REPORT

ON THE

GEOLOGICAL RECONNOISSANCE OF KENTUCKY,

MADE IN 1838

By W. W. Mather

Dr. William Williams Mather
(1804-1859)

Reprinted in Commemoration of the Sesquicentennial Anniversary of the Kentucky Geological Survey

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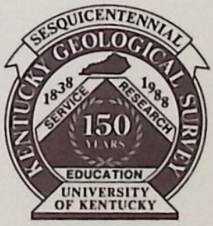

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PREFACE

The importance of establishing a Geological Survey of Kentucky, so that its mineral wealth and resources would be adequately understood and properly developed, was recognized early in the Commonwealth's history.

On February 16, 1838, the first official investigation of the mineral resources of Kentucky was authorized by Governor James Clark upon his approval of a joint resolution of the General Assembly of the Commonwealth. Governor Clark appointed William W. Mather, who had previously served as State Geologist of New York and Ohio, to carry out the first official geological reconnaissance of the Commonwealth during the summer of 1838.

The results of Mather's work, entitled "Report on the Geological Reconnoissance of Kentucky, Made in 1838," were published in the Journal of the Senate in January 1839. Mather's findings outlined Kentucky's two major coal fields and discussed the State's other important mineral resources, as well as recognizing the great potential of using Kentucky's waterways as avenues of natural transportation for its mineral commodities. William Mather proved to have remarkable foresight in predicting future developments concerning the Commonwealth's natural resources.

With the passage of time, it has become very difficult to find a copy of Mather's report except in a rare-books collection; therefore, it seems fitting that this first official report of the Kentucky Geological Survey be reprinted as part of the activities commemorating the Survey's 150th anniversary.

JOURNAL

OF

THE SENATE

OF THE

COMMONWEALTH OF KENTUCKY,

BEGUN AND HELD IN THE TOWN OF FRANKFORT ON MONDAY THE THIRD DAY OF DECEMBER, IN THE YEAR OF OUR LORD, 1838, AND OF THE COMMONWEALTH THE FORTY SEVENTH.

FRANKFORT, K.
A. G. HODGES, PUBLIC PRINTER.
1838.

(Title page from the Senate Journal in which W. W. Mather's "Report on the Geological Reconnoissance of Kentucky, Made in 1838" was published.)

REPORT

ON THE

GEOLOGICAL RECONNOISSANCE OF KENTUCKY,

MADE IN 1838.

BY W. W. MATHER,

GEOLOGIST AND MINING ENGINEER.

EXECUTIVE DEPARTMENT,
Frankfort, January 3, 1839.

SIR:

I have received the accompaning report of W. W. Mather, the geologist appointed to make a geological reconnoissance of the mineral resources of the State. Permit me, through you, to lay the same before the house over which you preside.

JAMES CLARK.

Hon. ROBERT P. LETCHER,
Speaker House of Representatives.

JACKSON C. H. JACKSON COUNTY, OHIO,
December 28, 1838.

SIR:

Having been appointed by your excellency to carry into effect a joint resolution of the General Assembly of the Commonwealth, to make a geological and mineralogical reconnoissance of the State, and submit a report thereon, together with a plan in detail, and estimates, for a geological and mineralogical survey of the State, I have the honor to report. that on receiving my appointment, I entered immediately on the discharge of my duties, and have made a reconnoissance of the mineral districts of Kentucky. Less time was devoted to this reconnoissance than would have been desirable, in consequence of other duties; but amply sufficient, it is believed, for the purpose intended by the joint resolution of the General Assembly, and sufficient to impress one with an assurance of the vast mineral resources of the Commonwealth, which have so long lain dormant beneath and on our soil, ready for the hand of industry and enterprise to apply them to the various useful purposes of life.

Less has been written on the mineralogy and geology of Kentucky than almost any State or territory in the confederacy, and it has probably been owing to the apparent uniformity of its minerals, and their small number in that portion of the State which is most densely populated, and which is appropriately called the "garden of Kentucky." Agriculture is almost exclusively the occupation of the people, and for this purpose the soil is admirably adapted. Few ores or minerals calculated to attract the attention, either by their beauty or their economical value had been observed, and the subject has not, therefore, attracted much attention, until the recent developements in other States, have caused the people to realize the importance of a knowledge of their mineral resources. The inhabitants of the mountainous parts of the State, and some of those in other portions, have long known of the valuable beds of coal, iron ore, &c., but even now, they are not properly appreciated as the elements of future wealth, and as the source of unlimited employment to a large manufacturing population. In consequence of a knowledge of mineralogy and geology not being generally diffused through the community, the people are neither aware what minerals may be expected to be discovered, nor in what situations to look for them, and even where particular minerals of value have been found, few know how to trace out their extent, or find the continuation of the beds in the adjacent hills and mountains. It has often been observed in examining the mining districts of the State, that the minerals worked, were supposed to be confined to the localities where they were found, when a slight knowledge of the elementary principles of geology, would have enabled the proprietor to trace the beds to situations where they would be more favorably situated for working and for transportation.

