

ANNUAL REPORT OF N. S. SHALER, STATE GEOLOGIST, FOR THE YEAR 1877.

The operations of the Survey during the field season of 1877 have been less extensive than during the two preceding years. This was owing to the carefully determined plan of extending the field work, during the year 1876, beyond the limits of the half of the biennial appropriations especially belonging to that year. In this way a larger part of the work done by the Survey, under the last appropriations, will be ready for publication before the session of the Legislature in 1878. At best, a large part of the labors of any survey, working in a rich field, must be long incomplete, owing to the need of awaiting the progress of the search for fuller information on many of the questions it encounters. It is generally impossible to bring the results of any one summer's field work into shape for publication before the coming spring. This plan of putting the burden of the work upon the first of the two years gives time for the completion of a larger share of the work undertaken in the intervals of legislative action, and enables the officers of the Survey to keep the work in better shape for legislative criticism.

The largest part of the work done during the preceding year has been given to the extension of the topographical surveys. The following summary will make the operations on this branch of the work sufficiently clear.

In the eastern district, Mr. C. Schenck has carried forward his map work in Menifee and adjoining counties, substantially completing the map of the district between the Licking and the Kentucky rivers, and extending for a depth of about forty miles east from Slate creek. This work, together with the reconnoissance of Mr. Crandall, gives us a tolerably complete basis for the topography of the district between

the head waters of the Licking and the Kentucky. In the central district Mr. Schenk has carried forward the topography in Cumberland and Clinton counties, completing the work over a district containing about five hundred square miles. I regret that the exhaustion of the appropriations made it necessary to end the work in these counties before its completion. Another season's labor would make it possible to finish the detailed topography of this important oil district. The district between the Cincinnati Southern Railway and the Louisville and Nashville Road has been so much traversed by carefully-made railway surveys, that it will be possible to complete the topographical work there with a relatively small amount of labor. On account of its rich resources in coal oil, coal, and timber, as well as its excellent agricultural character, it is important that it should be among the first to have an accurate representation of its surface.

The larger part of the topographical work done during the present year has been given to the district west of the Louisville and Nashville Railway. The map of the eastern border of the western coal field has been completed to the Ohio river. This part of the district, embracing nearly two thousand miles of area, and extending from near the junction of Big Barren and Green rivers to the Ohio at Hawesville, is now accurately mapped on the scale of six inches to the mile, with a careful study of the heights along the streams and roads. The published map is reduced to the scale of one inch to the mile. One half of it is given in the first volume; the rest will appear in the fourth.

The task of determining the outline of the western face of this western coal field was taken up in the month of June. The three parties, in charge of Mr. W. B. Page, began this work, in the district between the Tradewater and the Cumberland rivers, in the month of June. This work was pressed with great energy by the officer in charge, and with such success, that when the exhaustion of the appropriation forced its discontinuance, the data were all in hand for the making of a complete outline map of this district. Three weeks more

work, with the same force, will serve to complete the field work for a map of the whole district bounded by the Ohio, the Cumberland, and the Tradewater rivers, south to the Elizabethtown and Paducah Railroad. This map work will be reduced and drawn during the autumn, and it is expected that it will be ready for publication by the first of February, 1878. Besides its importance as an advance in determining the outline of the western coal field, this map will have a very great value in aiding the development of this rich territory, which abounds in the elements of agricultural and mining prosperity. The natural outlet of the larger part of this district, as I have elsewhere repeatedly remarked, is by the channel of the Tradewater river, a stream that remains unnavigable, owing to the want of comparatively inexpensive improvements. The completion of this topographical survey cannot fail to have a very important influence in calling attention to the importance of canalizing this stream.

