

KENTUCKY GEOLOGICAL SURVEY.

JOHN R. PROCTER, DIRECTOR.

REPORT

ON THE

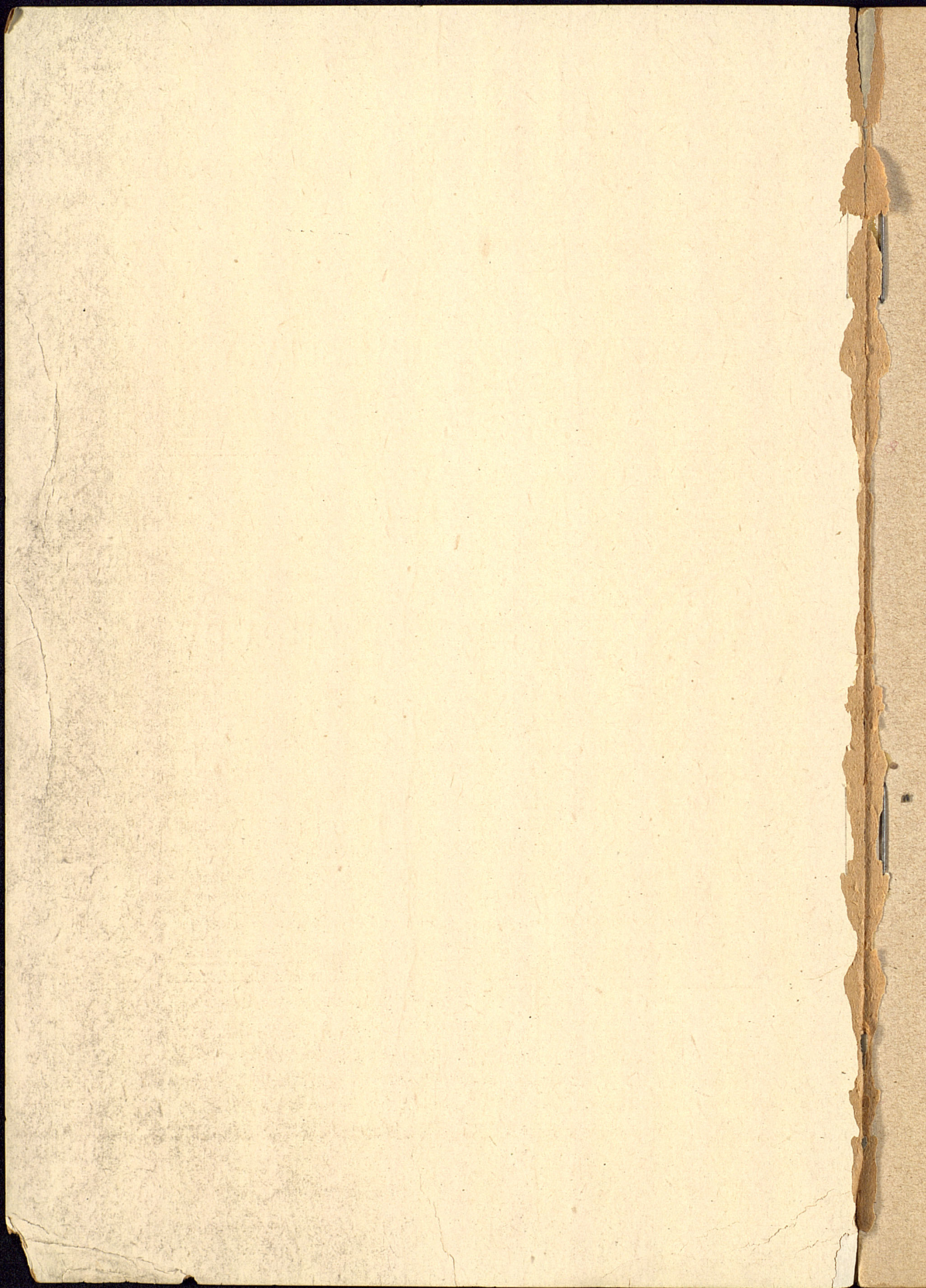
PROGRESS OF THE SURVEY

From January, 1890, to January, 1892,

By JOHN R. PROCTER.

FRANKFORT, KY.:

CAPITAL OFFICE: E. POLK JOHNSON, PUBLIC PRINTER AND BINDER.
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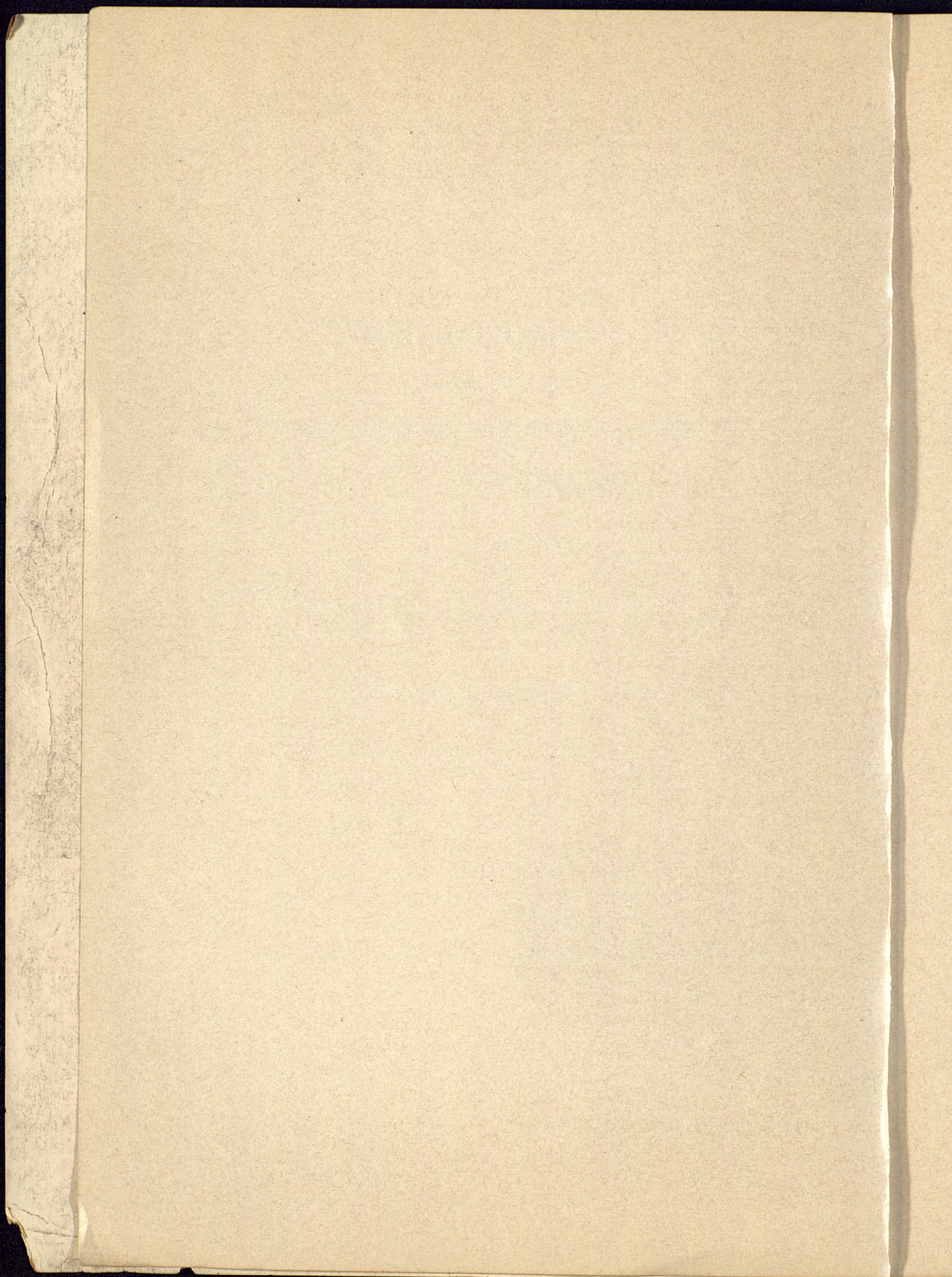
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REPORT OF STATE GEOLOGIST.

