the State was first settled. The author discusses the question of cost, and of value after reclamation, how funds are obtained, etc.

Some idea of the magnitude of the undertaking is gained from the statement that there are estimated to be 1,000,000 acres, in West Tennessee alone, needing reclamation, and involving an expenditure by the districts involved of from \$10,000,000 to \$15,000,000, but he points out that when fully reclaimed, the State will have gained practically 1,000,000 acres of the most productive land in its borders, and the lands so reclaimed will have increased in value by probably not less than \$50,000,000.

The paper then discusses the present conditions in West Tennessee, the width of the bottom lands, the gradient of the streams, the fact that flooded conditions are growing worse, rather than better. The author points out the distinct problems to be met, the stages of the work of reclamation, the causes of past failures elsewhere, the preliminary data to be collected and how the construction work is to be planned.

The passage of drainage laws in Tennessee, making possible the proposed reclamation is referred to and the special province of the Geological Survey in the work pointed out.

The second paper is by Messrs. A. E. Morgan and S. H. McCrory, drainage experts of the National Drainage Investigations Division of the Agricultural Department at Washington. It is the first of the reports covering cooperative work between the State and National Governments. It describes the results of a preliminary study of the drainage conditions as they exist in Gibson County. The idea of this study was first to determine the feasibility of the reclamation of the stream bottoms of that county, then the factors to be dealt with and their relative importance, to get some idea of the cost and to give general recommendations on the carrying on of the work. The advantage of having the opinion of experts of such wide experience and training can hardly be estimated. It is realized somewhat when it is noted that they report that the plan of construction that has been proposed for the North Fork of the Forked Deer River would not have taken care of more than one-fourth of the average storm waters, of the average year, let alone the abnormal storms, which occur every few years. Also that they report that the plan of constructing side ditches, which has been proposed, would result in quickly choking up the main channels and require their constant cleaning out, or

nullify all of the benefits of the reclamation work. The report, which is illustrated with a map, gives a general description of each of the river valleys. It gives detailed figures of the rainfall in that region, making a special study of the more important storms of which there is record, especially of the storms of December, 1902, and November, 1906. It describes the conditions governing the run-off, the side wash, etc., and points out that while control of soil erosion and deposition from the hillsides will not be a very serious problem, it is one which cannot be neglected, and which, if not adequately provided for, will render all the rest of the work of no avail. They suggest methods of controlling the soil erosion either by the use of collecting ditches, or of collecting basins. They discuss the prevention of erosion, etc. Under other headings they consider the possibility of enlarging smaller channels by erosion and discuss in a broad way what constitutes reclamation. In general they recommend that no work be undertaken, which will not insure entire freedom from overflow at least three or four years out of five. They suggest that the very occasional storm, which may on the average come not more than once in ten years, need not be taken into account, though it would be much better were it done. They discuss plans for the improvement, the benefit to be derived, the surveys that it will be necessary to make and close with certain recommendations for the future carrying on of the work.

It may be noted in passing that the detailed surveys of these valleys are to be undertaken in the very near future, and it is expected that additional data on the run-off will be obtained the coming fall, thus securing all of the data necessary for planning adequate construction work.

The third paper of the bulletin is a reprint of the drainage law in the State in this form to be of service to engineers and others interested in the drainage problems of this and other States.

While part of the edition of this bulletin will be bound together in a single volume, another part of the edition of the three papers will be bound separately in order to facilitate their distribution where only one of the papers is desired.

Copies of the bulletin as a whole or of any of the three papers may be obtained upon request from the State Geologist, Capitol Annex, Nashville, Tennessee, upon receipt of the necessary postage. The postage of the bulletin as a whole will be six cents and two cents for each of the three papers.

PRESS BULLETIN NO. 5.

AN OUTLINE DESCRIPTION OF THE MINERAL RESOURCES OF TENNESSEE.

The State Geological Survey has just issued a new bulletin, this time a preliminary paper on the Mineral Resources of Tennessee. This bulletin was prepared primarily to accompany the exhibit of the State's resources being made by the Survey at Knoxville at the Appalachian Exposition. The bulletin deals with the general geology of Tennessee in a very few paragraphs, and then gives from a part of a page to several pages to each of the many mineral resources of the State. The bulletin opens with a general introduction on the State as to its size, location, its favorable situation with reference to markets, climate, etc. In this connection the State Geologist makes the assertion that "with her abundant and varied mineral resources, soils and climate, Tennessee,

if cut off from communication with all other States, could continue to supply herself with all, or nearly all, of the needful materials to maintain her present or future civilization. Water power and coal would supply her with power; her iron, lead, zinc, copper, gold, silver, aluminum and other mines would supply her with metals; her building stones, marbles, clays, cement materials and forests would supply her with building materials; the materials used in chemistry and the arts she could secure from her own storehouse, if cut off from outside supplies; and with the exception of tropical fruits, she can raise any food raised anywhere in the United States."

Under the heading of surface features of Tennessee, he states that "it is safe to say that no State in the Union excels it in general attractiveness of physiographic aspect," and gives the reason therefor. A table is given of all of the named rock formations in the State, showing their position in the geological time scale, their correspondence in different parts of the State, and then is given a brief description of each formation. This is followed by an outline history of the State's geology, pointing out the recurring times in which the State has, in part, or whole, sunk beneath the ocean and received deposits of one kind or another, and again been lifted out of the sea and been subject to erosion; he cites the great changes which took place, resulting in the mountains and valleys of the State.

Under the heading, "The Lay of the Rocks," a brief description is given of the way the rocks of the State lie, whether horizontally or in folds, a condition that has a great bearing on the position of oil and gas pools.

The most important part of the bulletin, however, is that dealing with the economic minerals of the State. These are taken up alphabetically, and a brief summary is given of what is now known of their occurrence and character, the ores from which they are derived, their value, etc. Among the many minerals discussed might be mentioned barytes, bauxite, cement, chert, clay and shale, coal, copper, fluorite, gas, glass sand, gold, granite, iron, lead, lignite, limestone, manganese, marble, metallic paints, mineral springs, novaculite, oil, phosphate, silver, slate, zinc and many other less important minerals.