The internal improvement system which has been prosecuted so liberally under the enlightened policy of our statesmen, is now furnishing means of transport for our coal, iron, salt, agricultural products and manufactures to their appropriate markets.

As these public works were in part planned in reference to the transport of our mineral products, it follows as a consequence, that our mineral resources should be thoroughly developed, in order to give full value to these improvements already constructed, and to indicate the routes of future lines of transport which, the wants of the community may render necessary.

No State, probably, possesses such natural facilities for the transport of her mineral and agricultural products, and her manufactures as Kentucky. The Big and Little Sandy flow in the midst of a region of coal, iron ore, copperas and alum rocks, sand rock, &c. The Licking, Kentucky, and Cumberland penetrate beyond the agricultural into the very heart of the coal, iron and, salt regions, affording every facility for an easy interchange of such products as are not sent from these districts to a more distant market. So with Green River, it flows from the heart of the State, through a rich agricultural and mineral country. And since this region conains an extensive coal formation far distant from any other in the valley of the Ohio, (except that portion of it which extends into Indiana,) it is reasonable to suppose that a large share of the coal which will be consumed in the valley of the lower Mississippi, will be drawn from the coal basin of the western part of Kentucky, and Indiana. It is well known that there are no coal beds on the waters of the Arkansas and Red rivers, until near the west boundary of Arkansas, and none accessible near the Mississippi, except near St. Louis, and

thence north to the Rock river. It is thought that the coal of the Green river valley can be shipped to the lower markets at as low a price as that of St. Louis, the Illinois river, and Mississippi above the Illinois, and probably cheaper, and will be able to compete with those mines, and perhaps have the preference in the market.

The amount of coal now consumed on the waters of the Ohio and lower Mississippi is very great, but I have not been able to collect accurate data for an estimate. It is used for domestic fuel, in Iron works, steam mills, and various manufactories, steamboats, and sugar boiling in Louisiana.*

The consumption is rapidly increasing in all the various purposes to which coal is applied, but the use for sugar houses and steamboats is going far in advance of the others. Those who have used coal on steamboats and in sugar houses, almost universally prefer it to wood, not only on the score of economy, but because it is easily regulated, and there is a greater uniformity in the heat. It is to be observed, however, that care should be taken in the selection of the coal for steam boilers to have it free from sulphuret of iron.†

The mineral districts are grouped in different parts of the State, and varied in their character and aspect as in their products. Coal, iron ores, salt, saltpetre, limestone for common and hydraulic lime, sandstones for building and firestone, limestone for building stones and marbles, clay for bricks and coarse pottery, shale for firestone, fire bricks and pottery, and pyrites for the manufacture of copperas, are among the most important mineral substances of economical interest.

These substances occur in abundance within the limits of the State, but few of the locations, comparatively, are either known or appreciated by the mass of the people. In addition to these are various valuable medicinal springs, petroleum or burning springs, and lead ore. Chalcedony, agate, and amethyst, such as are extensively manufactured in Germany into small ornamental articles and precious stones, are common in some parts of the State. The mineral districts of Kentucky embrace in the aggregate almost the whole area of the State.

The coal, iron and salt districts occupy about one fourth the area of the State, and are parts of the coal basins of the upper and lower Ohio.‡

The coal formation of the upper Ohio is very extensive, occupying, the eastern part of Ohio, the western part of Pennsylvania, Maryland and Virginia, and about 7000 square miles of the eastern part of Kentucky. The coal formation of the lower Ohio embraces about twelve counties in Kentucky, most of which are in the Green river valley, and thence extends across the Ohio river up the valley of the Wabash in Indiana.

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*The data thus far obtained, justify the conclusion that at least 1,000,000 bushels of coal are sent to market per annum, from the mines in the Cumberland, Sandies, Licking, Kentucky and Green rivers.

†This mineral is common in some of our coal beds, and may be easily recognized. It is yellow, hard and heavy, and is frequently mistaken for gold by those who are unacquainted with it; but its hardness and brittleness will enable any one to distinguish it. If put in the fire, it burns with a blue flame, and the odour of sulphur, and leaves a red residue which is the oxide of iron, and which is attractable by the magnet.