To His Excellency, JOHN YOUNG BROWN, Governor of the Commonwealth of Kentucky :

SIR: I have the honor to make the following report on the progress of the Geological Survey of the State for the years 1890 and 1891 :

As the Survey is drawing to a completion, I deem it of interest, after first detailing the progress of the work for the past two years, to give in brief a history of the Survey from its first organization in 1854, under the direction of Dr. David Dale Owen, to the present time, with a short statement of some of the more important discoveries directly traceable to the work of the Survey.

The facts justify the statement that more progress has been made, and more accomplished towards completing a study of the State during the years 1890 and 1891 than during any previous two years since the first organization of the Survey. This is due to the fact that the gentlemen constituting the present staff have been trained by work in the field, and have thus acquired a practical knowledge of the problems to be encountered, and a thorough acquaintance with the several fields in which they were at work ; and for these reasons have been enabled to push forward their investigations more rapidly and more effectively than ever before. This will be shown by the maps and reports published during the past two years, and by those now in the office of the Survey ready for publication, and others in course of preparation, a list of which will be given elsewhere.

The survey of the Eastern Kentucky coal-field, directly under the charge of Prof. A. R. Crandall, has made most satisfactory

progress. During the preceding two years work has been carried forward to completion over a large territory between the Levisa and Tug Forks of the Big Sandy river, having an area of about 1,100 square miles. Most of this region is wild land, with so few surface indications of its geology as to require much time and labor to make the opening necessary for a study of its resources. Additional areas west of the Levisa Fork, which were necessarily omitted from previous reports, aggregating about two hundred square miles, have been studied in the same manner.

In addition to the above, Prof. Crandall gave about half a year of field work to a more detailed examination of the coals in Magoffin and Floyd counties with reference to a report which we have in preparation on the Eastern Kentucky coal-field as a whole. The field work in this part of the Eastern Department, as above mentioned, has involved the making of about 400 excavations to expose beds of coal, 290 of which were made during the past two years. The work required for making so large a number of systematic openings has been carried on by Prof. Crandall's assistant, Mr. Jas. Ira Proffitt, whose interest and energy in the prosecution of this work can not be too highly commended. A number of carefully prepared maps, page size, showing location of most important openings, and the height above the several streams, are an important feature to be added to the reports now being made ready for the printer.

In the valley of the Kentucky river, mainly on the waters of the South Fork, work has been carried forward on the same plan. In this valley the work has been mainly under the immediate direction of Mr. G. M. Sullivan, aided for a time by Mr. H. M. McConathy. Mr. Proffitt was also employed in this field for a few weeks. About one hundred and sixty openings of coal have been made on the waters of the Kentucky river during the past two years, and the results of the studies are now being put in form for publication, most of the maps and sections having already been engraved.

In the valley of the Cumberland work has been carried on in extension of that of former years, chiefly by a more systematic examination of typical regions. This work has been greatly facilitated by land-owners paying expenses of excavations,

under direction of the Survey. By such aid the Survey has been enabled to more than double its work in this district, securing also a more thorough study of the resources than would otherwise have been possible. A thorough development of the beds of coal of the Log Mountain region, an area of about 100 square miles of mountain district, has been planned and carried forward to completion. The report is in course of preparation; the maps and sections have been engraved, ready for publication. A more systematic tracing of coals has also been secured north of Pine Mountain, in the Straight Creek and Four Mile Creek region in Bell county, and in the Red Bird Creek region in Leslie county.

A careful study has been made of the region north of Pine Mountain, opposite the Log Mountain district, on the heads of Greasy Creek, Golden's Fork, Harp's and Brushy Creeks, to determine the hitherto uncertain relation of the beds north of Pine Mountain to those of the higher mountains south of that fault ridge. A number of openings have also been made on the head of Straight Creek, in Harlan county.

The openings of coal made in the Cumberland Valley under the direction of the Survey during the past two years number about 450, representing a very large amount of work. Exact measurements have thus been obtained of the thickness of the coals, their character, and many samples collected for analyses.

The preliminary work on Jackson and Rockcastle counties was completed by Mr. Sullivan, and the report, with geologic map, published.

The report on the geology of Whitley and that part of Pulaski county embraced within the coal field was completed and published during the two years under consideration.

Work was commenced in Wayne county during the autumn of 1891, and the geology about half completed at the close of the season for field work. It is important that this work be pushed to completion, because it completes the study of that part of the eastern coal field, and because of the importance of the petroleum, natural gas and other resources of that county. A large area west of the Cincinnati Southern Railway is destitute of transportation facilities, and it is believed that an accu-

rate knowledge of the resources of that section of the State will lead to the building of the needed railway lines.

All of the work under the direction of Prof. Crandall, during the past two years, in addition to the object of making local reports, has been prosecuted also with reference to a report on the Eastern Kentucky coal field as a whole, in which the extension and the equivalency of the various coals will be treated.

Such a report could not well be planned in detail in advance, but data have been collected for it each year as the work progressed. The report on the Big Sandy Valley region above referred to will show that the Elkhorn, or coking seam, proven several years since to be a coking coal of great excellence, extends as a thick coal over a considerable area east of the Russell fork, and it is believed that the publication of this, together with the facts hitherto brought to light regarding the superior coals of the upper waters of the Big Sandy, will lead to the construction of railways through this region.

