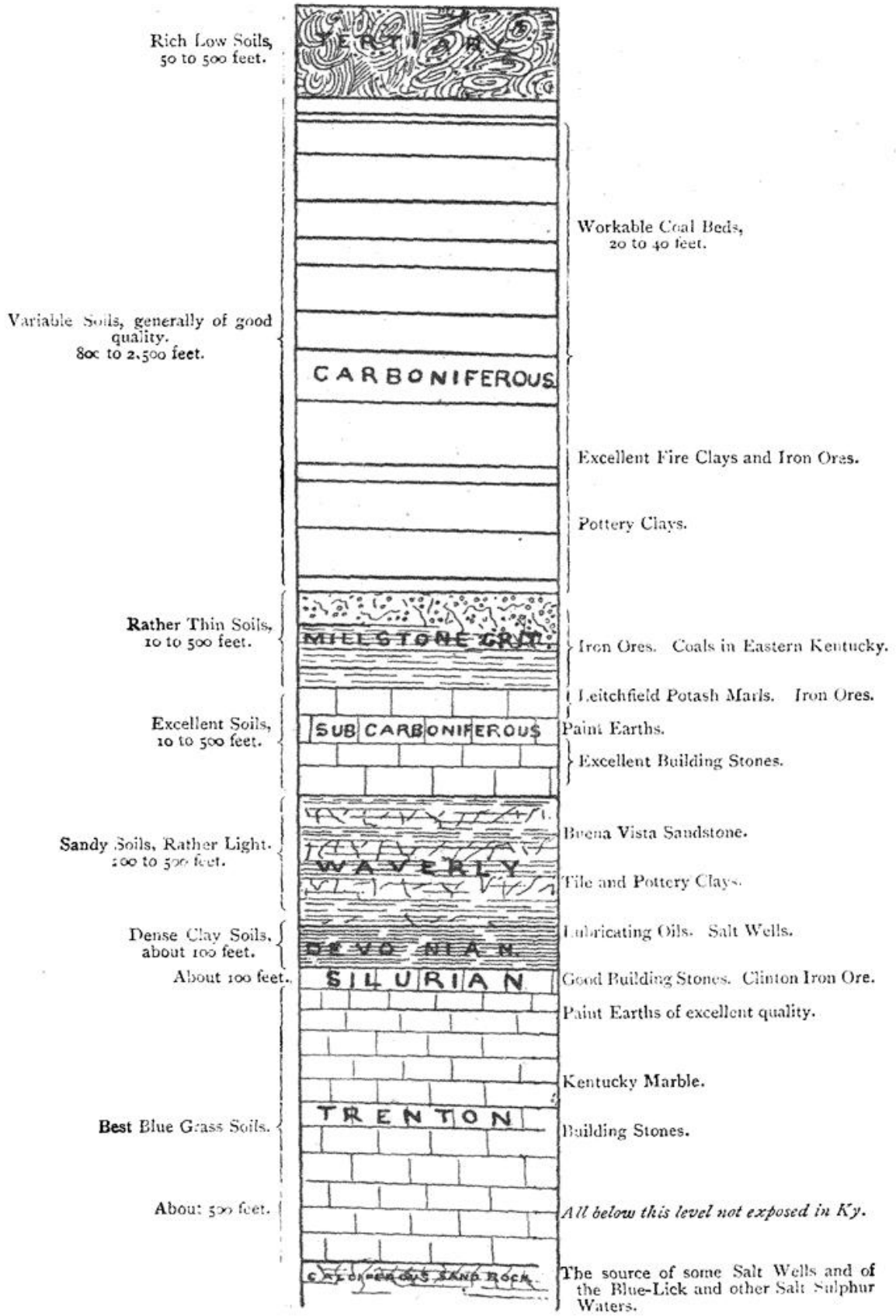
A

GENERAL ACCOUNT

OF THE

COMMONWEALTH OF KENTUCKY.


Rich Low Soils, 50 to 500 feet.
TERTIARY
Workable Coal Beds, 20 to 40 feet.
Variable Soils, generally of good quality. 800 to 2,500 feet.
CARBONIFEROUS
Excellent Fire Clays and Iron Ores.
Pottery Clays.
Rather Thin Soils, 10 to 500 feet.
MILLSTONE GRIT
Iron Ores. Coals in Eastern Kentucky.
Leitchfield Potash Marls. Iron Ores.
Excellent Soils, 10 to 500 feet.
SUB CARBONIFEROUS
Paint Earths.
Excellent Building Stones.
Buena Vista Sandstone.
Sandy Soils, Rather Light. 100 to 500 feet.
WAVERLY
Tile and Pottery Clays.
Dense Clay Soils, about 100 feet.
DEVONIAN
Lubricating Oils. Salt Wells.
About 100 feet.
SILURIAN
Good Building Stones. Clinton Iron Ore.
Paint Earths of excellent quality.
Kentucky Marble.
Best Blue Grass Soils.
TRENTON
Building Stones.
About 500 feet.
All below this level not exposed in Ky.
CALCIFEROUS SAND ROCK
The source of some Salt Wells and of the Blue-Lick and other Salt Sulphur Waters.

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GULF OF MEXICO
CARIBBEAN SEA
MAP OF
THE SOUTHERN PART OF NORTH AMERICA
designed to show the position of
THE COMMONWEALTH OF KENTUCKY.
KENTUCKY GEOLOGICAL SURVEY
N. S. Shaler, Director.

A

GENERAL ACCOUNT

OF THE

COMMONWEALTH OF KENTUCKY;

PREPARED BY THE

GEOLOGICAL SURVEY OF THE COMMONWEALTH,

FOR THE

Centennial Exhibition at Philadelphia.

1876.

CAMBRIDGE:
PRESS OF JOHN WILSON AND SON.
1876.

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PREFACE.

THE following brief and imperfect account of the Commonwealth of Kentucky has been prepared under the following circumstances: Owing to the fact that the Legislature of Kentucky did not meet in 1874, or until 31 Dec., 1875, no sufficient action was taken to insure the representation of the Commonwealth in the Centennial Exhibition of 1876. On the sixteenth of February of this year, an appropriation of five thousand dollars was made for the purpose of making some showing of the resources of the State, and the following gentlemen were appointed commissioners to control the expenditure thereof: —

Gov. JAMES B. MCCREARY, N. S. SHALER, Esq.

First	District	W. B. MACHEN, Esq.
Second	"	CLINTON GRIFFITH, Esq.
Third	"	JAMES H. BOWDEN, Esq.
Fourth	"	Gen. E. H. HOBSON.
Fifth	"	Dr. E. D. STANDEFORD.
Sixth	"	JOSEPH C. HUGHES, Esq.
Seventh	"	WILLIAM WARFIELD, Esq.
Eighth	"	Dr. JENNINGS PRICE.
Ninth	"	JOHN DISHMAN, Esq.
Tenth	"	F. L. CLEVELAND, Esq.

At the first meeting of this Board it became evident that, in the brief time at its disposal, it would be necessary to put the principal part of the burden on the State Geological Survey. The work of making the collections of minerals, soils, &c.,

that accompany this Report, as well as the preparation of the Report itself, was put upon the Survey. Coming in the time of preparation for the field-work of the year, these Centennial preparations have proved a great burden to the Survey, and have been less perfectly executed than was desired. It is believed, however, that the collections, together with this and the several other pamphlets, will give the intelligent observer a good general knowledge of the condition and prospects of Kentucky. Persons desiring additional information are referred to the publications of the Survey, or to the Reports now in preparation, — a list of which is given at the end of this pamphlet. All other information concerning the resources of the State will be cheerfully furnished, on application to the Secretary of the Geological Survey at Lexington, Kentucky.

In the completion of these pages, every possible care has been taken to exclude errors. Owing, however, to the haste of its preparation and printing, some errors have doubtless crept into the text. Corrections are respectfully solicited, and all that may be furnished will be noted in subsequent editions. It is believed that the Tables from the United States Census, the Reports of the Sanitary Commission and the State Treasurer are quite without error.

My acknowledgments are due to my assistants, Dr. ROBERT PETER, Mr. J. H. TALBUTT, Chemists of the Survey; to Messrs. A. R. CRANDALL, P. N. MOORE, C. J. NORWOOD, Geological Assistants; and more especially to Assistant JOHN R. PROCTER, for his coöperation in preparing the work for the press.

N. S. SHALER,

Director Kentucky Geological Survey.

MAY 10, 1876.

A

GENERAL ACCOUNT

OF THE

COMMONWEALTH OF KENTUCKY.

GEOGRAPHY.

Position. — The Commonwealth of Kentucky — situated between latitude 36° 30′ and 39° 06′ north, and longitude 5° 00′ and 12° 38′ west, from Washington — includes about forty thousand square miles of area, extending for six hundred and forty-two and a half miles along the south bank of the Ohio River, from its junction with the Mississippi to the mouth of the Chatterawah or Big Sandy. This river forms the northern, north-western, and north-eastern borders of the State. A part of its north-eastern border, one hundred and twenty miles, is formed by the Chatterawah River; a south-eastern face of about one hundred and thirty miles has a natural boundary in the several ranges which receive the common name of Cumberland Mountains. The southern face alone is an arbitrary line of two hundred miles in length. The western boundary of about fifty miles is formed by the Mississippi River.

A glance at the accompanying map will make it plain that the region occupied by this Commonwealth has a position of peculiar importance with reference to the great feature-lines of the continent. The Mississippi-River system is the key to the continent. Those parts which lie beyond its borders are, by their limited area or their severe conditions of climate, relatively of minor importance. In this system the State of Kentucky, all things being considered, occupies a most important place. Its western border is only one thousand and

seventy-five miles* from the mouth of the Mississippi, and its eastern boundary is within five hundred miles of the Atlantic ports.

The special features of position to be considered in measuring the importance of this Commonwealth are its central place with reference to the Valley of the Mississippi, and the advantages it has from its extended contact with the river system of that valley. More than any other State in America it abounds in rivers. Including the Ohio and Mississippi Rivers, where they bound its borders, the State has within its limits rather more than four thousand miles of rivers, which are more or less completely navigable. Improvements of small cost will give this amount of navigation with complete permanency, except for an average of about fifteen days per annum, when they are ice-bound.

GENERAL GEOLOGY.

Just as the State of Kentucky is geographically but a part of the Mississippi Valley, so it is geologically composed of a series of rocks which extend far and wide over the same region. On the eastern line, between Cumberland Gap and Pound Gap, it is generally in sight of the old crystalline rocks of the Blue Ridge, or original axis of the Appalachian Chain, and is closely bordered by rocks of the middle Cambrian or Potsdam age; but the lowest exposed rocks of the State are those found at a point on the Ohio River, about twenty miles above the Licking River, where we come upon Cambrian rocks answering to the base of the Trenton period in New York, and probably to the Bala or Carodoc beds of England. This series is about six hundred feet thick, and consists principally of the remains of organic life laid down in a continually shallowing sea, interrupted by occasional invasions of coarser sediment, derived from the northward. At the close of this Cincinnati section of the Cambrian, there came the invasion of a heavier sand-flow, probably coming from the south-east, that arrested the life and formed some thick beds of rock, known in the reports

* It is 528 miles from Columbus to New Orleans by railroad, and 472 miles to Mobile.

of the Kentucky survey as the Cumberland Sandstone. After this the floor of the sea was sparingly peopled with life, during the whole of the Clinton and Niagara epochs, when it was probably deep water. This deep sunken condition of the ocean floor continued in the Devonian time, when this section seems to have been the seat of a deposition such as is now going on beneath the Sargassa Sea of the Atlantic of to-day. The decaying sea-weed and other organic matter made a bed from three hundred feet thick along Lake Erie to forty feet thick in Southern Kentucky, averaging about one hundred feet in Kentucky. This bed furnishes the rich lubricating oils of the Cumberland Valley. After this came again shallow water, and quick successive sand-invasions moving from the north, which formed several hundred feet of beds. These beds probably represent but a fraction of the time required to form the Black Shale which lies below. This part of our section is called the Waverly, and is commonly regarded as being more nearly related to the Carboniferous than to the Devonian series of rocks. After this period came a repetition of subsidence, and a cessation of the sand-invasions. During this time there was such a development of sea-lilies or stemmed Echinoderms, that this time deserves to be called the period of crinoids. This accumulation ranges in depth from a few feet along the Ohio River to five hundred or more feet under the Western Coal-field. It marks a period of tolerably deep still water, filled with lime-secreting animals. It is probably to the unbroken character of this succession of life, and especially to the crinoids with their upright stems, that we owe the uniformly massive character of many of the beds of this Subcarboniferous Limestone.

Next in the ascending series we come on the coal-bearing rocks. Their deposition was begun by the sudden shallowing of the water over this region, bringing the old sea-floor near the surface of the water, and subjecting it to alternating invasions of sand borne by strong currents, and exposures in low-lying flats covered by a dense swamp vegetation. Each of these swamp-periods answers to a coal-bed; each recurring subsidence, to the deposits of sands and shales that lie between the coals.

After the Carboniferous period, we are warranted in believing that this region was but little below the sea, and with this change it became essentially subjected to land conditions alone. The wear incident to these conditions has swept away a large part of the exposed rocks, and reduced the Carboniferous series to less than half of its original thickness.

Near to the present time there came a sudden subsidence of this whole region, that brought the low-lying western part of the State beneath the level of the sea, and retained it there while the Tertiary deposits were being formed out of the waste of the higher parts of the Mississippi Valley that still remained above the sea.*

The disturbances that have changed the position of the rocks in Kentucky have been few and far between, though they have materially affected the general structure of the State. From the mouth of the Licking south a little westerly, through Monroe County, extends a ridge or axis of elevation, the beds dipping gently, rarely over ten feet in a mile, in either direction away from it. This was in part formed during the deposition of the Lower Cambrian, but probably was completed at a much later date. This has caused the limitation of the Carboniferous beds of this region. To it in fact we owe the abundant diversity of the rock outcrops within the State. In the south-east corner of Kentucky there is a region between Straight Creek and Clear Creek, tributaries of the Cumberland, and the Virginia border, where the Appalachian disturbance has thrown the rocks into mountain folds. Here are some fine exposures of the deeper rocks brought up by the great faults of the region.

No glacial traces of the last period are known within the State, nor are the indications of the more ancient ice-periods at all distinct. This area has probably remained south of all those profound disturbances of temperature that have so greatly affected more northern regions.†

* The appended generalized section on second page of cover will give a general idea of the successions of the Kentucky rocks. Further facts can be found in the Reports of the Survey, for which see list at the end of this pamphlet.

† For further information on this subject, see the Biennial Report of N. S. Shaler for 1874–5, Kentucky Geological Survey, now in press.

Surface. — The whole of Kentucky lies within the Mississippi Basin, and within the special division of the Ohio Valley. Its principal feature-lines have been given it by the river excavations. A small area on the south-east, containing not more than four thousand square miles, lies within the disturbed region of the Alleghanies, and has a true mountain-folded structure. The remainder is essentially a plain or table-land, sloping from the south-east towards the north-west, and little broken, except by the deep-cutting river excavations. In the eastern half this table-land has an average height of about one thousand feet above the sea; the ridges often reaching to fifteen hundred, and the valleys down to seven hundred feet. The greatest difference between the bottom of any one excavation valley and the borders of the divide does not exceed about seven hundred feet, and is usually about half this amount. Eight degrees west of Washington the country begins to sink down rapidly to the west. The cause of this change will be explained in the geological description of the State. Its effect is to carry the upper surface of this table-land gradually downwards, until along the Mississippi its average height is not more than three hundred feet above the sea, and the average difference between the bottoms of the valleys and the tops of the ridges is not over fifty feet. This considerable height of the State above the sea is of great advantage in securing it against fevers, from which it may be said to be practically exempt, except in a narrow belt in the extreme western district, near the borders of the swamp regions.

Although the general surface of the State is that of a table-land sloping towards the Ohio River, and consequently towards the north-west, it has many subordinate features which should be separately described. All that part of its surface indicated as Tertiary on the accompanying map is rather imperfectly drained, the rivers having low banks, and during the winter and early spring being subject to overflow from the floods. The remainder of the State, saving a strip a few hundred feet wide along some of the larger streams, is absolutely free from this danger. The remainder of the State, to the east of this line, has only the variety which comes from the difference in the

wear of the streams in the rock. The nature of this difference will be discussed under the head of geology. It is only necessary to say here that the whole of the area described on the map as Cambrian is characterized by broad flat-topped ridges, with steep-banked rivers between; the general character being that of a much cut up table-land. The part marked as Devonian has broad valleys and steep-sided, tower-like hills. That marked Subcarboniferous, especially in the region west of the Cincinnati Southern Railway, is characterized by having all its smaller streams underground, usually only the rivers over fifty feet wide at low water having their paths open to the sky. All this region wants the small valleys which we are accustomed to see in any country, but in their place the surface is covered by broad, shallow, cup-like depressions or sink-holes, in the centre of which is a tube leading down to the caverns below. All this region is completely honey-combed by caverns one level below the other from the surface to the plane of the streams below. In one sense, this set of underground passages may be regarded as a continuous cavern as extensive as the ordinary branches of a stream when it flows upon the surface. The sink-holes answer to the smallest extremities of the branches. Some idea of the magnitude of these underground ways may be formed from the fact that the Mammoth Cave affords over two hundred miles of chambers large enough for the passage of man, while the county in which it occurs has over five hundred openings leading far into the earth, none being counted where it is not possible to penetrate beyond the light of day.

The Carboniferous formation is characterized by being cut into very numerous valleys, mostly rather narrow and with steep-sloped, narrow-topped ridges on either side. The relatively narrow valleys, and the general absence of any large areas of flat land on the top of the ridges, cause this region to have less land well fitted for cultivation than any other part of the State. Every part of the surface of the State not permanently under water may be regarded as fitted by its surface for the uses of men, not one thousandth of it being so precipitous as to be unfit for cultivation in some fashion. The writer knows

of no equal area in Europe that has as little waste on account of its contour.

RIVER SYSTEMS.

Reference has been made to the fact that the whole of this Commonwealth lies within the basin of the Mississippi, and over ninety per cent. of its area within the Ohio Valley, the remainder pouring its waters directly into the Mississippi. There are, however, a number of large streams which are the property of the State; and two, the greatest tributaries of the Ohio, gather a part of their waters in the State.

Big Sandy. — Beginning at the eastern end of the State, we have the Big Sandy or Chatterawah River, which separates for forty miles, by its main stem and then by its eastern fork, the State of Kentucky from West Virginia. This stream is the only river of its size in America all the basin of which is in the coal-bearing rocks. It drains a valley of about four thousand square miles. Its name of Sandy is derived from the very large amount of moving sand in the bed, coming from the rapid wear of the sand rocks which compose the beds of all its tributaries. The valley consists of a narrow belt of level, arable land bordering the streams, and a great extent of hill land of a good quality of soil, but only fit for permanent cultivation on the more gradual slopes. The greatest value of soil-products in this valley is to be found in its timber resources, which will be found specially mentioned under the head of timber. It may be said here that the valley contains, next to the Upper-Kentucky and the Cumberland Valleys, the largest amount of original forest found in any part of the State, and more than any other valley is especially fitted for the continued production of timber of varied quality. The forests throughout this region readily and rapidly reproduce themselves in the same species, after being cut away. The soil of this valley is very well fitted for the growth of fruits of all kinds. The season is rather later than that of the other river basins of the State, and the liability to frosts possibly rather less than in the central region. Owing to difficulties of transportation, fruits have been as yet but little grown for exportation.

The whole of the cereals are produced in the valley. The soil is usually of a light sandy nature, with generally enough clay to give it a fairly lasting quality. The principal disadvantage arises from the steepness of the slope of the hills.

Mineral Resources. — The coal resources of this valley are, in proportion to its total area, greater than any other in the State, scarcely an acre of its area but probably has some workable coal beneath it. These coals are mostly of the ordinary bituminous qualities; some cannel coal occurs therein of workable thickness. A full account of these coals, with illustrative sections, will be found in the general description of the eastern coal-field. Little effort has been made to find iron ores in this valley. The dense forests and the softness of the rocks prevent the occurrence of trustworthy surface indications. In the lower part of the valley very important ores have recently been discovered, of which the precise areas and character are yet to be determined. (See the reports of A. R. Crandall and N. S. Shaler for further details.)

The Little Sandy Valley. — The general character of this small valley is much the same as that of the Big Sandy. The river is altogether within the Carboniferous formation. The early utilization of the iron ores of this valley has led to a knowledge of its mineral resources superior to that yet obtained for any other equal area in the State. About thirty-five feet of workable coals are known in the several beds of the valley. (See p. 42.)

Tygert's Creek. — Here the coal resources are more deeply cut down by the stream, which in good part flows upon the Subcarboniferous Limestone. Though wanting some of the best coals, it has many of the best iron ores of the State. Some beautiful caverns are found along its banks in Carter County. The general surface is much as in the valleys before described. In its upper part, the Limestone rocks give occasional areas of more enduring soils than are furnished by the Sandstones of the country to the eastward. The timber and other soil products are much the same.

The stream is not navigable, but can easily be made so by locks and dams, giving continuous navigation for about forty miles along the meanders of the stream.

The streams from the mouth of Tygert's Creek to the mouth of the Licking or Nepemini are all quite small, and drain a region of limited mineral resources. Kinniconick Creek gives access to a region abounding in admirable Sandstone for building purposes, and to some iron ores of undetermined richness, but of considerable promise. It can be made navigable at small expense. The whole of this valley abounds in excellent oak timber.

The Licking. — This stream, the fourth in size of the rivers of the State, ranking next to the Big Sandy, passes over all the formations found in the State except the Tertiary. From its source to near the mouth of Blackwater Creek it runs on the Carboniferous rocks. As far as Duck Creek, it is still bordered by these beds containing excellent coals, both cannel and bituminous. On the Subcarboniferous Limestone, which crosses the river near Blackwater Creek, is an excellent iron ore. On Slate Creek, near Owingsville, is an admirable mass of ore, the richest of the State, having at places a depth of fifteen feet or more.

Triplett and Salt-Lick Creeks afford excellent building-stones, and the same series of rocks (the Waverly) furnish some stones which give great promise for lithographic purposes.

From the mouth of Fox Creek to the end of the river the stream is entirely in the lower Blue Limestone or Upper Cambrian rocks, which afford excellent building-stones, but no other marketable underground products.

The soil of the valley varies greatly, — light sandy loam in the Carboniferous and Waverly series; rather wet clays on the Black Shale and Silurian; rich, loamy clays giving soils of the first quality over the lower or Cambrian half of the stream.

Kentucky. — Sixty miles below the Licking, the Ken- discharges into the Ohio. This stream is the second Kentucky streams in volume, and the first in length. Blue Limestone lands of the counties drained by the Fork are noted for their large yield of a tobacco highly by the manufacturers of "fine cut," and well known in rkets under the name of "Mason County tobacco."

Its head-waters, from Sturgeon Creek east, lie altogether with the coal-bearing rocks. At least four hundred miles of water-front, open to vessels able to carry three hundred tons of coal, can be made on the three forks of this river. The coal holds along the hill-sides as far as Station-Camp Creek. The upper half of the Red-River branch contains also an abundance of coal. The entire drainage of the Kentucky River, above its forks in Lee County, is in the Carboniferous rocks. No portion of the State exceeds the Upper Kentucky region in number, thickness, or quality of coals. A preliminary section, made by Mr. P. N. Moore, of the Kentucky Geological Survey, from Red River in Wolfe County to the mouth of Troublesome Creek in Breathitt County, establishes the fact that up to the latter point there are at least five workable coal-seams above the Conglomerate Sandstone. The following analyses, from carefully averaged samples, will show the excellent quality of these coals: —

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific Gravity	1.300	1.294	1.297	1.290	1.289
Moisture	2.50	3.50	3.56	2.76	2.10
Volatile Combustible Matter .	41.10	35.20	33.56	36.60	36.20
Fixed Carbon	49.22	56.70	58.38	56.50	58.20
Ash	7.18	4.60	4.50	4.06	3.50
Coke	56.40	61.30	62.88	60.56	61.70
Sulphur	0.818	1.189	1.381	0.865	0.836

No. 1 is a coal from Frozen Creek, Breathitt County.
No. 2 is a coal 5′ 7″ thick, from Devil Creek, Wolfe County.
No. 3 is a coal from Spencer's Bank, Breathitt County.
No. 4 is a coal 6′ thick, from Wolfe Creek, Breathitt County.
No. 5, from near Hazard, Perry County.
Analyses by Dr. Robert Peter and Mr. Jno. H. Talbutt, chemists for the Kentucky Geological Survey.

The cannel coal of the Upper Kentucky is to be found over an extensive area, and is of a remarkably good quality, as will be seen from the following analyses by the chemists of the survey, made from average samples: —

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific Gravity	1.280	1.265	1.280	1.180	. . .
Moisture	0.94	1.30	3.40	1.20	1.20
Volatile Combustible Matter .	52.38	47.00	34.40	58.80	40.86
Fixed Carbon	35.54	44.40	46.96	35.30	46.44
Ash	11.14	7.30	6.24	4.70	9.50
Coke	46.68	51.70	53.20	40.00	57.94
Sulphur	1.423	1.574	0.630	not est.	0.634

No. 1. Georges' Branch Cannel Coal, Breathitt County.

No. 2. Haddock's Cannel Coal, mouth of Troublesome Creek, Breathitt County.

No. 3. Robert's Coal, Perry County.

No. 4. Frozen Creek, Breathitt County.

No. 5. Salt Creek, Perry County.

Three of the best gas-coals in Scotland and England are: (No. 1), Lesmahago Cannel; (No. 2), Ramsay's Newcastle Coal; (No. 3), Weym's Cannel Coal. Compare with the above the following analyses, taken from Dr. Peter's Report, Vol. II. First Series Kentucky Geological Survey: —

	No. 1.	No. 2.	No. 3.
Specific Gravity	1.228	1.29	1.1831
Volatile Matter	49.6	36.8	58.52
Fixed Carbon	41.3	56.6	25.28
Ash	9.1	6.6	14.25
	100.0	100.0	98.45

Sulphur not determined.

The indications are that the coal-measures thicken, and the number of workable coals increase south-easterly from the mouth of Troublesome Creek. This, however, can only be determined by detailed survey.

In addition to the numerous workable coals above the Con-

glomerate Sandstone in this region, there are two workable coals below the Conglomerate. The excellent quality of these coals can be seen from the analysis, No. 1601, p. 81.

Just below the coal the Carboniferous Limestone bears upon its top the ore known as the Red-River iron ore, which has long furnished a very celebrated cold-blast charcoal iron, well known as Red River car-wheel iron. There is probably about one hundred miles of outcrop of this ore within a short distance of the tributaries of the river, and within twenty miles of the main stream. Salt, fire-clay, and hydraulic cement abound in the Black Shale and Upper Silurian rocks. From Burning Creek to the mouth the Kentucky Valley runs entirely within the Upper Cambrian or Blue Limestone.

The soils in this valley have the same character as in the Licking, ranging from the light loamy soils of the Carboniferous, through the clays of the Silurian and Devonian to the exceedingly rich blue-grass soils of the Cambrian and Cincinnati Limestone rocks. The navigation of the Kentucky River has been improved by locks and dams as far up as a point about twenty-five miles above Frankfort. The stream is admirably adapted for the extension of this method of navigation, until over six hundred miles of navigable water is secured. As in the case of the Licking and the Green, it has the peculiar advantage of having a very great variety of soil and natural products within a narrow compass.

The timber resources of the part of this valley that lies within the coal-bearing area are very great; all the important timber trees of Kentucky, except the cypress, are found within the valley. The black walnut is found in abundance on the hill-sides throughout this section, the finer qualities of oak, much yellow pine, some white pine, &c.