While the report as a whole is simply a digest of what has already been written about Tennessee, much of what has been written is not in available form, and many new facts have been added, some of which have been well known but have not gotten into print, and some of which have been gained by the Survey during the past few months. The section on oil and gas may be cited as a case where the results of a special study the past summer are drawn on. The detailed results of that study will appear later as a separate bulletin.

The paper just issued forms part "A" of Bulletin 2, "Preliminary Papers on the Mineral Resources of Tennessee," and will be followed by parts "B" to "H" containing somewhat longer papers on the coal, oil and gas, marble, iron, phosphate and other resources.

The report can be obtained at the office of the Survey in the Capitol Annex, or by writing to the State Geologist and inclosing postage, two cents.

PRESS BULLETIN NO. 6.

GREAT QUANTITIES OF ZINC ORE IN TENNESSEE ONLY AWAIT CAPITAL FOR THEIR DEVELOPMENT.

Recent developments have demonstrated the possibility of profitable mining the bodies of low grade ore forty to fifty miles long and hundreds of feet wide. The State Geological Survey has just issued a bulletin of less than twenty pages, dealing with the mining of zinc in Tennessee. The paper is illustrated and was written by Samuel W. Osgood, of Knoxville, who has been associated with zinc mining in the Joplin and Galena districts, and more recently in the East Tennessee district. The paper refers briefly to the character and geology of the ore. Then discusses the past history of zinc mining in Tennessee, and points out the causes of past failures. Then it describes recent experimental developments on a much larger scale than had heretofore been attempted with results that lead Mr. Osgood to believe that the profitable development of the ores have been demonstrated.

The ore is of a low grade though higher than the Joplin, Missouri, ore, and Mr. Osgood believes that the key to the situation is simply the working of the deposits on a large enough scale to permit of the use of labor-saving machinery so as to reduce the per ton cost of mining and milling the ore, and he gives the figures upon which his conclusion are based. He also gives figures to show that the smelting of Tennessee ores in Tennessee should prove a very profitable business when properly carried on.

It is only another case similar to the copper situation at Ducktown, where a deposit that could be worked on a small scale only at a loss will yield a handsome revenue if worked on a large scale with proper machinery. The same thing is true of much of the mining operations on the metaliferous ores everywhere today. A large share of the metals are today obtained from low grade ores by the use of up-to-date machinery that could not have been profitably mined a few years ago. It is believed that ultimately Tennessee will be found to possess many other low grade deposits that will be workable only when capital to the extent of at least several hundred thousand dollars is invested in their development.

The bulletin is part "G" of Bulletin No. 2, and is entitled "Zinc Mining in Tennessee." It can be obtained from the State Geologist by inclosing postage, one cent.

APPENDIX C.

Samples of press bulletins, especially prepared papers and addresses to give a more comprehensive idea of the work of the Survey. There are here given three press bulletins, one describing a piece of work just being undertaken, one describing an interesting economic condition that appeared to be worthy of public notice, and the third describing the results of field work, which did not involve publication. As illustrating the type of articles specially contributed may be given one

published by the Appalachian Trade Journal, stating the relation of the State Survey to the coal interests; that is followed by an address given before the annual middle division of the Farmers' Institute on the relation of the State Survey to the farming interests. The last two papers have the further advantage of bringing out more clearly than have any of the regular survey publications the work of the Survey as it appears in relation to those two great interests of the State.

PRESS BULLETIN NO. 7.

STUDY OF TENNESSEE'S FOREST PROBLEMS.

Tennessee is one of the largest lumber producing States in the Union. How long will the supply last? Detailed surveys in Kentucky, extending from 1907 to 1909 have shown that "assuming that the *output of the last three years is maintained*, and that growth is balanced by local consumption and damage, the timber supply of Kentucky will last fifteen years." Is Tennessee any better off? Both in Kentucky and Tennessee it is true that absolute exhaustion will never be reached under any condition, because as the supply approaches exhaustion the output will be decreased until it is finally met by the annual growth. But Tennessee does not desire a decreasing output. The lumber interests of Tennessee are today among its largest industries, especially when taken in connection with all of the dependent industries which have come into the State to take advantage of the abundant supply and cheap cost of lumber. Large parts of the State are better suited to the raising of trees than anything else, so that if the lumber industry is allowed to decline, it will not be supplanted by some other more important industry. Its decline would mean a dead loss to the State.

With a growing appreciation of this impending loss, the people are giving more attention to the problems of renewing and maintaining the forests so that the present output may be maintained or increased indefinitely. Since the timber industry must ultimately depend on the growth of the forests, that growth must be increased by every means possible.

In the belief that the first step in the study of the problem is the securing of facts, the State Geological Survey has entered into a cooperative agreement with the National Forest Service for a preliminary study of the present forest conditions of the whole State. The work will be in charge of Mr. R. Clifford Hall, of the Forest Service, U. S. Department of Agriculture, who has recently completed a three-year study of Kentucky, and the results will be published by the State Geological Survey. Although work involving detailed estimates and measurements is not contemplated in this preliminary study, the most important problems affecting forestry in the different sections of the State will be considered. The aim is to bring the general facts before the public in the hope that as a result ample provision may be made for the actual carrying out of active measures, looking to the maintenance of the State's present position as a great lumber and wood-working State.

PRESS BULLETIN NO. 8.

A GOLD MINE IN TENNESSEE CLAYS.

An examination of the clays of West Tennessee, now being made by the State Geological Survey, has already convinced the State Geologist that Tennessee offers exceptional opportunities for the development of a large industry in the manufacture of chinaware, sanitary and porcelain ware of all kinds, glazed and encaustic tile, electric high tension insulators and fire brick, to say nothing of the great number of lower grade products—ornamental, paving, and common brick, terra cotta, roofing and drain tile, domestic ware, etc. At the present time the State produces between one and two million dollars worth of clay products; but most of that is in the form of common building brick. It is in the manufacture of the higher grade products that the State Geologist believes there is room for great expansion.

In the first place the State has the necessary raw materials. At the present time, Tennessee clays are being shipped in large quantities to Kentucky, Indiana, Ohio, Pennsylvania, New York and Connecticut, in many cases supplying the largest part of the raw clay used.