The last work of importance done by the Topographical Assistant was to get the existing data for a map of the "Purchase" district, or the counties west of the Tennessee, into shape for publication. This district, having been incorporated into the Commonwealth long after its foundation as a State, was provided with a township survey, which seems to have been made with reasonable care. The notes of these surveys have never been reduced into a shape for publication. They have now been copied and reduced by Mr. Page and his aid, Mr. Hoeing, and will be platted during the coming winter. They will then be revised in the field, in order to bring the work to date, and then published on the scale of one inch to the mile. At the same time a competent officer will make a study of the levels on the district, with the view of furthering the consideration of its important problems of diking and drainage. In the reports for the preceding years I have frequently referred to plans for the bettering of the drainage, and the prevention of floods in this district. I have become convinced, however, that the first step must be to prepare a

sufficient map of the district on which, as a basis, a study of the measures of betterment may be founded.

The summer's work has, despite its brevity, given us a larger area of topography than any other campaign of the Survey. About three thousand square miles of area were brought into shape for platting, and if we include the "Purchase" district in our computation, we may claim that not less than one sixth of the whole area of the State has been brought into shape for mapping during the present year.

As time advances, and the officers of the Survey become the better trained for their work, it is possible to attain a higher and higher degree of skill in this difficult task of making good, and at the same time inexpensive, maps. During the first two years of the Survey work, the map work done cost not far from five dollars per square mile for the field work alone, and about one third that sum for the platting, reduction, and engraving of the results. This season the experience and the increased skill of the topographer have enabled us to bring the cost of the field work down to less than three dollars per square mile, and I hope to accomplish a nearly proportional reduction in the cost of putting the map into the engraved plate. I am satisfied that it will be possible henceforth to proceed with the work of making a careful topography of our State in a very economical way. I believe that a map with all the principal roads and streams—say all county roads and all streams with beds over three feet wide run by the telemeter, and the lesser streams and unimportant roads either paced or run by the odometer, can be prepared at a cost of not exceeding four dollars per square mile. This includes the cost of the field and office work, as well as the expense of engraving the same. A small additional expense, not exceeding one dollar per square mile, will place contour lines along the roads and creeks, so as to give an approximation to the levels in the country. The errors in map work of this kind will not be considerable enough to be traceable on the scale of one inch to the mile. The error will fall within the width of the lines used to denote the streams, roads, &c.

Although this work is not up to the level of accuracy of the great European surveys, or of the Coast Survey in this country, it will, nevertheless, be superior to that of any State on this continent. When brought within the triangulation system that is now in progress across the State, these maps will give a perfectly accurate idea of the horizontal relations of every point in the State. The determination of the contour lines for every fifty feet of altitude along the roads and streams, will give sufficient data for the vertical element of the topography, though it is to be regretted that the cost will not make it possible to connect the lines of equal height over the whole surface.

The geodetic work of the Coast Survey, which has been going on within the State for the past three summers, has done much towards the accomplishment of its purpose of aiding in the construction of the State map. The reconnoissance has already been extended from the Cumberland Mountains to Louisville, the area explored having an average width of fifty miles. The map in the first report in the fifth volume gives the condition of this work for the end of the second year of its progress. It has already afforded data for a great many corrections in the maps of the Survey. Through it we know the relative position of a hundred or more points in the region the work has traversed. The average error of position of these points on our old maps was probably as much as three miles, showing very clearly how impossible it was, without some such triangulation, to give the basis for a topography. I am very glad to say that there is now little doubt that this triangulation can be extended over the whole of the State, and that it will be so extended by the Federal Government. In addition to the geodetic work, strictly so-called, the Federal Government is beginning a system of observations for longitude determination at various points in the State. Columbus, Hickman, and Paducah have already been selected as stations, and work has begun at these points. When these extreme western stations have been accurately determined, it will be possible, by carefully chaining the distances between

them, to make an efficient triangulation of the flat wooded lands in this district, where ordinary triangulation is not possible, on account of the absence of hills or other lookout points. This work of determining the longitude of certain points by astronomical means will probably be extended to the eastern part of the State during the coming year.