The forthcoming report on the Log Mountain region will show the existence of several valuable coals in that district, two of which, it is believed, will prove valuable as coking coals. Such an amount of work could not have been accomplished during the past two years but for the thorough knowledge of the field by Prof. Crandall, gained by his intelligent study extending through a series of years, and the untiring, intelligent labors of his Chief Assistant, Mr. G. M. Sullivan.

In my Report on Progress of the Survey for the years 1886, 1887, I mention the fact that all topographic work had been concentrated on the western part of the State, in order to have maps prepared for the geologist in that section. This work has been prosecuted in Western Kentucky since. In 1890 the plats of Meade and Breckinridge counties were completed, and the maps made ready for the geologist. Alignment surveys were made of the railway from West Point to Cecelia Junction, and of the Breckinridge Coal Road (the records of the original surveys of these roads not being obtainable). Mr. F. H. Bagby and party made survey of Hart county, and began work in Green and Taylor counties. Mr. L. M. Sellier and party completed the field work in Muhlenberg county. During the winter

of 1890-91 Mr. Bagby and Mr. Sellier platted and reduced to working scale the maps of Hart, Green, Taylor and Muhlenberg counties.

In 1891 Mr. Bagby and party surveyed Trigg county, and Green river from the mouth of Little Barren river to the Casey county line, and completed the field work previously commenced in Green and Taylor counties, and made a survey of Adair county. During the summer of 1891 Mr. Sellier was kept in the office, when, in addition to assisting in the work of caring for the Geological Cabinet and Library, he platted such work of the field party as was sent in from time to time. He also made tracings of map of Wayne county for use of geologist in the field, and reduced same to scale for engraving.

During winter of 1891-2 Mr. Bagby and Mr. Sellier have been platting maps and making tracings for use of geologists in the field, so that by the spring of 1892 all of the work in the above six counties—Trigg, Adair, Taylor, Green, Hart and Muhlenberg—will be completed, ready for the geologist. To these must be added the counties hitherto surveyed in this field, Lyon, Webster, Hopkins, Butler, Ohio, Hancock and Grayson.

Mr. Bagby and Mr. Sellier were assisted in the field work by Messrs. H. M. Frazier, J. M. Major, E. H. Bull, W. H. Averill, J. M. Haynes, B. H. Blanton and G. B. Jefferson.

Mr. J. B. Hoeing, in addition to work in geology as hereafter given, drew for the engraver the geologic maps of Warren, Jackson, Rockcastle, Meade and Breckinridge counties; geological sections for Dr. Orton's report, and for the Meade and Breckinridge reports; also a new edition of the State map, and a map of the Cumberland Mountain System.

GEOLOGIC WORK IN WESTERN KENTUCKY.

Prof. R. H. Loughridge completed the field work in Livingston county, and his report on the geology and resources of that county is now in the hands of the printer. As Prof. Loughridge has accepted a position elsewhere, the Survey could only have the benefit of his work for a few months during his summer vacation. After completing Livingston county, he began and completed the field work in Meade county. The completed report is now in the hands of the printer. The geologic map of

this county has been published, and also a map on which is shown the location of all of the gas and salt wells in that county.

In the autumn of 1890 Mr. M. H. Crump and J. B. Hoeing completed the field work in Warren county. The geologic map of that county has been published, and the completed report is in the office of the Survey ready for publication. Mr. E. O. Ulrich had previously done the geologic field work in Caldwell and Crittenden counties, but additional field work was made necessary by observations in these and the adjoining county of Livingston. This was completed, and he is now engaged in preparing the report on these two counties for publication.

In the summer and autumn of 1891 Mr. J. B. Hoeing completed the study of the geology of Breckinridge county. The geological map of this county has been published, and the completed report is in the office of the Survey ready for publication. This work has demonstrated the position of two important anticlines in the above-named county, which will have a bearing on the future development of gas in that county.

The geologic work in the above-named counties will probably have a more direct bearing on the development of the coal mining interests of the western coal-field than would work in the counties containing the coal, for the following reasons: Railways traverse that coal-field from east to west and from north to south, and Green river, made navigable at all seasons by locks and dams, extends through the center of the coal-field. Coal mining has already been well developed in that part of the State. In several of the counties to the west of this field are large deposits of excellent brown iron ores. Recent developments confirm the opinion that these ores are more extensive than has hitherto been supposed. The Survey has brought to knowledge the existence of extensive deposits of fire and pottery clays of great variety and excellence in the counties west of the Cumberland river, known as the "Jackson Purchase" counties.

Lead ores, fluor-spar, clays, etc., abound in Caldwell, Crittenden and Livingston counties. The forthcoming reports on Meade and Breckinridge will show a wealth of resources: Asphalt rock; potash shales or marls; material admirably adapted to the manufacture of Portland cement; salt brine

and carbonate of lime most advantageously located with relation to natural gas and cheap coal for the manufacture of soda ash. The development of the above-mentioned resources will furnish a large local demand for coals, and coke from the Western coals. Experiments made within the past two years lead to the hope that a coke suited for furnace purposes can be made from two of the Western Kentucky coals. The important bearing of the tests in making steel by the basic process, on the coals and ores of Western Kentucky, will be given elsewhere.

The Director of the Agricultural Experiment Station, connected with the State College at Lexington, has undertaken to test some of the marls collected and forwarded to the Station by the Geological Survey, and the preliminary tests, as given in "Bulletin No. 39," recently published, gives promise of results that will be very beneficial to the agriculturists of the State.

It has been demonstrated that a percentage of the potash contained in some of the marly shales from Breckinridge and other counties in Western Kentucky is soluble, and thus available for plant food. The quantity of soluble potash contained in some of these marls amounts to as much as 2,000 tons to the acre, and as this is estimated to be worth five cents per pound as a fertilizer for tobacco, we can see what enormous wealth is locked up in these deposits. It is believed that a proper application of these marls to the sandy soils of the Chester plateau surrounding the western coal field will add greatly to the agricultural value of those lands.

STATE MAP.

A much needed map of the State was compiled and published during 1888-9, on a scale of 10 miles to the inch. This was the first map ever published, giving correctly the outlines of the State, and also the geology of the State. Several editions have been demanded, and it has also been published in various forms by the Commissioner of Agriculture and the Railway Commission.

The Survey began in 1884 the compilation of a larger map of the State, on a scale of 1.300,000 (the nearest decimal scale to 5

miles to the inch). This scale is large enough to show public roads and prominent features in topography, and subdivisions in geology somewhat in detail. As only accurate work is put upon this map, its progress must be determined by the progress of the survey of the various counties. The skeleton of the map has already been engraved, consisting of the complete State boundary, the principal railway lines, and a number of counties. The Survey has now, ready to put upon this map, a mass of additional data—enough to require the work of Mr. Hoeing in the office for from four to six months.

CHEMICAL DEPARTMENT.