In the second place, south, west and southwest of Tennessee lies a great market at present obtaining its supplies from States to the north and east of that State, the raw materials being shipped from Tennessee to the potteries, manufactured and shipped back again to the State, or through it on its way southwest.

In the third place, Tennessee is well supplied with shipping facilities, both by rail and water.

To take a single illustration: In 1891 a pottery was started in Evansville, Indiana, making semi-porcelain and white granite table wares. It uses ball clay from Tennessee, kaolin from North Carolina and Georgia, feldspar from Pennsylvania and ground flint from East St. Louis. In 1904 the output of that plant alone had grown to an annual value of \$220,000 and gave employment to three hundred hands.

Portions of West Tennessee are already dotted with great holes from which clays are being shipped. The clay beds range in thickness from two feet or less to eighteen feet or more, sometimes in solid beds of uniform character, sometimes in a succession of beds of varying character, the individual beds being suitable for distinct uses. Thus, one bed may be especially suited to the making of saggars, the next underlying bed for white chinaware, the next for high tension electric insulators, etc. As a rule the deposits are limited in extent to a few acres, but as a bed of clay ten feet thick and ten acres in extent will yield over 200,000 tons of dry clay, these little pockets in the aggregate could supply a large output, as indeed they are doing at present. As a rule the deposits have a rather heavy overburden amounting, in some cases, to thirty or forty feet, though the average for the pits now being worked will probably not run over fifteen or twenty feet.

Apparently the main obstacle in the past to the location of clay plants in West Tennessee for the manufacture of high grade wares has been the lack of trained labor, and the fact that the nearest coals, those from the west

Kentucky fields, are too high in sulphur. It is probably true that a plant starting in that territory would have to import a certain amount of its skilled labor. As the belt through which the best clays run follows the high divide between the Tennessee and Mississippi rivers—a region of fine farms, prosperous towns, rapid streams, and excellent health conditions, equal in those respects to most parts of Ohio, Indiana or Illinois, the importation of such labor should present no difficulties. The fuel problems may be met by converting the coal into producer gas and washing; by the use of oil from the neighboring Caddo oil field, by the possible use of producer gas from the beds of lignite found in the same region, or by the use of coal from East Tennessee. In the latter case it would require the bringing in of only coal enough for the kilns, as Kentucky coal could be used for power for the mills, etc.

Or the plants could be located at Nashville or some other Middle Tennessee point within easy reach of the ball clay from West Tennessee, the kaolin and feldspar from Georgia (if Tennessee deposits prove insufficient) and coal from the coal field just east of the city. Nashville is naturally a distributing point with both rail and water freight, and already has other large clay interests.

Considering, therefore, that the bulk of the raw materials of all kinds used in the manufacture of high grade clay wares are obtained from the South, it would seem that as much of those wares as may be needed to supply the southern and southwestern market could well be made there.

PRESS BULLETIN NO. 9.

A YEAR'S PROGRESS IN DRAINING THE BOTTOM LANDS OF WEST TENNESSEE.

Now that the season for work in the bottom lands of the little rivers of West Tennessee is drawing to a close, it may be of interest to know what has been accomplished toward their reclamation. It will be remembered that the drainage of these swampy bottom lands first became possible through the law passed at the last session of the State Legislature. Until a short time before that the Supreme Court had held against the principle of local taxation for local improvements; then a decision favorable to such taxation opened the way to such laws as the drainage law. During 1909 initial work was started both in Obion and Gibson counties. In Gibson County a line of survey was run down the North Fork of the Forked Deer River, and a suggested plan of construction outlined. In Obion County an engineer was employed to make a study of the drainage problem in that county, and to report on the feasibility of such drainage.

On receiving a favorable report the people of Obion County employed Mr. P. E. Fletcher, an engineer who has been engaged in drainage work in Illinois, and early in the spring of 1910 surveys were started on the 70,000 acres of bottom land in Obion County. These surveys were completed during the summer, and then an equally difficult task was taken up of disentangling the land lines and tying them to the survey. Because of the almost entire lack of corner stones and the loose methods of describing land lines in the early days, this part of the work took almost or quite as long as the detailed survey. It has recently been completed, and the report of the engineer made. Next

will come the period of adjustment, the determination and adjustment of damages, if any, and the classification of the lands and their assessment for benefits; then will come the sale of bonds, and if all goes well next summer ought to see the beginning of construction work. The plans as at present approved include not only the clearing and straightening of the channel of Obion River, but the formation of levees above and outside the channel. At Obion these levees will be ten feet high and fifteen hundred feet apart.

When it is realized that this one project will cost between a half million and one million dollars, some idea of the magnitude of the work may be gathered. On the other hand, when it is remembered that the 70,000 acres in this district, now practically worthless, should be worth fully \$5,000,000 when reclaimed, some idea of the value of the work is had.

In Gibson County further steps were delayed pending the inauguration of the State Geological Survey, which had already been provided for. As soon as that organization came into existence, a conference was held at Trenton, and as a result of the plans outlined, the State Survey entered into a cooperative agreement with the Drainage Investigations Division of the U. S. Department of Agriculture. Under this agreement two of the Federal drainage engineers made a thorough preliminary study of all of the factors involved in the proposed reclamation, the special difficulties to be met, the surveys and data necessary to be obtained before planning the work, the cost, etc. The report was published as Bulletin 3-B by the State Survey. Meanwhile the State Survey entered into a cooperative agreement with the Topographic Branch of the U. S. Geological Survey, and ran a net work of accurate primary levels over the area in which drainage work was being undertaken or might be undertaken in the near future, including parts of Obion, Weakley, Dyer, Gibson and Crockett counties. Permanent bench marks were set which would serve as the basis for all of the future survey work.

By October first this work had progressed so far that the surveys of the valley bottoms could be started, and during October two topographic parties were started in Gibson County, one on the Rutherford Fork of Obion River and the other on the North Fork of the Forked Deer River. The work was greatly retarded by the heavy rains of the first part of October, which flooded the stream bottoms in places as high as they had ever been, and required weeks to run off. These parties will complete the portion of the Rutherford Fork of Obion River and the North Fork of the Forked Deer River in Gibson County, and may be able to map the Middle Fork of the Forked Deer River in Gibson and Crockett counties, or the river below the junction of the two forks as far down as Dyersburg. In this detailed mapping the local districts cooperate with the State Survey and the U. S. Geological Survey—the local districts taking much of the financial burden, and the U. S. Geological Survey doing or directing the work. In addition the local districts have employed surveyors to determine the land lines and tie them into the topographic surveys.