With regard to the future topographical work of the Survey, I venture to recommend that a sufficient appropriation be made to keep at least two double parties in the field for five months each year. This will require the services of one officer during the whole of the winter months, when he will be occupied in the reduction of the work, and its preparation for the engraver. This assistant may be the only permanent officer of the topographical corps, the parties being recruited each year from the teachers and students in schools where engineering is taught. In this way it will be possible to do about two thousand square miles of topography each year; and the cost need not exceed six thousand dollars per annum. This estimate is based on previous experience of a sufficient kind, and may be relied on as a safe, though close estimate. At this rate it will require about ten years to complete the topography of the State, and the total cost of the work to be done by the State will be not far from sixty thousand dollars. The amount to be expended by the Federal Government, in the triangulation and astronomical work, will be quite as much, so that the State has two dollars expended within her borders for every dollar given to this work. The resulting map will be much superior to that of any State in this Union, and will compare favorably with the ordnance survey of Great Britain in its accuracy in all essential points. Such a map will immensely facilitate every step in the development of the State. In facilitating the platting of land surveys, in helping the laying out of roads of all descriptions, in shaping the taxation system of the State, and in a thousand other ways, such a map would, each year, return the State far more than its cost. To maintain the economy essential in this scheme, it will be necessary for the Commonwealth to make

the appropriations in such a way that there shall be a reasonable certainty of the continuance of the work through the specified term. In no other way will it be possible to retain the cost within these narrow limits.

During the progress of the present Survey, it has become very evident that a good deal will be gained by placing meridian stones in each county seat within the Commonwealth. The need of this form of aid to the land surveyors of the county has been recognized and acted upon by other States. Ohio long since completed this work, and has had the profit therefrom. The advantages to be derived from these meridian stones will be apparent on consideration of the fact that the land surveys of the Commonwealth have always been made by the magnetic compass, and that, apart from the errors of the instrument, this compass does not give the same direction in any two succeeding years. The lines of a survey made this year will not coincide with the most careful survey made twenty or fifty years hence on the same calls, because the instruments will give different directions for the required courses. If, however, there is at each county town a well-determined meridian mark, it will be possible for each surveyor to determine, from time to time, the variation of his instrument from the true north, and enter it with the notes of his surveys in the records. The Geological Survey has already established these stones in six different county towns. At these points they have been constantly used, and are greatly appreciated by the surveyors as a correction of a very dangerous source of error.

It has been found, however, that the work of fixing these meridian marks is a task of considerable difficulty, and tends to retard the regular work of our topographical parties. There is only a certain limited time in each month when the position of the pole star is such as to make it suitable for the determinations which have to be made. The topographer is generally remote from the point where the work has to be done, and loses time in his journey to the point of observation. Moreover, this work, being astronomical in its nature, demands for

its most exact results peculiar instruments and a special training. It seems to me advisable, therefore, that this work should be put in the hands of a specially designated officer, who might, if it were deemed desirable, be under the control of the Director of the Survey. I have made a careful computation of the cost of this work, and find that, including the salary of the person in charge of the work and one aid, as well as all charges for transportation, for the cutting of the stones designed as meridian marks, the whole cost need not exceed three thousand dollars per annum. I estimate that an average of thirty-five stations could be established each year, making the total time required not exceeding three years and a half. As this work is not necessary to the Survey of the State, though of the highest public utility, I shall not provide for it in the estimates, but will leave it to the separate judgment of the Legislature.

I have now to set forth the work of the geological division of the Survey during the past year. Of this much less was done than it was desirable to accomplish. The appropriations asked from the Legislature were reduced in the committee by the amount of six thousand dollars; unforeseen expenses in connection with the State Cabinet made a reduction of another thousand dollars in the means I hoped to have been able to expend, and the Centennial expenses somewhat exceeded my reckoning. As the letter of the law required me to give more care to the continuance of the topographical work and the work of stereotyping than to any other part of my task, I felt it necessary to reduce the amount of that part of the operations of the Survey which was strictly geological.