Salt River. — This stream is the only considerable river in the State that has little in the way of mineral resources. It will be seen that it follows the line of the outcrop of the Subcarboniferous Limestone throughout its whole extension, being the only river in the State that does not run across the general trend of the stratification. The valley abounds in good Limestone for building purposes, the whole of the Subcarboniferous

Limestone being exposed along its banks. The underlying Sandstones of the Waverly also furnish excellent building materials. Iron ores occur in the Waverly Shales, and perhaps also in the Subcarboniferous. The salt-bearing rocks of the lower Waverly and the Black Shale are doubtless accessible from the line of the surface of the valley. The flow of water is rather more steady than in the other rivers to the eastward, on account of the cavernous nature of the rocks along its banks. It will, therefore, furnish excellent water-powers along its whole course.

The soil of this valley is of pretty even excellence throughout. The head-waters drain a region of Blue or Cambrian Limestone, and the main stream takes the soils of the Waverly which are rather sandy, and the Carboniferous Limestone which affords very good soil.

The river has a more than usually rapid fall, descending about six hundred feet in its course of about one hundred miles from the head-waters, — probably the most rapid fall of any stream of its size in Kentucky. This will make the improvement of the stream more difficult than of other rivers of the State.

The Green. — This, on many accounts the finest of the rivers that have their whole course within the State, differs in many striking regards from the other streams. It is at its lowest stage about one-third larger than the Kentucky. The Kentucky and Licking streams have their mineral belts at their head-waters, while the lower part of their course lies in districts having their greatest value in their agricultural resources. The Green, however, has its lower half within the western coal-field, and its upper waters in the older rocks. This western coal-field is described in another section of this pamphlet, to which the reader is referred for details. In a general way it may be said that it is exceeding rich in coals of varied quality, and abounds in iron ores of high grade. Muddy River, Bear Creek, and Nolin, are peculiarly rich in iron ores, the district between Bear Creek and Nolin being one of the richest in America in the ores of the Carboniferous period.

Soils. — The soils of this valley have throughout a high order

of merit when they lie on the Subcarboniferous Limestone. They are clay loams with a perfect underground cavern drainage, excellent for all grains and for fruits. The coal-bearing rocks give soils of a much higher quality than is usual in such formations, nearly the whole of the area occupied by these rocks giving good grain crops and tobacco of a high quality and of a large yield to the acre.

The whole of this valley is peculiarly fitted for furnishing water-power. Rough Creek, Pond River, Muddy River, Bear Creek, Nolin River, Big Barren River and its tributaries, and all the other streams heading in the Subcarboniferous or lower Limestone are singularly steady in their flow, owing to their underground reservoirs of water. To these underground sources they owe as well their comparative immunity from freezing, the Green rarely freezing in the winter season. The whole of this valley is singularly well fitted for fruit culture, on account of its immunity from winter killing and destructive spring frosts, and its neighborhood to Chicago, Cincinnati, Louisville, and other great markets.

Nearly the whole of this valley abounds in excellent timber, principally hard-wood. The upper waters have large quantities of valuable cedar timber; the Carboniferous district abounds with the several species of oak, great quantities of valuable hickories, walnut, tulip-tree (or poplar), some holly of large size, sometimes over fifteen inches in diameter. There is also a good deal of hemlock along the cliff borders of the streams, and some cypress in the lower swamps in the Pond River district.

Tradewater River. — This stream bears about the same relation to the western mineral field that the Little Sandy does to the eastern coal-field. Excepting a few of the less important head-waters, the whole of its basin lies within the coal-bearing rocks. Its soil is very fertile and well fitted for the growth of cereals and tobacco. An abundant growth of hard-wood timber of varied species compose its forests; for its area it is one of the richest fields for the oaks, hickory, poplar, that exists within the State.

The coals accessible in this valley are, in part, only above

the drainage level. They represent some of the best coals in the western district. Iron ores exist in abundance, but have never been worked.

The Cumberland. — This river has the upper half and lower sixth of its course within Kentucky. The upper region lies within the coal-field and traverses some of its richest sections. The part above Cumberland Ford is in a great mountain valley between Cumberland Mountain and Pine Mountain. This valley is about twelve miles wide, and is a fertile region abounding in excellent timber, with the land, so far as arable on account of its steepness, of excellent quality. About one-third of the surface is fit for culture with the plow. Below Cumberland Ford the river bottom widens, and the mountains sink down. The land along the river is very rich indeed, and that back on the hills is of good quality. At about two hundred miles from its source, the stream cuts down into the lower rocks, and from near the Kentucky line throughout most of its current in Tennessee runs on the Upper Cambrian or Blue Limestone formation; when it reënters Kentucky it is back to the rocks of the Subcarboniferous age, and the valley is an exceedingly fertile district. The line of this valley brings its southern edge near to the Tertiary formation of the western part of the State. Its proximity to the Tennessee on the west and to the Green on the east narrows the valley to small size; all the tributaries on the lower waters are small, but the upper confluents of this stream contain some of the finest rivers of the State. Martin's Fork, Clear Creek, Straight Creek, Rockcastle River, and Big South Fork are all considerable rivers, and afford excellent water-powers. They are all streams of great steadiness of flow, and all the conditions are favorable to the formation of valuable water-powers. They all traverse regions of very great resources in the way of iron and timber, and have soils of fair quality.

It is probable that no other valley in the West possesses so great a body of valuable timber as the Cumberland and its tributaries. Poplar, the several varieties of oak, beech, maple, sweet and sour gum, walnut, and other deciduous trees abound. Red cedar, yellow and white pine, are found in certain districts in considerable quantities.

The Cumberland is nearly equal to the Kentucky in the area and richness of its mineral districts. The coal section in the valley between Pine Mountain and the Cumberland Mountains has a depth of two thousand feet, and about twenty distinct beds of coal,* of which half-a-dozen are workable. The iron ores have not been examined or sought for. They may be expected to occur at several points in the coal-bearing rocks and on the top of the Subcarboniferous Limestone. The rich Clinton ores of the Cumberland-gap district,† though not in the drainage area of the Cumberland River, are in necessary commercial relations with it, inasmuch as they must be smelted by the charcoal and stone-coal of this valley. It is also most probable that these same ores are accessible along the hundred miles of the Pine-Mountain fault, by means of adits or galleries above the drainage, or by shafts of shallow depth. Detailed reports concerning this region may be expected in the fifth and eighth volumes of the Reports of the Survey. Beneath a large part of the upper Cumberland region the formation, commonly called the "Black" or "Devonian" Shale, is filled with a lubricating oil of great value. Experience has shown that these wells are practically inexhaustible, and that the oil is of a very superior quality, especially fitted for use in high latitudes, where other oils congeal. From one of these wells on Otter Creek, in Wayne County (see map), the oil is exported by wagon to Cumberland City, thence by rail to the river, thence by a precarious navigation to Nashville; even with these hindrances the business is

* Analysis of an average sample taken from a coal-bank forty-four inches thick, on Yellow Creek, Bell County: —

Specific gravity	1.282
Moisture	1.36
Volatile combustible matter	35.80
Fixed Carbon	59.54
Ash	3.30
Coke	62.84
Sulphur	0.975

† See Report of P. N. Moore, in fourth volume, and the Biennial Report of N. S. Shaler, third volume, in second series.

found to be profitable. With effective transportation a very large industry could be founded on this product; for, unlike the light burning oils, those heavy lubricating petroleums are of rare occurrence, and find a market that is scarce supplied by the present production.

This river is navigable for steamboats for a part of the year as far as the crossing of the Cincinnati Southern Railway. The great falls offer an obstacle to improvement of navigation into the upper waters, but not an insuperable barrier. Except this fall and the rapids immediately above it, the stream offers great facilities for improvement; it would be possible to make at least four hundred miles of slack-water navigation within the mineral belt on the upper waters of this stream.

The Tennessee. — This river debouches into the Ohio, within Kentucky, and has the last sixty miles of its magnificent course within the State. This part of the valley is among the lowest lands of the State; on the east side the river is bordered by the Subcarboniferous Limestone, rich in iron ores; on the other, it extends into the low Tertiary lands which reach to the Mississippi River. The land along this stream is very fertile.

The limitations of this brief sketch make it impossible to speak of many lesser streams of great economic importance, some of them capable of being made navigable by simple canalization. Nor has reference been made to the resources of the main Ohio. The mineral resources available in this valley are only in part derived from Kentucky, so they will not be discussed here. The alluvial soils within the valley of the Ohio are of a high order of fertility throughout its course. From the mouth of the Chatterawah, or Big Sandy, downwards to the mouth, the valley is distinctly bounded by cliffs, which gradually diminish from about six hundred feet to less than thirty feet near its mouth; no part of alluvial plains have any distinct swamp character until we come below the mouth of the Tennessee, though they, in part, are liable to winter overflows. This strip of arable land on either side of the stream widens from an average of about one-half of a mile near the Big Sandy to about one and a half miles near the mouth of the Tennessee. Its fertility becomes the greater the further it is removed to the west.

WATER-POWERS.

The very numerous rivers of the State supply a large number of water-powers of great value. Although the soils want the retentive power which belongs to regions where they were formed by the glacial period, and extensive lakes are wanting, owing to the absence of the action of the same agent in this region, yet the freedom from closure by ice, and the excellent character of the foundations for dams and mills, goes far to balance the advantages. It is impossible to consider these mill powers in detail. The following points may be noted: —

The main Ohio at the falls at Louisville offers a very great but unused water-power; the flow at the lowest stage of water exceeds that of any water-power used in this country. A very valuable power exists at Cumberland Falls, in Pulaski County, where a stream as large as the one named falls about sixty feet. This point is near the Cincinnati Southern Railroad. The various slack-water dams now building and to be built in the State all afford admirable water-powers where the power itself and the transportation of the manufactured products are both well assured. As a general rule, the other water-powers are best where the waters drain from the Subcarboniferous Limestone; next in order of merit when their supply is from rocks of the Waverly or Subcarboniferous Sandstones. Next in value are the streams in the Blue Limestones, or Upper Cambrian; and, least of all, the streams from the coal-bearing rocks, which are generally largely composed of dense Sandstones and impervious Shales, having little in the way of water-storage spaces. The deficiency in the storage of water in the soil can be easily remedied by use of storage reservoirs, which, from the depth of the upper valleys and the generally good foundations, can be readily made.

SOILS AND AGRICULTURE.

All the Kentucky soils except the strip of alluvial land along the banks of the rivers have been derived from the decay of the underlying rocks. They may be called soils of

immediate derivation, as distinguished from the soils made up of materials that have been borne from a distance by water, or which deserve the name of soils of remote derivation. This feature of immediate derivation gives the Kentucky soils a more local character dependent on position than those of any State north of the Ohio. In that region the intermingling of materials due to the last ice period has reduced the soils to a more nearly equal character. Beginning with the lowest rocks, the soils of the Blue or Cambrian Limestone are those of the first quality, and are surpassed by no soils in any country for fertility and endurance. These soils are derived from a Limestone very rich in organic remains, which decays with great rapidity, and continually furnishes its *débris* to the deeper-going roots. This soil varies considerably in different districts, and at some few points, where the underlying rocks are locally rather sandy, it falls from its usual high quality. The best soil may be known by the growth of blue ash, large black locust, and black walnut. Many other trees are found in its forests, but these are characteristic, and are never found together save on best soils.

The most advantageous crops on this soil are grass, it being a natural grass land, all the grain crops, and on the richer parts hemp. Fruits of all kinds belonging in this climate do quite well on this soil. The steep slopes along the valleys are well suited for grape culture. The peculiar features of the soil are its endurance under culture. This region having been the first settled in the State, the extraordinary capacity of this soil for withstanding bad methods of farming led to the general opinion that soils of less inexhaustible properties were not worthy of notice; hence the comparative neglect of the soils of the lower rocks, which, though generally fertile, can be wasted by careless agriculture far more easily than those of the blue-grass region.

The soils of the Silurian (commonly called Upper Silurian Limestone) are much less fertile than those of the underlying rocks. When not too cherty, they make good grain and grass lands. There is generally such a mixture of the decayed matter of the underlying and overlying rocks that this thin formation, which does not exceed about one hundred feet thick, gives

but little soil which can properly be called its own. As this formation ranges from forty to one hundred feet thick in the outcrop, there is only a small area, not exceeding eight hundred square miles, occupied by these soils.

The soils of the Black or Devonian Shale have even less importance than those of the formation last mentioned; not over four hundred miles of the area of the State is covered by them. When found, they are generally a tough clay which only needs drainage to have very valuable qualities.

The Waverly or Subcarboniferous Sandstone has a thickness of several hundred feet, and furnishes an area of about five thousand square miles. Its soils are generally light clay loams, becoming more sandy as we go towards the north-east. They are throughout excellent fruit-soils, and yield fair crops of all the grains.

Next higher in the geological succession we find the Subcarboniferous Limestone, or Cavern Limestone, as it is commonly called. This rock makes a larger area of soil than any other formation except the coal-measures and the Blue Limestone (Cambrian), and may slightly exceed the latter in area. These soils are generally excellent enduring soils, ranking next to the best of the Blue Limestone soils. They are excellent grain and fruit lands, and in the western region are well suited for tobacco. Their drainage is generally excellent, on account of the cavernous character of the Limestone beneath.

The soils of the Carboniferous belt occupy by far the largest single area in the State, covering not far from fourteen thousand miles of surface. The soils in it are exceedingly variable in character, but are generally a sandy loam. On the conglomerate or lowermost part of the coal-measures, the soils are usually the poorest, — about the only really infertile soils of the State being the small strips of the soils formed on this rock.

These strips are usually very narrow, and do not include altogether more than three hundred or four hundred square miles. The remainder of the Carboniferous area is composed of fairly fertile light lands, interspersed with areas of great fertility.

Some of the best lands of the State are upon the summits of the Carboniferous mountains of Eastern Kentucky; it is safe to say that, wherever the shape of the surface admits of cultivation, the Carboniferous rocks of Kentucky furnish fair soils adapted to a varied range of crops. The considerable part of its surface that is not fit for agriculture is admirably suited for the production of hard-wood timber of the most valuable varieties, and will doubtless have in this fitness a source of wealth scarcely less than tillage of the best lands could give.

As a whole, the surface of Kentucky includes a larger area of very fertile land and a less area of barren soil than any other equal area in a State so rich in mineral wealth. The prize of wealth hidden beneath the earth is generally bought by conditions that do not favor agriculture; but, despite the fact that Kentucky has resources of coal and iron that exceed those of Great Britain, she has scarcely a square mile of surface that cannot give a constant return from its soil.

The production of these soils includes the whole of the crops of the Mississippi Valley, except the sugar-cane. Indian corn, wheat, oats, rye, barley, buckwheat, flax, flourish over its whole surface. Sorghum, for making molasses and sugar, is grown over its whole area. The conditions favor the making of sugar from beet-roots. All the ordinary fruits attain their perfection here. Cotton is raised as a crop in the south-western region of the State. Tobacco is more extensively cultivated here than in any other State in the Union. The best natural grass lands of the continent are found in the Cambrian or Blue Limestone district. Hemp is extensively grown in the same area. The blooded horses of the State are perhaps the most famous of its exports. Its remarkable superiority in this regard is doubtless in part due to the care given thereto, but, in the opinion of the best judges, is in the main the result of the peculiarly favorable effects of a combination of conditions in which soil, climate, and water all have their place. Horned cattle and sheep also do well here.

Climate. — That this State is peculiarly well fitted for the European races is shown by the fact that in no region is there a greater degree of physical vigor than in the population

within its limits. The statistics of the United States Sanitary Commission distinctly show that this is the largest-bodied native population in this country or Europe, as in the table on the opposite page.

The climatic conditions, as far as they can be described here, are as follows:* The average temperature is about 50° Fahr. As in all America, the range of temperature throughout the year is considerable; it is, however, much less in Kentucky than in the States further to the north. It is rare to have the thermometer below the zero of Fahrenheit, and it never happens that it remains for twenty-four hours below that point. The summers, though warm, are less oppressive than along the lowlands near New York for instance, owing to the considerable elevation above the sea and the relative dryness of the air. The summer heats do not at all interfere with the labor of northern-born people in the open sun. There is much experience to show that in this respect the climate is not more trying than that of New York State. Open-air work is generally possible during the whole winter, the ground rarely being so frozen as to impede construction-work or even ploughing. Cattle are not generally fed more than three to four months, and are often left in the pasture for the whole winter.

The rainfall is about forty-five inches per annum along the Ohio River, increasing towards the south-east to about sixty inches at Cumberland Gap. This is distributed with fair regularity throughout the year, — the summer droughts not being sufficient at any time to destroy crops well planted on well ploughed ground, and rarely sufficient in any way to embarrass

* The following, compiled from the United States Census Reports for 1870, shows the healthfulness of Kentucky: —

In population, Kentucky ranked as the eighth State in the Union.

In percentage of deaths to population, Kentucky ranked as the twenty-eighth State: that is, there were twenty-seven States having a greater death rate than Kentucky.

Population, in 1870, 1,321,011. Deaths, from all causes, 14,345, — or 1.09 per cent. of the population. The health of the State has increased, since 1850, as follows: —

Death to population was, in 1850, 1.53 per cent.
" " " " " 1860, 1.42 " "
" " " " " 1870. 1.09 " "

TABLE OF MEASUREMENTS OF AMERICAN WHITE MEN,

COMPILED FROM REPORT OF THE SANITARY COMMISSION, MADE FROM MEASUREMENTS OF THE UNITED STATES VOLUNTEERS DURING THE CIVIL WAR. By B. A. GOULD.

Mean Height by Nativities.			Mean Weight by Nativities.	Mean Circumference of Chest.		Mean Dimensions of Heads.	Proportional Number of Tall Men in each 100,000 of same Nativity.	Ratio of Weight to Stature.
Nativity.	No. of Men.	Height in inches.	Pounds.	Full Inspiration in inches.	After each Expiration.	Circumference around the Forehead and Occiput in.		Pounds to Inch.
New England	152,370	67.834	139.39	36.71	34.11	22.02	295	2.075
New York, New Jersey, Pennsylvania	273,026	67.529	140.83	37.06	34.38	22.10	237	2.102
Ohio and Indiana	220,796	68.169	145.37	37.53	34.95	22.11	486	2.153
Michigan, Missouri, and Illinois	71,196	67.822	141.78	37.29	34.04	22.19	466	2.106
Seaboard Slave States			140.99	36.64	34.23	21.93	* 600	2.094
Kentucky and Tennessee	50,334	68.605	149.85	37.83	35.30	22.32	848	2.192
Free States West of Mississippi River	3,811	67.419		37.53	34.84	21.97	184	2.136
British Provinces, exclusive of Canada	6,320	67.510	143.59	37.13	34.81	22.13	237	2.126
Canada	31,698	67.086	141.35	37.14	34.35	22.11	177	2.114
England	30,037	66.741	137.61	36.91	34.30	22.16	103	2.056
Scotland	7,313	67.258	137.85	37.57	34.69	22.23	178	2.086
Ireland	83,128	66.951	139.18	37.54	35.27		84	2.096
Germany	89,021	66.660	140.37	37.20	34.74	22.09	106	2.123
Scandinavia	6,782	67.337	148.14	38.39	35.37	22.37	221	2.158

* Slave States not including Kentucky and Tennessee.

agriculture. The number of days of sunshine is relatively very large, considering the amount of rainfall.

MEAN TEMPERATURE.

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Annual Mean.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1870–71.													
Louisville. .	59.08	46.4	33.4	36.7	39.5	50.7	59.1	64.	75.	77.2	79.	6.67	57.3
1871–72.													
Louisville. .	60.5	44.0	38.0	30.8	36.0	38.7	59.1	67.6	74.3	79.0	78.2	69.8	56.3
1872–73.													
Lexington .	....	38.2	27.9	30.4	35.6	40.9	53.1	64.7	73.7	76.5	73.7	66.8	....
Louisville. .	56.6	39.5	29.4	31.1	37.8	43.3	54.6	67.	78.	79.	78.	69.5	55.23
1873–74.													
Lexington .	53.8	40.7	39.6	36.5	39.2	44.3	46.9	63.6	77.9	77.8	75.1	70.9	55.5
Louisville. .	54.	41.5	38.7	37.5	39.5	45.6	48.8	68 2	80.7	80.7	79.3	72 2	57.2

RAIN-FALL. — Inches.

1870–71.													
Louisville. .	3.89	2.40	2.20	3.05	5.74	7.29	20.6	5.97	3.86	2.22	3.06	1.23	42.95
1871–72.													
Louisville. .	1.85	2.51	3.29	(*)	(*)	1.41	8.40	4.49	6.19	3.67	2.45	4.41	38.67 †
1872–73.													
Lexington .	....	1.21	3.53	2.53	4 05	3.73	2.88	6.05	4.54	3.37	2.94	1.69	....
Louisville. .	3.92	0.56	2.58	2.93	5.42	3.39	3.05	5.73	3.87	3.43	3.04	2.56	40.42
1873–74.													
Lexington .	5.47	2.03	4.41	5.41	4.89	5.90	6.81	0.79	3.55	6.26	1.57	2.89	50.04
Louisville. .	3.26	2.19	6.99	2.39	5.18	6.63	6.01	1.17	2.95	2.71	3.23	0.62	43.33

Average Annual Mean for thirty years, 55.9° Rain-fall, 50.30 inches.

* Rain-Guage not in position.
† Ten Months.

The healthfulness of this region is not exceeded by any State in this country. Epidemic diseases have never been destructive outside of some of the towns. The experience of the city of Lexington has shown that even in the towns such diseases are curable by the use of pure drinking-water. Miasmatic diseases are not known on the table-lands, being limited to the low regions near the large rivers; at least seven-eighths of the State enjoy an absolute immunity from such diseases. Consumption is rare, compared with the northern and eastern States. Yellow fever never occurs. This region is remarkable for the number of persons in extreme old age, who retain their faculties quite unimpaired and a large share of bodily vigor. The writer, who has made this subject of longevity a

matter of much inquiry, is satisfied that the region from the Big Sandy to the Cumberland, especially the higher parts of the table-land, and where Limestone soil is found, is peculiarly fitted by its conditions to retain the vigor of the body to an extreme old age, deserving, in this regard, to rank with the Canton de Vaud in Switzerland and the few other favored spots where longevity is a characteristic of the people. He is also satisfied that the proportion of bodily deformities and diseases of imperfect development, — such as curvature of the spine, rickets, &c., — is smaller within this area than among any equally large native population in this country or in Europe. Of the whole population of whites and blacks, about eleven hundred thousand of the former and three hundred thousand of the latter have been on the soil for three generations (these numbers are approximate). It needs only inspection to show that there has been no degeneration during this time, and that the world-wide reputation for vigor which the State has acquired is not likely to be lessened in the time to come.

Natural Beauties of Scenery.—In all those features of natural beauty which go to lend attractiveness to a fertile region, this State is much favored. Above any other State it is rich in rivers, and these have an incomparable variety of loveliness. Their head-waters lie around the stately mountains of the Cumberland range, their middle distances course through gorges often cut into deep cañons, and their lower waters verge gently into the great valleys of the Ohio and Mississippi. The valley of the Upper Cumberland lies in a broad mountain trough, affording some of the finest scenery of the whole Appalachian chain. Big South Fork of the Cumberland, Rockcastle River, Red River, of the Kentucky the whole of the Upper Kentucky, Tygert's Creek, the upper part of the Big Sandy, — all present that mingling of clear stream, steep cliff, and beautiful vegetation, which is the great charm of a mountain country. The cañon of the Kentucky, between Frankfort and Boonesburg, is perhaps the most charming scenery of its kind in the region east of the Mississippi. The deep gorges of Green River and its tributaries, Nolin and Barren

Rivers, abound in exquisite scenery; cliffs, in the semblance of castles, towering hundreds of feet above the streams, their faces pierced by caverns, and hung with a foliage of almost tropical luxuriance.

The cultivated district of Central Kentucky, commonly known as the Blue-grass District, is perhaps for its area the most beautiful rural district in America. The surface is undulating; large areas of the original forests have been cleared of their undergrowth and produce a fine close sod, and in these wood-pastures are some of the finest flocks and herds in the world. It has happened to the writer to pass on several occasions from this region to the richest lands of Middle England, or *vice versa*, and he has always been struck by the singular likeness of the two countries. There is probably a closer resemblance between the surface of the country, the cattle, horses, the agriculture, and even the people of these two areas than any two equally remote regions in the world.

The western part of the State abounds in natural beauties; the rich forests and the noble rivers, the Mississippi, Ohio, Tennessee, Cumberland, and the Green, give it a most attractive surface. Even the deep swamps of the lowest regions have a sombre charm that deserves the attention of the tourist. No region ever visited by the writer exceeds in weird beauty the environs of Reel Foot Lake, where the great earthquakes of 1811–13 formed a lake some fifty miles in area. All over its surface stand the trunks of the cypresses that grew in the swamp before the convulsion. These are now reduced to tall columns blackened and whitened by decay. The surface of the lake is a mass of water-plants, in summer a perfect carpet of flowers; Nymphæas, a half-foot or over, and the Nelumbium, water-chenquepin, or American lotus, a golden flower often exceeding a foot in diameter, cover its surface with their blossoms and fill the air with their perfume.

Caverns. — The subterranean beauties of the State are already famous. The Mammoth Cave is, however, only a noble specimen of a vast series of caverns, to be numbered by the tens of hundreds, that occupy nearly all of the Subcarboniferous Limestone area of the State. This cavern-belt extends

in a great semicircle from Carter County, where there are several beautiful caves and two remarkable natural bridges, to the Ohio below Louisville. These caverns have as yet been but little explored, and their beauties are mostly undiscovered. There are probably many thousand miles of these cavern-ways accessible to man. The Indian tribes knew them better than our own race; for it is rarely that we find any part of their area which does not show some evidence of the presence of ancient peoples.

MARKETS AND TRANSPORTATION.

As regards proximity to markets, this State has peculiar advantages, which only await the completion of transportation routes already begun to render its position unequalled among American States. Reference to a map will show that it is the most centrally placed in the group of States east of the Rocky Mountains. From the geographical centre of Kentucky it is about an equal distance to Central Maine, Southern Florida, Southern Texas, and Northern Minnesota. The State of Colorado, the Great Lakes, and the mouth of the Mississippi fall in the sweep of the same line.

The river system of the Mississippi has its centre within the borders of Kentucky, and her lands are penetrated by more navigable rivers than any other State in the Union. Her territory includes about fifteen hundred miles of streams that are navigable at all stages of water, and about four thousand miles of other streams that can be made navigable by locks and dams. These streams give access to the whole Mississippi system of inland navigation, which includes about twenty-five thousand miles of streams now navigable, or readily rendered so by the usual methods of river improvement. The State has at present connection by water transportation with at least twenty millions of people, occupying an area that will probably contain near two hundred millions within a century from this date. There is a proposition now under discussion to use the convict labor of the State on the improvement of the rivers, which if carried to success is likely to make their complete canalization an accomplished fact within twenty-five years.

The existing railways of the State form a system which wants but a few connecting links to give it an admirable relation to the rest of this country. The north and south lines consist of the following roads, beginning on the east: The Eastern Kentucky, from Riverton in Greenup County to Willard in Carter County; thirty-five miles of road built to develop the coal and iron district of this section, with the expectation of eventual continuation to Pound Gap, and connecting with the south-eastern system. The Maysville and Lexington Railway, running south as far as Lexington, and connecting there with the system of roads about to be described. Third in the series on the west we have the Kentucky Central Railway, now extending to Lexington along the banks of the Main Licking Valley and its South Fork. The continuation of this road, by either Pound Gap or Cumberland Gap, to the railway system of Eastern Tennessee and the valley of Virginia, is likely to be accomplished at an early day. The Cincinnati Southern Railway, from the mouth of the Licking directly south to Chattanooga, will be completed during the present year, and afford an admirably built road traversing the State on its longest south and north line, and crossing the Blue-grass lands on their longest and best section. This road is likely to be of incalculable value to the State, forming as it does a main line to the South and South-east.