Cooperation between the State Survey and the Drainage Investigations Division of the Agricultural Department will become active again in December, when studies will be undertaken of the amount and character of the run-off, and the collection of much other data necessary to the planning of the construction work. These studies will extend through the rainy season. With all of this data collected and the topographic and other surveys completed, the

Gibson County districts plan to employ a thoroughly competent engineer to plan the construction and to supervise it. It is hoped that plans may be made during this winter, as well as the adjustments for damages and benefits, so that contracts may be let in the spring for the work of construction. In addition to the work thus actually accomplished, several districts outside of Obion and Gibson counties are considering taking up drainage work, but only one has taken the initial step. A meeting was held in Sharon, November 12, at which time the land owners along the Middle Fork of Obion River in Weakley County took the preliminary steps toward forming a drainage district. It is hardly probable that surveys can be made in that district this fall, but it is hoped they may be ready to take up work as soon as the valleys are free of water in the spring.

THE GEOLOGICAL SURVEY AND THE COAL MEN.*

With the inauguration of any new enterprise, those whose interests it touches have a natural desire to know what its attitude and program will be in its relation to those interests. What the State Geological Survey of Tennessee hopes to accomplish for the coal men of Tennessee may best be judged by an examination of what those in charge of the newly organized State Survey have been doing for the coal men of this and other States. Most of the operators of the State are already familiar with the results of the work of Messrs. Ashley and Glenn in the Cumberland Gap region of Kentucky and Tennessee, in 1902. Those results were published by the U. S. Geological Survey as Professional Paper No. 49, and distributed, at that time, to all of the coal companies of the State. Briefly, that report attempted to show, by maps on a scale of one mile equals one inch, the line of outcrop of each principal workable coal bed, its position in the hill, and the area underlain by it, and points where each bed was being mined, or was exposed and could be measured and examined. In the text were given many graphic and written columnar sections to show the relation of the different coal beds to each other, or their distance apart and the distance of each below or above any prominent cliff making sandstone or any observable or conspicuous rock. Of each bed there were given from a score to a hundred or more personally measured sections and general conclusions were drawn as to the thickness and partings, extent, irregularity or variability, chemical and physical character of such beds, etc.

While that work may be taken as a fair earnest of what the State Survey will do for all of the coal fields of Tennessee, on the other hand

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it is hoped for several reasons to secure much more accurate and complete results in the work recently started in this State. In the first place when the Cumberland Gap work was done in 1902, the only topographic base map available was the one made by the U. S. Survey, nearly twenty years before on a scale of two miles to the inch, and with one hundred foot contours and the character of the geologic work was gaged by the character of the base map. The report when published used a new topographic map made in 1903, or after the geologic work had been done. In contrast with that the coal work being done this year in Tennessee is using a new base map on the scale of one mile to the inch, with twenty-foot contours and with a wealth of detail entirely out of reach twenty years ago. In the second place, the work in the Cumberland Gap area was done at a rate of six to ten square miles a day for each man working. The work now in progress in the Pikeville region is covering the ground with about four times as much detail, and necessarily only one-fourth as fast. In the third place, in the eight years since 1902, both Messrs. Ashley and Glenn have had opportunity to study broadly, as well as in detail, the coal fields of many States from an economic and commercial standpoint as well as a geologic.

Some of the results obtained in these States by the present State Geologist, or under his supervision, particularly in Pennsylvania, may be of interest. Geologic work in the coal fields by the State and National governments has shown a steady increase in accuracy and detail. At first little was attempted beyond determining the presence of coal and outlining in a general way the boundaries of the coal-bearing rocks. The work of the second Geological Survey of Tennessee, under Mr. Safford, represented about this stage. Later on the attempt was made to show by separate patterns on the maps the position of particular groups of rocks that appear to be more largely coal-bearing. Suggestions may have been made as to the correspondence of the coals at points some distance apart, as indeed was often done in the first stage, but as a rule no attempt was made to show the actual horizontal and vertical position of the coal beds or to trace the outcrop of even the most important coals over the area mapped. This was the stage of progress at the time of the folio work by the U. S. Geological Survey covering the coal field of Tennessee. With larger funds per square mile the ground could be covered more closely, and the actual tracing and mapping of the coals attempted, involving necessarily the exact correlation of the beds from point to point and resulting in the acquisition of a large amount of information about the coal beds themselves. The Cumberland Gap work represented about this stage in the progress.

At the time of the second Pennsylvania Geological Survey, large scale maps were made of the anthracite coal field (which covered less than five hundred square miles) that show not only the outcrop of the principal coal beds, but also by structure contour lines the actual elevation above sea level of some principal bed. Similar structure contour maps, usually covering only a few square miles, were made in western Pennsylvania, and had been made in other States. But the first attempt in this country to do such structure work on a large scale began with the reorganization of geologic work in Pennsylvania about ten years ago. In the recent work the State and National governments have cooperated, each paying one-half the expense, and the National bureau has done the work. In this work an area about twice as large as the whole coal field of Tennessee has been mapped, showing not only the outcrop of the coal beds, but the structure of the rocks and coals, by structure contours with a contour interval of from fifty feet to ten feet. On a map where ten-foot contours are used, it is possible to compute the depth of any coal bed within ten feet; where fifty-foot contours are used, the depth may be computed to within fifty feet. Repeated tests by subsequent drilling and mining have attested the general accuracy of this work. The ten-foot contouring has been possible only under the most favorable conditions.

Such detailed results have been possible only because correspondently detailed maps were being made by the Topographic Branch of the National Geologic Survey. The work of the topographers has increased in accuracy and detail in the same way as that of the geologists. In the recent Pennsylvania work spirit level lines were run over all of the public roads, which in that region are very abundant, and bench marks painted on the fences at least every one-fourth of a mile, besides the many more permanent bench marks that were set. Special levels were also run to all mines and prospects. In Pennsylvania a State law requires that the mine maps show the levels all through the mine. In addition to the levels so acquired, the geologists, who followed the topographers, have constantly used the hand level in running short lines from the nearest bench marks or painted elevations to outcrops of the coals and other recognizable rocks. In this way hundreds or thousands of elevations have been obtained, and on the basis of this the contour lines were drawn.