Assistants Crandall and Moore have received indefinite leave of absence, and have done no work since their preparation of the results of the last season's campaign was completed. Assistant Norwood continued employed until the data necessary for his report on Ohio county was all in hand, and until he had the data for a preliminary report on Adair county, closing his field work in July. Mr. Hermann Herzer, Palæontological Assistant, was partly employed in field work in the Upper

Cumberland, the Green River district, and near Louisville, up to September first; his principal task, however, was the arrangement of the Cabinet in Frankfort—a work that is already far advanced. Assistant Procter has been employed for a part of the year in the geology of the Upper Green River district, and in the study of the region adjacent to the line of the Louisville and Nashville Railway. This latter work is well nigh done, and will be a valuable contribution to the geology of the transportation routes within the State. This study has developed the existence of a number of valuable building stones along this line, which have not yet been brought into use. It has also served to lay the foundation of a more careful and well-directed search for oil, salt, and marl-bearing strata within this district.

Mr. L. H. DeFriesse, Assistant in charge of the studies we are making on our forest resources, has been able to give only about two months' field work during the present season; this was devoted to a study of the forests in the western part of the State, especially in the Tradewater Valley and the district west of the Tennessee river. His valuable observations will be contained in the forthcoming fifth volume of this series of Reports. I hope in coming years to continue these very important studies of our forest resources. They form a large share of the immediate resources of our Commonwealth, and in their economical administration our people have a very great interest.

Dr. Robert Peter has been steadily engaged in the chemical researches of the Survey; but, owing to the retirement of Mr. John H. Talbutt, who, with our diminished resources, could not be retained as Chemical Assistant, the work has not been able to make its usual rapid advancement. The loss of Mr. Talbutt's services is a serious disadvantage to the Survey, for his energy and skill greatly contributed to the success of its chemical work. The reports of Dr. Peter will show that, even with the limited work in his department, a good advance has been made in solving the more important chemical problems which have been encountered.

The Survey has been fortunate in securing the services of Mr. Wm. B. Caldwell, jr., a well educated metallurgist, who has had the advantages of a careful training in the European establishments best calculated to give a knowledge of the problems which concern our metallic resources. Mr. Caldwell is now engaged in a careful review of the iron ores of the State, with a view especially to the methods of treatment necessary to secure the best results in the reducing furnaces where they are used. The distinguished chemist, Dr. J. Lawrence Smith, has kindly given Mr. Caldwell the use of his extensive private laboratory, and the advantage of his valuable advice in his investigations.

The work done by myself during the year of this Report has, in the main, been limited to the preparation of the Reports and Memoirs of the Survey, and the direction of its officers. It is, perhaps, well to call attention to the fact, that, as the Director of the Surveys, I am not permanently employed by the State, but only engaged for such part of the year as may be necessary for the work. It has not been necessary for me to give much over one half of my time during the past year in the offices of the Survey, owing to its limited work in the field.

The only important field researches that I have made, have been upon the oil district of the upper part of the Green River Valley, and upon the geology of the district adjacent to the Louisville and Nashville Railway. In the course of these studies I have more or less thoroughly examined about twenty counties, arranging the detailed work that is to be done by my assistants. When, in the second section of this year's report, I come to consider the problems of our geology which have been dealt with during the present year, I shall give a fuller account of this work, none of which, however, is as yet far enough advanced for publication.

The publication work of the Survey has gone forward with rapidity, though, owing to our narrow means, but limited editions of its reports could be distributed. The following is a

summary of the publications of the Survey up to the present time:

REPORTS OF PROGRESS. ROYAL OCTAVO.

VOLUME I. NEW SERIES.