The Lexington and Big Sandy Railway is completed, as far as Mount Sterling in Montgomery County. This road when finished will give Kentucky cheaper and more direct communication, by way of the Chesapeake and Ohio Railroad, with the Atlantic ports. The Mount Sterling coal-road, now almost completed, extends from the latter place to the border of the eastern coal-field, in Menifee County. The extension of this road will greatly facilitate the development of the coal and iron region through which it is proposed to continue it.

The Kentucky and Great Eastern Railway is a proposed road on which considerable work has been done; extending up the south bank of the Ohio River from Newport, Kentucky,

to the Big Sandy River. The completion of this road will add greatly to the wealth of river line of counties, and will give the State a shorter road to the Atlantic ports than she now has.

The Louisville, Frankfort, and Lexington Railroad extends through the Counties of Jefferson, Oldham, Shelby, Franklin, and Fayette. From Lagrange in Oldham County a branch extends from this road to Cincinnati, known as the Louisville and Cincinnati short line, — that line, passing through the counties of Oldham, Henry, Grant, Carroll, Gallatin, Boone, and Kenton.

The Cumberland and Ohio Railroad, narrow-guage, now building, when completed, will pass through the counties of Henry, Shelby, Spencer, Nelson, Washington, Marion, Taylor, Green, Metcalf, Barren, and Allen. Its length in Kentucky will be 165 miles.

The Louisville and Nashville Railroad extends, with its branches, a distance of 356.4 miles through Kentucky in different directions. The Main Stem, from Louisville to Nashville, has a length within the limits of the State of 139.6 miles, running through the counties of Jefferson, Bullitt, Nelson, Hardin, Larue, Hart, Edmonson, Barren, Warren, and Simpson. The Memphis Branch runs through the counties of Warren, Logan, and Todd, having a length in the State of 46 miles. The Lebanon Branch extends into Southeastern Kentucky, running through the counties of Nelson, Marion, Boyle, Lincoln, and Rockcastle; it has a completed length within the State of 109.9 miles, and its extension to the State line is projected, and its completion only a matter of time; it will then connect with a road leading to Knoxville in the State of Tennessee. The Richmond Branch runs through the counties of Lincoln, Garrard, and Madison for 33.4 miles, to within a short distance of the rich iron region of Kentucky. The Bardstown Branch runs through the county of Nelson, a distance of 17.3 miles. The Glasgow Branch, 10.2 miles long, runs to Glasgow, the county-seat of Barren County. The Louisville and Nashville Railroad is undeniably one of the most important thoroughfares of this continent; it is second only to the Mississippi River as a way for the com-

merce between the Northern and Southern States. By means of the magnificent railway bridge over the Ohio River at Louisville it connects with all the great northern roads, and at Nashville and Memphis, its southern termini, it connects with all the important roads of the South.

The Louisville, Paducah, and South-western Railroad extends from Louisville to Paducah, a flourishing city situated on the banks of the Ohio River, fifty miles from its junction with the Mississippi, and is the principal market-town of Western Kentucky. This railroad penetrates Western Kentucky in such a manner, therefore, as to afford easy access to a large portion of that section. It runs through the counties of Hardin, Grayson, Ohio, Muhlenberg, Hopkins, Caldwell, Lyons, Livingstone, Marshall, and McCracken. It passes directly through that section of the valuable coal-fields of Western Kentucky which lies within the area of the counties of Ohio, Muhlenberg, Hopkins, and Grayson. The entire length of the Louisville, Paducah, and South-western Railroad is 225 miles, all of which is within the territory of Kentucky.

The Paducah and Memphis Railroad runs through the counties of McCracken and Graves, connecting at Memphis all of the south-western railroads.

The Owensboro, Russelville, and Nashville Railroad is completed from Owensboro, on the Ohio River, to Owensboro Junction on the Louisville, Paducah, and South-western Railroad, passing through the counties of Daviess, McLean, and Muhlenburg.

The Evansville, Henderson, and Nashville Railroad, from Henderson on the Ohio River to Nashville, Tenn., passes through the counties of Henderson, Webster, Hopkins, Christian, and Todd. At Henderson a ferry takes cars to the northern system of roads. It forms the most important link in a great trunk line known as the St. Louis and South-eastern Railway. The New Orleans, St. Louis, and Cairo Railroad passes through the counties of Ballard and Hickman. The Mobile and Ohio Railroad, connecting the city of Mobile on the Gulf of Mexico with the Ohio River, penetrates Kentucky through the counties of Hickman and Fulton.

At Columbus, in Hickman County, a ferry fitted for the carriage of trains gives passage to cars from St. Louis directly through to the south-eastern cities. Of the ten before described north and south railways, four have northern connections; two (the Cumberland and Ohio and the Cincinnati Southern), now under construction, will have southern connections. The others all look to the same end, but have not yet succeeded in accomplishing it.

It is in roads with eastern connections that the State lacks most. There is not yet a single railway crossing the eastern line of the State. It is to this difficulty of access from the seaward that the State owes the small share it has had in the immigration of capital and labor that has filled the lands of less attractive regions. Three routes have been begun, which, when complete, will fully remedy this grave defect; namely, a road from Louisville to the south-east *via* Cumberland Gap, completed to Livingston, and requiring a continuation of about one hundred miles to connect with roads leading from Morristown, Tenn., to Charleston, S. C.; a road from Mount Sterling to Abingdon, Va., *via* Pound Gap, requiring about one hundred and sixty miles of road to complete the connection; a road from Lexington to connect with the Chesapeake and Ohio, requiring about eighty miles to bring it to completion. The northernmost and southernmost of these roads are likely to be carried forward to completion within a few years. There is a project for building up, east and west, a road along the northern range of counties of the State, giving a continuous route from Henderson, and the roads connecting at that point, to the connections with Charleston and Savannah from Morristown, Tenn.; also a project for a road from Chicago to Charleston, crossing Kentucky from Gallatin County to Cumberland Gap.

It will be seen from this brief sketch that the railway system of Kentucky is on the whole good, and wants but little to make it, as a system of trunk lines, exceedingly well adapted to the development of her resources. Taken in connection with the river system, it is clear that, within a generation, we may expect here a transportation system excelled by no State on the continent.

With reference to markets, it will be seen, by consulting the census tables, that the State has at present access to a larger number of markets than any other Western State: although there is but one large city within her limits, the cities of Cincinnati, St. Louis, Nashville, and Indianapolis lie upon her borders. Her principal export products have a special value that makes them sought on her own soil by purchasers enough to take any product that can be furnished; on the borders of the State, a host of manufacturing towns are rising that will certainly make a market for all the food, fuel, and raw products from her soil, quarries, and mines.

PRICE OF LANDS.

In no other State having any thing like the same advantages can lands be bought at so low a price. The best agricultural lands, or those commanding the highest price, are found in the Limestone regions and along the principal rivers; these, when cleared and not worn, bring from thirty to one hundred dollars per acre. The same, uncleared, will be about half these rates. The second-rate lands in the same regions bring from ten to forty dollars per acre. The lands on the coal-bearing beds, though often exceedingly fertile, are generally very cheap. When contiguous to transportation they may generally be estimated at about ten dollars per acre, but the tracts of good tobacco lands, with excellent timbering and great mineral resources, can often be purchased for two to four dollars per acre in tracts suitable for ordinary farming, within ready access of permanent transportation. Vast tracts of timber land, suitable for grazing, with much excellent land in the *coves*, or other level places, can be bought for from fifty cents to one dollar and a half per acre.

As a general thing, it may be said that the lands in this State are much cheaper than in any State north of the Ohio River. This is owing to the fact that, destitute of eastern communication, the State has hitherto had but a small share of the tide of immigration of capital and labor that has poured past her borders to fill the favored fields of the far West.

Nearly all the products of Kentucky have their prices

determined by the cost of transportation to the great centres of population along the Atlantic seaboard or beyond the sea. Its tobacco, pork, grain, and some of the costlier native woods, and some other products find their principal markets in Europe; cattle, and to a certain extent the other agricultural products of the State, have their values determined by the cost of transportation to the American Atlantic markets. Hitherto, this access to the domestic and foreign markets of the Atlantic shores has been had by way of the railway systems which traverse the region north of Kentucky, and from which the State has been divided by opposing interests and the physical barrier of the Ohio River. All the development of the State has taken place under these disadvantages. A comparison of the tables of cost given below will show that the complete opening of the mouth of the Mississippi to ocean ships will result in the enfranchisement of the productions of Kentucky in an extraordinary way.* At the present time, the freight-rates from the lower Ohio to Liverpool would permit the profitable shipment of the cannel coal

* "The following are taken from published freight-rates, and give time and cost of transit from St. Paul's, two thousand miles above New Orleans, to Liverpool by the two routes: —

	Cost per bushel. Cents.	Time. Days.
From St. Paul's to Chicago	18	4
Lake from Chicago to Buffalo	8	6
Canal from Buffalo to New York	14	24
New York to Liverpool	16	12
Elevator or trans-shipment charges, Chicago	2	2
" " " Buffalo	2	2
" " " New York	4	2
Total	64	52

	Cost per bushel. Cents.	Time. Days.
From St. Paul's to New Orleans (*via* river)	18	10
New Orleans to Liverpool	20	20
Elevator charges, New Orleans	2	1
Total	40	31

Here is a saving by direct trade of twenty-four cents per bushel, or eight shillings per quarter, and a saving of twenty-one days in time. To be fair, I have taken the extreme point: *but the nearer the grain is to the Gulf, the cheaper the transportation.*"

and native woods of many different species to Europe with one trans-shipment at New Orleans. It is impossible, on account of limited space, to give a detailed statement on this point; but evidence can be furnished to those desiring it. It is to be noticed that it is possible for several months each year to bring ships of large draught of water to the loading points on the Ohio River, and load them for direct trade with Europe. The tonnage of such vessels both ways from New Orleans would be at the lowest rates for such work current in any region. It will be seen that the State of Kentucky has the most extensive shore on the navigable waters of the Mississippi Valley, and that even in the present incomplete development of her navigation system she will have over fifteen hundred miles of frontage on continuously navigable waters. There can be no doubt that the market expenses of the products of the State will be reduced nearly one-half when the far-reaching consequences of the development of water-transportation are attained. It will not be amiss to notice that the costs of transportation by water, far lower than by rail in most countries, is peculiarly cheap on the Mississippi and its principal tributaries; coal is lower than in any other country, as is also timber for boat-building; there are no tolls on the streams, and the currents are generally slow near the shores, admitting of tolerably easy ascent.

FITNESS FOR INVESTMENTS OF CAPITAL AND LABOR.

For all the important branches of agriculture and manufacture, so far as they depend on cheap and fertile soils, good climate, and a great abundance and low price of coal, iron, and hard-wood timber, and last, but not least, low taxation, — Kentucky offers unsurpassed advantages for the creation of industries. It will be impossible to name these opportunities in detail, but some of the most important may be suggested. The growing industries of the Ohio-River Valley and the neighboring regions offer continued opportunities for the increase in the export of the raw products of the State. Coal, iron, salt, timber, cements, building-stones, can all be produced at great profits, even in the present depressed state of the industries of the

world. The Ohio Valley probably gains in population at an average rate of not less than five per cent. per annum. This great elasticity of demand insures a successful result in any discreet industrial venture. Besides the coal and iron mines, the attention of capitalists is requested to the production of other articles of equally steady demand. Salt can be produced over a large area at the cheapest possible rate,— the water hardly requiring pumping from the shallow wells, and the gas furnishing fuel. The great amount of fire-clays should be considered. The tile-clays are admirable in quantity and quality. An area of several thousand square miles in the State is rich in marls, containing large quantities of potash and soda, fitted for the production of fertilizers. The western section of the State is admirably fitted for ship-building; excellent ship-timber can be had cheaper than in any other country, and there is ample water to take ships drawing twenty feet to the sea for half the year. Besides the enormous possibilities of business derived from the working of raw products, finding their market in the great and growing States of the Mississippi Valley, there are most important opportunities derived from its relation to the regions beyond the sea. The natural outlet to the Atlantic ports for these products is by way of the Mississippi to the sea. The freights from Western Kentucky to New Orleans are less than one-half of the rate from the same region directly to New York. Until the success of the Eades-Jetty project, this method of carriage to the sea was practically impossible. At present it is practicable to load timber-ships and colliers at the ports from the western coal-field, and send them directly to the Atlantic ports, or to any markets beyond the sea. Already a large trade in wine-cask staves exists between this region and Europe. These staves pass through six hands before coming to the consumer. These exchanges could be readily reduced to three by direct shipment. The demand seems to be practically inexhaustible, and the timber exists in very great quantities. To this industry there could be readily added a business in the manufacture and shipment of spokes, felloes, and other carriage-parts, the parts of railway-carriages, agricultural implements, &c. Building-stones of admirable quality

exist all along the tributaries of the Ohio, and their export to the Atlantic ports is already a considerable commerce.

As will be seen from the accompanying map, the State of Kentucky lies, as a region of peculiar mineral resources, in the centre of the region now holding, and destined always to hold, the mass of American population. The present centre of population is adjacent to the northern border of Kentucky, and it is practically certain that in centuries to come it must remain within or on the borders of Kentucky. This makes it sure that manufactures will from this region always command the widest markets with the least carriage.

The advantages of this district to the agriculturist are known by the cheap land, good climate, and abundant variety of crops. These crops are near to a great and growing set of markets. Among the new ventures in agriculture must be placed fruit-culture for the northern markets, — a business that is now taking a very important place in the industries of the State. The poorer lands of the southern part of the State have a peculiar fitness for this purpose.

The following table, compiled from the United States census report, proves that Kentucky is susceptible of a greater variety of production than any other State. It will be observed that it is in each census the first State in the production of some one or more staple articles: —

	1840.	1850.	1860.	1870.
Wheat	First.	Ninth.	Ninth.	Eighth.
Swine	Second.	Second.	Fourth.	Fifth.
Mules		Second.	Second.	Third.
Indian Corn	Second.	First.		Sixth.
Tobacco	Second.	Second.	Second.	First.*
Flax	Third.	First.	Third.	Eighth.
Rye	Fourth.		Fifth.	Fifth.
Hemp		First.	First.	First.
Cotton	Eleventh.			Twelfth.
Value of Home Manufactures	Third.		Second.	Third.

* In 1870 Kentucky produced near one-half of all the tobacco produced in the United States, and more than half of all the Hemp. The production of Tobacco increased from 105,305,869 pounds in 1870, to 158,184,929 pounds in 1873.

The high rank of Kentucky as an agricultural State can best be appreciated when it is remembered that more than one-

half of the State is in forest, and that the State is only exceeded in area of woodland by three States. Yet, with less than half the land in cultivation, the State ranks eighth in the value of agricultural products.

Building and other Economic Stones.— The building-stones of this State are limited to Limestones and Sandstones. Within these limits, however, there is a most abundant variety of color, hardness, and other qualities. The Limestones of the Upper Cambrian, or so-called Lower Silurian, are excellent stones of exceedingly varied qualities. Usually they afford a gray marble of admirable resisting powers against wear, especially fitted for buildings when their courses of rocks are suitable. Along the Kentucky River this series of rocks affords a beautiful buff and cream-colored marble, admirably fitted for detailed sculpture work, the Clay Monument at Lexington being made of this stone. This stone can be quarried on the banks of the river in any quantity and at small expense, and transported by boat to the Ohio River. Next above this level we have the equivalent of a part of the cliff-limestone of Ohio, which has received the local name of Cumberland Sandstone in the Kentucky reports. This Sandstone is thin, and passes into a cherty Limestone in the northern part of the State; but in the basin of the Cumberland it is of a peculiar greenish color, affording a very handsome and durable building-stone, resembling in many regards the Buena Vista Sandstone of Ohio. This stone will doubtless have considerable value in the time to come, as it is peculiar in its color among all the building-stones of the Ohio Valley. No other good building-stones occur until, after passing above the Black Shale, we come to the beds of Sandstone of the Waverly period. The beds of this section afford the only Sandstones of the State that have been extensively worked for building purposes. These beds, commonly known as Buena Vista stone, are the only source of the Sandstones used in Cincinnati and Louisville, and in most of the other western cities. At present they are worked along the Ohio and south-east of Mount Sterling in Montgomery County; but they can be had where the Licking, Kentucky, Salt, and Green Rivers cross the Waverly, and at the points where the railroads of the State pass over the same formation.

It is, however, in the Subcarboniferous or Mountain Limestone that the greatest variety and area of economic stones occur. Here we have Limestones (carbonates) which are the finest known in this country; Oölites which, for beauty of grain and endurance of time and other forms of wear, are unsurpassed; Dolomites that have all the fine qualities belonging to those Magnesian Limestones; and, finally, a series of more or less Argillaceous Limestones, some of which are already in use as lithographic stones, and promise good results. These Oölites have been in use for forty years in the town of Bowling Green, and retain all their tool-marks as when dressed, having hardened very much since their working. Stones for furnace-hearths abound throughout the whole mineral district. Some millstones have been worked for local purposes, but have had no extensive test. Grindstones are made from the Waverly Sandstone, which is admirably fitted for this use. Some good grindstones have been made from the Carboniferous Sandstones of Western Kentucky.

GOVERNMENT, POPULATION, TAXES, EDUCATION, FUTURE.

The government of Kentucky is at present modelled in part on that of New York, and in part on that of Virginia, — the legal framework being essentially that of the former State. The legislative machinery differs somewhat from that of the other States, in that the senate is re-elected one-half each two years, while the lower house is simply renewed each two years by election. There is no actual State debt, — the school-fund debt being such only in appearance, in fact only an obligation to pay a certain sum for the support of schools. No State debt can constitutionally be contracted, and during the last ten years, while other States have been steadily increasing their obligations, Kentucky has paid off the debt which was left by the war, and now is debtless, and with considerable assets. The last legislature (1876) reduced the taxes by one-eighth, after a careful inquiry going to show that it could be done with safety. The following statement summarizes the condition of the State in 1875: —

"It will thus be seen, that in the last two years we have redeemed and paid off $347,000 of the public debt, and there now only remains of bonds outstanding and unredeemed $184,394. The residue of these bonds are not due and redeemable until 1894–5–6."

To meet this indebtedness we had, on the 10th of October, 1875, the end of the fiscal year,* —

To the credit of the Sinking Fund	$153,559.07
230 United States 5–20 gold-bearing interest bonds, worth not less than 20 per cent. premium . . .	246,000.00
Making	$399,559.07

The whole traditions of the State are strongly in favor of economy and honesty in every branch of public affairs. No loss by defalcation has ever occurred to the State. Debts cannot be incurred by counties, cities, or towns without special authority from the legislature. This permission is now given only in rather rare cases, and is subject to great limitations from the organic law. The result of these conditions is an immunity from the danger of destructive taxation, such as does not exist in any other State in this country.

Education. — The State now gives from the general treasury the sum of one million dollars to the purpose of common school education; this is, *per capita*, as large a contribution from the general fund as is given in any State; as yet, this has been inadequately supplemented by local aid, but much progress is now making towards the creation of graded schools in every village where the population admits of it. The laws allow the imposition of a considerable local tax for schools. There is no State with an equally scattered population where so much has been done for the elementary education.

Universities and colleges have never received the aid of the State. There are, however, a number of excellent institutions of this grade in the State. The first collegiate institution west of the Alleghanies was Transylvania University, at Lexington. Kentucky University, Georgetown College, Centre College, and a number of other similar schools of newer date, many of

* In a report made by the State Treasurer, January, 1876, the State debt was shown to have been much less than the above, and the surplus in the Treasury had increased to near one million of dollars. This report will appear in next edition of this pamphlet.

them excellent in their methods, and provided with considerable endowments, furnish the higher education of the State.

The charitable institutions, nominally so called, are sufficiently furnished by the State. A very high place is held by the asylums for the deaf and dumb and for the feeble-minded, in both of which recognized advances have been made in the methods of dealing with these forms of human infirmity.

It remains to speak of the most important element in the State, its population.* Probably no other State in this Union contains a people as purely English in descent as this. At this date (1876) the population numbers 1,600,000; of these only 200,000 are of African descent, or about one-eighth of the total. There is a steady decrease in the black population, and an equally steady increase of the white, so that the negro now makes but an inconsiderable fraction of the State; by far the greater part of the blacks are gathered about the towns in light labor of the domestic class. The relations between the two races are those of entire harmony. Separate schools are founded for the two races.

In 1870, the foreign-born population in Kentucky amounted to 63,398 (is probably at the present time less than 100,000); of these 31,767 were Germans, and the remainder from various other European countries. The greater part of this foreign population is settled along the Ohio River, but it exists in almost every county. The honest and self-supporting citizen of every country has always received a warm welcome in Kentucky; no jealousy has ever shown itself towards the foreigner. The government of the State has for years always had a number of conspicuous members from beyond the sea; one of the United States senators and several of the members of the legislature are also from other countries.

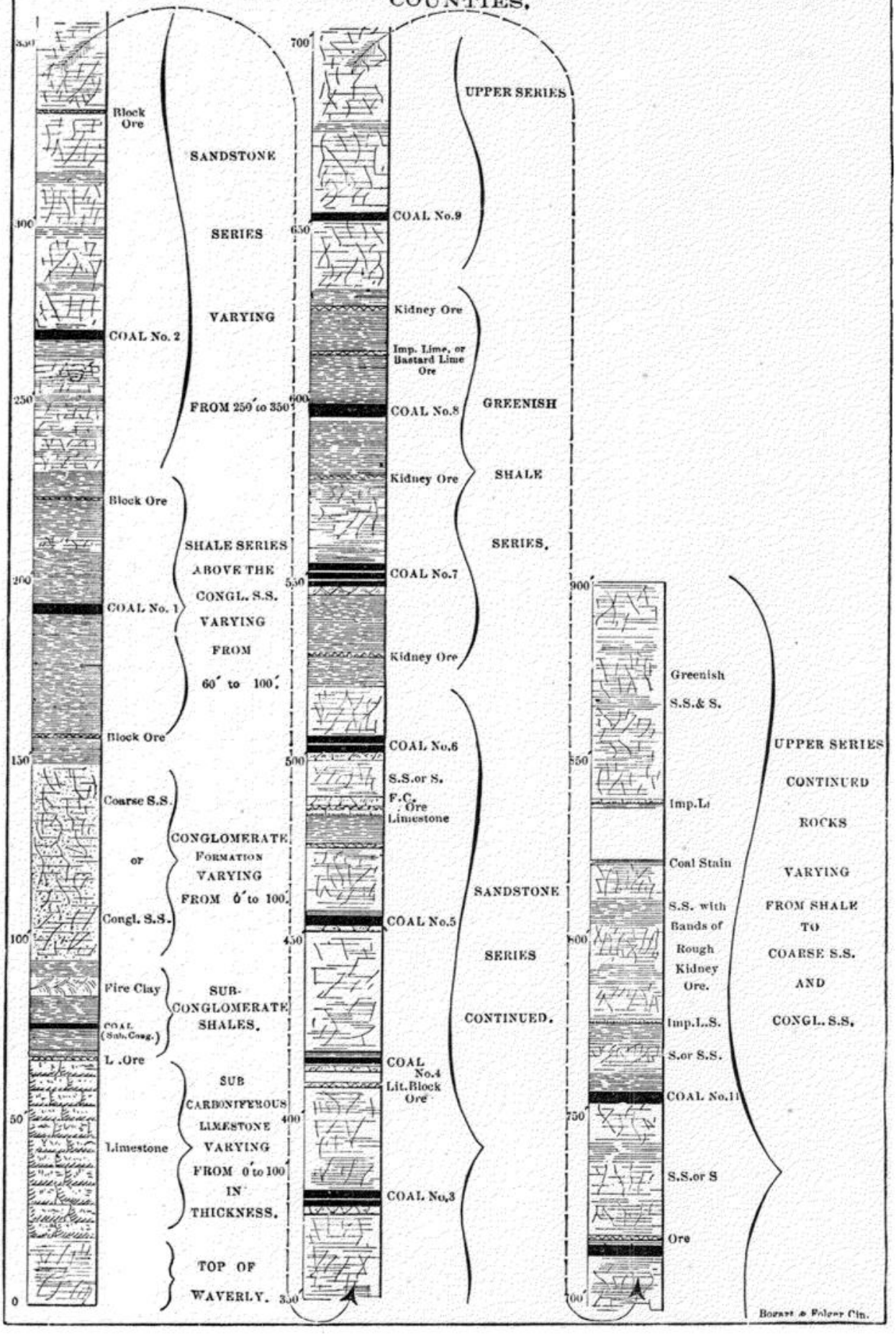
Without indulgence in excessive claims, which would be quite foreign to the sober tone of this Commonwealth, we may reasonably expect for Kentucky, in the time to come, a substantial growth proportioned to her natural advantages. As at the present moment, when the country generally is under

* In 1790, Kentucky was the fourteenth State in population, having a population of 73,677. In 1870, Kentucky was the eighth State in population, having 1,321,011

a heavy burden, the result of its commercial extravagances, the State of Kentucky is actually prosperous in a fair degree, so we may expect in the future a consistent and conservative progress that will not be attended by those periods of commercial depression that so generally accompany a growth of an excessive kind. The unequalled blessings of the Ohio Valley, its wealth of mineral stores, fertility of soil, goodness of climate, and facilities for transportation, are all shared in large measure by Kentucky. Another century will doubtless see this Valley the greatest seat of those productions that require cheap power and cheap food for their making, bringing a population equal to that of the equal areas in the great European States; when this comes, this Commonwealth will contain within her borders probably not less than eight millions of people, and sources of wealth and power unsurpassed on this continent.

Plate No. 1.

GENERAL SECTION FOR GREENUP, BOYD, CARTER, & Part of LAWRENCE COUNTIES,



BRIEF STATEMENT OF THE ECONOMIC GEOLOGY OF THE BIG-SANDY VALLEY.

THE valley of the Chatterawah or Big-Sandy River is entirely within the limit of the coal-measures, and, with perhaps one or two exceptions, where the Subcarboniferous Limestone is brought to the surface, the rocks exposed on the waters of the Big Sandy are those of the coal-measures proper.

The number of distinct beds of coal known to be present in this valley is twelve. Iron ores are found at about an equal number of levels. The accompanying general section, from report of A. R. Crandall on the geology of Greenup, Carter, Boyd, and Lawrence Counties, shows the order of the beds, both of coal and of iron ore, near the Ohio River. Further southward changes occur in the general character of the rocks above coal No. 3, so changing the general section as to render any identification of beds from the little that is now known of them quite untrustworthy. Fuller investigation will doubtless discover most of the coals as found near the Ohio, and the thickening of beds as found southward gives promise of richer fields than those already developed.

The following table shows the thickness of the beds that have been fully identified as seen in the localities where mined: —

	Minimum.	Maximum.
Coal, No. 1.	3 ft. 0 in.	5 ft. 0 in.
" " 2.	2 " 0 "	3 " 8 "
" " 3.	2 " 6 "	6 " 6 "
" " 4.	2 " 0 "	4 " 6 "
" " 5.	3 " 6 "	9 " 0 "*
" " 6.	3 " 0 "	4 " 0 "
" " 7.	3 " 0 "	6 " 0 "
" " 8.	2 " 6 "	8 " 0 "
" " 9.	2 " 0 "	2 " 6 "
" " 10.		3 " 6 "
" " 11.	2 " 0 "	2 " 6 "
" " 12.		†

* Coal 5 is generally slaty in part where found in great thickness.
† Not opened.