The Kentucky Geological Survey has been noted among State Surveys for the number and value of the chemical analyses. This department has been, from the first organization of the Survey in 1854, in charge of Dr. Robert Peter. The numerous chemical reports, with the vast accumulation of valuable information contained, are a worthy monument to the zeal, industry and ability of Dr. Peter. Within the past two years, the seventh chemical report in the new series (vol. A, part 3), has been published, and the eighth chemical report is now in the office of the Survey ready for publication. These two reports contain much valuable data respecting the more recent tests of coking coals. The data are the more valuable because they extend our knowledge over hitherto unexplored portions of the State.

OFFICE WORK.

The amount and importance of the office work increases with each year's progress of the Survey, as will be shown by the increasing correspondence. Year by year the people of our own State look more to the Survey as a source of information respecting the deposits of coals, clays, building stones and other substances, and the published maps and reports elicit letters of inquiry from all parts of the country.

During the two years just passed much time was necessarily given to the preparation of the reports and maps, geologic sections and illustrations for publication, reading proof, etc. In

the office work I have been ably assisted by Mr. E. A. Fellmer, who has been my principal aid in this department since 1879. Although there has been no Bureau of Immigration since it was discontinued in 1887, there is yet a large correspondence growing out of the work of the Bureau previous to that time, and through the immigrants who have already made their homes in the State. This correspondence has been altogether in charge of Mr. Fellmer. He has endeared himself to the many thrifty colonists who have settled in Kentucky by his untiring labors in their behalf. He is now in correspondence with a number of farmers in Switzerland and elsewhere who expect to come to Kentucky during the present year. It is a pleasure to bear testimony to the zeal and efficiency of this faithful assistant.

The following brief summary will give the present status of the unpublished work of the Survey:

Livingston county.—Topographic map engraved. Geology colored on map ready for engraving. Report being stereotyped by Public Printer. About ten days' review in field will be necessary before the engraving of the geology on map, in order to settle definitely the location of certain fault lines extending into adjoining counties.

Meade county.—Geologic map and map showing location of gas and salt wells printed. Report in hands of printer.

Breckinridge county.—Geologic map engraved and printed. Illustrations printed. Report in office of Survey ready for printing.

Warren county.—Geologic map and sections engraved and printed. Report in office of Survey ready for printing.

Caldwell and Crittenden counties.—Map engraved, and geology colored on map ready for engraving. A few days' review in field necessary before engraving. Reports in course of preparation for printing.

Big Sandy River Valley, east of Russell's Fork. Page maps and sections engraved. Report in office ready for printing.

Log Mountain District. Map engraved and published. Page maps of streams and sections engraved. Report in office nearly ready for publication.

Upper Cumberland District, including Straight Creek. Map and sections engraved. Report nearly ready for publication.

South Fork of Kentucky River District. Maps and sections engraved. Reports now being written and made ready for publication.

Wayne County.—Map completed and drawn ready for engraving; field work in geology began in autumn of 1891; about two months' work of one man necessary to complete.

Petroleum, natural gas and asphalt rock of Western Kentucky, just published.

Data collected for final report on Eastern coal-field, as a whole.

Six counties in the Western coal field, and six counties in the Subcarboniferous limestone of Western Kentucky, are ready for the Geologist.

A map of the Cumberland Mountain system, comprising Pine and Cumberland Mountains, and the Log, Big and Little Black Mountains, has recently been published. This is a most useful map, and bears testimony to the skill of the Chief Topographer of the Survey, Mr. Hoeing.

A map has recently been published, showing the Eastern Kentucky coal-field and its relation to the iron ores and transportation routes of the South Appalachian District. On this map I have shown the coke iron blast furnaces erected from 1875 to 1892, with a table showing the growth of furnace capacity during the same time. This map is designed to accompany a report which I have in preparation on the coking coals of Eastern Kentucky and their relation to the iron ores of the South Appalachian region, and the Ashland, Kentucky, Iron District. It is believed that this great Central Appalachian District can be shown to have advantages over all others for the cheap production of iron and steel.

Since I was appointed Director of the Geological Survey in the spring of 1880, the following work has been accomplished by the Survey. A statement more in detail will be given elsewhere:

In Western Kentucky the topography and geology has been completed over thirteen counties, aggregating an area of 4,870 square miles; and in addition the topography has been com-

pleted and the maps drawn ready for the Geologist, or for the engraver, if it be decided to print them without the geology, of nine counties in Western Kentucky, aggregating 3,564 square miles.

Geology and topography have been completed in seventeen counties of Central Kentucky, aggregating 4,826 square miles.

Topography has been completed—and geology partially completed—over five counties in South Central Kentucky, aggregating 1,829 square miles.

Geology and topography have been completed over an area aggregating at least 10,000 square miles in the Eastern coal-field.

We thus have completed since the beginning of 1880 :

In Western Kentucky, Geology and Topography	4,870 square miles.
In Western Kentucky, Topography only	3,564 “
Total	8,434 square miles.
Central Kentucky, Geology and Topography	4,826 “
Eastern Kentucky	10,000 “
South Central Kentucky	1,829 “
Grand total	25,089 square miles.
To the above add completed work done by the second Survey	
prior to 1880. Eastern Kentucky, 4 counties, Geology and	
Topography completed (see I, map No. 1, accompanying this	
report)	
	1,070 “
Nolin River District, Geology and Topography completed (see	
IV, map No. 1)	
	264 “
Topography completed, parts Menefee, Wolfe, etc. (see VII,	
map No. 1)	
	580 “
Topography Grayson, Hancock, and part of Ohio county (see	
VI, map No. 1)	
	550 “
Total	2,464 square miles.

The above does not include the mass of valuable preliminary work done prior to 1880, such as sections across western coal-field. (See XVI and XVII map No. 1.) Nor does it include the work done by the Survey under the direction of Dr. David Dale Owen, such as the topography of Union county. (See No. 1 (in blue), map No. 1, and a mass of published preliminary work that may be made available in preparation of final reports.)

The Survey has been indebted to the United States Geological Survey for the topography over a portion of the eastern coal field, and it is to be hoped that this valuable work will be continued, and extended to other portions of the State not yet mapped, thus enabling the more rapid completion of the topographic work over the entire State.

It is safe to assume that quite 30,000 square miles of the State has been mapped, and that the geology has been completed over the most difficult portions. For instance, the seventeen counties surveyed in Central Kentucky are located around the rim of the Blue-grass region (see map No. 2), and contain the largest number of geologic horizons, one county having all the rocks, from the lowest found in the State—Chazy, up to and including the Carboniferous. The work in Eastern Kentucky was mainly in districts remote from railway transportation, mountainous, wooded, and requiring more time for a thorough understanding of the problems than any other district of like area in the State.