- PART I.** Report on the Timber Growth of Greenup, Carter, Boyd, and Lawrence Counties, in Eastern Kentucky. By N. S. Shaler and A. R. Crandall, Assistant.
- PART II.** Report of the Botany of Barren and Edmonson Counties. By John Hussey, Botanical Assistant. With an introduction by N. S. Shaler.
- PART III.** Report on the Iron Ores of Greenup, Boyd, and Carter Counties, the Kentucky Division of the Hanging Rock Iron Region. 8 Plates. By P. N. Moore, Assistant.
- PART IV.** Chemical Report of the Soils, Marls, Clays, Ores, Coals, Iron Furnace Products, Mineral Waters, &c., of Kentucky. By Robert Peter, M. D., &c., Chemist to the Kentucky Geological Survey. Assisted by John H. Talbutt, S. B., Chemical Assistant. The First Chemical Report in the New Series, and the Fifth since the beginning of the Survey.
- PART V.** The Iron Manufacture of the Kentucky Division of the Hanging Rock Iron Region. 1 Plate. By P. N. Moore, Assistant.
- PART VI.** Report on the Geology of the Region adjacent to the Louisville, Paducah and Southwestern Railroad, with a Section and 4 Plates. By Charles J. Norwood, Assistant.
- PART VII.** Report of a Reconnaissance in the Lead Region of Livingston, Crittenden, and Caldwell Counties, including a Sketch of their General Wealth. Map and 4 Plates. By Charles J. Norwood, Assistant.

VOLUME II. NEW SERIES.

- PART I.** Report on the Geology of Greenup, Carter, and Boyd Counties and a part of Lawrence. By A. R. Crandall, Assistant.
- PART II.** Report on the Geology of the Nolin River District, embracing portions of Grayson, Edmonson, Hart, and Butler Counties. By P. N. Moore, Assistant.
- PART III.** Chemical Examination of the Ashes of the Hemp and Buckwheat Plants, with Remarks on its Bearing on Hemp Culture in Kentucky. By Robert Peter, M. D., etc., Chemist of the Survey.
- PART IV.** Report upon the Airdrie Furnace and Property, Muhlenburg County, Kentucky. By P. N. Moore, Assistant.
- PART V.** Topographical Report of the Nolin River District. By William Byrd Page, Assistant.
- PART VI.** Report of a Reconnaissance on the Proposed Line of Railway from Livingston Station to Cumberland Gap. By C. J. Norwood, Assistant.
- PART VII.** A Reconnaissance Report of the Lead Region of Henry County, with some Notes on Owen and Franklin Counties. By C. J. Norwood, Assistant.
- PART VIII.** On the Origin of the Galena Deposits of the Upper Cambrian Rocks of Kentucky. By N. S. Shaler.
- PART IX.** Report on the Timbers of Grayson, Breckinridge, Ohio, and Hancock Counties. By L. H. DeFriesse, Assistant.

- PART X. Report on the Geology of the Proposed Line of the Elizabethtown, Lexington and Big Sandy Railroad, from Mt. Sterling to the Big Sandy river. By A. R. Crandall, Assistant.
- PART XI. A General Account of the Commonwealth of Kentucky. Prepared by the Geological Survey of the Commonwealth.

VOLUME III. NEW SERIES.

- PART I. General Report of the Geological Survey of Kentucky. By N. S. Shaler.
- PART II. History of the Operations of the Survey in 1874 and 1875. By N. S. Shaler.
- PART III. Notes on the Investigations of the Kentucky Geological Survey during the years 1873, 1874, and 1875. By N. S. Shaler.
- PART IV. Annual Report of N. S. Shaler for the year 1876.
- PART V. The Transportation Routes of Kentucky, and their Relation to the Economic Resources of the Commonwealth. By N. S. Shaler.
- PART VI. Description of the Preliminary Topographical and Geological Maps of Kentucky, edition of 1876. By N. S. Shaler.
- PART VII. Annual Report of N. S. Shaler, State Geologist, for the year 1877.
- PART VIII. Report on the Unfinished Work of the Survey of the Commonwealth under the Direction of Dr. David Dale Owen. By N. S. Shaler.