The following table of analyses of samples, taken from the whole thickness of beds as mined, will serve to indicate the character of the beds included, and of the coals of this field generally: —

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
	Graham Bank.	Kibby's Bank.	Peach Orchard.	Cannel Hunnewell.	Buena Vista.	Keye's Creek.	Coalton.	Head of Nat's Cr'k.
Specific Gravity . .	1.267	1.289	1.317	1.306	1.360	1.279	1.320	1.367
Moisture	2.50	4.10	3.26	1.50	3.20	2.94	5.00	3.50
Volatile Com. Mat.	36.00	34.60	34.22	52.20	32.30	32.50	34.50	31.90
Fixed Carbon . .	57.30	55.25	55.36	40.60	53.00	56.76	55.40	52.06
Ash	2.90	4.77	7.16	5.70	11.50	7.74	5.10	12.50
Sulphur	1.148	1.414	0.901	0.782	1.999	1.972	1.285	0.873

Coal No. 8, as represented in this table, is from the head of Nat's Creek, in the north-eastern corner of Johnson County, where it is fully eight feet in thickness, with slight partings. The only average sample from this locality was necessarily taken from near the outcrop, giving too large a percentage of ash, and probably too small a percentage of sulphur.

The thickness of the measures, which include the coals of this table, is about four hundred feet in the regions best known. Coal No. 1 is exposed along the Big Sandy, southward from Peach Orchard and Warfield, at a level which is in general slightly above high-water mark. The hills along the river and the main creeks rise to the height of six and seven hundred feet, including the equivalents of the accompanying general section from coal No. 1 upward. What beds are present in these hills is yet to be ascertained.

GENERAL RESOURCES

OF THE

WESTERN COAL-FIELD AND BORDERING TERRITORY.

I.

SUBCARBONIFEROUS BEDS.

THE coal-field is bordered by Subcarboniferous beds, which are, in succession, those forming the Chester group, and those included in the St. Louis group.

The Chester series are rich in stores of potash-marls, while the St. Louis group yields a number of beds of very admirable building-material.

It is also in the region underlaid by the Subcarboniferous beds that the excellent Limonite iron-ore, so highly esteemed by iron-manufacturers, is found.

As the group is of especial interest, the following typical section of the Chester group, as it occurs on the eastern outskirts of the coal-field, is given:* —

No. 1.	Shale, with thin beds of Limestone	15 feet.
2.	Heavy-bedded, cherty Limestone	13 „
3.	Red and green Shale	5 „
4.	Rhomboidally-jointed Sandstone, frequently charged with Brachiopoda	0 to 10 „
5.	Limestone	2 „
6.	Shale	10 „
7.	Limestone and Shale	20 „
8.	Green, red, purple, and blue, marly Shales; the Leitchfield marls	25 to 60 „
9.	Shale and thin-bedded Limestone	5 „
10.	Shaley Sandstone	0 to 20 „
11.	Heavy-bedded, dark-gray, and blue Limestone	15 to 45 „
12.	Massive Sandstone; the "big-clifty" Sandstone	60 to 130 „

* Described in detail in Part VI., Vol. I., Second Series Kentucky Geological Reports. N. S. Shaler, Director.

This section is frequently modified. The economic values of the different beds are dependent, in a measure, on their persistency. Space forbids any detailed discussion of the question here. It may be remarked, however, that none of the beds are found to be trustworthy over large areas, unless it be the marls. The persistency of the marls, however, as *individual* beds, is not a settled question. The strata are exceedingly variable in their lithological features, and lateral changes are very frequent, both in their composition and thickness. It is not uncommon for Limestone or Sandstone-beds to be, either in whole or in part, replaced by Shales. Hence beds occurring at some certain locality that would, from their color and composition, be referred to the horizon of the Leitchfield marls, may really belong at a lower or higher level, having replaced some more solid bed. This, however, does not militate against the fact that the Leitchfield marls proper extend over a great area.

The St. Louis group is distinctly separated by the physical characters of its strata into two divisions. The upper or gray Limestone division is formed of a series of gray and drab beds, among which are included two well-marked varieties. One variety, a white Oölite, is quite characteristic of the division. Usually associated with the Oölite are beds of dense drab to cream-colored stone, which breaks with a smooth, conchoidal fracture, and resembles lithographic stone.

The upper division furnishes some of the best building-stones and materials for lime that are to be found in the State. The lower division includes beds of dark-blue to bluish-gray Limestone. The rock is frequently fetid from carbonaceous matter, such as bitumen, held in it, and nests of massive calcite and fluor spar are not infrequent in it. The study of this group is especially interesting on account of its being the repository of the lead deposits of Western Kentucky.

* A section of the beds forming the group, and other matters concerning it, will be found in Part VI., Vol. I., Second Series Kentucky Geological Reports. N. S. Shaler, Director.

II.

THE COAL-FIELD.

In studying the resources of the area occupied by the Carboniferous beds in Western Kentucky, the greatest interest naturally belongs to that section underlaid by the coal-measures.

In form the coal-field is somewhat basin-like; that is, the beds incline from the margins towards the centre. The border of the field has never been completely traced with accuracy; but its course may be approximately delineated as follows: * —

Commencing at the Ohio River, in Crittenden County, it follows up the valley of the Tradewater River into Caldwell County; thence crossing into Christian County at a point about five or six miles above Tradewater station (on the Louisville, Pacudah, and South-western Railroad), it keeps in a south of easterly course towards the head-waters of the Pond River. From a point about two and a half or three miles south of Petersburg, Christian County, the southern boundary makes a south-eastwardly curve, passing by the head-waters of the Pond River to the Muddy River, which stream it crosses somewhere near its forks. Thence it passes through the southern part of Butler County, crossing Barren River below the mouth of Gasper River, thence eastwardly along the divide between those rivers, crossing Green River above the mouth of Nolin River, and extending north-eastward to the head-waters of Casey Creek in Hart County. Thence it curves to the north-west, crossing Nolin River near the mouth of Dog Creek; passing a point between Millwood and Leitchfield in Grayson County, — an outlier or tongue extending north-eastwardly, on the north side of Nolin River to the

* These outlines have been mainly obtained from Vol. I. Kentucky Geological Reports, First Series; D. D. Owen, Director. They are quite imperfect, so far as regards details, but are sufficiently accurate for present general purposes. The faithful delineation of the outline of the coal-field has been made part of the work of the present survey.

head-waters of Hunting Fork, of Rock Creek, — and thence on to the Ohio River, to a point not far below Cloverport in Breckenridge County.

In the space thus included lie the whole of nine counties, and parts of five more, making an approximate total of nearly four thousand square miles for the area of the coal-field.

The Number of Coal-beds, &c. — Twelve coal-beds have been identified in the space between the Conglomerate (the base of the coal-measures) and the summit of the series.

It is believed as not improbable, however, for reasons unnecessary to discuss here, that, when sufficient data have been gathered to warrant a generalization concerning the number of beds, it will be found expedient to designate a less number of coals in the general section for the coal-field. For the present, therefore, a letter is used to designate each bed.

The results of the work of the Survey, so far, point to eight as the number of beds that may prove sufficiently trustworthy to receive final numbers. The total thickness of the coal-measures is as yet only approximately known. The thickness is variable, as is the number of coal-beds, and is greater at some localities than at others. It does not seem probable, however, that it will anywhere exceed one thousand (1,000) feet, and there are districts in which it is less than eight hundred (800) feet.

On the map of Kentucky will be found a section showing the position and number of these coals as determined by Dr. Owen's Survey, as well as some modifications made by the present Survey.

The thickness indicated for each bed, and the included space, are strictly in accordance with Dr. Owen's statement.

1. Anvil Rock Sandstone	20	feet.
2. Coal, No. 12 (Coal A)	3	"
3. Space	21	"
4. Coal, No. 11 (Coal B)	5	"
5. Space	46	"
6. Coal No. 10 (Coal C)	3	"
7. Space	68	"
8. Coal No. 9 (Coal D)	5	"
9. Space	50	"

10. Coal No. 8 (Coal E)	2½	feet.
11. Space	43	„
12. Coal No. 7 (Coal F?)	2	„
13. Space	84	„
14. Coal No. 6 (Coal G?)	3	„
15. Space	65	„
16. Coal No. 5 (Coal H?)	4	„
17. Space	95	„
18. Coal No. 4 (Coal I)	4	„
19. Space	154	„
20. Coal No. 3 (Coal J)	2½	„
21. Space	71	„
22. Coal No. 2 (Coal K?)	No thickness given.	
23. Space	82	„
24. Coal No. 1 B (Coal L)	5	„

The preliminary arrangement adopted in the present survey differs in some particulars from the foregoing. In some instances the distances between the coals are increased, and in others diminished; and several of the beds are represented at a greater or smaller thickness than they are in Dr. Owen's Section.

The irregular distribution of the coal necessitated the separation of that part of the coal-field thus far examined into three divisions. The first extends from the eastern border of the field to the Green River; the second is approximately bounded by the Green and Pond Rivers; and the third extends from the Pond River to the western margin of the field.*

In the first division are found coals A, B, C, D, E, H, K, and L; proving eight of the twelve beds to be present.

In the second division are found coals A, B, C, D, E, F, G, and H; the number here also being eight. This, however, does not represent all of the coals that may be found, as the base of the coal-measures was not reached; it represents only those coals that come to the surface, or that have been reached in pits; no doubt, most of the lower beds are present.

* The region in question is that which is traversed by the Louisville, Paducah, and South-western railroad: none of the country bordering the Ohio River is included; nor yet that lying near the southern margin of the field. None of that region has yet been sufficiently studied to report on the number of beds. See Part VI. Vol. I., Second Series Kentucky Geological Reports, page 374.

In the third division most of the coals are found, the absent ones probably being C, F, G, and K (?).

Generalizing from the results obtained in each of these divisions, it is found that the average distances between the coals from A to H inclusive, in the region examined, are about as follows: —

1. Coal A		5	feet.
2. Space		5	"
3. Coal B		6	"
4. Space		15	"
5. Coal C	Nothing to	2	"
6. Space		75	"
7. Coal D		5	"
8. Space		75	"
9. Coal E		1½	"
10. Space		20	"
11. Coal F		1½	"
12. Space		50	"
13. Coal G		½	"
14. Space		100	"
15. Coal H		4½	"

From coal H to coal L the spaces between the beds are very variable, and sufficient data have not been obtained to warrant the making of an average. As an instance of the changes, it may be mentioned that the distance from coal I to coal J varies from fifty to eighty-three feet.

Were all of the coals united in one bed, the deposit would be about thirty-five feet thick. As far as our examinations now show, coals K, G, F, E, and C may prove to be only local beds.

Quality of the Coals. — As a consequence of the very imperfect knowledge hitherto had concerning the coals of this field, the percentage of sulphur in the coals of Western Kentucky has been rated by many not only as inordinately high, but greater than in the coals of neighboring regions. This has been an error. It is true that in some of the beds the percentage of sulphur is large; but as a class the coals will compare favorably with those in any section of the Western coal-field. The matter of sampling coals for a representative analysis has not always received the attention that should be given it; what may be termed "hand" or

picked specimens have in the largest number of cases been used for analysis, and analyses made under such conditions cannot be fairly compared with ours, that were in every case made from samples *mechanically* taken and faithfully averaged.

It has been known for some years that the coals of the Western coal-field carry, as a class, more sulphur than do those in the Appalachian field; and less than do those in the Missouri and Iowa coal-field. It is not, therefore, with the coals of the States in the Appalachian coal-field that the Western Kentucky beds are to be compared as a class, but with those in the West; and when such comparison is impartially made, the Kentucky coals, as a class, are not excelled by those in other sections of the Western coal-field.

In Indiana and Illinois there are certain beds that have won a high reputation, a better one indeed than has hitherto been accorded the Kentucky coals; but later investigations have developed the fact that here, too, are exceptionally good beds, unexcelled, perhaps, by the most famous of those States. They have hitherto escaped general notice, from the fact that they do not lie in what has been the district of active mining operations, although within convenient reach of transportation facilities. Following are averaged analyses of those beds which so far have been deemed the most important: —*

	Number of Coal.						
	A.	B.	D.	J.	L.*	L?†	?‡
Moisture	3.43	3.27	3.37	3.70	4.85	3.30	1.30
Volatile Comb. Mat.	39.26	38.80	36.66	32.56	32.22	36.00	59.60
Fixed Carbon . .	50.23	51.23	51.97	50.04	55.03	57.88	27.00
Ash	7.08	6.70	8.00	13.70	7.90	2.82	12.10
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur	2.753	2.548	2.806	3.716	1.373	1.024	1.896
Specific Gravity .	1.383	1.309	1.354	1.398	1.319	1.241	1.213

* From the Coaltown Banks, Christian County.
† From near Wrightsburg, McLean County.
‡ The "Breckenridge" Cannel Coal, from near Cloverport, Breckenridge County.

* Some of the beds as yet insufficiently studied for judgment to be passed on them may prove fully as important, so far as regards quality, as those now wrought.

For comparison with the analyses of coal L, the following analyses of the Indiana "block" coal, and the "Big Muddy" coal of Illinois are given. These coals are considered to be among the best in the Western coal-field: —

	Number of Analysis.			
	No. 1.	No. 2.	No 3.	No. 4.
Moisture	2.70	2.68	2 62	3.44
Volatile Combustible Matter .	36.38	36.32	32.04	31.86
Fixed Carbon	55.64	53.58	58.58	59 54
Ash	5.28	7.42	6.76	5.16
Sulphur	1.664	1.802	2.472	1.376
Specific Gravity	1.313	not est.	1.310	1.310

Numbers 1 and 2 are analyses of the Indiana "block" coal; numbers 3 and 4, of the "Big Muddy" coal of Illinois.

The analyses were made in the laboratory of the Kentucky Geological Survey of carefully averaged samples collected in the same manner that the Kentucky coals are sampled.* Special attention is directed to the analyses of the Coaltown and Wrightsburg coals. These are what are known as "blocking" coals, and withstand weathering remarkably well.

The Wrightsburg coal is remarkably good, containing less than three per cent. of ash, a small proportion of water, and but little more than one per cent. of sulphur. There is reason to hope that the Wrightsburg and Coaltown coal may prove serviceable as an iron-making fuel.

The Breckenridge Cannel is already well known for its remarkable properties.

Coal D seems to be the most trustworthy of all of the beds, and is the one most generally wrought throughout the coal-field. It is most useful as a household fuel.

Coal B is usually divided about the middle by a clay parting. The upper sixteen inches serves admirably for gas-making; several analyses show it to contain very little sulphur, and a large proportion of volatile combustible matters. At some points the coal yields an admirable coke.

* See page 177 of the Chemical Report of the Kentucky Geological Survey; Vol. I. Second Series. N. S. Shaler, Director.

III.

WATER-WAYS AND RAILWAYS.

THE coal-field is crossed by three railroads, and is so drained by several streams that, were they all prepared for navigation (a work of no very serious difficulty), no part of it would suffer for means of transportation.

All of the streams drain towards the Ohio River, which offers cheap transportation to the sea.

The streams that have already been made navigable for part of their extent are the Green, the Tennessee, and the Cumberland Rivers; those streams whose partial improvement is both feasible and desirable are the Tradewater and Pond Rivers, Rough Creek, Nolin River, Muddy River, and Bear Creek.

The Green River and its tributaries is navigable by locks and dams for two hundred and sixty-eight miles. The Tennessee is navigable from its mouth to Florence, Alabama, a distance of about two hundred and fifty miles; and the Cumberland River is navigable from its mouth to a point about one hundred miles above Nashville.

Regular lines of steamers ply on these rivers. Large shipments of coal are sent south by the Tennessee River.

The Pond River flows into the Green River, and during high stages of water is navigable for about fifteen miles; it may be rendered navigable by a system of locks and dams, as far up as Bakersport, a distance of about thirty miles.

The Tradewater River is ascended by light-draught boats during the spring freshets as far up as Belleville; it is quite practicable for it to be rendered navigable for forty miles, or more.

Prior to the building of the Louisville, Paducah, and Southwestern Railroad, Rough Creek (which empties into Green River), was regularly plied by light-draught steamers as far up as Hartford, Ohio County, having been rendered navigable by locks and dams. It will be seen that it is a mere question

of enterprise whether or not the streams may be used as roads for carrying out produce, &c.

The railways are the St. Louis and South-eastern Railway (connecting St. Louis, Mo., and Nashville, Tenn.), which passes north and south through Henderson, Webster, Hopkins, and Christian Counties; the Evansville, Owensboro', and Nashville railroad (not yet completed), which (so far as built) passes north and south through Daviess and McLean Counties into Muhlenburg County; and the Louisville, Paducah, and South-western railroad which passes westwardly through Grayson, Ohio, Muhlenburg, Hopkins, and Caldwell Counties intersecting the north and south running railroads; one at Owensboro' Junction, and the other at Nortonville.

The total number of miles of railroads in the coal-field is about one hundred and eighty-five.

Thus it will be seen that transportation is, or can easily be, furnished to nearly all of the workable coal-beds. The Green, Pond, and Tradewater Rivers and their tributaries (some of them of considerable size), and Rough Creek drain a large portion of the coal-field; while other portions are reached by the several railroads. Some of the best coals are found on the Green and Tradewater Rivers; but as yet comparatively little mining has been done in them.

So far nearly all of the important mines have been opened along the paths of the railroads, a plan which has resulted in giving them a more rapid, although more costly, transportation than was offered by the rivers.

IV.

NUMBER OF COAL MINES, &c.

In all there are about thirty collieries of importance in the coal-field.

The mines are worked on a general plan modelled on the post and stall-system. About fifteen of them are located along the Louisville, Paducah, and South-western Railroad; six along the St. Louis and South-eastern Railway; and two

on the Evansville, Owensboro', and Nashville Railroad. Others are located in the neighborhood of Owensboro', bordering the Ohio River; at Airdrie on the Green River; and several in Crittenden and Union Counties, in the vicinity of Caseyville.

The Coal Trade. — It is difficult to determine the precise amount of coal raised in this field, as the records are very imperfect. The product of the Kentucky collieries, however, has operated greatly in regulating the amount of foreign coal brought into the State and into the Southern markets.

Louisville, of the home markets, has especially been benefitted by these mines, as the following will show: —

In the winter of 1871–72, on account of low water, the Pittsburgh coal reached the price of $7.00 per load of twenty-five bushels, while the Kentucky coal sold at $5.00 and $5.50 per load.* In the succeeding winter (1872–73), the Ohio River was again at a low stage; but the highest price paid for Pittsburgh coal was $5.00, the average being $4.50; the Kentucky article selling at $4.50 and $4.00 per load. In the winter of 1873–74, there was a good stage of water in the Ohio River, and at the same time plenty of Kentucky coal, and the Pittsburgh coal sold at $3.50 and $4.00 per load. In 1874–75, there was a still greater reduction in prices, the Pennsylvania coal selling at $3.00, and that from Kentucky at $2.75 per load.

This season, the Kentucky collieries have suffered in common with those of other regions, and also from internal complications; hence their product may fall behind that of former seasons, or at most not go beyond it.

According to the census reports of 1870, when few collieries were in operation in this field, the production of the mines amounted to about 115,094 tons of coal; of which 67,466 tons were raised in Union County, and 23,600 tons in Crittenden County.

The product of the mines on the Louisville, Paducah, and South-western Railroad alone, from October 1872 to October 1874, amounted to 270,000 tons,† and at least half as much

* A ton of coal contains about twenty-five bushels.

† A number of the largest collieries were not in operation until 1873, hence for some of them the statement does not represent a business of two years. Scarcely any of the mines had been opened longer than two years when the statistics were obtained.

more may be estimated for the product of the other mines for that time, placing the probable product at 405,000 tons.

V.

BUILDING MATERIALS.

Wood. — The larger portion of the region west of Salt River, especially that lying within the limits of the coal-field, is supplied with forests of valuable timber.

In different sections of the region bordering the Green River fine white oak, chestnut, oak, yellow poplar, and black-walnut trees are found. In Daviess, and some other Counties, large-sized chestnut trees are not infrequent. The forests of Hopkins County and neighboring regions are noted for their growth of large-sized oaks and poplars.

Stone. — The St. Louis group furnishes admirable building-stone and material for lime. Some important quarries have been opened in its beds. At Bowling Green the Oölite is quarried very extensively, and the exportation of the stone in dressed blocks has grown into an important industry. At Glasgow Junction, in Barren County, the "lithographic" beds have also been largely quarried and dressing-works erected.

The Oölite and "lithographic" stone are both very valuable as building material, being unexcelled, perhaps, for nice work by any of the Subcarboniferous beds. The Oölite is especially esteemed by builders for its durability and beautiful appearance after dressing. Large quantities of it are sent to St. Louis and other western cities and to the south, and even to the Atlantic States. The dark blue beds of the St. Louis group, and a few of the Chester group, serve very well for heavy work.

Few of the Sandstones in the coal-measures are of much value as building material. They are, as a class, too soft and incoherent; hence liable to disintegrate when set in a wall. They are occasionally found suitable for ordinary purposes. The great sand-rock at the base of the Chester group is in a number of places a fairly good building stone.

Gravel Beds. — Between the Cumberland and Tennessee Rivers are large deposits of gravel, the shipment of which to cities in which gravelled streets are used may prove a source of profit. The gravel covers a considerable area, and in many places seems to have formed into ridges. The beds seem to be practically almost inexhaustible, and may be accounted among the valuable deposits stored in Western Kentucky.

The material is largely used on the streets of Paducah, and has also been tried in Louisville.

Paint Materials. — It is possible that some of the red earths found associated with the St. Louis beds may prove useful as materials for paint; their merit, however, is as yet only conjectural.

The Chester group, however, furnishes deposits of undoubted value for paint material. Southwardly from Leitchfield, Grayson County, beds are found of two colors, — red and light blue. The material has been locally used, and with very favorable results. The Shales overlying Coal A frequently furnish an abundance of ochre.

VI.

OTHER MATERIALS.

Marl Beds. — One of the most interesting results of the geological survey was the discovery of potash and soda in some of the marls of the Chester group, in such quantities as to prove them valuable as fertilizers.

Attention was first directed to the deposits near Leitchfield, Grayson County, and now they are searched for with interest wherever the Chester group is known to occur. They have been found in Grayson, Edmonson, Breckenridge, Caldwell (?), Christian (?), and Livingston Counties. Their entire extent is unknown, but it is not improbable that further explorations may prove their existence wherever the Chester group is fully developed.

Scarcely too high an estimate can be placed on these marls in Kentucky, as we have therein a ready and cheap fertilizer

for tobacco lands, — the properties of the marl being to renew the vigor of the soil as it is impoverished by the tobacco. The infertility of much of the land is largely due, not to original poorness, but to the exhaustion produced by tobacco; these potash marls are expected to serve in placing the lands once more in a fertile condition.

Following, is the analysis of a sample of the marl collected from Haycraft's Lick, Grayson County: —

Composition, dried at 212° Fahrenheit: —

Alumina, iron, &c., oxides	27.811
Lime carbonate	.880
Magnesia	.824
Phosphoric acid	.109
Potash	5.554
Soda	.657
Water and loss	4.245
Silica and insoluble silicates	59.920
	100.000

Lead. — In nearly all of the regions where the St. Louis group is fully developed more or less lead has been found. The only mining that has been done for the metal, however, has been in Livingston, Crittenden, and Caldwell Counties. In Livingston and Crittenden Counties a number of pits and excavations of various sorts have been dug for the purpose of working the deposits; with possibly one exception, however, the work has so far proven unprofitable. In Crittenden County considerable lead has been found at a point known as the Columbia mines, leading to the supposition that, economically managed, they may be wrought at a small profit. So far these lead-mines have had to contend with the production from the mines in the Rocky Mountains, where a large quantity of this metal has been produced, almost without cost, in the reduction of ores for their silver. Should this competition be in time removed, they would become more important sources of profit.

Zinc. — Zinc is frequently found in the form of the sulphide (Black-Jack) accompanying the lead; it has never been found in sufficient quantities for working.

Iron Ore. — As hitherto mentioned, some of the regions underlaid by the Subcarboniferous beds furnish admirable Limonite ore.

Towards the base of the coal-measures the Shales frequently carry good beds of the Carbonate ore; in general, however, the beds of the coal-measures are unproductive, save near their base, where some of the best ores of the Ohio Valley are found.

Fluor Spar. — Fluor spar is found in more or less quantities throughout the lead region. In Crittenden County, northwardly from the Columbia mines, fluor spar is found in great abundance. Considerable deposits of the massive variety, very white and apparently free from impurities, are found at the Memphis mines and vicinity. It is not unlikely that other important deposits may be found.

Mineral Springs. — Springs of sulphur and chalybeate water are not uncommon in regions where the Subcarboniferous series come to the surface.

The ones most frequented are the Grayson and Rough Creek Springs in Grayson County, the Ohio Springs in Ohio County, and the Sebree Springs in Webster County.

The Grayson and Rough Creek Springs are watering-places of considerable popularity in Kentucky and the South; the Grayson Springs being, perhaps, the most generally known. There are a number of other springs resorted to, and whose waters are esteemed by many; they have, however, more of a local reputation. The Sebree Springs have many visitors from the western part of the State and contiguous regions during the summer.*

The coal-measures also furnish mineral waters in some regions. The most interesting are in Daviess County, and are known as Hickman's Springs. Several of the waters are remarkable for the amount of alum they contain.

* Analyses of the waters from the various springs will be found in the Chemical Report, Vol. I., Second Series, Kentucky Geological Reports.

VII.

GENERAL REMARKS ON AGRICULTURE.

Soil. — There are three general varieties of soil found in the region of the Carboniferous rocks.

The soil of the coal-measures, originating as it does from Sandstones and Shales, is a light, sandy mixture, usually yellowish in color; or a rather dense, dark-colored material becoming waxy and unmanageable after rains, — according to localities. The soil resulting from the beds of the coal-measures seems especially adapted for the growth of tobacco. This may be due to the fact that nearly all of the Sandstones are micaceous, and that upon disintegration the mica furnishes the mixture with the potash required by the plant.

In the Chester group we get a mingling of sandy, calcareous, and aluminous materials, producing in some regions a fairly good soil. In general, however, Shale predominates largely, and produces, when unmingled with other materials, a poor and stubborn soil.

The finest soil for general purposes is furnished, perhaps, by the St. Louis group. It is a deep-red earth, rich in iron and other desirable matters. This soil is very characteristic of the St. Louis group, and is almost invariably found where the limestones are the first beds below the surface.

Crops. — Tobacco is the staple agricultural product of Western Kentucky; the other crops, such as wheat, oats, corn, and hay, are raised more for home consumption than as an article for exportation.

The following are the yields per acre of the several products, so far as past observation would indicate: —

	Lowest Yield.	Highest Yield.	Average Yield.
Corn *	10	60	30
Wheat *	8	35	10
Hay, (Timothy) †	1½	2	1½
" (Red Top) †	1	2	1½
Tobacco ‡	300	1500	800

* Yield in Bushels. † Yield in Tons. ‡ Yield in Pounds.

In her tobacco yield, Kentucky now stands first among the States, and the western part of the State furnishes by far the larger portion.

The principal tobacco-growing counties east of the Tennessee River are Caldwell, Christian, Daviess, Henderson, Hardin, Hopkins, Muhlenburg, and Ohio; Daviess County is said to be the largest producer, Christian County standing second.

The principal shipping points are Henderson, Owensboro', and Hopkinsville; Princeton and Eddyville are also depots for the handling of tobacco, — the former place doing a considerable business.

Owensboro', it is said, is the largest "strip" market in the world; Henderson falls but little behind it, and was until within the last year or two the largest market.

The time has been too limited wherein to obtain complete statistics of the trade at the different shipping points; the following statements, however, of the market at Owensboro' and Hopkinsville for a period of years will serve to show the magnitude of the tobacco interest.

The statistics concerning the Owensboro' market were kindly furnished by Captain R. L. Triplett.

Statement of the Amount of Tobacco exported from Daviess County for six years previous to 1876.