Since I was placed in charge of the Survey, the entire sum available for topography, geology, chemical analyses and office work, after deducting amounts appropriated for Bureau of Immigration, has been about \$10,000 per annum. The total cost for geology and topography, completed since 1880, has amounted to less than \$5 per square mile, an insignificant sum compared to the cost in some of the Eastern States, and in Great Britain, Germany and France.

BRIEF HISTORY OF SURVEY.

The first Geological Surveys of the State was organized in the Spring of 1854, under the direction of the eminent Geologist, Dr. David Dale Owen. No brief review of the large amount of work accomplished by Dr. Owen and his assistants can do it justice. Much of the work was necessarily in the nature of preliminary work, and obtained by a rapid reconnoissance of the State. Little was known hitherto of the geology or topography of the State. Dr. Owen, by his industry in visiting all of the counties of the State, obtained a general knowledge of the geology of each county in brief. In the four volumes published

by the Survey under his direction is to be found a mass of valuable information. Dr. Robert Peter, the chemist of the Survey, published four chemical reports.

The first annual report of Dr. Owen, he gives the results of his reconnoissance of the Western coal-field. This information was supplemented by additional reports on that field accompanied with a general section of the coal-measures of the Western field, and a numbering of the coals, beginning with No. 1, the first coal above the Conglomerate or "Millstone Grit." These numbers remain in force to the present day, and it is curious that men of the present day talk about "Coal No. 9," "Coal No. 11," etc., without knowing that these numbers were given by the State Survey prior to 1860.

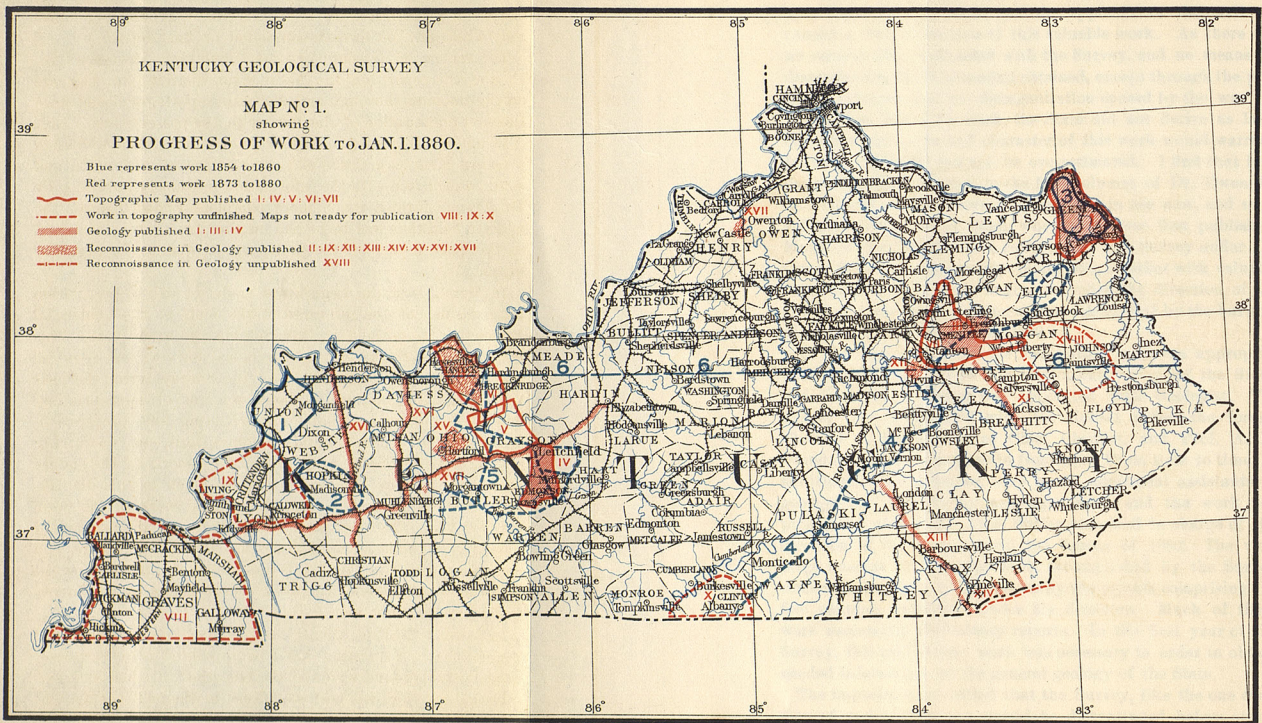
The most expensive single work undertaken by the first Survey was the east and west base line run across the State. This is shown by the line in blue, marked No. 6, on Map No. 1 accompanying this report. This was designed as a base line on which to tie future work in obtaining a map of the State. It has been found more advantageous to locate subsequent topographic work from points located by latitude and longitude determination, and by triangulation. Under this first Survey a map of Union county (see No. 1, Map No. 1) was published, and also a map of parts of Greenup, Carter and Boyd (No. 3, Map No. 1), and a skeleton map of Hopkins county (No. 2, Map No. 1). A skeleton map was made south from Hancock county to Green river to accompany a report by S. S. Lyons on this region. The report was published, but the map was never published. This large manuscript map is now among the archives of the Geological Survey. Copies of the maps enumerated above have been framed and placed in the State Museum. A most important and valuable work was a reconnoissance along the western border of the Eastern Coal-field, by Joseph Leslie. This report contains much valuable information respecting the region traced; and constant reference is to-day made to this report. On Map No. 1 accompanying this report I have given in blue the map-work undertaken by the Survey prior to 1860. I could not give the great amount of valuable reconnoissance work in geology accomplished by the Survey for the same time, as there is no way of representing it on the map. No attempt was made

to give complete maps, accompanied by report, on any county or district. This work was in contemplation, but the unfortunate death of Dr. Owen and the approach of the civil war caused a discontinuation of this valuable work. As there was no central office connected with the Survey, and no means for disseminating the information obtained, except through the published volumes, and the disorganization caused by the war following fast upon this work, the State did not derive as large benefits as the value and character of this work would warrant. Its value, however, can not be overestimated. I find that I am daily compelled to turn to the four volumes of Dr. Owen for information, and I believe they are more in use now, and more valuable to the State, than when they were first published. Much of the valuable data collected by the Survey under Dr. Owen, field notes, manuscript maps, etc., together with valuable maps made by the State engineers under the direction of the Board of Internal Improvement, were destroyed by the burning of one of the State offices in 1869.

In the Spring of 1873 the Legislature made an appropriation for beginning anew the Geological Survey of the State, and Prof. N. S. Shaler was appointed State Geologist. The Survey was reorganized with Dr. Robert Peter, the former Chemist of the Survey, as Chief Chemist, and Prof. A. R. Crandall as First Assistant in Geology. From time to time, as additional appropriations were made, additional assistants in geology and topography were appointed, and the work was prosecuted with zeal. Prof. Shaler remained in charge of the direction of the Survey until the Spring of 1880. The very large amount of valuable work accomplished by the Survey under his direction is best shown by the reports comprising the five volumes published under his direction. Much of these were necessarily preliminary reports. In the first year of the Survey, this preliminary work was necessary in order to obtain needed information on the general geology of the State.