Coming back to Tennessee, several points may be noted in connection with the coal work of the State Survey. First, some three years

ago the U. S. Geological Survey began remapping topographically the Tennessee coal field. This work is being done on the same scale, and with the same accuracy as the work in Pennsylvania, so far as the conditions will permit. Therefore, unless the State Survey is to go to the expense of making such a topographic survey itself, it must confine its operations to those areas already remapped or else content itself with such results as may be possible upon the old "reconnaissance" maps. Another argument lies in the fact that the U. S. Geological Survey has already shown its willingness to cooperate in a geological resurvey of the areas remapped topographically.

In the second place, experience has shown that much better results are secured by continuous tracing of the coals and other rocks than by jumping about from point to point. One or two facts may be cited to show why this is so. For example, starting at Freeport, in Pennsylvania on the Allegheny River, it is possible to trace the upper Freeport coal almost continuously in complete exposure in the railroad cutting for mile after mile down the Allegheny River, the Allegheny at that point following the axis of a syncline and the dip of the rocks is very little more than the grade of the stream. A study of the coal section shows that the coal varies from a thickness of seven feet to nothing, sometimes maintaining its thickness with great regularity, and then where subject to an erosion of carboniferous time, of slightly later date, it is cut out either in part or whole, sometimes for a long stretch. If one were to be dropped down into one of those stretches where the coal and its immediately accompanying rocks were gone, he would be entirely at sea as to the stratigraphic relations of the rocks before him, but having traced the coal continuously from where it has not been eroded, it is possible for him to lay his hand on the rocks and say that had it not been for this subsequent erosion the upper Freeport coal bed would have existed right there. To cite another case from Indiana, the No. III coal of that State had a magnificent development ranging from six to thirteen feet all through Green, Sullivan, Clay, Vigo, Southern Parke and Vermilion Counties. Then the coal gradually thins out, but its horizon can be traced for a great many miles to the northward, possibly clear over into northeast Illinois, just at the top of a very sandy fire clay. Hundreds of other cases might be cited, showing the advantage of tracing continuously, and other cases might be cited of errors that had been fallen into by the other plan of starting work from time to time at separated points.

In the third place, the results in Pennsylvania have only been possible because of the very cordial and complete cooperation of the mining men of that State. The coal companies almost without exception have turned over to the Survey all of their drilling records, coal analyses and many other data of great value in carrying on the work. As a rule but very little of this data has actually been published, and practically always only with the consent of the company that gives the information. As time has gone on the companies have been more willing that data should be published, as they have recognized the mutual advantage that would come to themselves and others by the fullest discussion of the data given.

At this point it ought to be stated that the basis for any assistance that the geologists may render to the individual coal operators is principally in the fact that has been demonstrated by long experience that notwithstanding all the seeming variation of the coal beds, individual beds show marked similarity from point to point, and *coal horizons* can often be traced over vast areas. The Pittsburg coal bed of Pennsylvania, Ohio, Maryland and West Virginia used to be pointed to as an illustrious example of a widespread coal bed. With a broader knowledge today we know that many coal beds in the Appalachians and the Illinois field, as well as others, have far exceeded the area covered by the Pittsburg bed. For example, coal V of Indiana has been traced almost continuously from where it enters Indiana in Vermilion County to where it crosses the Ohio east of Evansville. From there it can be traced through a large share of the western Kentucky coal field where it has been designated coal 9. Coming back to the Ohio it crosses into Southern Illinois and from there can be traced entirely across the southern part of the coal field in that State, and is today being traced northward until it looks as though that bed can be actually followed over probably a score of thousand square miles or more. And again, one of the most interesting developments of recent work has been to show that apparently disconnected pockets lie at certain definite horizons and that the same succession of benches can be traced from one pocket to another. So that if the geologists can determine the number and position of coal horizons, and then further the character, general thickness, regularity and variability of each bed, it may be possible to predict roughly the coal contents of a piece of land without ever touching foot on it.

STATE GEOLOGICAL SURVEY AND THE FARMING INTERESTS.*

In the marvelous development that is taking place in the South today the keynote has been cooperation. We all recognize that with few exceptions one man alone cannot advance very far. It is only as he takes advantage of all of the experiences and experiments, not only of his immediate neighbors, but of those having similar problems over the whole world, that he makes the most rapid advance. He may get this in part from such meetings as this, from the agricultural journals, or from the talks and publications of the State and Government agencies for aiding the farming interests. Among these agencies in this State may be counted the State Geological Survey.

This Survey has not, as yet, been in existence long enough to "point with pride" to a long line of services, and the benefits which should be derived from such services. On the contrary, in the seven months of its existence, it has been able only to inaugurate work in various lines, and so today instead of telling you what the Survey has done for the farming interests, I must content myself with mapping out its program, telling you incidentally what has been started.

One-half of the farmers' problems have to do with the ground and its contents, and the other half have to do with the plants and animals he raises. The Geological Survey has to deal with the ground half of his problems—the mapping and study of soils, the drainage of marsh lands and river bottoms, the supply of water, the study of hillside wash, its prevention and amelioration, the location, extent and adaptability of road materials, and the methods of road building best adapted to any locality, belong in the province of its work. In addition the study of the forests has been added to the duties of the Survey.

The Survey has now been running seven months. During that time it has given more attention two or three times over to the drainage of the overflowed river bottoms of Tennessee than to any other one problem. It was felt that this work was of definite and tangible value, and that there was no guess work about its repaying every dollar spent on it several times over in actual dollars and cents. The actual results accomplished this season have recently been published in the papers. It has been estimated that there are 1,000,000 acres of the State's richest farm lands in the bottoms of the little rivers of West Tennessee alone, now practically valueless, that can be reclaimed at from \$5.00 to \$20.00 an acre. This does not include the Mississippi River bottoms, or the river bottoms of Middle and East Tennessee, and

*Address before State Farmers' Institute, Nashville.

Stewart County alone has been estimated to contain 50,000 acres of bottom lands.