‡The terms upper and lower are convenient for conciseness in description, and we take the falls of the Ohio at Louisville as a natural division between them.

The western limit of the coal formation of the upper Ohio in Kentucky, may be indicated, approximatively, by a line drawn from near the mouth of Tygart's creek, by West Liberty on the Licking, the forks of the Kentucky and the South Fork of the Cumberland into Tennessee. The country east of this to the west line of Virginia abounds in coal, iron ore and salt.

The boundary of the lower Ohio coal formation, within Kentucky, may be indicated by an irregular line drawn from near the mouth of the Wabash, so as to include Henderson, Daviess, Hancock, Ohio, and most of Union, Hopkins, Muhlenburg, Butler, Edmonson, Grayson, and a small portion of Breckinridge, Hart and Warren counties. Below the coal formation is a formation of slate rock, several hundred feet in thickness, and abounding in iron ore. It forms the surface of a belt of country several miles in width, and extending parallel to the coal formation from near Clarksburg, in Lewis county, S. S. W. across the Licking, between Owingsville and the narrows of the Licking, thence by Irvine on the Kentucky river, thence S. W. by Stanford and Liberty across the Cumberland river. Another *branch*, as it seems to the eye, (although in reality it underlies the surface rocks between the forks,) ranges from Irvine along the base of Muldrow's hill by New Haven to the Ohio river. The iron ore in this formation is exceedingly abundant. It appears to be a calcareous and argillaceous carbonate of iron, but it has not yet been analysed, so far as I know. It is extensively used in the manufacture of iron in several of the counties, and particularly in Bullitt county. It is said to make iron of a superior quality. It occurs in layers in the slate, either as continuous strata, or in courses of round or oval nodules which vary in size from an orange to a barrel in magnitude.

In the ravines and on the hill sides, where the slate is undergoing continual disintegration, and forming a clay which washes away almost as soon as formed, the nodules of ore are found in abundance, and may be picked up in large quantities.

Fine furnace locations were observed in several parts of the State, while making the geological reconnoissance, where abundant supplies of ore might be easily obtained for long periods of time. Such deposits were observed between Mount Vernon and Irvine; near the Blue Licks; between Irvine and the forks of the Kentucky; and between Owingsville and the narrows of the Licking. The survey, if authorized by the Legislature, will doubtless cause hundreds of valuable locations to be discovered and made known to the public.

The remaining portion of the State is mostly occupied by limestone as a substratum, and forms the richest and most productive agricultural region of the State. This, also, may be properly termed a mineral region, although its mineral resources are not yet understood or appreciated.

Besides the limestone, the different strata of which are adapted for lime, hydraulic lime, building stones, or marbles, iron ore abounds in many places, and lead ore has been found in small quantities in numerous localities.

COAL FORMATIONS OF KENTUCKY.

The coal formation, or those rocks that contain coal, cover an area which may be calculated at 12000 square miles. Coal is not accessible over all this area, neither are the beds, in all places, thick enough, or of a suitable quality for workable coal.

The general boundaries of the two coal formations in Kentucky have been already described. These formations are composed of various rocks, such as sandstones, conglomerate, shales, limestone, coal and iron ore.—Sandstone forms by far the greater portion of the mass of rock in these coal formations, and it every where attracts the attention of the traveller, by the wild romantic scenery to which it gives rise. This rock is almost the only one calculated to attract the attention, as the others, when exposed, soon become covered with their crumbled up fragments arising from the disintegration of the rock.

The coal is of two, perhaps three distinct qualities, but all of them are bituminous.

The varieties are,

1st. The common bituminous, or caking coal.

2d. A similar coal which does not cake and adhere in lumps when burning, but each piece keeps separate and distinct.

3d. Cannel coal.

All these coals burn well and give out much heat, but the two latter are far more pleasant for domestic use, and do not emit that kind of smoke from which flakes of soot, like lamp-black, are diffused through the air. These coals are already worked extensively in Kentucky, and are daily getting into more common use for a great variety of purposes, such as for iron works, steam mills, manufactories of various kinds, steamboats, and for domestic use. The aggregate quantity consumed cannot be estimated correctly, but it is supposed that from 400,000 to 800,000 bushels per annum are sent down the Cumberland river to Nashville, to the Iron Works, and to the other towns in Tennessee: that 200,000 bushels descend the Kentucky to Frankfort, and other towns on the river, and perhaps 100,000 bushels descends the Licking, and 30,000 the two Sandies.