The impression prevailed that the Survey, like the one commenced under Dr. Owen, would be discontinued before attention was given to the several localities, and some attention or investigation, however general, was demanded from all parts of the State. On map No. 1, I have indicated in red the work as





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published under the direction of Prof. Shaler. Much work, such as preliminary horse-back reconnoissance excursions, etc., could not be indicated on the map. Nos. I, III and IV, represent what may be termed completed or final reports.

The report on Greenup, Carter, Boyd and Lawrence (No. 1), and the report on the Nolin river district (No. IV), are among the most thorough and elaborate reports published since the first organization of the Survey to the present time. Nos. XVI and XVII, are sections along the western railways crossing Western Kentucky Coal-Field, east and west and north and south, and, taken with the information previously published by Dr. Owen, furnish much more complete knowledge of the western field than was to be had on the much larger coal-field in the eastern part of the State, up to within the past few years.

In March, 1886, the Legislature made a small appropriation for a display of the resources of the State at the Centennial Exposition, to be held at Philadelphia the same year. This was placed in charge of the Geological Survey, and required much of the time of the officers of the Survey during the year 1876. Notwithstanding the small amount of appropriation, and the short time available for collecting and preparation, the display of minerals, building stones, soils, etc., was highly creditable to the State, as shown by the reports of the judges of award, and the number of medals given to this display. This, however, was at the expense of field work in the State for that year. The reports of Prof. Shaler on the progress of the Survey, published at each session of the Legislature, and collected together in Vol. III of the published reports, show the importance and value of the work accomplished by the Survey under his able direction.

In April, 1880, Prof. Shaler resigned as State Geologist, and honored me by requesting that I be appointed as his successor, in the following kind words to the Governor: "I find an assurance that my work has been well done, in the fact that the Survey has trained a man as well-fitted as any one could be to take up the work where I lay it down."

The act appropriating money for the continuation of the Geological Survey, passed April, 1880, whilst making the smallest

appropriation since the first organization of the Survey, created a Bureau of Immigration, making the State Geologist *ex officio* a Commissioner of Immigration, and made no additional appropriation for two years for the carrying out of the mandatory requirements of the law, without trenching upon the small amount appropriated for the geologic and topographic work.

With the limitations thus imposed, it was no easy task to plan work for the future in order to give to the several portions of the State needed attention, and at the same time secure the best results for the entire State. In my first biennial report I say :

"The region most requiring immediate attention was that portion of the Eastern coal-field on the upper waters of the Big Sandy, Licking, Kentucky and Cumberland rivers. Here is the largest area of the State unprovided with transportation facilities; the country is but sparsely populated, and unable to construct the necessary transportation ways to bring it in communication with the great tides of commerce passing to the North and South." * * * "Of the region comprising the counties of Elliott, Morgan, Johnson, Martin, Floyd, Pike, Letcher, Magoffin, Harlan, Powell, Lee, Rockcastle, Laurel, Leslie, Wolfe, Clay, Knox, Bell, Whitley, Pulaski and Wayne, no reports on the geology and resources, save preliminary reconnoissance reports on limited areas, had been made by either the present Survey, or the Survey conducted by Dr. D. D. Owen."

It was believed that a coking coal could be found at the headwaters of the above-named rivers, and Prof. Crandall, who was placed in charge of the work commenced in that region, was instructed to institute tests of such coals as gave promise of having coking properties. His success was greater than anticipated. A coking coal was found and traced over a wide area, on the headwaters of these streams, averaging from six feet to eight feet in thickness; and from numerous tests and analyses, it was proven to be a coking coal of remarkable excellence. The subsequent work in tracing this coal, and extending its known area into adjoining counties, has been detailed in each of the reports of progress to the present time. As these reports are to be found in the published documents of the State,

it is not necessary to repeat here. The knowledge of the remarkable coking coals of Eastern Kentucky is now widespread, and important railway lines are being pushed into that region, one of which has already reached the coking coals, and coke plants are being erected. The main coking seam was named the "Elkhorn" coal from the stream in Pike county where it was first discovered, and proven to be a coking coal of great value.

The value of this coal is determined by the following conditions :

- (1.) Its superior quality and low cost of mining.
- (2.) Ease by which it may be brought to the Ohio Valley and the north-west by proposed railway lines.
- (3.) Nearness to great deposits of iron ores of the South Appalachian region.
- (4.) Position with regard to the South Atlantic States, there being no coal between the south-eastern border of this coal-field and the Atlantic ocean. Two coals above the Elkhorn seam have been proven to be coking coals of good quality.

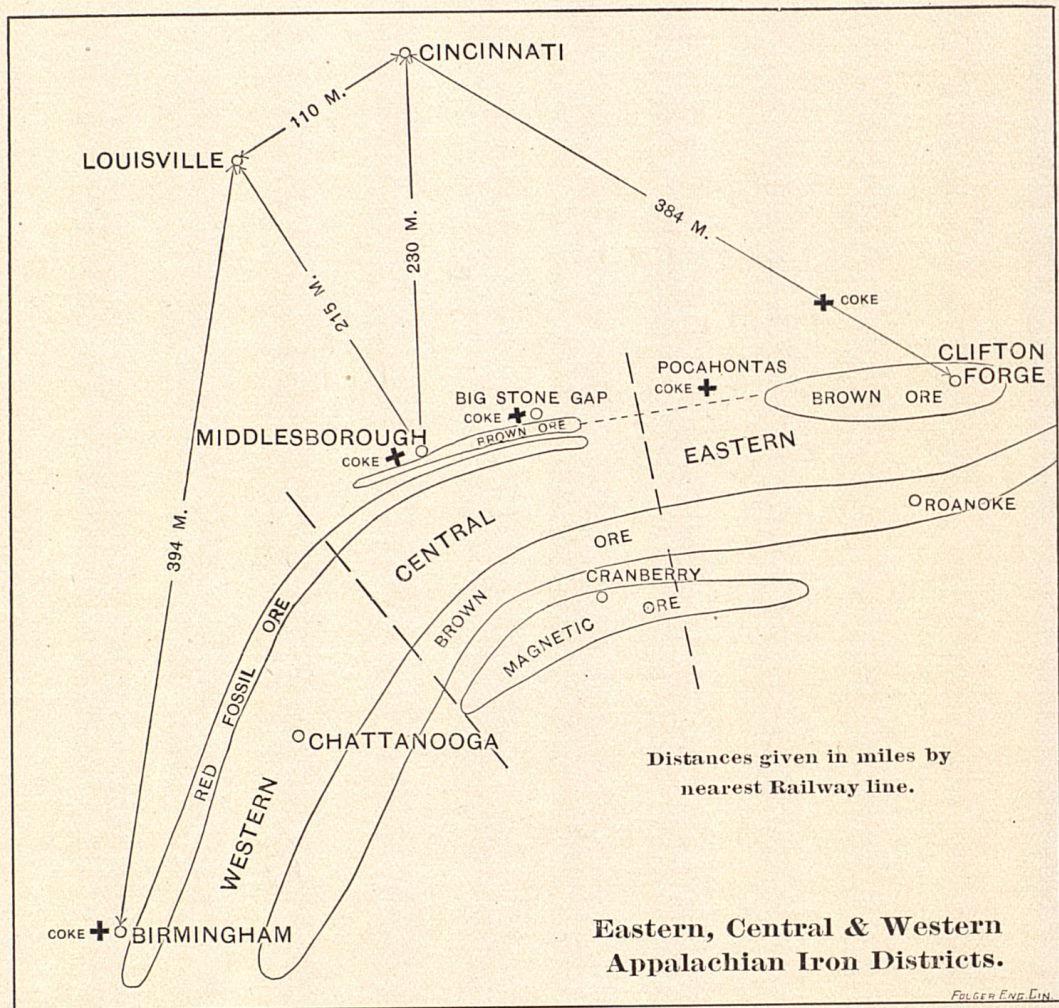
The value of these great coking coals to the State can better be understood from a study of the table compiled below, and the diagram facing page 21. Railways connecting the coals and ores in the Central district were only completed within the two years past, and already six large coke iron blast furnaces have been completed, and two others have been commenced, and it is believed that the Central division will make more progress in the future than either the Eastern or Western.