A beginning has been made toward detailed soil surveys. It had been expected that much more would be done, especially as the result of a cooperative agreement with the U. S. Bureau of Soils. This Survey was established too late to enter into the regular program of that bureau. However, an agreement was made for a small amount of work to be done after the completion of some of the northern work, but unfortunately the bureau has found it impossible to carry out its part of the agreement. By taking up the matter in due season next year, it is hoped that much work may be accomplished.

In the soil work, which the Survey proposes to do, it has been planned that all of the work done except preliminary studies shall be in as great detail as any of the geologic work, and the U. S. Bureau of Soils in entering into a cooperative agreement to assist in such soil surveys has agreed that such work as it may do in this State in the future will be in such detail. To do detailed geologic work or soil work involves the possession of an accurate detailed base map. Such a map to be of value should be on such a scale and have such a degree of accuracy that it is possible to represent boundaries of any type of rock or soil within at least one to two hundred feet. On most of the old maps it was often impossible to show boundaries closer than a fourth to a half mile, and you could not tell whether the boundary included your farm or not. There are regions in which identical conditions spread over whole counties, but in this State, as a rule, the series of rocks differ in character, and each one is exposed in outcrop, and therefore responsible for a corresponding soil over usually rather narrow belts. Thus of two limestones similar in appearance, one may be highly phosphatic and the other not, resulting in a narrow strip of soil with a high phosphate content, while just beyond it is another strip of soil entirely lacking in phosphate. To simply group such rocks as all the same as has sometimes been done in the past, because they have somewhat the same appearance and physical structure, is of little value. So that in our detailed soil maps, as well as in our geological maps, we are planning to confine our work to those regions where such accurate base maps exist. Where such maps do not exist, it will be the purpose of the Survey to secure them as rapidly as possible. Such maps are being made by the U. S. Geological Survey, but they can cover only a small territory in any one year, unless the State will cooperate, and the State Survey is already cooperating as far as its funds will allow.

Prof. Glenn, of Vanderbilt University, who has already given several years' study to the water resources of the State, is continuing that study under the Survey, and has a bulletin on these resources in preparation. In this work the cooperation of the Water Resources Branch of the U. S. Geological Survey has been secured by which the Survey's report will have the benefit of all of their records and data.

The study of the water resources will include a study of the sources of water, for farm and other use, not only as at present being obtained, with its quality, etc., but also whether other sources of supply lie deeper, whether they would be artesian in character or not, whether hard or soft, likely to be contaminated or not, the possibilities of water storage, water power, mineral springs, etc.

Definite studies on road materials have been started, and a report on road building in this State is now in preparation. It is intended that that bulletin shall emphasize especially the possibilities of the several regions of the State securing good roads by the use of materials close at hand, or of methods to which the natural soils or lay of the land are naturally adapted, such as the building of sand-clay roads, etc.

Studies of hillside wash and its prevention and the reclamation of lands already injured will form a subject of work in the near future. Prof. Glenn has already given a large amount of attention to this subject and to the subject of the filling of the river channels, under the auspices of the U. S. Forest Service, and is therefore well prepared to take up that subject after the completion of his present study of water resources. Preliminary studies of the forests of the State are now being made in cooperation with the U. S. Forest Service, and it is hoped to follow that up by a more detailed study, which may in the future solve the problem of maintaining our lumber industry. The report on these studies will be made public the coming winter.

One of these studies is being made of the forest conditions all over the State to secure data which will be of value in formulating and carrying out a definite State program. The other study, just started this week, has to do with second growth timber in the Appalachian region, especially determining its rate of growth under the varying conditions, the kinds of timber that grow under these conditions, and other related facts. With these facts it should be possible to so plan methods of forestry that the yearly growth will just balance the yearly cut, and the forest becomes a continuing supply.

In addition to the subjects which I have mentioned and which are of interest to you primarily in connection with your work as farmers, there is another side of the matter, which has a very large interest for

all landowners and without any question the farmers are the largest landowners in the State. Thus the Survey is making studies of the coal, clay, iron, oil and gas, building stone and a hundred other mining and geological materials. And it will be noticed that all of these materials exist in the ground. Experience has shown that a large part of the Survey's work is in answering inquiries from the owners of land as to the value of materials which they find on their land, or as to the possibility of certain minerals being on their land or under it, the determination of specimens, etc. Of even more importance, the actual mapping being done in the field gives to the farmer an idea of what may be of value from a mineral standpoint, on or under his land. For these reasons similar surveys in other States have shown themselves to have as much value to the farmers as landowners as to the mining and quarrying interests.

Now, I said in the beginning that the advance of the South has been due to cooperation, the same as the advance elsewhere. But what has the Geological Survey to do with cooperation? Simply this: The Geological Survey and all of the other State and Government scientific departments and bureaus are simply clearing houses of information and experiences. Cooperation begins when you and your next door neighbor swap notes over the garden fence. If your neighbor is a wideawake gardener and of an experimental turn of mind, you could doubtless get many pointers from such note swapping, and if you could swap notes with all of the wideawake gardeners of an experimental turn of mind, who have the same problems as you, you could doubtless go a long ways towards solving your problems. The Geological Survey, the Department of Agriculture, the Forest Service, the Bureau of Soils, and all the other scientific bureaus, both State and National, are primarily organizations for the purpose of bringing together the experience of men in dealing with their thousand and one problems, drawing general conclusions from the most successful experiences and publishing these for the benefit of all that may be interested.

But these scientific bureaus go further than that. When none of the experiences of which they learn appear to have been entirely successful, they try experiments on their own hook, on the experimental farm, on experimental roads and forests, in the laboratory, etc., and then publish the results of these experiments. Sometimes these studies are of such nature or are so costly that it would be almost out of the question for private individuals to carry them on; such as the study of the transportation of citrus fruit recently carried on by the U. S.

Department of Agriculture, which probably cost \$20,000 to \$40,000. But it is said that the results of that work are saving the orange growers of California alone \$1,000,000 a year, and numberless similar examples might be cited.