	From Owensboro'.	From other Points.	Hhds.	Pounds.
Product of 1868	5,000	500	5,500	8.250,000
,, ,, 1869	5,500	500	6,000	9,000,000
,, ,, 1870	6,500	500	7,000	10,500,000
,, ,, 1871	6.000	500	6,500	9.750,000
,, ,, 1872	7,500	500	8,000	12.000,000
,, ,, 1873	9.000	500	9,500	14.250.000
,, ,, 1874 *	3,000	500 †	3,500	5,250.000
,, ,, 1875 ‡	8,000	500	8,500	12,750,000

* A short crop year.
† Not quite that much, but a fair enough estimate.
‡ Product not yet gone forward, but will reach as much.

Statistics concerning the Hopkinsville market are taken from the Annual Circular of Messrs. J. K. Gaut & Son: —

In 1870, there were sold 2,468 hogsheads.
" 1871, " " " 5,970 "
" 1872, " " " 6,711 "
" 1873, " " " 9,155 "
" 1874, " " " 13,047 "

These sales are up to Nov. 1 of each year, and include all the sorts of tobacco that are sent from the place.

Statistics of the Henderson market have failed to come to hand.

It must be borne in mind that Louisville and Paducah also receive large amounts of tobacco from this region;* hence the foregoing show but a small proportion of the yield.

The following Table, extracted from a late circular from Liverpool, may be of interest, as it shows the number of hogsheads of Virginia and Kentucky tobacco on hand, March 1, for a series of years: —

VIRGINIA.	Leaf.	Strips.	KENTUCKY.	Leaf.	Strips.
1872	2,402	1,820	1872	8,436	9,754
1873	2,372	1,363	1873	6,449	4,228
1874	3,206	3,517	1874	8,024	10,817
1875	2,706	4,353	1875	9,039	14,032
1876	3,313	3,824	1876	9,204	7,740

This table serves as an approximate means of measuring the exports from the two States.

* Much of the Puducah exports, however, are of the tobacco grown west of the Tennessee River.

THE IRON ORES OF KENTUCKY.

THE iron resources of Kentucky are extensive and varied. At a few localities a considerable development of them has been attained; but, taking the State as a whole, it has hardly reached a fraction of the possibilities of production. The greater portion of the ore territory of the State is as yet untouched by the pick of the miner; but enough has been done in most of the ore districts to learn the quality and something of the extent of the ores.

Geographically the ore districts of the State may be divided into the eastern and western.

Geologically the ores of most importance may be divided into three classes, as follows: —

1. The Clinton ore of the Silurian period. This is the equivalent of the Dyestone ore of Tennessee and Virginia.

2. The unstratified Limonites of the Subcarboniferous Limestone.

3. The stratified Carbonates and Limonites of the coal-measures.

There are also ores associated with the Waverly and Devonian Shales in many parts of the State, which have been worked to some extent; but they are of minor importance in comparison with the other varieties of ore. Of the three classes of ore above named the first and the third are found in Eastern and the second and third in Western Kentucky. It may be said also that the ores of the coal-measures are the best developed and of the most importance in Eastern, while the unstratified Limonites of the Subcarboniferous Limestone are of the greatest value in Western Kentucky.

It is also proper to state here that the State has been imperfectly prospected, and that it is altogether possible, and indeed probable, that the ores of one or another of these varieties will be found to be much more extensive and valuable than at present supposed.

The Iron Ores of Eastern Kentucky. — The ore districts of Eastern Kentucky, where the ores have been manufactured, are two, known as the Red River and the Hanging Rock iron regions. The Red River iron region embraces portions of Estill, Lee, Powell, Menifee, and Bath Counties.

The ores found in this region are the Clinton ore, and an ore, stratified, resting upon the Subcarboniferous Limestone at the base of the coal-bearing Shales. It is found both as Carbonate, or clay Ironstone, and as Limonite, or Brown Hematite. It is this ore which has been most largely worked, and upon which the excellent reputation of the iron from this region has been made.

The Clinton ore has not been so extensively worked; but the principal deposit of it is situated geographically near this region, and may be said to belong to it.

The best known deposit of this ore in Kentucky is in Bath County, on the waters of Slate Creek, and is known as the Slate Furnace Ore-bank. It is a stratified deposit of Oölitic Fossiliferous Limonite, capping several hills in the vicinity. It reaches a thickness of fifteen feet at places. The area covered by the ore at this point is somewhat over forty acres, and the total amount of ore about one and a half million tons. The ore bears evidence of having been formerly a Hematite, similar to the Dyestone ore of the same geological horizon along the great valley from New York to Alabama, but it has lain so long, unprotected by any thing except a slight covering of earth, that it has absorbed water, and been converted into a Limonite.

This deposit seems to be somewhat local, — at least of this thickness, — as it grows thin, and finally disappears in this neighborhood. The Limestone which bears the ore is, however, present in a narrow rim all round the central part of the State, and it is probable that, when thorough examination is made, other deposits of the ore will be found.

The following analysis by Dr. Peter and Mr. Talbutt, of the Kentucky Geological Survey, of a sample of ore from this deposit, shows the composition of the ore: —

Iron Peroxide	70.060
Alumina	4.540
Lime Carbonate	.040
Magnesia	.021
Phosphoric Acid	1.620
Sulphuric Acid	.031
Silica and Insoluble Silicates	11.530
Combined Water	12.300
	100.142
Metallic Iron	49.042
Phosphorus	.707
Sulphur	.012

The Dyestone ore, a Fossiliferous Hematite, extends along the flank and foot-hills of the Cumberland Mountain in Virginia, just across the State line from Kentucky, the crest of the mountain forming the line for about forty miles. It lies in two or three beds, ranging from six inches to three feet or more in thickness, and forms in the aggregate an enormous mass of cheaply-obtainable ore. This ore, although situated in Virginia, is of the greatest importance to Kentucky, as it is destined to be smelted with Kentucky coals, which lie on the opposite side of the mountain, and are the only coals accessible to the ore, as there is no coal to the south of the mountain.

This ore, although somewhat phosphatic, is easily worked, and yields from forty to fifty per cent. of iron. From this ore, smelted with stone-coal, iron will probably be made as cheaply as in any region of the country.

The great Pine-Mountain fault, which extends from some distance south of the Kentucky line in Tennessee, in a course about north thirty degrees east through Kentucky to the Chatterawah or Big-Sandy River, at many places is of sufficient uplift to have brought the rocks of the Clinton or Dyestone group above the drainage; and it is probable that on exploration the ore will be found in Kentucky. It has been found at the foot

of the Pine Mountain in Tennessee. In Kentucky the place of the ore is usually covered deeply by the talus from the overlying rocks, which probably accounts for its not having been discovered. Should it be found along the foot of Pine Mountain in Kentucky, it will be most favorably situated for cheap iron-making, as on the opposite side of the stream, which flows at the base of the mountain, there is found excellent coal in great abundance.

The Limestone ore of the Red River iron region, from which the iron is manufactured which gives to the region its reputation, rests upon the Subcarboniferous Limestone, and from this association takes its name. It lies in a bed of irregular thickness, ranging from a few inches to three feet or more in thickness, but probably averaging, where found in any quantity, about one foot thick, or a little less. It is occasionally irregular and uncertain in its distribution; but, in general, it may be said that it is found in its proper position almost wherever the Subcarboniferous Limestone is above the drainage, along the edge of the coal-measures from the Kentucky to the Ohio River. South of the Kentucky River the ore is known to extend a short distance, as far as it has been explored; but its limit in this direction is as yet unknown.

The Red River region embraces, however, only that portion between the Licking and the Kentucky Rivers. This region has been little developed, except in a portion of Estill County, where four charcoal-furnaces have been in operation. There are many eligible sites for charcoal-furnaces in this region, where timber and ore are both in abundance and as yet untouched. The development of this region has been retarded by the lack of transportation facilities, as the iron had to be hauled a long distance in wagons to railroad or river. This difficulty is likely to be remedied in the near future by the construction of one or two projected railroads into or along the edge of this region, and we can then look for a largely-increased production of the excellent iron from this region. The iron is of great strength, and ranks very high in the markets of the West. It is used principally for car-wheel purposes, as it is of very great strength and chills well.

The following analyses show the character of the ore of this region: —

	No. 1.	No. 2.	No. 3.	No. 4.
Iron Peroxide	66.329	63.535	74.127	65.591
Alumina	12.532	2.798	3.542	5.762
Lime Carbonate	trace.	.450	.390	trace.
Magnesia	.173	1.073	.461	.248
Phosphoric Acid	.709	.537	.601	.447
Silica and Insoluble Silicates	9.720	20.480	9.580	16 230
Combined Water	9.580	9.800	11.270	11 060
Total	99.043	100.673	99.971	99.914
Metallic Iron	46.440	45.874	51.889	45.914
Phosphorus	.309	.234	.262	.195

No. 1. From the Richardson Bank, Clear Creek, Bath County.
No. 2. From Logan Ridge, Estill Furnace, Estill County.
No. 3. From Thacker Ridge, near Fitchburg, Estill County.
No. 4. From Horse Ridge, Cottage Furnace, Estill County.

The above analyses were made by Dr. Peter and Mr. J. H. Talbutt, chemists of the Kentucky Geological Survey, from samples selected by the writer.

THE HANGING ROCK IRON REGION.

The Kentucky division of the Hanging Rock Iron Region at present embraces the whole, or parts, of Greenup, Boyd, Carter, and Lawrence Counties. The ores are stratified Carbonates and Limonites, occurring in the lower coal-measures, beginning with the ore just described, resting upon the Subcarboniferous Limestone, and extending through six hundred to seven hundred feet of the coal-measure strata. The ores are mineralogically similar, but differ somewhat in their physical character and circumstances of deposition. They are popularly known as Limestone, Block, and Kidney ores. They usually occur at well defined geological levels, but do not always form connected beds. They also differ in thickness, ranging from four to eight inches in some of the thinner beds to fourteen feet in one local deposit. This latter is the Lambert ore of Carter County. The most common thickness is from six inches to one foot. There are from ten to twelve ore

beds which are of more than local extent in this region. In addition there are numerous local beds, one or more of which is found at nearly every furnace. This region supports eleven charcoal and two stone-coal furnaces. The Hanging Rock iron bears a reputation for excellence for general foundry purposes, which is unsurpassed by any iron in the United States. The iron produced is mostly hot-blast charcoal iron; but some of the furnaces are worked with cold-blast for the production of car-wheel iron. The reputation of the iron of this region is, however, chiefly founded upon its excellence for castings of all sorts. The iron combines in a remarkable degree great strength with fluidity in casting, and non-shrinkage on cooling.

The stone-coal iron of this region is used almost entirely for the manufacture of bar iron and nails.

The stone-coal iron is made from the ores of this region mixed with a considerable proportion of ore from other States. The fuel used is the celebrated Ashland, or Coalton coal. It is a dry-burning, non-coking coal, which is used raw in the furnace, and is of such excellent quality that no admixture of coke with it in the furnaces is necessary, as is the case with most of the other non-coking furnace coals of the West.

The charcoal iron is manufactured exclusively from the native ores, which yield, as shown by the books at a number of the furnaces, for periods ranging from one to four years, an average of between thirty-one and thirty-two per cent. of iron. The ores of the region are known as Limestone, Block, and Kidney ores. These names are due to peculiarities of structure or position, rather than to any essential difference in chemical composition. As a rule, however, the Limestone ores are the richest and most uniform in quality. The Kidney ores are next in value; while the Block ores present greater variations in quality than any other, some of them being equal to the best of this region, and some so silicious and lean that they cannot be profitably worked.

The following analyses by Dr. Peter and Mr. Talbutt, of the Kentucky Geological Survey, show the composition of some of the ores of each class in this region: —

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Iron Peroxide. . .	67.859	71.680	54.530	68.928	61.344	66.200
Alumina	1.160	4.155	2.120	2.768	4.236	3.907
Mang. Brown Oxide	.980	.090	1.380	.290	. . .	.030
Lime Carbonate . .	.120	.380	.040	.680	.750	.430
Magnesia	1.275	.050	1.823	.641	.208	.345
Phosphoric Acid .	.143	.084	.908	.249	.795	.130
Sulphuric Acid . .	. . .	.270	.336	.748	.041	.182
Silica and Insoluble Silicates. . . .	15.560	12.650	28.360	15.240	21.480	16.530
Combined Water .	*12.903	10.800	10.900	11.100	11.200	11.730
Total . . .	100.000	100.159	100.397	100.643	100.054	99.484
Metallic Iron . . .	47.501	50.176	38.171	48.249	42.941	46.340
Sulphur	. . .	.108	.134	.298	.016	.072
Phosphorus . . .	.062	.036	.428	.098	.347	.057

* And loss.

No. 1. Lower Limestone Ore, Kenton Furnace, Greenup County.
No. 2. Upper Limestone Ore, Graham Bank, near Willard, Carter County.
No. 3. Lower Block Ore, Kenton Furnace, Greenup County.
No. 4. Upper or Main Block Ore, Laurel Furnace, Greenup County.
No. 5. Yellow Kidney Ore, Buena Vista Furnace, Boyd County.
No. 6. Yellow Kidney Ore, Mount Savage Furnace, Carter County.

THE IRON ORES OF WESTERN KENTUCKY.

The most extensive and best developed ore region of Western Kentucky is called the Cumberland River iron region. It embraces the whole, or parts of, Trigg, Lyon, Livingstone, Crittenden, and Caldwell Counties. The ores of this region are Limonites found resting in the clay and chert above the St. Louis or Subcarboniferous Limestone. They occur in deposits of irregular shape and uncertain extent, but in the aggregate the amount of ore is immense. The ores are distributed with great irregularity throughout this region, but they seem to be found in greatest abundance and quantity where the Limestone has been most extensively worn away, and where, as a consequence, the clay and chert which are the result of its decomposition are of greatest thickness.

The ores are, perhaps, found in greater abundance in the country between the Cumberland and Tennessee Rivers than in any other portion of this region, although there

are extensive deposits on the east side of the Cumberland River which have been largely worked. As a rule, however, the deposits decrease in size and frequency in going from the Cumberland River toward the east, and, after a few miles' distance from the river is reached, they are scattering and small. The ores are of excellent quality, being almost entirely free from sulphur, and containing but a small amount of phosphorus; but they are sometimes mixed with chert and sand. The quality in this respect is as variable as the size of the deposits; the ore in the same deposit frequently showing all degrees of admixture with chert, from a chert breccia, to a rich, pure ore with only an occasional lump of chert enclosed.

The average yield of iron from the ore at the furnaces of this region, where it is not very carefully selected previous to roasting, is between thirty and thirty-five per cent. With careful sorting the yield can be brought much higher, from forty to fifty per cent.

The iron produced from these ores is of a very high grade. There are three active furnaces in this region which use charcoal fuel exclusively for the production of pig-iron. From this iron is manufactured the celebrated Hillman's boiler-plate, of which it is said, by the manufacturers, that no boiler constructed of this iron has ever exploded. This iron ranks equal, or superior, to any other boiler-plate manufactured in the United States. It is used largely for steamboat and locomotive boilers, for which latter purpose it finds an extensive market, even as far as the Pacific slope.

Considerable ore from this region has been shipped to furnaces at a distance; but within the past two years the depressed condition of the iron market has rendered this unprofitable. This region is well situated as regards transportation facilities, — it being drained by the two navigable rivers, the Cumberland and Tennessee, and on the lower border by the Ohio, so that the iron manufactured here can be very cheaply placed in market.

The following analyses of two samples of ore from the Suwannee furnace-lands, Lyon County, will show the charac-

ter of the ore from this region. The analyses are by Dr. Peter and Mr. Talbutt of the Kentucky Geological Survey: —

	No. 1.	No. 2.
Iron Peroxide	59.370	70.518
Alumina	1.622	.045
Manganese	.090	.190
Lime Carbonate	.170	.090
Magnesia	.100	trace.
Phosphoric Acid	.179	.275
Sulphur	.212	.045
Silica and Insoluble Silicates	30.000	18.910
Combined Water	8.400	9.850
Total	100.053	99.923
Metallic Iron	41.559	49.363
Phosphorus	.077	.120

This same variety of ore is found, in greater or less quantity, in many other counties where the St. Louis Limestone is the prevailing rock formation, but in none of them, save those mentioned, has any extensive iron industry been established. In the Cumberland-River iron region there are many furnace-sites unoccupied where iron can be cheaply and profitably manufactured.

This region is capable of, and destined to, a much greater development than it has yet attained. The charcoal-iron manufacture will always be an important and extensive industry, for over a large part of the region the most profitable use that can be made of the land is the production of timber for charcoal. There is destined at no far-distant day to be a large stone-coal or coke iron industry established here, using the ores of this region with the coals of the Western Kentucky coal-field, either raw or coked. The best known of the Western coals at present are too sulphurous for use in iron-making, without previous separation from sulphur by washing and coking. It is through the introduction of modern machinery and ovens, by which these operations can be cheaply and thoroughly effected, and a coke fit for iron-smelting produced, that the coal and iron ore of Western Kentucky will be most profitably and extensively developed. The Louisville, Paducah, and

South-western Railroad affords direct communication between the coal and ore fields. Already measures are in progress for the erection of extensive coke-works on the line of this railroad, which will doubtless prove but the first step in the successful development of a different form and more extensive iron industry than any yet established in Western Kentucky.

THE NOLIN-RIVER DISTRICT.

In Edmonson and Grayson Counties, north of Green River, between Nolin River and Bear Creek, is an area of considerable size called the Nolin-River District. The ores of this region are stratified Carbonates and Limonites, found near the base of the coal-measures. The ore of most value occurs above the Conglomerate. It is about four feet thick, and, so far as present developments indicate, underlies an area of large extent. It is almost wholly undeveloped. A number of years since a small charcoal furnace was established on Nolin River, but it was so far from market, and transportation of the iron was so uncertain and expensive, that the enterprise soon failed. It ran long enough, however, to establish the fact that an excellent iron could be made from these ores.

The following analyses, by Dr. Peter and Mr. Talbutt, show the quality of a sample of this ore from near the head of Beaver-Dam Creek in Edmonson County: —

Iron Peroxide	52.926
Alumina	4.792
Manganese	.210
Lime Carbonate	.180
Magnesia	.425
Phosphoric Acid	.355
Sulphuric Acid	.143
Silica and Insoluble Silicates	30.580
Combined water	10.400
Total	100.011
Metallic Iron	37.048
Phosphorus	.154
Sulphur	.057

In addition to the great amount of timber available for charcoal, stone-coal in abundance occurs in the same region. This coal is the lowest of the series, and is of most excellent quality, — analyses showing it to be far superior to the higher coals of Western Kentucky, which are the ones more generally mined. This region is now more accessible than formerly, as it lies within fifteen miles of the Louisville, Paducah, and South-western Railroad; but the lack of transportation facilities directly to it has prevented its development. The aggregate amount of ore, coal, and timber suitable for charcoal in this region, is immense, and it offers great opportunities for development. It is one of the most richly endowed undeveloped iron regions of the State.

In many other localities in the Western coal-field iron ores have been found, but they have not been thoroughly prospected, and little is known of their extent. One of the best-known localities of this sort is in Muhlenburg County. In this county are found, at Airdrie Furnace, on Green River, and at Buckner Furnace, near Greenville, deposits of so-called black-band iron ore, — a ferruginous bituminous Shale, yielding about thirty per cent. of iron. At Airdrie Furnace this ore rests immediately above an excellent coking coal, and the two can be mined together very cheaply. At this place iron can be produced very cheaply by bringing ore from the Cumberland-River region, and using it in admixture with the native ore. For a more detailed description of this locality, see Report in the second volume, new series, "Kentucky Geological Reports, on the Airdrie Furnace."

The above described localities embrace all the most important iron-ore districts of the State. There are numerous ore deposits at other places, some of which have been worked, but, in comparison with the others, to a small extent only.

For more detailed information in regard to some of these districts, the reader is referred to the volumes, first series, "Kentucky Geological Reports;" to the "Report on the Iron Ores of Greenup, Boyd, and Carter Counties," in the first volume, second series; to the "Report on the Geology of the

Nolin-River District," in the second volume, second series; to the forthcoming reports on the iron ores in the vicinity of Cumberland Gap, and on the iron ores of the Red-River iron region, in the fourth volume, second series, "Kentucky Geological Reports."

CHEMICAL GEOLOGY OF KENTUCKY.

THE Geological Survey of Kentucky has given very especial attention to the study of the chemical conditions of its products, — the soils, ores, coals, &c., on which industries could be founded. In the following tables will be found selections from the work of its laboratories, done by Dr. Peter, the chief chemist of the present Survey, as well as of that under Dr. Owen, with the assistance for the last three years of Mr. John H. Talbutt. Attention is called to the fact that these tables represent analyses made with a high degree of care to securing trustworthy results. In the first place, a great deal of care has been exercised in procuring average samples representing the actual character of the several substances considered as workable deposits. Usually such analyses are made from selected specimens, or at best from a rough selection of several fragments believed to represent the average of the beds. A series of experiments has shown that, taken in this way, the samples lead uniformly to too favorable results. The Survey has been to the trouble to have carefully-averaged samples obtained from a number of important deposits of coal in neighboring States. The analyses based thereon have shown the general untrustworthiness of the usual method of collecting the specimens from which the analyses were made. The errors of this imperfect method of sampling are particularly striking in the case of coal analyses, where it is easy to halve the amount of sulphur, and greatly diminish the ash by a careless selection of the specimens. The reader is, therefore, requested to be on his guard in comparing these analyses with those from other regions, and to remember that the quantities of the several substances given in each analysis recorded in these tables are as near to the average amounts found in the deposits whence they were taken as it was possible to make them by a very great care.

In the several reports from the Chemical Laboratory will be found various practical recommendations concerning the use of the materials represented in these tables. Any further information can be had by addressing the Secretary of the Geological Survey, Lexington, Ky.

TABLE I. Of Composition of Soils.

(Dried at 212° Fahrenheit.)

No. in Report.	County.	Organic and Volatile Matters.	Alumina.	Iron Oxide.	Manganese Oxide.	Lime Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand & Silicates.	Water lost at 380° F.	Hygroscopic Moisture.	Potash in the Silicates.	Soda in the Silicates.	Extracted from 1000 parts by carbonated water.	Geological Formation, General Remarks, Etc.
					Soils	on the	*Camb*	*rian o*	*r Blue*	*Lime*	*stone*	forma	tion.					
574	Bourbon	7.702	4.620	6.585	0.720	0.622	0.508	0.321	0.145	0.224	0.077	78.680	5.865		not		6.760	Virgin Soil, Cane Ridge, Wood-pasture.
820	Bracken	7.981	6.645	6.825	0.296	1 582	1.354	0.342	0.110	0.758	0.047	72.920	6.975		estimated.		9.861	Virgin Tobacco Soil, Hill-side, near Augusta.
27	Fayette	8.000	4.181	6.170		1.037	0.200	0.256	n. e.	0.205	0.062	79.910	4.440		,,		9.861	Virgin Soil, Wood-pasture, Meredith Farm.
619	Gallatin	7.005	5.965	6.035	0.320	0.920	0.768	0.360	0.114	0.484	0.013	77.770	5.575		,,		2.068	Field, 30 years in cultivation, near Big Lick Cr'k.
621	Garrard	8.548	6.190	3.920	0.520	1.910	0.763	0.559	0.128	0.393	0.081	77.380	5.825		,,		7.634	Virgin Soil, Wood-pasture, J. S. Hoskins.
622	,, ...	5.238	7.805	5.165	0.649	3.270	1.358	0.484	0 059	0.386	0.025	75.570	4.550		,,		4.586	Field, 60 or 70 years in cultivation, J. S. Hoskins.
1134	Mason	8.462	4.745	6.240	0.146	0.836	0.798	0.231	0.084	0.558	0.160	78.100	4.175		,,		4.570	Virgin Tobacco Soil, Hill-side, near Dover.
681	Mercer	10.365	5.395	7.110	0.620	1.995	1.234	0.333	0.093	0 762	0.106	72.035	4.500		,,		11.095	Virgin Soil, Woods, West part of County, near Cornishville.
682	,, ...	6.980	7.495	7.270	0.645	2.080	1.184	0.298	0.090	0.705	0.106	72.810	4.375		,,		3.754	Old Field, 50 years in cultivation, same locality.
550	Woodford . . .	7.771		12.961		2.464	0.173	0.319	0.150	0.394	0 130	75.266	4.700		,,		6.014	Virgin Soil, near Versailles, Judge R. C. Graves.
551	,, . . .	5.513		13.344		2.734	0.333	0.306	0.037	0.205	n. e.	77.591	4.600		,,		3.720	Field, 47 years in cultivation, same locality.
				Soils	on the	*Silici*	*ous M*	*udsto*	*ne* of	the Lo	wer Si	lurian	formation.					
504	Fayette	4.881		10.306		0.276	0.133	0.254	0.109	0.139	0.047	83.834	4.120		,,		3.520	Virgin Soil, 2½ m. from Lexington, Richmond R'd.
1204	Owen	4.865	2.965	2.810	0.005	trace.	0.514	0.086	0.050	0.094	0.035	88.020	2.375		,,		1.770	Virgin Soil, Woods, Southern edge of Owen C'y.
						Soils	on the	*Upper*	*Silur*	*ian* fo	rmatio	n.						
805	Bath	8.165	4.565	6.965	n. e.	0.570	0.710	0.174	n. e.	0.290	0.059	79.145	3.650		,,		3.050	Clinton Group Soil, 2½ m. West of Owingsville.
522	Jefferson	7.996		7.480		0.304	0.240	0.205	0.082	0.200	0.043	83.134	4.420		,,		n. e.	Virgin Soil, O'Bannon's St'n, on Mag. Limestone.
1070	,, ...	5.173	2.900	3.085	0.395	0.370	0.719	0.203	0.076	0.208	0.154	86.370	2.100		,,		2.783	Virgin Soil, Middle F. of Bear-grass Creek.

						Soils	on the	*Black*	*Devo*	*nian*	Shale.						
583	Bullitt	5.665	2.476	4.790	0.176	0.196	0.526	0.253	0.054	0.258	0.058	85.056	4.680		,,	2.022	Soil, Flats, near Shepherdsville.
1125	Madison	6.125	2.215	11.015	n. e.	0.095	0.385	0.271	n. e.	0.121	0.039	79.270	2.450		,,	1.733	Soil, mid-way between Elliston and Richmond.
1215	Powell	8.033	3.215	4.885	0.130	0.095	0.581	0.278	0.278	0.579	0.031	81.795	2.900		,,	2.135	Soil, M. S. Conners, F. near Red River.
						Soils	on the	*Wav*	*erly*	*Sands*	*tone.*						
1222	Rowan	5.461	3.490	3.085	0.195	0.220	0.311	0.078	0.110	0.400	0.022	86.520	1.850		,,	2.161	Virgin Soil, near Morehead.
1405	Carter	2.860		4.540		0.145	0.035	0.125	n. e.	0.111	0.157	91.240	0.690	1.215	,,	1.180	Old Field Soil, West Branch Tygert's Creek.
*						Soils	on the	*Subca*	*rbonif*	*erous*	*Lime*	*stone.*					
229	Wayne	5.370	4.326	2.526	0.236	0.256	0.246	0.036	n. e.	0.115	0.136	86.066	3.160		,,	2.551	Average of the "Barren" Soil of Wayne County.
817	Bath	10.527	4.240	2.210	0.295	0.645	0.405	0.223	0.050	0.212	0.046	81.295	3.350		,,	5.733	East Hill-side of McCormick's Valley.
839	Breckenridge . .	8.411	5.240	4.838	0.345	1.880	0.830	0.130	0.076	0.434	0.090	77.495	4.000		,,	6.823	Virgin Soil, 1 m. W. of Sinking Cr'k, Mr. Dant's.
960	Estill	8.483	6.750	3.210	0.460	0.030	0.460	0.318	0.055	0.408	0.068	79.695	3.510		,,	4.066	Virgin Soil, on Billy's Creek.
1473	Grayson	4.950		6.195		0.340	0.176	0.125	n. e.	0.327	0.023	86.780	1.075	1.950	,,	n. e.	Soil 3 years in cultivation.
1549	Hardin	4.150		6.865		0.495	0.501	0.108	trace.	0.209	0.079	86.590	1.250	1.650	,,	n. e.	Soil 5 years in cultivation.
						Soils	on the	*Subca*	*rbonif*	*erous*	*Sand*	*stone.*					
812	Bath	4.215	1.515	2.210	0.130	0.195	0.329	0.095	0.033	0.130	0.050	91.095	1.425		,,	3.077	Virgin Soil, Valley of McCormick's Run.
1469	Grayson	3.850	7.215			0.345	0.240	0.076	n. e.	0.243	0.125	86.850	0.925	2.025	1.039	0.479	n. e. Old Field Soil, uncultivated for last 15 years.
1061	Jackson	4.737	9.210		n. e.	0.080	0.306	0.176	0.050	0.373	0.085	84.620	1.850		not estimated.	3.833	Virgin Soil, Indian F. of Rockcastle River.
						Soils	on the	*Tert*	*iary*	forma	tion.						
1	Ballard	3.040	3.814		0.411	0.034	0.461	0.116	n. e.	0.108	0.037	92.010	1.840		,,	1.530	Soil, heavily timbered land, South part of County.
2	,, ...	4.120	4.695		0.081	0.134	0.280	0.155	n. e.	0.139	0.063	89.650	2.440		,,	1.943	Soil from North-western part of the County.