The salt works and iron furnaces in the coal region consume a large quantity of coal, and it is probable that the coal consumed within the State, and that sent down the Cumberland and Ohio, amounts to 3,000,000 bushels per annum.

The use of coal for steamboats is increasing far more rapidly than for other purposes, and for the following reasons:

1st. It makes a more uniformly hot fire, and is more easily regulated than that of wood.

2d. Ten bushels of coal are equivalent, in effect, to a cord of wood; and as coal may be averaged in price at 10 cents per bushel, and wood at $2 50 per cord, the economy in the use of coal is very great, viz: three fifths.

3d. The weight of equivalent quantities of coal and wood is as 1 to 3.

4th. The bulk of equivalent quantities of coal and wood is as 1 to 9.

5th. The labor and expense of putting equivalent quantities of coal and wood on board steamboats are as 1 to 4.*

Thus we see there is an economy in the actual outlay of purchase and shipment of the article, and also in the weight of, and space occupied by the material.

Steamboats that consume twenty cords of woods per diem, burn 200 bushels of coal.

* Triplett's Circular.

Hon. D. Trimble, in his report on the coal and iron trade of Kentucky, made to the Legislature at its last session, estimates the amount that Kentucky would furnish to steamboats, if all on the western waters used it, at 400,000 tons, which at 10 cents per bushel, and thirty bushels to the ton, would yield an annual income of $1,200,000. This estimate of the consumption of coal for this purpose is conceived to be a low one, as the population and business are rapidly increasing, so the means of transport must increase in a corresponding ratio.

The economy of coal over wood, as wood is rapidly decreasing in quantity, and rising in value, must necessarily cause its substitution as a means of motive power for transport within a few years.

During the reconnoissance of the past season, I had occasion to examine many of the coal mines which are now wrought in Kentucky. The system generally pursued is a very defective one, and must eventually cause a great expense to be incurred, or result in the abandonment of the mines.

Mines and beds of minerals are of public utility, and when exhausted they cannot be renewed; hence it becomes a matter of moment, not only to the proprietor, but to the people, the State, and the Nation, that they should be wrought in such a manner as shall produce the greatest quantity and best quality of the materials, with the least waste and expenditure of labor, time and money.

The course pursued in many of our mines, is to mine into the coal bed on the side of a hill, where the coal is in a position nearly horizontal, and excavate it until the roof falls in, or until the miner fears being crushed if he continues his work. This is then abandoned, and a new opening made at another point on the hill side. The hill sides are thus riddled with openings, where the rock above, for want of adequate support, has fallen down, which will make future mining both expensive and difficult. Such mines are always more wet than they would be under other circumstances.

No mines in the world are capable of being more easily worked than those in Kentucky. The strata of coal and iron ore are in a position nearly horizontal, dipping just about enough to permit the water to flow off, if the mine be opened on the right side of the hill. These materials are in such abundance in the hills above water level, and on or near important lines of water transport, that hundreds of years must elapse before it will be necessary to mine deep into the earth by means of vertical shafts. This method would cause a great expense for draining, like the mines of England, France, Germany, &c.

The principal cause of the defective system of working the mines, is undoubtedly due to the general fact, that they are worked by men of little or no capital, and hence, it is necessary for them to extract the mineral with the *least possible present expense*, regardless of the future good condition of the mine. For the same reason, those who mine the coal send it down in boats and depend upon a chance market. They thus sometimes make a handsome profit, but frequently, do not obtain enough to defray the expense of mining, transport and the boats.

This, like any other branch of business, in order to be conducted with the greatest advantage, requires the investment of a considerable amount of capital, in the various necessaries and conveniencies for mining operations, for transport to a market, &c. Incorporated or joint stock companies, which can command a large capital, and exercise an extensive sphere of influence,

must always have an important advantage over individual citizens, who can only use his own smaller capital and personal influence.

Chance markets for the coal now sent from the mines, ought no longer to be depended upon. There is always an unpleasant uncertainty, both for the producer and the consumer. Coal yards or depots should be established in all our principal towns, where coal can be collected during the proper season of the year, and thus give a certainty of supply to one party, and of profitable sale to the other. Another advantage would be gained, viz: when the supply is certain, so as to meet all the wants of the community, the consumption will rapidly increase.

RECONNOISSANCE IN THE COAL DISTRICTS.

During the reconnoisance, coal was seen in many places where the people scarcely know of its existence. I will mention some of the places observed where coal occurs, some of which are worked, some are known to the inhabitants, and some have not before been known.