In its studies directly affecting the farming interest, the State Geological Survey has in nearly all cases cooperated with the Department of Agriculture. In this first season of work we have cooperated with the Drainage Investigations Division, the Bureau of Soils, the Division of Public Roads and the Forest Service; but notice that in each case it has been with the Federal Department of Agriculture, not with the State department. Now, this has been so not because we do not want to cooperate with the State Department of Agriculture, or they with us, but simply because they do not have the money with which to cooperate. Therefore, our cooperation with that department has been confined to conferences and the giving of advice and counsel, all of which has been most freely given. If this State did as well by its Department of Agriculture as the United States does by its department, the State Department would be given \$200,000 to \$300,000 a year or more, depending on what basis you use in comparing this State with the United States. You realize what Col. Thompson has done in this State, practically without funds. Can you imagine what he could have done if he had had funds? We talk about investing in gold mines. I venture to say that very few gold mines in the world's history has ever returned as much on the investment as has been received from the appropriations given to the U. S. Department of Agriculture, and I do not see any reason why your State Department of Agriculture should not return equal dividends if as liberally supported.

APPENDIX D—EXHIBITS.

Exhibit at Appalachian Exposition, Knoxville, September 12 to October 12, 1910.—In the plans for an exposition of the resources of the Appalachian region, held at Knoxville, Tennessee, from September 12 to October 12, a cooperative agreement was entered into between the State Geological Survey and Appalachian Exposition Company, to cooperate in preparing an exhibit of the State's resources. Dr. Chas. H. Gordon, Professor of Geology at the University of Tennessee, and Associate Geologist of the Survey, was placed in charge of the proposed exhibit. The exposition company furnished a one-story frame building 64 x 82 feet in size, situated upon the crest of a knob overlooking the exposition grounds. This building was

shared by the mineral exhibit and the forestry exhibit. The main part of the coal display consisted of a building constructed entirely of blocks of coal, standing in front of and below the main building. The coal building contained two rooms and intermediate passage way, and it is needless to say proved to be one of the most striking features of the exposition.

In the main building the most attractive feature was the marble exhibit, consisting of seven marble pedestals, four feet by four feet or two feet by four feet, and about three feet high, in part supporting a timber pergola. On the top of the corner pedestals were placed large masses of ores and between them were show cases of minerals, fossils, etc. The exhibit contained large displays of the iron ores of East Tennessee, zinc, copper, phosphate, slate, coal and other minerals. A large amount of material was loaned by the University of Tennessee, including minerals, fossils, relief maps, photographs, etc. It is safe to say that a large majority of the people who visited the exposition examined the mineral exhibit. In addition to the display from Tennessee, a small amount of material was shown from other States. The general appearance and character of the exhibit is shown in the photographs of the frontispiece.

As the exposition company has leased the present grounds for ten years, and plan to make the exposition a yearly one, for at least that length of time, it was felt it would be unwise to attempt to transfer the material to Nashville and to send it back again each year, as much of the material is very heavy and the glass cases would be very liable to breakage; accordingly only a few typical specimens were selected from certain of the exhibits and sent to Nashville to combine with the collections being formed there. These included notably two pairs of slabs of marble, a number of blocks of iron ore from East Tennessee, a suite of copper ores and the minerals accompanying the copper, and a few miscellaneous specimens. Mr. Gordon has forwarded the following list of those who donated material to the exposition:

Adams, John N., Del Rio, Tenn.....	Iron ore
Buffet, A. G., Knoxville, Tenn.....	Zinc ore
Cranberry Furnace Co., Johnson City, Tenn.....	Iron ore and furnace products
Davis, T. L., Sharp's Chapel, Tenn.....	Zinc ore
Donelly & Wills, Mountain City, Tenn.....	Iron ore
Ducktown Copper, Sulphur Iron Co., Isbella, Tenn.....	
.....	Copper ores, associated minerals and smelter products
Evans Marble Co., Knoxville, Tenn.....	Tennessee marble
Gray Eagle Marble Co., Knoxville, Tenn.....	Tennessee marble



VIEW OF NORTH END OF EXHIBIT.



PART OF EXHIBIT OF CLAY AND CLAY PRODUCTS OF WEST TENNESSEE.

STATE GEOLOGIC EXHIBIT AT NASHVILLE.

Killebrew, Geo. W., Mt. Pleasant, Tenn.....	Lime phosphate
Knox Marble & Railway Co., Knoxville, Tenn.....	Tennessee marble
N. C. Talc & Mining Co., Hewitt, N. C.....	Marble, talc, etc.
Peck, T. F., Etowah, Tenn.....	Gold ore from Coker Creek, Tenn.
Rockwood Furnace Co., Rockwood, Tenn.....	Iron ore, coal, coke and pig iron
Ross & Republic Marble Co., Knoxville, Tenn.....	Tennessee marble
Royal Marble Co., Knoxville, Tenn.....	Tennessee marble
Southern Coal Operators' Assn., Knoxville, Tenn.....	Coal building
Southern Gypsum Co., North Holston, Va.....	Gypsum and its products
Tellico Co., Tellico Plains, Tenn.....	Brown iron ore and slate
Tennessee Copper Co., Copper Hill, Tenn.....	Copper ore
Victoria Marble Co., Knoxville, Tenn.....	Tennessee marble
Zechini Coal Co., Newcomb, Tenn.....	Cannel and bituminous coal
Blount County	Slate
Hancock County	Iron and zinc ores, etc.
Union County	Iron ore, zinc ore, etc.

Loan contributions—

Barber, M. D., Knoxville, Tenn.....	Fossils
North Carolina Economic and Geological Survey.....	Minerals, etc.
University of Tennessee	Minerals, maps and pictures

State Geological Exhibit at Nashville.—Soon after the starting of the Survey an attempt was made to gather material looking to the starting of a permanent geological exhibit. This material consisted principally of specimens obtained by members of the Survey in the several fields being examined by them. After the Knoxville exposition some of the material from that display was shipped to Nashville and added to that already gotten together. At this writing about one thousand specimens have been collected toward such an exhibit. Late in the fall a room on the third floor in the Capitol Annex was prepared, and exhibition cases and shelving was obtained and the material prepared and the exhibit opened to the public. At present the exhibit consists first of a large collection of clays from West Tennessee and of the various products made from these clays, including many examples of fine pottery, encaustic tile, electric insulators and other high grade wares made from the clays of Tennessee, but by plants located outside of the State. There is a fair exhibit of the iron ores of East Tennessee, a suite of specimens illustrating the copper ores of Polk County; zinc, lead, manganese and other ores; a small display of marbles; a display of the various types of phosphate rock and the prepared products; and a display of the minerals, fossils and rocks of the State. Outside of the clays of West Tennessee, which are fairly complete, the other materials form only the beginning of what it is hoped may ultimately be shown.