* See Table Carboniferous Soils, page 76

TABLE II. MARLS AND MARLY SHALES.

No. in Report.	County.	Silica and Silicates.	Silica.	Alumina.	Iron Oxide.	Lime Carbonate.	Lime.	Magnesia Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Potash.*	Soda.*	Total Potash.†	Total Soda.†	Water expelled at red heat.	Remarks.
587	Bullitt	48.840	. . .	5.480		41.740	. . .	1.088	. . .	0.157	0.066	0.573	0.152	. . .	. . .	1.904	In *Favosites Maximus* Beds, Lower Silurian.
1431	Franklin	77.380	. . .	10.415		1.440	. . .	. . .	0.800	0.435	0.738	3.488	0.042	0.847	0.696	5.350	Green Marly Shale, Upper Cambrian Group.
1432	„	70.060	. . .	15.395		. . .	0.875	. . .	2.298	0.460	0.570	3.565	0.318	7.130	0.748	6.400	Olive Marly Shale, „ „ „
1434	„	. . .	52.060	18.831	9.200‡	. . .	3.666	. . .	1.210	0.319	0.920	. . .	. . .	5.402	0.720	7.672	Marly Shale (mineral paint), Cincinnati Group.
1433	„	. . .	50.360	16.816	6.997‡	. . .	8.736	. . .	0.936	0.217	2.280	. . .	. . .	3.623	1.730	8.304	„ „ „ „ „ „
971	Fayette	. . .	56.880	24.656		2.480	. . .	3.276	. . .	0.182	n. e.	. . .	. . .	6.655	0.105	5.676	Marly Clay, Brink's Quarry, Lower Silurian.
1446	Grayson	70.580	. . .	19.133		. . .	0.269	. . .	0.353	0.267	0.027	2.910	0.052	4.115	0.605	6.230	Marly Shale, Sunset Lick, 1½ miles West of Litchfield.
1446 (a)	„	. . .	60.060	14.130	13480‡	. . .	0.538	. . .	1.158	0.280	0.204	. . .	. . .	4.625	0.783	6.000	Marly Shale, Sunset Lick, 1½ miles West of Litchfield.
Page 496 L. B.	„	59.920	. . .	27.811		0.880	. . .	. . .	0.824	0.109	n. e.	. . .	. . .	5.554	0.657	n. e.	Marly Shale, Haycraft's Lick.
Page 492 L. B.	„	62.160	44.760	21.592	4.629	9.160	. . .	6.629	. . .	1.089	n. e.	. . .	. . .	4.944	1.061	6.136	Marly Shale, Hat Branch of Bear Creek.

* Extracted by digestion in Chlorohydric Acid. † Whole amount of the Alkalies obtained by fusion, etc. ‡ And Manganese Oxide.

The large proportion of Sulphuric Acid, which appears in the statements of the analyses of some of these Marls, is doubtless mostly derived from the oxidation of Iron Sulphide, which was not separately determined.

TABLE III. IRON ORES (*a. Limonite Ores*).

(Dried at 212° Fahrenheit.)

No. in Report.	County.	Iron Peroxide.	Iron Carbonate.	Alumina.	Manganese br. Oxide.	Lime Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Combined Water.	Silica and Silicates.	Moisture and Loss.	Per cent. of Iron.	Per cent. of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
1269	Bath	76.077	. . .	2.592	0.430	0.130	0.281	0.731	0.030	12.300	8.180	. . .	53.254	0.319	0.011	6.160	Old Slate Furnace Ore.
782	„	82.120	. . .	0.820	1.340	trace.	. . .	0.220	0.386	5.420	8.680	. . .	57.510	. . .	. . .	. . .	Limestone Ore, Clear Creek.
1274	Boyd	58.960	. . .	7.284	0.380	0.430	0.227	0.376	0.206	10.800	21.210	0.127	41.272	0.164	0.082	19.080	Yellow Kidney Ore, Star Furnace.
1275	„	51.802	10.596	4.523	trace.	7.480	0.440	0.570	0.089	8.772	15.730	. . .	41.357	0.231	0.035	13.161	Limestone Ore, Bellfont Furnace.
1277	„	56.022	8.821	7.194	„	2.540	1.271	0.526	0.091	10.126	13.430	. . .	43.473	0.229	0.036	11.660	Yellow Kidney Ore, Buena Vista.
1371	Carter	81.640	. . .	3.160	„	0.180	0.919	0.060	n. e.	11.280	2.600	0.221	57.148	0.026	n. e.	n. e.	Horsley Bank, Boone Furnace.
1373	„	65.657	. . .	4.921	„	trace.	0.040	0.893	0.604	10.740	17.780	. . .	45.959	0.391	0.241	15.960	Potato Knob Ore.
1375	„	38.285	. . .	5.455	0.120	0.460	0.065	1.000	0.071	9.500	44.760	0.284	26.799	0.436	0.030	40.960	Royster Hill, Lambert Ore.
1376	„	57.557	. . .	2.727	trace.	trace.	0.065	1.746	0.185	11.700	26.180	. . .	40.290	0.760	0.074	n. e.	Smith Hill, German Ore.
1381	„	71.502	. . .	8.557	„	„	0.054	0.466	0.800	9.500	9.030	0.091	50.051	0.203	0.320	7.640	Old Mt. Tom, Main Block Ore.
1384	„	71.680	. . .	4.155	0.090	0.380	0.050	n. e.	0.270	10.800	12.650	. . .	50.176	n. e.	0.108	11.560	Graham Bank Ore.
1385	„	66.200	. . .	3.907	0.030	0.430	0.345	0.130	0.182	11.730	16.530	0.633	46.340	0.057	0.072	13.860	Yellow Kidney Ore, Mt. Savage Furnace.
1411	Edmonson	76.284	. . .	2.361	0.030	0.180	0.068	1.055	0.151	12.000	7.951	. . .	53.399	0.460	0.059	7.660	Proctor Ore Bank.
1509	Greenup	80.040	. . .	2.680	. . .	trace.	0.425	0.115	0.264	10.000	6.560	. . .	56.280	0.050	0.107	. . .	Limestone Ore, Tygert's Creek.
1516	„	72.957	. . .	1.660	0.640	0.380	0.083	0.500	0.178	9.344	15.160	. . .	51.070	0.218	0.070	. . .	Limestone Ore, Shover Drift.
1521	„	68.928	. . .	2.768	0.260	0.680	0.641	0.249	0.748	11.100	15.240	. . .	48.249	0.038	0.209	13.600	Main Block, L. Morton Bank.
1538	Lyon	70.518	. . .	0.015	0.090	0.090	trace.	0.275	0.113	9.850	18.910	0.009	49.363	0.120	0.015	18.160	Suwannee Furnace Bank.
1600	„	69.392	. . .	trace.	0.170	0.140	„	0.303	trace.	9.550	20.500	. . .	48.574	0.144	. . .	19.660	Suwannee Iron Mt. Bank.
1605	Muhlenburg	63.048	. . .	5.290	0.090	0.680	0.930	0.147	0.112	12.430	17.250	. . .	44.133	0.064	0.014	16.500	Airdrie Furnace Ore, near No 4 entry.
1606	„	60.492	. . .	7.075	0.360	1.980	1.550	0.083	0.185	12.530	15.560	0.185	42.344	0.035	0.074	13.660	Jerry Hope's Land, Muddy River.
1608	„	69.546	. . .	3.914	0.230	0.480	0.921	0.115	0.216	11.250	12.730	0.598	48.822	0.050	0.086	11.300	Martin Ore.

TABLE IV. Iron Ores (*b. Clay, Iron Stones, and Black Band*).

(Dried at 212° Fahrenheit.)

No. in Report.	County.	Specific Gravity.	Iron Carbonate.	Iron Peroxide.	Alumina.	Lime Carbonate.	Magnesia Carbonate.	Manganese Carbonate.	Phosphoric Acid.	Sulphuric Acid.	Silica and Silicates.	Water and Loss.	Per cent. of Iron.	Per cent. of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
1271	Boyd	3.362	66.854	0.276	4.260	2.460	4.086	0.572	0.709	0.885	18.360	1.538	32.466	0 308	0.354	15.500	Blue-Block Ore, Wilson's Creek.
865	Carter	n. d.	87.527	0.778	0 984	trace.	1.924	1.324	0.207?	0.613	6.680	. . . . .	42.807	. . .	. . .	. . .	Blue Kidney, Star Furnace.
1363	,,	. . .	62.662	10.024	1.600	0.240	2.838	3.251	0 127?	0.521	13.720	3.017	37.285	0.055	0.208	n. e.	Old-Orchard Diggings.
1365	,,	. . .	44 242	27.296	1.560	6.580	1.046	0.842	0.732	4.587	11.160	1.955	40 465	0.321	1.855	n. e.	Horsley Bank.
1369	,,	. . .	30 708	31.544	1.779	2.730	0.144	0.060	0.421	0.491	25.430	6 523	36.627	0.184	0.196	10.560	Mt. Savage Furnace Ore.
937	Estill	. . .	78 086	1.050	2.460	1.290	4 508	3.492	0.438	0.176	8.670	. . . . .	38.461	. . .	. . .	n. e.	Gray Ore, Cottage Furnace.
1614	Grayson	. . .	16.598	42.761	4.994	2.840	n. e.	n e.	1.017	trace	20.830	8.054	37.945	0.444	trace.	n. e.	Glady Ore, West of Bear Creek.
1503	Greenup	3.297	78.722	0.204	2.746	2.250	0.380	0.421	0.595	1.160	11.340	2.272	38.146	0.221	0.524	9.700	Blue-Kidney Ore, near Laurel Furnace.
1507	,,	n. d.	55.258	13.468	0.670	4 880	4.528	0.060	0.368	1.043	15.600	4 065	36.103	0.200	0 416	13 360	Main-Block or Gray Ore, Laurel Furnace.
1611	Muhlenburg	,,	42.950	29.618	2.454	2 490	4.828	1.083	0.083?	1.596	9.030	5.868	36.916	0.035?	0.638	6.220	Slate Ore, Old Buckner Furnace.
149	,,	,,	62.420	3.380	0.050	3.650	7.410	2.490	0.100	n. e.	15.270	(*a*) 1.570	32.520	. . .	. . .	. . .	Black Band, William's Landing.
150	,,	. . .	64.900	7.410	0.600	3.250	6.570	1.180	0.350	n. e.	7.070	(*b*) 0.110	36.540	. . .	. . .	. . .	Black Band, Battist Creek.

(*a*) Bituminous matters = 2.41 per cent. (*b*) Bituminous matters = 7.81 per cent.

TABLE V. Iron Ores (*c. Red Hematite Ores of the Clinton Group*).

Page in L. B.	No. in Report.	County.	Specific Gravity.	Iron Peroxide.	Alumina.	Manganese Brown Oxide.	Lime Carbonate.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Combined Water.	Silica and Silicates.	Moisture and Loss.	Per cent. of Iron.	Per cent. of Phosphorus.	Per cent. of Sulphur.	Per cent. of Silica.	Remarks.
	533	Nr. Cumb. Gap, Ten.	n. e.	80.820			. . .	. . .	. . not	deter	mined	. . .	. . .	56.574	. . .	. . .	11.260	Dyestone Ore, Clinton Furnace.
	540	,, ,,	3.942	77.380	3.941		0.420	trace.	0.319	trace	2.500	15 960	. . .	54.166	0.140	trace.	. . .	Poor-Valley Ridge, Upper Bed.
	541	,, ,,	3.914	73.935	5.776		4.510	0 260	0.319	trace	3.850	11.730	. . .	51.754	0.140	trace.	11.760	Foot of Poor-Valley Ridge, Upper Bed.
	542	,, ,,	3.190	47.965	2.130		1.230	0.194	0.575	trace.	4 000	43.690	. . .	33.575	0.251	trace.	42 76	Foot of Poor-Valley Ridge, Middle Bed, 26 in. thick.
	1594	Lawrence, Ky. . .	4.184	80.004	3.474	0.250	0.360	0.396	0.172	0.055	1.089	14.200	. . .	56 028	0.075	0.020	13.500	Near Louisa, Top of Hill.

TABLE VI. COALS (*Air-dried*).

Number in the Report.	County.	Specific Gravity.	Hygroscopic Moisture.	Volatile Combustible Matters.	Coke.	Total Volatile Matters.	Carbon in the Coke.	Ashes.	Character of the Coke.	Color of the Ash.	Per cent. of Sulphur.	Remarks.
1280 (*a*)	Boyd	1.358	3.40	32.30	64.30	37.70	55.40	8.90	Dense	Light purple-gray	1.230	Turkey-pen Hollow, Raccoon furnace (Coal No. 6).
1280 (*b*)	"	n. e.	4.70	34.30	61.00	39.00	59.04	1.96	"	" " "	0.082	Turkey-pen Hollow (a selected sample, Coal No. 6).
1285	"	1.315	2.70	36.70	60.60	39.40	52.60	8.00	Spongy	Dark lilac-gray	1.711	Horse-Run Coal (Coal No. 6).
1286	"	1.308	3.30	33.30	63.40	36.60	57.60	5.80	Moderately Dense	Light lilac-gray	2.480	Coalton Coal, Ashland Co. Mine (4 entry, Coal 7).
1289	"	1.320	5.00	34.50	60.50	39.50	55.40	5.10	Spongy	Light brown-gray	1.285	Coalton Coal, Ashland Co. (250 yds. from West end, Coal 7).
835	Breathitt	1.219	0.30	56.70	38.10	57.00	43.00	4.90	Dense	Light purple-gray	0 452	Cannel Coal (South's), near Jackson.
871	Carter	1.200	.60	66.30	28.30	66.90	33.10	4.80	"	Tawny yellow	1.320	Cannel Coal, Stinson Bank.
1318 (*a*)	"	1.435	5.40	32.70	61.90	38.10	52.52	9.38	Moderately Dense	Lilac-gray	2.356	W. Pritchard's Bank (Coal 7).
1318 (*b*)	"	n. e.	4.50	37.10	58.40	41.60	56.40	2.00	" "	Yellowish	0.571	W. Pritchard's Bank (Selected sample, Coal 7).
1350	"	1.340	6.40	31.40	62.20	37.80	57.66	4.54	Porous	Purplish-gray	1.670	Drift on Gum Branch of Straight Creek (Coal 7).
1353	"	1.274	3.80	34.50	61.70	38.30	58.50	3.20	Dense porous	Brownish-gray	2.164	Graham Bank, near Willard (Coal 1).
1356	"	1.289	4.10	34.60	61.30	38.70	56.525	7.775	" "	Lilac-gray	1.414	Kibby drift, Everman's Creek (Coal 2).
1357	"	1.298	4.60	33.50	61.90	38.10	51.60	10.30	" "	Yellowish-gray	1.200	Stone-Coal branch of Tygert's Creek (Coal 1).
1413	Edmonson	1.282	2.30	32.10	65.60	35.40	56.30	9.30	Cellular	Light lilac-gray	1.059	Tar-Lick Coal, 5½ feet thick.
1418	"	1.336	3.66	35.14	61.20	38.80	54.26	6.94	Light Cellular	Lilac-gray	2.706	Shoal Branch, Main, Nolin Coal.
1448	Grayson	1.305	4.70	31.40	63.90	36.10	52.20	11.70	Spongy	Lt. Brownish-gray	1.945	Tar-Lick Coal, Dismal Creek.
1484	Greenup	1.316	4.82	32.90	62.28	37.72	55.18	7.10	Friable	Chocolate	1.409	Coal used at Kenton furnace (Coal 1).
1486	"	1.250	4.80	34.64	60.56	39.44	52.58	7.98	Dense	Lilac-gray	1.331	Main Coal at Raccoon furnace (Coal 3).
1493	"	1.289	4.10	34.96	60.94	39.06	55.54	5.40	Spongy	Dark brick	1.590	Below the Kidney Ore, Laurel furnace (Coal 3).
1496	"	1.300	3.20	36.60	62.20	39.80	53.14	7.06	Dense Spongy	Lilac-gray	2.264	From a drift near Pennsylvania furnace (Coal 3).
1649	"	1.306	1.50	52.20	46.30	53.70	40.60	5.70	Very Friable	Lt. Yellowish Gray	0.782	Cannel Coal, Hunnewell Mines.
1579	Hopkins	1.322	3.20	35.90	60.90	39.10	54.00	6.90	Light Spongy	Light lilac-gray	2.759	St. Charles's Mines.
1588	Lawrence	1.316	4.60	35.70	59.70	40.30	52.28	6.42	Spongy	" " "	1.080	McHenry Bank, near Louisa (Coal 3).
1589	"	1.281	5.10	35.30	59.60	40.40	57.80	1.80	Light Spongy	Light gray-buff	0.736	F. Swetman's Bank, Brushy Creek (Coal 1).
1591	"	1.349	2.10	33.90	64.00	36.00	56.00	8.00	Friable	Yellowish-white	0.736	Holbrook's coal, Brushy Creek (Coal 3).
1601	Menifee	1.319	2.94	33.06	64.00	36.00	56.60	7.40	Dense	Lt. Brownish gray	0.997	Subconglomerate Coal, Hawkins's Creek.
1618	Muhlenburg	1.278	3.60	31.40	65.00	35.00	58.50	6.50	Dense Spongy	Lilac-gray	1.438	Airdrie furnace Coal (Coal 12).
1623	"	1.221	3.80	32.70	63.50	36.50	58.60	4.90	Dense Spongy	Br'sh. Salmon-gray	1.923	Muddy River Coal mine.
185	Union	1.308	3.50	36.00	60.50	39.50	57.50	3.00			1.746	Mulford's Main, or five-foot coal.

TABLE VII. Mineral Waters (*a. Sulphur Waters*).

Composition; in 1000 parts of the Waters.

	Number in Report.											
	No. 798.	No. 1456.	No. 1457.	No 1458.	No. 1459.	No 952.	No. 953.	No. 956.	No. 1436.	Page 525 of L. B.	No. 733.	Page 583 of L. B.
Specific Gravity . .	n. e.*	1.0012	1.0011	1.0015	1.0016	n. e.	n. e.	n. e.	. . .	1.005	1.007	n. e.
Free Carbonic Acid .	n. e	0 195	0.1234	0.150	0.165	0.3256	0.360	0.263	0 2772	n. e.	0.355	n. e.
Free Sul. Hydrogen	n. e.	.020	.0248	.0203	.410	n. e.	n. e.	n. e.	.0343	n. e.	.0395	n. e.
Lime Carbonate . .	0.233	0. 173	0.1952	0.1806	0.2002	0.2020	0.303	0.113	0.1397	0.1223	0.385	0.2178
Magnesia Carbonate.	.124	trace	.0512	.0002	trace.	.0832	.011	.027	.1029	.0253	.003	.0499
Iron Carbonate . .	trace.											
Manganese Carbonate	n. e.	.0027	.0048	.0078	.0066	trace.	trace.	.069	trace n. e.	.0013	.006	.0009
and Phosphates .	n. e.											
Silica	n. e.	.0022	.0094	.0028	.008	n. e.	n. e.	n. e.	n. e.	.0112	n. e.	n. e.
Organic Matters and Loss	n. e.	n. e	n. e.	.0022	.0268	n. e.	n. e.	n. e.	n. e	. . .	n. e.	n. e.
Total sediment on boiling . . .	. . .	0.1785	0.2606	0.1914	0.034	. . .	. . .	. . .	. . .	0.1601		
Lime Sulphate. . .	trace.	1.1649	0.4541	0 4528	0.6291	. . .	. . .	. . .	. . .	0.1156	0 553	0.0617
Iron Manganese and Alumina Sulphates.	trace.	.0034	.0007	.0192	n. e.	. . .	.016	.023	. . .	. . .	trace	
Magnesia Sulphate .	. . .	.5774	.3768	.4616	.6093	.0105	.105	.018	. . .	.4329	. . .	.0570
Potash Sulphate . .	. . .	n. e.	n. e.	.0024	.0023	.0926	.072	.017	.2535	. . .	.152	.0042
Soda Sulphate . . .	. . .	n. e.	n. e.	.0126	.0374	.1723	.043	.035	. . .	.5347	. . .	1433
Sodium Sulphide . .	n. e.	.0521	.0409	n. e.	n. e.	n. e.	n. e.	n. e.	.1057	n. e.	. . .	n. e
Soda, combined with Organic Acids . .	n. e.	.0044	.0066									
Potash, combined with Organic Acids . .	n. e.	.0007	.0038									
Potassium Chloride .	0.183	. . .	. . .	. . .	. . .	. . .	. . .	. . .	.0798	trace.	.223	
Sodium Chloride . .	2.847	. . .	. . .	.0200	.0053	.0842	.009	.036	1.0152	3.3647	8.347	.2760
Magnesium Chloride	.950	.1898	.0145	. . .	. . .	. . .	. . .	. . .	.0228			
Calcium Chloride. .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	.0713			
Silica	.018	.0034	.0145	n. e.	n. e.	.0068	.004	.013	.0343	. . .	.018	.0176
Lithium	n. e.	trace.	trace.	trace.	trace.	. . .	. . .	. . .	trace.	. . .	n. e.	trace.
Iodine and Bromine .	trace.	trace.	trace.	trace.	trace.	. . .	. . .	. . .	trace.	.0018 †	.0007 †	trace.
Soda Carbonate . .	. . .	. . .	. . .	. . .	. . .	.0237	.083	. . .	. . .	.2366	.004 ‡	
Total Saline Matters	5.709	2.0718	1.6011	1.3252	1.5740	0.7153	0.686	0.410	1.8250	. .	4.8404	0.8358
Temperature of Spring	n. e.	61°	66°-67°	60	64°	n. e.	n. e.	n. e	n. e.			
Organic Matters . .	n. e.	n. e.	n. e.	n. e.	.020	.040	.050	0.059	trace.			

* n. e. = not estimated. † Magnesium Iodide. ‡ Magnesium Bromide.

TABLE VII.— *Continued. (b. & c. Chalybeate and Saline Waters.)*

Composition; in 1000 parts of the Waters.

	Number in Report.										
	No. 954.	Page 581 (No. 1).	Page 581 (No. 6).	Page 514 of L. B.	No. 531.	No 532.	Page 527 of L. B.	Page 584 of L. B.	Page 581 (No. 4).	No. 535.	No. 536.
Specific Gravity	n. e.	1.0031	1.0016	n. e.	n. e.	n. e.	n. e.	n. e.	1.0012	1.0041	1.0068
Free Carbonic Acid . . .	0.269	. . .	. . .	n. e.	. . .	n. e.	0.093	. . .	n. e.	n e.	n. e.
Lime Carbonate	0.159	. . .	. . .	0.1155	0.195	0.117	0.0438	0.0247	0.1196	0.673	0.912
Magnesia Carbonate . . .	0.046	. . .	. . .	.0046	.041	.020	.0148	.0179	.0331	.116	.131
Iron and Manganese Carbonates, with Phosphates, &c.	0.032	. . .	. . .	.0260	.026	.033	.0145	.0297	trace.	trace.	trace.
Silica	n. e.	. . .	. . .	.0107	n. e.	. . .	n. e.	n. e.	n. e.	n. e.	n. e.
Total held in solution by Carbonic Acid	. . .	. . .	. . .	0.1568	. . .	. . .	0.0731				
Lime Sulphate	0.286	0.5996	0.3271	0.0204	. . .	0.015	0.0029	0.0218	0.0838	0.203	0.185
Magnesia Sulphate . . .	.168	.3330	.2513	.0768	.056	.112	.0036	. . .	.1057	3.454	3.520
Potash Sulphate	.011	.0005	.0074	.0403	.013	.028	. . .	.0042	.0129	.067	.170
Iron Sulphate (per basii) .	. . .	.8756	.1460								
Copper Sulphate	. . .	.0009	. . .								
Alumina Sulphate	trace.	1.2468	.3500								
Manganese Sulphate . . .	. . .	.0032	.0721								
Sodium Chloride	.009	.0031	.0651	.0146	.013	.018	.0026	.0026	.0223	.081	.304
Potassium Chloride . . .											
Calcium Chloride											
Magnesium Chloride . . .											
Iodine and Bromine . . .	n. e.	n. e.	n. e.								
Lithium	n. e.	trace.	trace.	.0013 *	. . .	. . .	. . .	. . .	trace.	n. e.	n. e.
Silica	.032	.0012	.0022	.0142	.040	.046	.0128	.0010	.0254	. . .	.056
Soda Carbonate											
Soda Sulphate	.012	. . .	. . .	.0476	. . .	. . .	.0531	.0205	.5039	.774	1.013
Total Saline Contents .	0.896	3.1364	1.4090	0.3720	0.384	0.442	0.1481	0.1290	0.9041	5.428	6.884

* Chloride.

TABLE VIII. CLAYS.

(Dried at 212° F.)

No. in Report.	Page of Laboratory Book.	County.	Silica.	Alumina.	Iron Oxide.	Lime.	Magnesia.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Water expelled at red heat.	Remarks.
1337	48	Carter	48.560	37.471	trace.	0.112	trace.	0.255	n. e.	0.289	0.283	13.030	Fire Clay, 4 feet thick, Boone Furnace Property.
1338	49	"	45.960	38.531	trace.	0.145	trace.	0.563	n. e.	0.250	0.341	14.210	Fire Clay, Lower Bed, Boone Furnace Property.
1339	50	"	54.620	32.466	trace.	trace.	trace.	0.243	n. e.	0.212	0.679	11.780	Fire Clay, Rougher part of Upper Layer, Boone Furnace Property.
1340	51	"	62.460	27.203	trace.	trace.	trace.	0.147	n. e.	1.850	0.584	7.756	Fire Clay, Under Coal, Old Orchard Diggings, Boone Furnace Property.
1341	52	"	45.560	44.150	trace.	0.145	trace.	0.307	n. e.	0.963	0.728	8.522	Fire Clay, Dark Colored, from lower portion of deposit, Boone Furnace Property.
1342	226	"	64.260	24.604	n. e.	0.538	0.209	0.946	0.157	0.751	0.515	8.300	Clay, under the 12-inch Coal, G. Ossenton's land, near Grayson.
	500	Edmonson . . .	77.660	18.800		0.268	n. e.	n. e.	n. e.	1.002	0.484	4.340	Clay, 7–8 feet thick, in Chester Group, Sowder's Farm, first layer.
	501	" . . .	74.460	20.440		0.348	n. e.	n. e.	n. e.	n. e.	n. e.	4.100	Clay, 7–8 feet thick, second layer (nearly white).
	502	" . . .	71.560	22.860		0.381	n. e.	n. e.	n. e.	n. e.	n. e.	3.500	Clay, 7–8 feet thick, third layer (Gray).
1477	64	Greenup . . .	49.680	35.281	trace.	0.213	0.136	0.626	n. e.	0.193	0.211	13.660	Fire Clay, Louder's Bank, near Kenton Furnace.
1479	68	" . . .	66.560	22.679	trace.	0.157	0.605	0.563	n. e.	1.946	0.690	6.800	Clay, 2–2½ feet thick, Pea Ridge, fourth above the Limestone.
1481	70	" . . .	67.700	22.092	trace.	0.101	0.285	0.498	n. e.	1.156	0.268	7.900	Clay, 2–2½ feet thick, Pea Ridge, second above the Limestone.
1483	225	" . . .	47.560	40.661	trace.	0.157	0.497	0.249	trace.	0.308	0.409	10.036	Fire Clay, Thomas's Bank, Upper Layer, Schultz Creek.
	668	Lincoln	61.580	23.946	5.814*	0.201	0.850	n. e.	n. e.	1.542	0.362	5.705	Clay (Tile Clay), Head-waters Green River, Hon. J. W. Varnon's.
	651	Madison . . .	57.976	27.640		0.156	0.606	n. e.	n. e.	3.931	0.547	7.120	Potter's Clay (best), Upper Silurian, from Waco.
	651 (a)	" . . .	56.960	28.740		0.112	0.752	n. e.	n. e.	2.502	0.315	10.531	Potter's Clay (blue, second quality), Upper Silurian, from Waco.