Table Showing Growth of Coke Iron Blast Furnace Capacity in Central and South Appalachian Region.—
From 1875 to 1892 Inclusive.—Compiled by JOHN R. PROCTER.

IRON DISTRICTS.	1875.		1880.		1885.		1890.		1892.	
	No. of Stacks.	TONS.	No. of Stacks.	TONS.	No. of Stacks.	TONS.	No. of Stacks.	TONS.	No. of Stacks.	TONS.
1. Hanging-Rock, Ohio, Dist.	10	133,500	11	145,000	11	145,000	14	175,000	14	175,000
2. Hocking Valley, Ohio, Dist.	4	50,000	12	165,000	12	165,000	14	205,000	14	205,000
3. Ashland, Ky.	2	60,000	2	60,000	2	60,000	3	80,000	3	80,000
4. Clifton Forge, Va., Dist.	1	15,000	2	40,000	4	115,000	6	161,000	8	235,000
5. Chattanooga Dist.	4	100,000	5	140,000	9	302,000	10	350,000	10	350,000
6. Birmingham, Ala., Dist.	0		3	65,000	8	233,000	32	1,127,000	32	1,127,000
7. Roanoke, Va., Dist.	0		0		2	70,000	4	125,000	11	488,000
8. Middlesborough—Big Stone Gap Dist.	0		0		0		0		7	300,000

NOTE.—District No. 4 has the ore ("Oriskany") 100 miles and more from the Coke. No. 8 has same ore within a few miles of Coke. Nos. 5 and 6 have red fossil ore within a few miles of Coking Coal, but Coke from Nos. 7 and 8 now being carried to furnaces in districts 5 and 6, because of superior quality. No. 8 has red fossil ore of Nos. 5 and 6 as near to Coke; has brown ore of Oriskany nearer to Coke than in district No. 4, and has brown ore ("Potsdam") in great abundance along northern base of Great Smoky Mountain nearer to Coke than are the same ores to the Coke in district No. 7. It will be seen that No. 8 has the combined advantages of Nos. 4, 5, 6 and 7 in addition to being nearer to the great deposits of pure magnetic ores of the Cranberry region.

obtained advantages of Nos. 4, 5, 6 and 7 in addition to being nearer to the great deposits of pure magnesite.



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The completion of the Cincinnati Southern Railway brought the coal and iron ores together in the Chattanooga portion of the Western District, and the manufacture of coke iron was begun there earlier than elsewhere in the South. The completion of the West Virginia Division of the Chesapeake and Ohio Railway brought together the brown ores of the Clifton Forge District and the coking coals of the New River District prior to 1875. In 1883 the New River Division of the Norfolk and Western Railway was extended to the Pocahontas coal, and iron manufacturing began in that district in 1885, and has made rapid progress, as will be shown by the accompanying table and diagram, which I have prepared to show the relation of this coke to the iron ores of the Eastern, Western and Central Appalachian Iron Districts, and to the main iron distributing centres of the Ohio Valley. I have divided these districts into the Eastern, comprising that region that will naturally draw a supply of coke from the New River and Pocahontas fields; the Central, to be supplied from the Southeast Kentucky field, and the Western, which will also in future draw largely from the Central, on account of the superior quality of the coke.

During the year 1892 three important industrial demonstrations will be made, having a potential bearing on the development of iron and steel manufacture in this Central Appalachian region. These are: (1.) The starting of the large basic steel plant at Middlesborough, Kentucky. This plant will have a capacity of three hundred tons basic steel slabs and billets a day. It, with the two large blast furnaces, is equipped with all of the most approved appliances, with the coking-coal, iron ore and limestone all within a few miles, to be delivered at low cost. Deep drifts have proven the reliability and excellent quality of the red fossil ore below the drainage level. Coke of good quality is now being made, and it is believed that the quality will be yet improved by the machinery to "disintegrate" the coal instead of crushing by rollers. This plant will, it is confidently believed, make a basic steel at low cost. The development of the manufacture of steel by this process has made hitherto but little progress in this country, because, to within a recent period, the patents were controlled by the American owners of the Bessemer process, and because of the more recent develop-

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ment of the ores in the South suited to this process. In Germany and on the Continent, where the conditions are not so favorable as in the Appalachian region, the basic has made greater progress than the Bessemer process. This is shown by the following table, in tons of twelve hundred and forty pounds:

GREAT BRITAIN.			CONTINENT.		
Steel—By Basic process.		By other processes.	Steel—By Basic process.		By other processes.
	Tons.	Tons.		Tons.	Tons.
1880.	10,000	1,285,382	1880.	40,000	1,827,000
1890.	503,400	3,075,643	1890.	2,021,903	1,140,000

That the development of the manufacture of steel by the basic, both open hearth and Bessemer-basic, is about to have a wonderful development in the South is evident, and this will have an important bearing of the entire development of the region. By this process, the phosphorus in the iron combines with the dolomite lining of the converter, forming a phosphate of lime, which has been demonstrated to be most valuable as a fertilizing material.*

In addition to the vast stores of iron ores of the Appalachian region, suited to the open-hearth basic process, there are very large deposits of ore—a dark, almost black, limonite—along the