VOLUME IV. NEW SERIES.

- PART I. Chemical Report of the Soils, Coals, Ores, Iron Furnace Products, Clays, Marls, Mineral Waters, Rocks, &c., of Kentucky. By Robert Peter, M. D., etc., etc., Chemist to the Kentucky Geological Survey, assisted by John H. Talbutt, S. B., Chemical Assistant. Second Chemical Report in the New Series, and the Sixth since the beginning of the Survey.
- PART II. Report on the Geology of Menifee County. By A. R. Crandall, Assistant.
- PART III. Report on the Iron Ores and the Iron Manufacture of the Kentucky Red River Iron Region. By P. N. Moore, Assistant.
- PART IV. Report on a Geological Reconnoissance of the Region Adjacent to the Kentucky and Virginia State Line, from Cumberland Gap to the Chat-terawha or Big Sandy River. By P. N. Moore, Assistant.
- PART V. Report on the Iron Ores of the Vicinity of Cumberland Gap. By P. N. Moore, Assistant.
- PART VI. Report on the Geology of a Section from near Campton, Wolfe County, to the Mouth of Troublesome Creek, Breathitt County. By P. N. Moore, Assistant.
- PART VII. A Report of Examinations made along the Paths of the North and South Running Railways of Western Kentucky. By Charles J. Norwood, Assistant.
- PART VIII. A Report of a Reconnoissance of a Part of the Breckinridge Cannel Coal District. By Charles J. Norwood, Assistant.
- PART IX. Report on the Timbers of the North Cumberland—Bell and Harlan Counties. By Lafayette H. DeFriesse, Assistant.
- PART X. On the Geology of Hancock County. By P. N. Moore, Assistant.
- PART XI. On the Geology of the Region Adjacent to the Eastern Border of the Western Coal Field, from the Louisville, Paducah and Southwestern Railway to the Ohio River. By P. N. Moore, Assistant.
- PART XII. On the Geology of Portions of the Upper Cumberland River Valley, in Bell and Harlan Counties. By A. R. Crandall and P. N. Moore, Assistants.

VOLUME V. NEW SERIES.

- PART I. Description of the Topography of the Area included within the Reconnoissance Triangulation of the United States Coast Survey in Kentucky during the Seasons of 1875 and 1876. By William Byrd Page, Assistant.
- PART II. Topographical Report of a Part of Greenup and Lawrence Counties for the year 1874. By C. Schenk, Assistant.
- PART III. On the Use of the Telemeter in Topographical Surveys. By C. Schenk, Assistant.
- PART IV. Report on the Timbers of the Tradewater Region—Caldwell, Lyon, Crittenden, Hopkins, Webster, and Union Counties. By Lafayette H. De Friese, Assistant.
- This volume is not yet completed.

VOLUME VI. NEW SERIES—CENTENNIAL VOLUME.

- PART I. Thoughts on the Agricultural, Manufactural, and Educational Interests of Kentucky, suggested by a Study of the Great International Centennial Exhibition of 1876. By Robert Peter, M. D.
- PART II. Report on the History, Culture, and Manufacture of Flax and Hemp, suggested by a Study of the International Exhibition of 1876. By John R. Procter, Assistant.
- PART III. On the Pottery Clays of Kentucky, and their Uses.
- PART IV. On the Timber Exhibits at Philadelphia in relation to the Forest Resources of Kentucky.

VOLUME VII. NEW SERIES.

Analytical and Synoptical Index of all the Publications of the Survey to this date, including those of Dr. Owen's Survey, designed to bring the matter of the ten volumes of Reports, the three of Memoirs, and the other publications of the Survey, into a shape calculated to facilitate reference to all the variously placed sources of information. It is intended to include in this volume indices of all the results of the Survey up to the end of 1878.

PHOTOGRAPHS. QUARTO.