* Protoxide.

TABLE IX. Building Stones (*Limestones*).

No. in Report.	Page in L. B.	County.	Specific Gravity.	Lime Carbonate.	Magnesia Carbonate.	Alumina.	Iron Oxide.	Manganese Oxide.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Silicates.	Per cent. of Lime.	Per cent. of Magnesia.	Remarks.
494	. . .	Bullitt	2.709	63.450	29.640		3.150		n. e.	0.270	0.200	0.210	2.180	35.532	14.114	Magnesian Limestone (Upper Silurian).
1638	442	Bourbon	2.600	79.140	11.826	0.380	5.510	n. e.	.511	.240	.231	.252	1.270	44 318	5.371	Magnesian Limestone (Lower Silurian).
1314	315	Butler	n. e.	93.020	2.088		0.917		.243	.604	n. e	n. e.	2.760	52.091	n. e.	From Barren River (Subcarboniferous).
1388	46	Carter	2.624	97 720	n. e.		.300		.083	n. e.	.115	.167	1.780	54.723	n. e.	Boone Furnace Limestone (Subcarboniferous).
1421	343	Barren	2.678	98.050	.363		.511		.051	260	.115	.327	1.060	50.428		Oölitic Limestone (Upper Subcarboniferous Limestone).
1422	344	,, ...	2.721	77.550	13.314		2.680		.051	.192	.154	.188	6.060	43.428	6.339	Compact Limestone (Upper Subcarboniferous Limestone).
512	. . .	Fayette	2.703	55.510	40.800		.960		n. e.	.020	.360	.220	2.790	31.160	19.680	Magnesian Limestone (Clay's Mon. Stone), Grimes's Qr.
616	. . .	,, ...	2.767	64.400	33.000		.950		n. e.	n. e.	n. e.	n. e.	2.000	36.064	16.143	Magnesian Limestone, Harris's Quarry.
109	. . .	Greenup	2.708	97.850	1 300		.550		n. e.	n. e.	.150	.500	1.270	54.796	n.e.	Subcarboniferous Limestone, New Hampshire Furnace.
1500	124	,, ...	2.700	92.050	.220		1.490		.128	.199	n. e.	n. e.	4.460	51.548		Subcarboniferous Limestone, Kenton Furnace.
530	. . .	Jefferson . . .	n. e.	56.360	37.070		1.280		n. e.	trace	.330	.350	5 630	31.620	17.639	Upper Silurian Magnesian Limestone.
1065	. . .	,, ...	. . .	52.080	31.473		4.473		.208	.303	.606	.307	10.480	29.165	14.987	Upper Silurian Variegated Limestone.
1123	. . .	Madison	2 691	49.320	30.729		2.090		.271	.509	.374	.058	14.180	27.169	14.631	Magnesian Limestone (Devonian).
164	. . .	Trimble	2.704	97.019	.740	.160	1.324	n. e.	.636	n. e.	n. e.	n. e.	.660	54.330	n. e.	Marble, from Dr. Hopson's Quarry.
776	. . .	Woodford . . .	2.655	59 860	36.640		0.980			.160	.400	.080	2.480	33.590	17.440	Magnesian Limestone, Shryock's Ferry (Lower Silurian).

TABLE X. Building Stones (*Sandstones*).

(Dried at 212° Fahrenheit.)

Number in the Report.	County.	Specific Gravity.	Sand and Silicates.	Alumina and Iron and Manganese Oxides.	Lime Carbonate.	Magnesia Carbonate.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Remarks.
496	Bullitt	2.427	93.68	3.95	trace.	0.84	n. e.	trace.	0.21	0.59	Building-stone at Bullitt's Knob.
497	,, ...	2.415	94.78	2.85	0.18	2.29	. . .	trace.	.27	.14	Building-stone at Button-mould Knob.
498	,, ...	2.453	94 75	3.48	.16	.70	. . .	trace.	.96	.10	Building-stone at Bellemonte Furnace.
1221	Rowan	2.539	90 240	3.965	1.480	1.857	0.117	0.269	.336	.089	Building-stone, mouth of Triplett's Creek.

TABLE XI. Hydraulic Cement Limestones.

(Dried at 212° Fahrenheit.)

No. in Report.	Page in Laboratory Book.	County.	Specific Gravity.	Lime Carbonate.	Magnesia Carbonate.	Alumina.	Iron Oxide.	Manganese Oxide.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Silicates.	Per cent. of Lime.	Per cent. of Magnesia.	Total Silica.	Remarks.
456	. . .	Grayson	2.651	46.830	26.840	0.380	2.380	trace.	0.120	0.330	0.500	0.370	20.780	26.280	12.960	n. e.	From near Grayson Springs.
521	. . .	Jefferson	n. e.	50.430	18.670		2.930		0.060	0.158	0.320	0.130	25.780	28.290	8.890	22.580	,, Falls of the Ohio, Louisville.
1066	. . .	,, ...	n. e.	42.819	21.819		6.560		1.284	0.233	0.233	0.372	23.980	24.118	10.395	n. e.	,, Chenowick Creek.
1137	. . .	Meade	n. e.	47.560	26.515			2.160		1.332	0.126	0.265	19.680	26.688	12.631	n. e.	,, Mitchell's Spring.
1165	. . .	Nelson	n. e.	40.480	24.267		4.493		0.207	0.819	0.455	0.042	29.380	22.667	11.554	. . . .	,, Bardstown.
1201	. . .	Oldham	. . .	41.580	24.030		5.860		0.374	0.303	0.455	0.204	23.580	23.284	11.443	. . . .	,, near La Grange.
1202	. . .	,, ...	. . .	41.980	21.400		6.860		0.310	0.386	0.370	0.379	24.680	23.508	10.190	. . . .	,, Curry's Fork of Floyd's Creek.

TABLE XII. Soils and Sub-Soils (*Coal Measures Formation*).

No. in Report.	County.	Extracted from 1,000 grains by water charged with carb acid.	Moisture expelled at 400° F.	Organic and Volatile Matters.	Alumina.	Oxide of Iron.	Lime Carbonate.	Magnesia.	Manganese Brown Oxide.	Phosphoric Acid.	Sulphuric Acid.	Potash.	Soda.	Sand and Silicates.	Remarks.
1029	Hancock	4.751	2.200	4.422	3.215	3.285	0.171	0.446	0.241	0.161	0.059	0.205	0.040	88.130	Virgin Soil (Woods).
1051	Hopkins	7.133	2.600	6.263	3.390	2.700	0.445	0.491	0.295	0.148	0.076	0.158	0.034	85.970	Soil.
1052	,, ...	2.983	1.900	4.205	4.845	2.910	0.160	0.507	0.370	0.078	0.059	0.330	0.113	86.070	Sub-soil.
1058	Jackson	2.450	1.915	4.098	5.560	2.970	0.011	0.444	0.120	0.126	0.042	0.243	0.074	85.860	Virgin Soil.
1156	Morgan	3.333	2.325	7.243	3.590	3.260	0.320	0.489	0.195	0.204	0.067	0.372	trace.	84.360	Virgin Soil.

DESCRIPTION OF TABLES.

SOILS.

(See Table I.)

Soils on Blue Limestone. — Lower Silurian Formation.

No. 574. (Vol. III. p. 218, Rep. Geol. Surv. Ky., O. S.) Virgin soil, from wood-pasture on Wm. Buckner's farm. Cane-ridge land. Primitive forest-growth, — large Buckeye, Oak, Honey-locust, Sugar-tree, &c. Lower Silurian or Blue Limestone formation. Bourbon County.

No. 826. (Vol. IV. p. 85, Rep. Geol. Surv. Ky., O. S.) Virgin Tobacco soil ; hill-side, north exposure ; Blue Limestone formation. Near Augusta, on Mr. L. J. Bradford's land, Bracken County.

No. 27. (Vol. I. p. 276, Ky. Geol. Rep., O. S.) Virgin soil ; wood-pasture. About seven miles south of Lexington (Meredith farm) ; farm of late Mr. Dallam, head-waters of North Elkhorn Creek. Blue Limestone formation. Fayette County.

No. 619. (Vol. III. p. 263, Ky. Geol. Rep., O. S.) Blue Limestone soil, from a field thirty to forty years in cultivation, near Big-Lick Creek, Gallatin County.

No. 621. (Vol. III. Ky. Geol. Rep., p. 265, O. S.) Virgin soil ; wood-pasture. J. S. Hoskins' farm, forks of road. Some of the best soil in the county. Lower Silurian formation. Garrard County.

No. 622. (Ibid., p. 266.) Same soil as next preceding, from the oldest field in Garrard County, sixty to seventy years in cultivation. Over the cherty beds of Blue Limestone, Lower Silurian formation. Garrard County.

(The second samples from the same locality exemplify a loss of available essential mineral fertilizing ingredients, resulting from cultivation.)

No. 1134. (Vol. IV. Ky. Geol. Rep., p. 217, O. S.) Virgin Tobacco soil. From hill-side near Dover, Mason County, about a hundred and fifty feet above the Ohio River, in the midst of the Blue Limestone. Growth — Sugar-tree, Walnut, Black and White Ash, Buckeye, &c.

No. 681. (Vol. III. p. 322, Rep. Ky. Geol. Surv., O. S.) Virgin soil, from woods near Cornishville, on Chætetes beds of Blue Limestone, western part of Mercer County. Characteristic forest-growth, White Oak.

No. 682. (Ibid.) Same soil, from an adjoining field, fifty years in cultivation ; now in corn, &c.

No. 550. (Vol. II. p. 281, Rep. Ky. Geol. Surv., O. S.) Virgin soil, from Judge R. C. Graves' farm. Water-shed between Greers' and Clear Creek, near Versailles, Woodford County. Natural growth — Hackberry, Ash, Walnut, Mulberry, Box-elder, &c. One of the best soils of Kentucky.

No. 551. (Ibid., p. 282.) Same soil as the preceding, from a field in constant cultivation since 1808. It has been fourteen years in Hemp. Average of the last year's (1855) crop of corn, eighteen to twenty barrels of five bushels each to the acre. It has produced thirty-five bushels of wheat to the acre.

Soils of the Silicious Mudstone. — Lower Silurian Formation.

No. 504. (Vol. II. p. 162, Rep. Geol. Surv. Ky., O. S.) Virgin soil, from a Beech ridge on Robert Wickliffe's farm, two and one-half miles from Lexington, on the Richmond Turnpike. Much less productive than the neighboring Blue Limestone soil, Fayette County.

No. 1204. (Vol. IV. p. 245, Rep. Geol. Surv. Ky., O. S.) Virgin soil, from woods on the first farm after ascending the hill from Harmony to Stamping-Ground, southern edge of Owen County. Forest growth, White Oak on the top of the ridge; some Beech on the sides of the hill.

Soils on the Upper Silurian Formation.

No. 805. (Vol. IV. p. 73, Rep. Ky. Geol. Surv., O. S.) Genuine Clinton group red soil, from over the encrinital, flesh-colored, Magnesian Limestone (see No. 797), two miles west of Owingsville, Bath County. Primitive growth — Blue Ash, Sugar-tree, Hickory, &c.

No. 1070. (Vol. IV. p. 192, Rep. Ky. Geol. Surv., O. S.) Virgin soil; eight inches of the surface, taken immediately under the sod of native Blue Grass, in wood-pasture. Farm of Theodore Brown, six miles east of Louisville on the Lexington Turnpike, middle fork of Bear-Grass Creek, Jefferson County. Primitive growth — Walnut, Black Locust, Wild Cherry, Elm, Ash, Hackberry, Box-Elder, Buckeye, Pignut and Shell-bark Hickories, Coffee-nut, Red and Over-cup Oak, large Sugar Maples, and Root-covered Beech. Upper Silurian formation. Some of the best Bear-grass land.

Soils on the Black Devonian Shale.

No. 583. (Vol. III. p. 227, Rep. Ky. Geol. Surv., O. S.) Soil from the flats near Shepherdsville, derived chiefly from the Black Devonian Shale, at the base of the knobs and overlying the ash-colored Shales; considered almost unfit for cultivation, except for grass, because too wet; but little cultivated. Primitive growth — Oak, Beech, Black Hickory, &c. Bullitt County.

No. 1125. (Vol. IV. p. 213, Rep. Ky. Geol. Surv., O. S.) Virgin soil, derived from the Black Devonian Slate, taken from the level tract of land about half way between Elliston and Richmond, Madison County.

No. 1215. (Vol. IV. p. 249, Rep. Ky. Geol. Surv., O. S.) Virgin soil, from Moses S. Conner's farm, near Red River, Powell County. Principal forest growth — small White Oak and small Hickories. Soil chiefly derived from the Black Devonian Shale.

Soils on the Waverly Sandstone.

No. 1222. (Vol. IV. p. 253, Rep. Ky. Geol. Surv., O. S.) Virgin soil, near Morehead, Rowan County. Forest growth — White Oak, Chestnut, Hickory, Beech, and some Sugar-tree and Black Walnut.

No. 1405. (Vol. I. Second Series, Ky. Geol. Rep., p. 60.) Old field-soil. Farm of Wm. Abbott, west branch of Tygert's Creek. Field fifty-five feet above the bed of the creek on a bench of Waverly Sandstone. Tops of the hills capped with Limestone; surface soil; has been cultivated sixty years; was once an orchard. Carter County.

Soils on the Subcarboniferous Limestone.

No. 229. (Vol. II. p. 272, Ky. Geol. Rep., O. S.) Average quality of the Wayne County "Barrens" soil, based on a reddish ferruginous sub-soil. Head-waters of Meadow Creek, Wayne County. Hickory and Black Oak land.

No. 819. (Vol. IV. p. 78, Ky. Geol. Rep., O. S.) Soil from east hill-side of McCormick's Valley, from field nine years in cultivation, &c. Geological position on the Subcarboniferous Limestone, &c. Bath County.

No. 839. (Ibid., p. 99.) Virgin soil, from Mr. Dent's land, two miles north of the base line, one mile west of Sinking Creek, Breckenridge County. The waste of the Limestone, two hundred feet below the base of the Millstone grit, &c.

No. 960. (Ibid., p. 145.) Virgin soil, taken from the north side of the house of Mr. Jas. Townsend on Billy's Creek, a branch of Miller's Creek, Estill County. Geological position on a terrace of Subcarboniferous Limestone.

No. 1473. (Vol I. N. S., Rep. Geol. Surv. Ky., p. 234.) Soil three years in cultivation to the depth of seven inches, on Louisville and Paducah Railroad, about one thousand feet west of the twenty-sixth mile-post, &c., in Grayson County. Timber — Red, Black, and White Oak, with Sugar-tree and Poplar.

No. 1549. (Vol. I. N. S., Rep. Geol. Surv. Ky., p. 256.) New soil, five years in cultivation in Corn, Wheat, and Oats, taken to the depth of eight inches. Farm of Daniel Klingelsnutte's heirs, 11,350 feet west of Elizabethtown, on the Elizabethtown and Paducah Railroad, and 250 feet to the north. Yield of Corn, thirty, of Wheat, twenty, and of Oats, twenty-five bushels per acre. Hardin County.

No. 1029. (Vol. IV. Ky. Geol. Rep., p. 175, O. S.) Labelled "Soil, top of hill, woods; farm of George Smith, Esq., waters of Blackford Creek; two and a half miles in the rear of Lewisport, Hancock County."

No. 1051. (Ibid., p. 184.) Labelled "Soil from east side of Whiteside's Creek, Hopkins County."

No. 1052. (Ibid.) Labelled "Sub-soil from east side of Whiteside's Creek, Hopkins County."

No. 1058. (Vol. IV. Ky. Geol. Rep., p. 186, O. S.) Labelled "Virgin Soil, on dividing ridge between Jackson and Estill Counties."

No. 1156. (Ibid., p. 226.) Labelled "Virgin Soil from the coal-measures of Caney Creek of Licking River, Morgan County. Forest growth — White Oak, Beech, Sugar-tree, and Black Walnut."

Soils on the Subcarboniferous Sandstone.

No. 812. (Vol. IV. p. 77, Ky. Geol. Rep., O. S.) Virgin soil, from the valley of McCormick's Run, Bath County. The soils of this locality show *débris* from the Conglomerate, Limestone, Olive Sandstone, and of the Iron and Coal horizon.

No. 1469. (Vol. I. N. S., Rep. Geol. Surv. Ky., p. 233.) Soil of an old field, fifty years in cultivation, lying fallow for the last fifteen years, 2500 feet west of the twenty-first mile-post on the Louisville and Paducah Railroad. Timber, mostly Black Oak, some White and Red Oaks, and a few Poplars.

No. 1061. (Vol. IV. p. 187, Ky. Geol. Rep., O. S.) Virgin soil; land of Mr. Sloan, Indian Fork of Rockcastle River, Jackson County, four miles from McKee on the Big Hill and Richmond Road.

Soils on the Tertiary Formation.

No. 1. (Vol. I. p. 259, Ky. Geol. Rep., O. S.) Soil from heavily timbered land, southern part of Ballard County, between the waters of Bowles and west branch of Mayfield Creeks.

No. 2. (Ibid., p. 261.) Soil from the north-western part of Ballard County, near Colonel Gohlson's.

MARLS. — MARLY SHALES.

(See Table II.)

No. 587. (Vol. III. p. 232, Ky. Geol. Rep., O. S.) Marl from the line between Bullitt and Spencer Counties; in the *Favosites maximus* beds. Lower Silurian formation.

No. 1431. (Vol. I. Geol. Surv. Ky., N. S., p. 211.) Green Marly Shale from below the Arsenal at Frankfort. Bed eight inches thick (Lower Silurian). Franklin County.

No. 1432. (Ibid., p. 212.) Marly Shale. Same locality as the preceding, but lying above that.

No. 1433. (Ibid.) Marly Shale. Used as mineral paint at Frankfort. Franklin County.

No. 1434. (Ibid.) Marly Shale. From Armstrong farm, Bridgeport, Franklin County. In Cincinnati group, just below the silicious mudstone. In same position as the marl near Newport, Ky. Used for paint.

No. 971. (Vol. IV. p. 150, Ky. Geol. Rep., O. S.) Marly clay from Daniel

Brink's place. One hundred and two feet above Phillip Brink's branch. Fayette County. Lower Silurian formation.

No. 1446. (Vol. I. N. S., Geol. Surv. Ky., p. 220.) Marly Shale, from Sunset Lick, a mile and a half west of Litchfield, Grayson County. Geological position, the Chester group.

No. 1446 *a*. Same marl analyzed by fusion.

Page 496 of Laboratory book (unpublished). Marly Shale, found just below the Upper Limestone. Haycraft's Lick, Grayson County.

Page 492 of Laboratory book (unpublished). Marly Shale, four feet thick; found below the Upper Limestone. Hat branch of Bear Creek, Grayson County.

IRON ORES.

(See Table III.)

a. *Limonite Ores.*

No. 1269. (Vol I. N. S., Ky. Geo. Rep., p. 152.) Limonite iron ore from the Block-House Ore Bank, one and a half miles from the Old-Slate furnace, Bath County. Bed ten to twelve feet thick, on the Clinton group.

No. 782. (Vol. IV. p. 63, Ky. Geol. Rep., O. S.) Limestone ore, from the east side of Clear Creek. Clear Creek furnace, Bath County.

No. 1373. (Ibid.) Potato-Knob ore. Average sample. Iron-Hills furnace, &c., Carter County.

No. 1274. (Vol. I. N. S., p. 155, Ky. Geol. Rep.) Yellow-Kidney ore, sampled from a number of places. Star furnace property, Boyd County.

No. 1275. (Ibid.) Limestone ore; average sample. Bellefonte furnace, Boyd County.

No. 1277. (Ibid.) Yellow-Kidney ore, or Kidney ore below the No. 7 Coal. Straight Creek. Buena-Vista furnace. Average sample. Boyd County.

No. 1371. (Ibid., p. 188.) Limestone ore, from Horsley Bank. Boone furnace property, Carter County. A cabinet specimen.

No. 1375. (Ibid.) From Royster-Hill Lambert ore bed. The ochre from the lower part of the bed. Iron-Hills furnace.

No. 1376. (Ibid.) German ore. Smith Hill. Iron Hills, Carter County.

No. 1381. (Ibid., p. 189.) Main-Block ore. Old Mount-Tom ore. Carter County.

No. 1384. (Ibid., p. 190.) Red-Limestone ore from the Graham Bank. Average sample.

No. 1385. (Ibid.) Yellow-Kidney ore. Mount-Savage furnace, Carter County. Average sample.

No. 1411. (Ibid., p. 200.) Procter Ore Bank. Sycamore Creek, Edmonson County.

No. 1509. (Ibid., p. 244.) Limestone ore. Samuel Wamock's land,

Tygert Creek. Bed one foot thick. Not an average sample. Greenup County.

No. 1516. (Ibid., p. 245.) Shover-drift Limestone ore. Average sample. Kenton furnace, Greenup County.

No. 1521. (Ibid., p. 246.) Main-Block ore. Little-Morton Bank. Laurel furnace, Greenup County.

No. 1598. (Ibid., p. 274.) Limonite. Old Suwannee furnace. Bank close to the furnace. Subcarboniferous. Lyon County.

No. 1600. (Ibid.) Old Suwannee furnace property. Iron-Mountain Bank. Subcarboniferous. Average sample.

No. 1605. (Ibid., p. 277.) Iron ore from near No. 4 entry. Airdrie furnace, Muhlenburg County.

No. 1606. (Ibid.) Limonite iron ore from Jerry Hope's land, near Muddy River. Average sample of the surface Limonite from the upper part of the bed.

No. 1608. (Ibid., p. 278.) Martin ore from near Greenville, Muhlenburg County. Average sample.

b. *Clay Ironstone and Black-band Ores.*

(See Table IV.)

No. 1271. (Ibid., p. 154.) Blue-Block ore from Wilson's Creek. Average sample from the Star-furnace stock pile, Boyd County.

No. 866. (Vol. IV. p. 108, Ky. Geol. Rep., O. S.) Blue-Kidney ore from Star furnace, Carter County.

No. 1363. (Vol. I. N. S., p. 186, Ky. Geol. Rep.) Kidneys in the Shale below coal; layer four inches thick; Old-Orchard diggings. Boone furnace property, Carter County.

No. 1365. (Ibid.) Average sample of Limestone ore at Horsley Bank. Boone furnace property, Carter County. (Clay iron-stone and Limonite mixed.)

No. 1369. (Ibid., p. 187.) Gray Limestone ore. Mount-Savage furnace, Carter County. Average sample.

No. 937. (Vol. IV. p. 136, Ky. Geol. Rep., O. S.) Gray iron ore, associated with the rough ore. Cottage furnace, Estill County.

No. 1644. (Vol. I. p. 300, Ky. Geol. Rep., N. S.) The Glady ore on the old Brownsville and Litchfield road, west of Bear Creek, Grayson County.

No. 1503. (Ibid., p. 242.) Blue-Kidney ore, locally replacing the Main-Block ore; from a drift one mile south-east from Laurel furnace, Greenup County.

No. 1507. (Ibid., p. 243.) Gray ore, or Main-Block ore. Baker drift. Laurel furnace, Greenup County. Average sample from the stock pile.

No. 1611. (Ibid., p. 299.) Bitumimous clay iron-stone, or so-called Black-band ore. Labeled Slate-iron ore, from Buckner furnace. Weathered thirty years. Average sample. Muhlenburg County.

No. 149. (Vol. I. p. 347, Ky. Geol. Rep., O. S.) Black-band ore from Williams's Landing, Muhlenburg County.

No. 150. (Ibid., p. 348.) Shaley Black-band iron ore from the waters of Battist Creek, Muhlenburg County.

An extensive layer of Black-band ore, from two to three feet thick, has recently been discovered in Lawrence County, some samples of which on preliminary examination are found to contain from thirty-three to thirty-four per cent. of iron, and from a half to a third of one per cent. of sulphur, much of which could be removed by roasting.

c. *Red Hematite Ore of the Clinton Group.*

(See Table V.)

Page 533, of Laboratory book (unpublished). Dyestone iron ore from near Cumberland Gap, Tenn.; from Old Clinton furnace.

Page 540. (Ibid.) Clinton ore (Dyestone or Fossil ore) upper bed. Poor Valley Ridge, Cumberland Gap, Tenn. Average sample from a number of exposures.

Page 541. (Ibid.) Clinton ore; upper bed. Foot of Poor Valley Ridge, on a branch down from the Virginia road. Cumberland Gap, Tenn.

Page 542. (Ibid.) Clinton ore; middle bed, twenty-six inches thick. Cumberland Gap, Tenn.

No. 1594. (Vol. I. p. 273, Ky. Geol. Rep., N. S.) Red Hematite iron ore; found on top of hill near Louisa, Lawrence County, Ky. In this locality it is in nodular lumps of various sizes; but it is doubtless to be found in regular layers in other localities in this State.

COALS.

(See Table VI.)

No. 1280 *a*. (Vol. I. N. S., Ky. Geol. Rep., p. 157.) Coal No. 6 from Turkey-pen Hollow, Old Clinton track. Bellefonte furnace, Boyd County.

No. 1280 *b*. (Ibid., p. 149.) Selected sample of same coal.

No. 1285. (Ibid., p. 157.) Coal No. 6 from Horse Branch (or Run), near Catlettsburg, Boyd County. Average sample.

No. 1286. (Ibid.) Coal No. 7 from the Ashland Company's mine No. 4, Coalton, Boyd County. Average sample.

No. 1289. (Ibid., p. 158.) Coalton coal No. 7. Two hundred and fifty yards from the west end of No. 4 entry. Average sample. Boyd County.

No. 835. (Vol. IV. p. 96, Ky. Geol. Rep., O. S.) Cannel coal from Mr. South's coal bank (three feet thick) near Jackson, Breathitt County. furnace, Carter County.

No. 871. (Ibid., p. 111.) Cannel Coal, twenty-one inches thick, Stinson Bank, Carter County.

No. 1348 *a*. (Vol I. N. S., p. 182, Ky. Geol. Rep.) Coal No. 7, Coalton. Average sample from Wiley Pritchard's bank, near Mount Savage.

No. 1348 *b*. (Ibid., p. 149.)

No. 1350. (Ibid., p. 182.) Coalton coal (No. 7), from a drift on Gum branch of Straight Creek. Mount Savage Company's drift, lower part of the bed. Carter County.