* The use of the basic slag as a fertilizer is making rapid progress in England, but more especially in Germany. The United States Commercial Agent at Mayence, in his report to the Secretary of State (see Consular Reports, No. 117, June, 1890, page 374) gives the annual consumption in Germany at four hundred and fifty thousand tons, and says: "This new phosphate is represented to be meeting with great favor among the farmers of Germany, and to do all that it is claimed for it. It is alleged to be a more powerful, effective and lasting fertilizer than any other phosphatic manure, and to be superior to bone meal, ground coprolites, natural phosphate, etc., and to produce the same results as superphosphates at much less cost per acre. It acts three times quicker than bone dust, and at one-third the cost. * * * Its price and efficacy makes it the cheapest of all manures, and by the use of it a saving of twenty-five to fifty per cent. per acre in the cost of manuring is said to be effected. Its much greater cheapness than superphosphates permits the employment of double as much of it as superphosphate, with a more marked after-action."

flanks of the Blue Ridge, in Virginia, and the Great Smoky Mountains, in North Carolina and Tennessee, having a high percentage of phosphorus and low in silica—ores admirably suited to the Bessemer-basic process. These ores have hitherto been unused in the furnace, with but one exception, within my knowledge, but I have seen these deposits at intervals along a line extending for two hundred miles in the district above referred to. It is probable that we will see, in the near future, a development of basic steel manufacture in the South as remarkable as the development of iron manufacture in the recent past. The ores of the Green river district, and of the Lower Cumberland, in Western Kentucky, are suited to the open-hearth basic, and the success of the Watts plant, at Middlesborough, will have an important bearing upon the future value of the deposits of those sections.

(2.) During the year 1892, a furnace will be started demonstrating, on a large scale, the value of the magnetic deposits of Western North Carolina for the manufacture of a high grade Bessemer steel. The value of these ores has been sufficiently demonstrated. During the past year, the furnace at Cranberry, North Carolina, has run on Virginia coke, and the run of the mine of Cranberry ore, and analyses of each day's run for a month, gave an average for the month of only .022 phosphorus in the pig; the highest for any one day being .027. The entire product is sold as a "special" Bessemer, on account of its great purity, at a price in advance of the Lake Superior Bessemer.

The demonstration on a large scale that a high grade Bessemer can be made at a low cost in this Central Appalachian district means much for the future development of the district.

Nowhere else is a low phosphorus ore so near to superior coking coals.

(3.) The third experiment, which is no longer an experiment, will be the manufacture of a superior coke at low cost. A coke with from 92% to 94% fixed carbon, and less than 6% of ash, and low in sulphur, will be produced. This will not only hasten the development of the Central Appalachian district, but it will have an important bearing upon the future of the Ashland, Kentucky, iron district. At Ashland, a large Bessemer steel plant has recently been completed. The iron-

masters of the lake region are beginning to look to the Southeastern Kentucky coking coals as a favorable region from which to draw much needed supplies of coke with which to smelt the immense deposits of high grade ores.

With the demonstration of the above-named industries, basic steel, Bessemer steel and coke, who can foretell the future of this great hitherto undeveloped region?

In my report on Progress of the Survey for the year ending December 31, 1883, I said:

"I am of the opinion that enough preliminary or reconnoissance work has been done by the Survey, and the work for the past few years has been directed with a view of securing (so far as the means will permit) final reports on the various regions studied. This, whilst it will lessen the number of reports published, will be a saving in time and money, as the special information contained in a preliminary report on a district must be duplicated in the final report, which should contain all that is known of the geology, soils, timber, etc.

"In the first stages of the Survey this preliminary, or special, work was necessary, in order to obtain needed information on the general geology of the State. Besides, the impression prevailed that the Survey might be discontinued before attention was given to the several localities. The method which this involved, whilst it was sufficient to meet pressing demands for special information, and has been productive of good, has not been so advantageous or economical as a plan based on the conviction that the Survey would be conducted to completion, and that when work was begun in a locality it should only be with a view of obtaining a final report, and should be prosecuted without interruption until that should be accomplished."

This plan has been adhered to up to the present time.

It has been one of the main objects of the Survey to collect data for a final report, embracing in a more condensed form a description of the topography, geology, agricultural features, mineral and forest resources of the entire State; in short, giving in one volume the physical condition of Kentucky, as determined by the Geological Survey. This, to possess the greatest value, must be delayed until the detailed Survey of

the State has been completed, or it is determined to discontinue the work.

The law governing the conduct of the Survey directs that the Governor shall cause the work to be prosecuted—first, in those counties that have received no work from the Survey, and, second, in those counties that have received least work from the Survey. This provision has been adhered to throughout, bearing in mind, at the same time, the best interest of the whole State.

In January, 1886, the Survey was first enabled to publish a corrected area of the State. Hitherto the area had been variously estimated at from 37,000 to 40,000 square miles. It was then computed by the Survey, and published to be 41,283 square miles. The areas of the counties are computed from time to time as the work is completed, and will form a valuable aid to the authorities to correct a wrong assessment of acreage of the counties.

The Survey finds that the area of the two coal-fields, as estimated by former Survey, was an underestimate. The area of the Eastern Coal-field, as estimated by first Survey, was 8,983 square miles, and the Western Field 3,888 square miles, making a total of 12,871 square miles. At the time this estimate was made, the State-line between Virginia and Kentucky had not been accurately surveyed, and was not properly shown on any existing map. Mr. Hoeing now estimates the area of the Eastern Coal-field at 11,180 square miles, and the Western Field at 4,500 square miles, making a total for the State of 15,680 square miles of coal-measures.

Map No., 2 accompanying this report, will give a better idea of the present condition of the Survey of the State, or the taking an account of stock of the natural resources with which this State has been so bountifully endowed, than can be given by words. That the State is upon the threshold of a phenomenal progress I have no doubt. Its progress in the recent past has been most satisfactory. This is well shown by the following table, showing the *gain* in assessed value of property in some of the Southern States from 1880 to 1890 (compiled from official figures):

Alabama	\$119,902,247
Florida	61,842,160
Georgia	164,178,627
Kentucky	209,536,405
Louisiana	57,254,332
Mississippi	47,332,812
North Carolina	57,842,447
South Carolina	20,848,346
Tennessee	135,737,567
Virginia	96,002,881
West Virginia	40,173,563

When it is remembered that the three great iron and steel plants at Middlesborough, Ashland and Grand Rivers, just completed, represent a larger outlay of money and a greater productive capacity than all that had hitherto been done in the manufacture of iron and steel in the State, from its first organization to the present day, it will be realized that this year, the centennial year of the Great State's history, is the birth year of an era of increased progress and prosperity.

Respectfully yours,

JOHN R. PROCTER, *State Geologist.*