Giving the first hundred plates of a Photographic Survey of the Commonwealth.

VOLUME I.

Scenery and Structural Geology of the Region Adjacent to Cumberland Gap. Thirty Plates, with forty pages of Text. Ready in April, 1878.

VOLUME II.

The Scenery and Structural Geology of the Central or "Blue Grass" District of Kentucky. Fifty Plates, and sixty pages of Text. Ready in April, 1878.

MEMOIRS OF THE KENTUCKY GEOLOGICAL SURVEY. QUARTO.

Designed for Reports of a non-economic nature.

VOLUME I.

- PART I. On the Antiquity of the Caverns and Cavern Life of Kentucky. By N. S. Shaler.
- PART II. American Bisons, Living and Extinct. By J. A. Allen.
- PART III. On the Fossil Brachiopods of the Ohio Valley. By N. S. Shaler.
- PART IV. On the Prehistoric Remains of Kentucky. By Lucien Carr, Assistant, and N. S. Shaler. One hundred copies were printed in 1876.

VOLUME II.

- PART I.** On the Prehistoric Remains of Kentucky. **Part II.** By Lucien Carr, Assistant, and N. S. Shaler.
- PART II.** On the Fossil Corals of Kentucky. **Part I.** By N. S. Shaler.
- PART III.** On the Fossil Brachiopods of the Ohio Valley. By N. S. Shaler.
- PART IV.** On the Cavern-dwelling Races of Kentucky. By F. W. Putnam, Assistant.
- PART V.** On the Stratigraphical Divisions of the Rocks found within the Commonwealth of Kentucky. By N. S. Shaler.
- PART VI.** On Certain Fossil Mammals from the Caverns of Kentucky. By J. A. Allen.
- PART VII.** On the Dynamic Geology of Kentucky. By N. S. Shaler.
- PART VIII.** On the Collection of Cavern Insects. By Elzear Abville de Perin, of Marseilles.
- PART IX.** On the Living Reptilia and Batrachia of Kentucky. By S. A. Garman.
- Of the Second Volume, all the Memoirs are in preparation; but probably only the I, II, VI, VIII, and IX Parts will be ready for issue during 1878.

LESSER MEMOIRS. OCTAVO.

It is designed to issue one or more volumes of scientific papers, which, from their nature, do not demand plates of the larger form. Of these, the First Volume is in preparation; for it the following Parts have been prepared:

- PART I.** On the Cavern Insects and Arachnidæ of the Kentucky Caverns. By A. S. Packard, jr.
- PART II.** On the Distribution of the Ancient Coral Reefs of Kentucky. By N. S. Shaler.
- PART III.** On the Former Connection of the Eastern and Western Coal Fields of Kentucky. By N. S. Shaler.
- PART IV.** On the Geological and Geographical Limits of the Barrens of Kentucky. By J. R. Procter, Assistant.
- PART V.** On the Earthquakes of 1811. By N. S. Shaler.

BULLETIN OF THE SURVEY. OCTAVO.

With the month of January, 1878, the Survey begins the publication of a series of occasional notes on various matters of economic and scientific importance, to which it may seem desirable to call attention, but which are not in shape to find their way into more complete Reports or Memoirs. It is hoped that it may be possible to issue numbers of this series quarterly, or oftener.

All these several publications are, according to law, stereotyped or electrotyped, and the plates are retained by the Survey, so that it will always be possible to issue new editions as they may be required.

The following reports have been for some time in the course of preparation, but must await the further extension of the Survey work for the necessary data for their satisfactory completion. It is designed to print the first five of these in the fifth volume of the Reports of Progress. The seventh and

the eighth are to find a place, if possible, in the sixth volume. The others will have to come in later numbers of the series.