In addition to the material collected by the State Geologist or members of the Survey, much material has been donated to the collections; some of this is material that has been sent in for identification. Only the larger specimens, as a rule, have been put on exhibition. Among these the following donations may be noted:

Akron Smoking Pipe Co., Magadore, O.....	Electric insulators
Bailey, Jas., Coal Creek, Tenn.....	Silica rock and ochre
Baker, —, Nashville, Tenn.....	Decayed chert
Bellamy, —, Sweetwater, Tenn.....	Manganese
Blevins, John, Blount County.....	Manganese
Bransford, T. L. & Sons, Union City, Tenn.....	Brick and Columbia loess
Brewer, Sterling C., Thomasville, Tenn.....	Wad
Brittain, J. F., Blount County.....	Brown hematite
Brockman Pottery Co., The, Cincinnati, O.....	Encaustic tile
Brunt, G. F., Porcelain Co., E. Liverpool, O.....	Insulators
Buffalo Pottery Co., Buffalo, N. Y.....	Plate
Cambridge Tile Mfg. Co., Covington, Ky.....	Encaustic tile
Cartwright, J. B., Goodlettsville, Tenn.....	Hematite iron ore
Cartwright Bros., E. Liverpool, O.....	Plate
Cooke Pottery, Kittanning, Pa.....	Plates, cup and saucer
Costen, Moore & Co., McKenzie, Tenn.....	Pressed brick
Creswell, J. M., Milan, Tenn.....	Soft mud brick
Davenport Brick Co., LaGrange, Tenn.....	Brick
Findlay Electric Porcelain Co., Findlay, O.....	Tube and insulator
Fulcher Brick Co., Nashville, Tenn.....	Brick
Gem Clay Forming Co., Sebring, O.....	Pitcher and gas tips
Gilmore Brick Co., Gilmore, Tenn.....	Fire and pressed brick
Grand Junction Pottery Co., Grand Junction, Tenn.....	Pottery
Green, —, Nolensville, Tenn.....	Lead ore
Hall China Co., E. Liverpool, O.....	Plates, cups, saucers and dish
Harley Pottery Co., Nashville, Tenn.....	Seeger cones, burnt
Hartford Faience Co., Hartford, Conn.....	Electric insulators
Hawks, Wm., Nashville, Tenn.....	Kaolin and white granite ware
Keinworth Tile Co., Newell, W. Va.....	Mosaic tiles and plates
Kent, W. W., Enville, Tenn.....	Lead ore
Locke Insulator Mfg. Co., Victor, N. Y.....	High tension insulators
Long & Co., Jackson, Tenn.....	Brick
McKnight Bros., Humbo'ldt, Tenn.....	Brick
Mayer Pottery Co., Beaver Fall, Pa.....	Plate, cups, saucers, pitcher and dish
Merrill, G. P., Washington, D. C.....	Marble
Milan Brick Co., Milan, Tenn.....	Brick
Mosaic Tile Co., Zanesville, O.....	Encaustic tile
Murray, J. J., Lewisburg, Tenn.....	Lime wavelette
Nonconnah Pottery, Capleville, Tenn.....	Pitcher, platter, cup, jardiniere, box
Ohio Electric Porcelain Co., E. Liverpool, O.....	Insulators
Ohio Porcelain Co., E. Liverpool, O.....	Bell
Oliver Springs Coal & Clay Co., Oliver Springs, Tenn.....	Brick and shale
Owen China Co., Minerva, O.....	Bowl, coffee pot, cup and saucer, etc.

Phelus, J. L., Lobelville, Tenn.....	Decayed chert
Pinson Pottery Co., Pinson, Tenn.....	Jugs, jars, etc.
Pittsburg High Voltage Co., Pittsburg, Pa.....	Insulators
Powell, J. B., Nashville, Tenn.....	Limonite
Quarles, R. T., Nashville, Tenn.....	Limonite
Reynolds White Sand Co., Bristol, Tenn.....	Glass sand
Reynolds, H. E., Nashville, Tenn.....	Lead ores
Roseville Pottery Co., Roseville, O.....	Jardinieres, pitchers, vase, etc.
Sanitary Pottery Co., Tiffin, O.....	Urn
Schmidt, M. G., Nashville, Tenn.....	Chattanooga shale
Sebring Pottery Co., Sebring, O.....	Platter
Sharer, Mrs. Ollie, Greenbrier, Tenn.....	Bog ore
Shenango Pottery Co., New Castle, Pa.....	Plate
Southern Tile & Brick Co., Gilmore, Tenn.....	Brick
Sparks Pottery Co., McKenzie, Tenn.....	Jugs, jars, jardiniers and brick
Taylor, Lytton, Nashville, Tenn. ...	Fluorspar, zinc blend, hematite, iron, lead ore
Thompson, C. C., Pottery Co., E. Liverpool, O.....	Plate
Thompson, John, Nashville, Tenn.....	
.....	Bog iron ore, limestone (Newsom Sta.) and limestone (Goodlettsville)
Thomas, The R. & Sons Co., East Liverpool, O..	High tension electric insulators
Toops, J. F., Dckson, Tenn.....	Clay
Unaka Mining & Development Co., Coker Creek, Tenn.....	Gold ore
Universal Sanitary Mfg. Co., New Castle, Pa.....	Sanitary ware
U. S. Electric Porcelain Co., New Cumberland, W. Va....	Tubes, insulators, etc
Vodrey Pottery, E. Liverpool, O.....	Plate
Wheeling Tile Co., Wheeling, W. Va.....	Mosaic tiles and plate
Winter, C. C., Lebanon, Tenn.....	Calcite crystal

The donation of other similar material is solicited.

It is hoped later on to be able to prepare small collections for distribution to such of the secondary schools of the State as are giving courses of study along the line of the Survey's work. While some of the material already collected will be available for that purpose, it will be some time yet before enough such material has been gathered to make it worth while to begin such distribution.