No. 1353. (Ibid., p. 183.) Coal No. 1 from Graham bank. Little Fork of Little Sandy River, near Willard, Carter County. Average sample.

No. 1356. (Ibid.) Coal No. 2 from Kibby drift, Everman's Creek, a mile from Grayson, Carter County. Average sample.

No. 1357. (Ibid.) Coal No. 1 from Stone branch of Tygert's Creek, Carter County.

No. 1413. (Ibid., p. 201.) Coal from Tar Lick, Davis's Creek, Edmonson County. Five and a half feet thick.

No. 1418. (Ibid., p. 202.) Coal from Shoal Branch. Nolin coal.

No. 1448. (Ibid., p. 222.) Tar-Lick coal. Dismal Creek, Grayson County. Average sample.

No. 1484. (Ibid., p. 238.) Coal No. 1, used at Kenton furnace, Greenup County. Average sample.

No. 1486. (Ibid.) Coal No. 3. Average sample of the main coal of Raccoon furnace below the Shale parting, Greenup County.

No. 1493. (Ibid., p. 239.) Coal, probably No. 3; thirty feet below the Kidney ore. Laurel furnace, Greenup County. Average sample from the coal-shed.

No. 1496. (Ibid.) Coal No. 3 from a drift near Pennsylvania furnace, Greenup County.

No. 1649. (Ibid., p. 302.) Hunnewell Cannel coal. Hunnewell mines. Greenup County.

No. 1579. (Ibid., p. 266.) Coal from St. Charles mines, Hopkins County. Average sample. Coal D.

No. 1588. (Ibid., p. 271.) Coal No. 3 from McHenry's coal-bank, six miles south of Louisa, Lawrence County. Average sample.

No. 1589. (Ibid.) Coal No. 1 from near Henderson. Bogg's Mill, Cane's Creek, Lawrence County.

No. 1591. (Ibid.) Coal No. 3. Holbrook's coal, Brushy Creek, Lawrence County.

No. 1601. (Ibid., p. 275.) Subconglomerate coal, forty feet above the Subcarboniferous Limestone. Hawkins's Creek, near the line of Powell County, Menifee County. Average sample.

No. 1618. (Ibid., p. 283.) Coal No. 12 of Owen. Airdrie furnace, near No. 4 entry, Muhlenburg County. Average sample.

No. 1620. No. 11 of Owen. Muhlenburg County.

No. 1623. (Ibid.) Coal from Muddy River coal-mine, Muhlenburg County.

No. 185. (Vol. I. p. 49, and Vol. II. p. 286, Ky. Geol. Rep., O. S.) Mulford's main coal, or five-feet coal. Union County.

MINERAL WATERS.

(See Table VII.)

No. 798. (Vol. IV. p. 69, Ky. Geol. Rep., O. S.) Salt Sulphur-water from a well ten feet deep, about sixty steps from the main house, Olympian Springs, Bath County.

No. 1456. (Vol. I. N. S., Ky. Geol. Rep., p. 225.) Sulphur-water from the Centre Spring, a natural spring, the most popular of the Grayson Springs. Grayson County.

No. 1457. (Ibid.) Sulphur-water from the Moreman Spring, Grayson Springs.

No. 1458. (Ibid., p. 226.) Sulphur-water from the McAtee Spring. Grayson Springs.

No. 1459. (Ibid.) Sulphur-water of the Stump Spring. Grayson Springs.

No. 952. (Vol. IV. p. 142, Ky. Geol. Rep., O. S.) Red Sulphur-water near the saloon, Estill Springs, near Irvine, Estill County.

No. 953. White Sulphur at the saloon. Ibid.

No. 956. Black Sulphur-water. Ibid.

No. 1436. (Vol. I. p. 215, Ky. Geol. Rep., N. S.) Sulphur-water from a bored well, ninety-six feet deep, at the Fleetwood farm of Colonel J. W. Hunt Reynolds, near Frankfort, Franklin County.

Page 525, of Laboratory book (unpublished). Salt Sulphur-water, from a bored well, 134 feet deep, on the premises of Mr. John B. Trice, Hopkinville, Christian County.

No. 733. (Vol. III. p. 361, Ky. Geol. Rep., O. S.) Salt Sulphur-water, of the Lower Blue-Lick Spring, Nicholas County.

Page 583, of Laboratory book (unpublished). Sulphur-water, from Sebree Springs.

(b.) *Chalybeate Waters.*

No. 954. (Vol. IV. p. 142, Ky. Geol. Rep., O. S.) Chalybeate water, north-west side of Sweet-Lick Knob, near Irvine, Estill County.

Page 581, of Laboratory book (unpublished). Alum Spring (No. 1), Crow's Station (on the E. O. and N. Railroad). Coal-measures formation. Daviess County.

Page 581. (Ibid.) Sweet Spring (No. 6). Ibid.

Page 524. (Ibid.) Chalybeate water, from Murray's Spring, near Lewis (E. O. and N. Railroad), Daviess County.

No. 531. (Vol. II. p. 233, Ky. Geol. Rep., O. S.) Chalybeate Mineral-water, from the Grove Spring, in the yard of the proprietor of Crab-Orchard Springs, Mr. Caldwell, Lincoln County.

No. 532. (Ibid., p. 234.) Chalybeate water, from the Brown Spring, half a mile from Crab-Orchard Springs, on the Lancaster Turnpike, Lincoln County.

Page 527, of Laboratory book (unpublished). Chalybeate water, from Rock-

castle Springs, Pulaski County. From a natural spring on the west side of Rockcastle River, near its margin. L. Renfros', near Cumberland Falls.

Page 584, of Laboratory book (unpublished). Chalybeate spring, Sebree Springs, of Webster County.

(c.) *Saline Waters.*

Page 581, No. 4, of Laboratory book (unpublished). Water from the Brick Spring, at Mr. Hickman's Springs, Crow's Station (E. O. and N. Railroad), Daviess County.

No. 535. (Vol. II. p. 236, Ky. Geol. Rep., O. S.) Mineral-water, from the Epsom Spring, one mile from Crab Orchard, on the Lancaster Turnpike, Lincoln County.

No. 536. (Ibid., p. 237). Mineral-water, from the Epsom Spring at Foley's, half a mile from the centre of Crab Orchard, on the Fall-Dick Road.

CLAYS.

(See Table VIII.)

No. 1337. (Vol. I. p. 179, Ky. Geol. Rep., N. S.) Fire-clay. Average sample from the upper four-foot bed; the whole bed eight to ten feet thick; on both sides of the hills; ridge between Grassy and Three-Prong Creeks; Boone furnace property, Carter County.

No. 1338. (Ibid.) Fire-clay, from same locality. From the lower bed.

No. 1339. (Ibid.) Fire-clay, from same locality; the rougher part of the upper layer.

No. 1340. (Ibid., p. 180.) Fire-clay, under coal, Old-Orchard diggings, Boone furnace property, Carter County.

No. 1341. (Ibid.) Fire-clay, from same locality as Nos. 1337, 1338, and 1339, — the dark-colored clay from the lower portion of the deposit. Carter County.

No. 1342. (Ibid.) Fire-clay, under the twelve-inch coal, on Geo. Ossenton's land, near Grayson, Carter County.

Page 500, of Laboratory book (unpublished). Clay, from a bed seven to eight feet thick, in the Chester group of the Subcarboniferous Limestone, on Sowder's farm, one mile north of Green River, on Caney Branch, Edmonson County, — the upper or light dove-colored portion of the bed.

Page 501. (Ibid.) Clay, from the same locality, — the second layer; light-gray or nearly white.

Page 502. (Ibid.) Clay, from the same locality; the third or gray layer. The lowest layer is of an olive-gray color, and contains about 2.5 per cent. of Potash, and nearly one per cent. of Lime.

No. 1477. (Vol. I. p. 236, Ky. Geol. Rep., N. S.) Fire-clay. Louder's Bank, near Kenton furnace, Greenup County.

No. 1479. (Ibid., p. 236.) Clay. Fourth bed above the Limestone and

Limestone ore, on Pea Ridge, Greenup County. Thickness of this bed, two to two and one-half feet; weathers, white; two hundred and fifty feet above the railroad at the depot. Hunnewell furnace.

No. 1481. (Ibid., p. 236.) Clay. Second bed above the Limestone ore, on Pea Ridge, &c., Greenup County.

No. 1483. (Ibid., p. 237.) Fire-clay. Thomas's Bank; upper layer; an average sample; five feet above the cherty Limestone. Head-waters of Wing's Branch of Schultz Creek, Greenup County.

Page 668, of Laboratory book (unpublished). Clay, from the head-waters of Green River, in Lincoln County, from a bed represented to be of great thickness, resting on Black Shale.

Page 651, of Laboratory book (unpublished). Potter's Clay; No. 1 quality; Upper Silurian formation. Waco, nine miles east of Richmond, Madison County, Ky.

Page 651 (a), of Laboratory book (unpublished). Potter's Clay; same locality; of quality No. 2.

BUILDING-STONES.

(See Table IX.)

Limestones.

No. 1638. (Vol. I. p. 291, Ky. Geol. Rep., N. S.) Magnesian Limestone, used for the foundation of the Court-house, Paris, Bourbon County. Lower Silurian. From Cane Ridge, five miles east of Paris.

No. 494. (Vol. II. p. 143, Ky. Geol. Rep., O. S.) Magnesian Limestone, on the road from Shepherdsville to Mount Washington, Bullitt County. Upper Silurian formation.

No. 1314. (Vol. I. p. 169, Ky. Geol. Rep., N. S.) Limestone, from Barren River, near the mouth of Gasper Creek. Subcarboniferous formation. Butler County.

No. 1388. (Ibid., p. 192.) Limestone, used as a flux at Boone Furnace, Carter County.

No. 1421. (Vol. I. p. 152, Ky. Geol. Rep., N. S.) Oölitic Limestone. Glasgow Junction, Barren County. Upper layers of Upper Subcarboniferous Limestone.

No. 1422. (Ibid., p. 152.) Compact Limestone. Upper Subcarboniferous Limestone. Glasgow Junction, Barren County.

No. 512. (Vol. II. p. 169, Ky. Geol. Rep., O. S.) Limestone, Building-stone, from Grimes' Quarry, on the Kentucky River, near Clay's Ferry on the Richmond Road, Fayette County. Lower Silurian, Magnesian Limestone, used in the construction of the Henry Clay Monument in the Lexington Cemetery, &c.

No. 616. (Vol. III. p. 259, Ky. Geol. Rep., O. S.) Magnesian Limestone, from Harris' Quarry on Elk Lick, about one mile below Clay's Ferry, and about one and one-half miles in a straight course from Grimes' Quarry on the Kentucky River, Fayette County.

No. 109. (Vol. I. p. 323, O. S., Ky. Geol. Rep.) Limestone from Brushy Fork of Tygert's Creek, under the Limestone ore. Used as a flux at New Hampshire furnace, Greenup County.

No. 1500. (Vol. I. p. 241, N. S., Ky. Geol. Rep.) Limestone, Subcarboniferous; average sample; used as a flux at Kenton furnace, Greenup County.

No. 530. (Vol. II. p. 227, O. S., Ky. Geol. Rep.) Magnesian Limestone, building stone; Upper Silurian formation. White-Oak Ridge at Pleasant Grove meeting-house, Wm. Galey's farm, Jefferson County.

No. 1065. (Vol. IV. p. 189, O. S., Ky. Geol. Rep.) Variegated Limestone, near the base of the Upper Silurian of Jefferson County. Three miles from Middletown, on the Shelbyville road.

No. 1123. (Ibid., p. 212.) Magnesian Limestone, a good building stone, from Mr. Covington's farm at Elliston, Madison County; where the Red-bed soil was collected. (Devonian?)

No. 164. Marble. (Vol. I. Ky. Geol. Rep., p. 358, O. S.) Coon Creek on the Ohio River, opposite to Marble-Hill quarry of Jefferson County, Indiana. Quarry of Dr. Hopson, Trimble County.

No. 776. (Vol. III. p. 409, O. S., Ky. Geol. Rep.) Limestone. The lowest rock in the bluff at Shryock's Ferry, Kentucky River, Versailles road, Woodford County. Lower Silurian formation. There are also some good building stones in the Clinton group not yet analyzed.

Sandstones.

(See Table X.)

No. 496. (Vol. II. p. 144, O. S., Ky. Geol. Rep.) Sandstone. Building stone from the Knob at Bullitt's Lick, Bullitt County. Waverly formation.

No. 467. (Ibid.) Sandstone. Building stone from a quarry on the top of Button-mould Knob, Bullitt County.

No. 468. (Ibid., p. 145.) Sandstone from seventy feet above the Shale at Bellemont furnace, Bullitt County.

No. 1221. (Vol. IV. p. 252, O. S., Ky. Geol. Rep.) Sandstone. Knob building-stone; mouth of Triplett's Creek, edge of Rowan County.

HYDRAULIC CEMENT.

Limestones.

(See Table XI.)

No. 456. (Vol. II. p. 208, O. S., Ky. Geol. Rep.) Magnesian Limestone. Hydraulic Limestone. Two miles west of Grayson Springs, Grayson County.

No. 522. (Ibid., p. 220.) Hydraulic Limestone (unburnt) from the falls of the Ohio River at Louisville, Jefferson County.

No. 1066. (Vol. IV. p. 189, O. S., Ky. Geol. Rep.) Hydraulic Limestone. Chenowick Creek, Jefferson County.

No. 1137. (Ibid., p. 219.) Hydraulic Limestone from Mitchell's Spring, Meade County. Cliff three hundred feet above the Ohio River.

No. 1165. (Ibid., p. 231.) Hydraulic Limestone from Bardstown, Nelson County.

No. 1201. (Ibid., p. 244.) Limestone from one mile north-east of La Grange, Oldham County. Upper Silurian.

No. 1202. (Ibid.) Hydraulic Limestone, Curry's Fork of Floyd's Creek, Oldham County.

DESCRIPTION OF THE MAPS ACCOMPANYING THIS PAMPHLET.

Two maps are given herewith, one a general map designed to show the position of the Commonwealth of Kentucky, with reference to the other parts of the Continent of North America. It will be seen from this map that the most important points are as follows: —

1. Its central position, with reference to the whole country; it being very nearly in the middle of the great fertile section of the continent. The present centre of population is probably at or very near the northernmost point of the State.

2. The relation of this Commonwealth to the natural transportation routes of the country, — its great rivers. There can be little doubt that, as this country becomes more and more peopled, the commerce will become more limited to the north and south channels. This will necessarily give a continually-increasing importance to the commercial relations of Kentucky.

It should be noticed that the shores of the Caribbean Sea and the Gulf of Mexico are in peculiarly favorable relations for commerce with the Mississippi Valley. A geological map would show that the most favorably-situated deposits of coal and iron for the supply of this great region lie within the central district of the Mississippi Valley, of which Kentucky has so large a share.

The large map of the State of Kentucky, bound with this pamphlet, is designed to show the special geography and geology of the State. It is a compilation from various sources, but is largely based on the work of the present Survey. Geologically and topographically it is much in advance of any other map of the State that has been made. Where the geological indications are given by coloring or shading, they may be trusted as approximately correct. All such work is from the results of the Kentucky Survey. Some parts of the outcrop lines are left undetermined. These, it is expected, will be surveyed within two or three years.

The topography of the State is still the most doubtful part of the work. This region has never been surveyed in its entirety in any fashion. There was no Government Survey in the beginning. During the war some lines of roads were run. The Geological Survey has mapped in some detail about five thousand square miles; but it is not possible to construct an accurate map at present. The errors at present may be reckoned as putting the position of nearly every point in doubt. The average error of position will not fall far short of two miles. The general relations of streams, towns, and roads is, however, given with sufficient accuracy for the purpose in view.

For the better understanding of this map, the reader is referred to the first pages of this pamphlet.

COLLECTIONS AND PUBLICATIONS

OF THE

KENTUCKY GEOLOGICAL SURVEY.

THIS survey, begun as a preliminary reconnoissance, in 1854, was interrupted by the war, and its records destroyed by fire. In 1873 the work was resumed. The collections and publications herein referred to have been prepared since the close of the year 1873. The specimens shown at the Centennial Exposition comprise only a part of the total collections made during the progress of the work. The large map exhibited with the collection shows the distribution of the rocks of the State, as far as yet determined. The specimens of coal, ore, &c., represent only the beds and other deposits that have been opened, in the present state of the industries of the State. It is probable that, when complete explorations have been made, the aggregate mineral wealth will be many times greater than is shown here.

Attention is called to the following publications of the Kentucky Survey, already issued or in preparation. These reports, memoirs, maps, &c., will be furnished at the cost of printing. Applications should be made to the Secretary of the Geological Survey, Lexington, Kentucky.

List of the Publications of the Survey already printed or in preparation.

Reports of the Geological Survey of Kentucky, all in royal 8vo.

VOLUME I. NEW SERIES.

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.

II. Report of the Botany of Barren and Edmonson Counties. By John Hussey, Botanical Assistant. With an Introduction by N. S. Shaler.

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.

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.

V. The Iron Manufacture of the Kentucky Division of the Hanging Rock Iron Region. 1 Plate. By P. N. Moore, Assistant.

VI. Report on the Geology of the Region adjacent to the Louisville, Paducah, and South-western Railroad, with a Section and 4 Plates. By Charles J. Norwood, Assistant.

VII. Report of a Reconnoissance 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.

I. Report on the Geology of Greenup, Carter, and Boyd Counties, and a part of Lawrence. With Map and Sections. By A. R. Crandall, Assistant.

II. On the Geology of the Edmonson Coal and Iron District. With Map and Sections. By P. N. Moore, Assistant, and J. R. Proctor; with Map by W. B. Page, Assistant, and C. W. Beckham and John B. Marcou, Aids.

III. On the Chemistry of the Hemp Plant. By Dr. R. Peter, Principal Chemist of the Survey.

IV. On the Airdrie Furnace. By P. N. Moore, Assistant.

V. Topographical Report of W. B. Page, Assistant, for the year 1874.

VI. On the Geology of the Line of the proposed Railway from Livingston Station to Cumberland Gap. With Sections. By A. R. Crandall and C. J. Norwood, Assistants.

VII. Geology of the Henry County Lead District. With Sections. By N. S. Shaler, and C. J. Norwood, Assistant.

VIII. On the Geology of the Route of the proposed Lexington and Big Sandy Railway. With Sections. By A. R. Crandall, Assistant.

IX. A General Account of Kentucky. By N. S. Shaler and Assistants. Maps and Sections.

VOLUME III. NEW SERIES.

I. Report of N. S. Shaler, Director, on the Conduct of the Survey for 1873.

II. Biennial Report of N. S. Shaler, Director, for the years 1874 and 1875, giving a summary account of the principal economic results of the Survey during those years.

III. Notes on the various Scientific Problems encountered in the prosecution of the Kentucky Geological Survey. By N. S. Shaler, Director.

IV. Plan for the organization of a State Cabinet. By N. S. Shaler.

V. Description of the Preliminary Geological Map of Kentucky. By N. S. Shaler, Director.

VOLUME IV. NEW SERIES.

I. Second Chemical Report of Dr. R. Peter and John H. Talbutt, Assistants.

II. Report on the Geology of the Counties of Bath, Menifee, Powell, and Lee. With Map and Sections. By A. R. Crandall, Assistant.

III. Report on the Iron Ores in the Region near Cumberland Gap. With Sections. By P. N. Moore, Assistant.

IV. Report of the Results of a Reconnoissance of the State Line from Cumberland to Pound Gap, and on a Line from Abingdon, Virginia, to Mount Sterling, Kentucky. By P. N. Moore, Assistant.

V. Report on the Breckinridge Coal Mines. By C. J. Norwood, Assistant.
VI. Report on the Geology of the Kentucky Red River Iron District. With Sections. By P. N. Moore, Assistant.
VII. Preliminary Report on the Geology of Martin County. With Sections. By A. R. Crandall, Assistant.
VIII. Report on the Geology of the North and South-running Railways of Western Kentucky. With Sections. By C. J. Norwood, Assistant.
IX. Topographical Report of W. B. Page, Assistant, for 1875.

VOLUME V. NEW SERIES.

I. Report on the Building Materials of Kentucky. By N. S. Shaler, and J. R. Proctor, Assistant. With Map and Sections.
II. Report on the Geology of the Section from Grayson County to the Ohio River. By P. N. Moore, Assistant. Map and Sections.
III. Report on the Improvement of Kentucky Rivers, with special reference to Navigation, Water Power, and the Prevention of Floods. By N. S. Shaler, and W. B. Page and J. R. Proctor, Assistants.
IV. Report on the Geology of the Region adjacent to the Louisville and Nashville Railway and its branches. By C. J. Norwood, Assistant. With Map and Sections.
V. Report on the Geology of the Region adjacent to the Cincinnati Southern Railway. By N. S. Shaler and Assistants. With Map and Sections.
VI. Report on the Mineral Waters of Kentucky. By Robert Peter and J. H. Talbutt, Assistants.
VII. Report on the Coal Measures Section between Slate Creek and the Virginia Border. By A. R. Crandall, Assistant. Map and Sections.

VOLUME VI. NEW SERIES.

This volume will be devoted to a special class of Reports, prepared with reference to the International Exhibition at Philadelphia, and designed to bring the results of that Exhibition to bear on the questions of mining, commerce, and other interests in Kentucky. It is not possible to announce the precise limitations of these Reports; but, as far as possible, they will be made to include the following classes of facts: —

I. The Management of Surveys, Topographical, Geological, &c. II. The Arrangement of Collections to illustrate resources. III. The Working of Coal, Iron, and other Economic Mineral Deposits. IV. The Use of Building Materials. V. Agricultural Geology. History of Soils, Marls, &c., Commercial Manures. VI. Metallurgy of Iron, Lead, &c. VII. The Improvement of Navigation in Rivers.

MEMOIRS OF THE GEOLOGICAL SURVEY OF KENTUCKY. VOL. I.

All in 4to.

I. On the Antiquity and History of the Caverns of the Ohio Valley. 1 Plate. By N. S. Shaler, Director.
II. On the History of the Buffalo, with special reference to the Fossils found at Big Bone Lick. Map and 12 Plates. By J. A. Allen.
III. On the Fossil Brachiopods of the Ohio Valley. Part I. 8 Plates. By N. S. Shaler, Director.
IV. On the Prehistoric Remains of Kentucky. Part I. 7 Plates. By Lucian Carr, Assistant, and N. S. Shaler, Director.

MEMOIRS. VOLUME II.

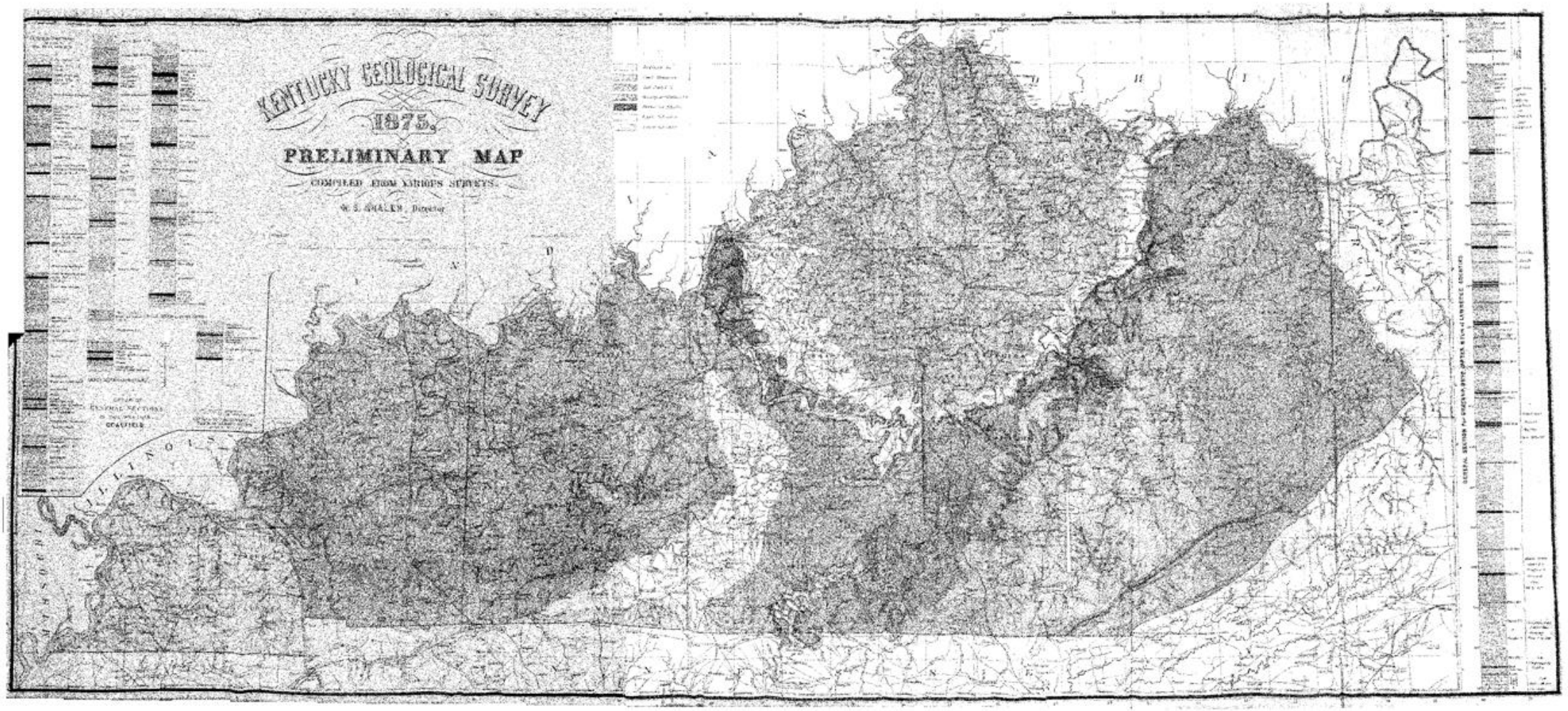
I. On the Prehistoric Remains of Kentucky. Part II. By L. Carr, Assistant, and N. S. Shaler, Director. Map and Plates.
II. On the Fossil Corals of the Family Calceolidæ. By N. S. Shaler, Director. Map and 4 Plates.
III. On the Cavern Animals of Kentucky. By A. S. Packard and F. A. Sanborn, Assistants, and others. 4 Plates.
IV. On the Fossil Brachiopods of the Ohio Valley. Part II. By N. S. Shaler. Maps. 8 Plates.
V. On the Cavern-dwelling Races of Kentucky. By F. W. Putnam, Assistant. 6 Plates.
VI. History of the Investigations into the Affinities of Cavern Animals. By H. A. Hagen.
VII. On the Dynamic Geology of Kentucky. By N. S. Shaler, Director. Maps and Plates.

A few copies of the volumes of the first series of Reports made between 1854 and 1860, now out of print and extremely scarce, can be furnished to those who desire to complete such sets of Reports.

Persons desiring information concerning these Reports, or any other information concerning the natural resources of Kentucky, with a view to immigration or to the investment of money in the State, should address Kentucky Geological Survey, Frankfort, Kentucky.

The order of arrangement of the Reports in the fourth and fifth volumes, as well as their titles, may vary somewhat from the list as above given ; but the changes will be only matters of detail. It is expected that all of the above described matter will be printed by December, 1877.

These Reports will be furnished, each part separately, in paper bindings, or as volumes bound in cloth or paper, as may be desired. The first volume of the Reports, and the first of the Memoirs, will be ready July 10, 1876. The second and third volumes of the Reports will be ready October 1st, 1876.


KENTUCKY GEOLOGICAL SURVEY
1875.
PRELIMINARY MAP
COMPILED FROM EARLIER SURVEYS.
W. S. HALEY, Director
ILLINOIS
MISSOURI