1. On the Geology of the District Adjacent to the Louisville and Nashville Railway.
2. On the Geology of the District Adjacent to the Cincinnati Southern Railway.
3. Geology of Jefferson County. With Map. By H. Herzer, Assistant.
4. Geology of Menifee County. By A. R. Crandall, Assistant.
5. Geology of Ohio County. By C. J. Norwood, Assistant.
6. Geology of Hancock County. By P. N. Moore, Assistant.
7. On the Washing and Coking of Coals for Furnace Use. By P. N. Moore, Assistant.
8. On the Various Building and other Economic Stones of Kentucky. By N. S. Shaler.
9. On the Agricultural Marls of Kentucky.
10. On the Oil and Gas-bearing Rocks of Kentucky. By N. S. Shaler.
11. On the Salt-bearing Rocks of Kentucky.

The foundations have been laid for special reports on twenty-five counties other than those above mentioned. Each of these county reports will contain a map, geologically colored, of the county, on the scale of one inch to the mile, and a careful assembling of all that is known concerning its resources, with reference to the sources whence further information can be obtained.

As this Report is especially designed to bring before the Legislature of the Commonwealth the condition of the Kentucky Survey, I shall now briefly set forth the needs of the Survey, and its plans for future work.

In the estimates laid before the representatives of the Commonwealth in January, 1876, I applied for the sum of twenty-five thousand dollars per annum, and promised that, if this sum were given, the work should be pushed at such speed that in the present year the whole detailed reconnoissance should have been finished, the lines of transportation reported on in all desirable detail, leaving only the completion of the State map and the county reports for the future. This estimate was made with all possible regard to economy, and not in the least with a view to such a reduction as was voted in the committee. The result has been that many things have been left incomplete which would have been finished under the original estimate.

To complete the work of the Survey necessary to set forth and make available the resources of the Commonwealth, by

all the means known to our sciences, will require the continuation of the Survey for several years to come. My approximate estimates are as follows:

For the field expenses and salaries of three topographical parties, for four months' field work each year	\$3,000
For the salaries of the Director, the Geological and Topographical Assistants, and the Assistant in charge of the Cabinet	5,000
For the salary of the Topographer employed in reducing the field work	500
For the chemical work of the Survey	1,000
For the field expenses of the geological parties	1,200
For stereotyping the Reports, &c., of the Survey	2,500
For the salary of an Engraver	1,000
For the purchase and repair of instruments	500
For the purchase of engraving stones, &c.	800
Office expenses, cases, postage, &c.	1,000
	\$17,500

On this basis it will be possible to complete about two thousand five hundred square miles of topography each year—thus requiring about eight years to complete the map of the State. The general reconnoissance work would be finished within three years to come, when the annual expenditure could be reduced to about fourteen thousand dollars per annum. On this basis the work in ten or twelve counties could be completed each year at least, after the ending of the reconnoissance work should leave the geologists of the Survey free to give their whole labor to the completion of the county maps and reports.

This computation is based upon the most rigid economy, and the sums cannot be lessened without materially reducing the effectiveness of the work. It will also be necessary that the Director shall be able to foresee, each year, just the sum available for the prosecution of the work, in order to make his contracts with that element of permanence which is necessary to secure the best class of labor. Should it seem to the Legislature of the State not desirable to have the Survey continued to its definite completion, I would strongly urge that at least twenty thousand dollars be appropriated in order to finish the work now in hand and far advanced towards publication.

In any event, I would recommend that money be appropriated to provide for the printing of at least one thousand copies of all the Reports, and three hundred copies of all the Reports and Memoirs of the Survey, the same to be distributed, in part, to public libraries and men of science, and the remainder placed on sale in the hands of certain designated agents. The very limited means of the Geological Survey has hitherto made their distribution impossible.

If the Legislature will make a permanent appropriation, of as much as fifteen thousand dollars per annum, for the work of the Survey, with the understanding that the work is to be continued for ten years to come, and the work should be left in my hands, I can promise that, if the plans I have put on record are carried out, the Commonwealth will have a better record of its resources than has as yet been obtained by any State in this or any other country.