A coal mine at the level of the Ohio river is worked in the bed of Clear creek, near Henderson, and another in the bank of the Ohio river about 1 mile from Henderson. The bed is stated to be 3 feet thick, but was covered by the high water of the Ohio at the time of my visit.*

Coal is found in many places on the route from Henderson to Owenboro', in the banks of the creeks, in the hills, and in digging wells. Six miles from Henderson a gentleman dug through coal in sinking a well. It is mined on Lick creek near Green river.

The terraces in the hills, and which are so indicative of coal where it occurs in nearly horizontal strata, are easily traceable by the eye, and on examining along the road where it crossed these terraces in the hills, distinct indications of coal were observed. There can scarce be a doubt that all this region, from Henderson to Green river, and Owenboro', is underlain by beds of coal, although much of it is probably below the water level of the country, and would require drainage to work it. But as much of it lies so convenient to water transport, it will well repay this expense, when the demand and price shall increase. From Green river, the road between Henderson and Owenboro' leads along a natural ridge for several miles through the wet lands. This ridge slopes off gradually to the south, but abruptly to the north, with springs at its base. It resembles in many respects the natural terraces of the coal banks. It continues several miles to the N. E. of Owensboro', and several fine private residences are erected on it, as Mr. Triplett's, Judge Bibb's, and others. At Bonharbor, 3 miles N. W. of Owenboro', ¾ and 1 mile from the river, are several openings where coal has been dug in considerable quantities. The bed of coal is 30 or more feet above high water mark of the Ohio, and is stated to be 4 to 5 feet thick and covered by limestone 4 feet thick. This limestone bears some resemblance to that from which hydraulic cement is made in some parts of the country. I saw the coal and limestone at the mouth of the mine, but could not see either, in place, as the earth had caved in, and covered both the coal and limestone

*I may here be permitted to express my obligations to Edmund H. Hopkins, Esq. of Henderson, who gave me much valuable information upon the coal of this part of the State.

beds. The coal bed forms a bench or terrace in the hills which is easily traced by a practised eye. The strata dip slightly to the N. W. Sandstone overlies the limestone in a bed 14 feet thick. Shale, one inch in thickness, intervenes between the limestone and coal, and shale forms the floor of the coal.*

Coal is found in the bed of the Ohio river about 1 mile above the mines. It is supposed by those who have endeavored to trace out the extent of this coal bed, that it underlies about 3000 acres of land. I should not be surprised if coal should be found every where around Owenboro', at some depth below the soil, by boring, as it is a part of the great coal formation of the Green river and Wabash vallies; but should this be the case, they could be of little present value, so long as they would require draining, while such an abundance can be procured from the Bonharbor hills without this expense.

Coal has been found in small quantities at Rumsey, at lock and dam No. 2 on Green river. It is not improbable that beds of greater or less thickness underlie the whole country between Owenboro' and Rumsey, but the country is so flat and marshy, that it could not be explored with advantage, if it lies below water level. A seam of coal of 8 inches was found at the falls in digging the foundation of the lock.†

Everlie's coal bed is ten miles southeast of Rumsey. The coal is three feet ten inches thick, overlaid by thick bedded sandstone. The coal is more or less mingled with pyrites; but that which I saw, would not be injured for ordinary uses by the quantity of this mineral contained in it. There are some appearances indicative of a coal bed above, and of another below, in the same hill, but no opening has been made to ascertain whether there are coal beds of workable thickness. The mine, at this place, is 70 or 80 feet above low water of Green river, and about 400 yards from its banks.

Coal was again observed about five miles south of Everlie's bed, about 30 feet above the river, at the base of a cliff of sandstone, which is extensively quarried for the locks and dams below. The quarry and underlying coal are on the immediate banks of the river. The coal is three feet thick, and contains pyrites. Passing thence up the river valley, the hills have the aspect of coal and iron ore deposits. Traces of iron ore were observed in many places.

On Pond ceek, at Vaught's Mills, two beds of coal are opened. The lower coal is near the level of the creek. It is 4½ feet thick, overlaid by shale. The shale, about 12 to 20 feet above the coal, is filled with layers and nodules of iron stone. Sandstone overlies the shale, and continues some distance up the hill. At about 70 feet above the lower coal is another seam of coal six feet thick. It contains some shale, and is covered by a bed of shale, and this latter is overlaid by a thin bed of limestone. Nodules of iron ore, some of which contain blende, occur in the earth arising from the decomposition of the shale, about 15 or 20 feet above the coal.

*This coal tract is owned by Robert Triplett, Esq., and must undoubtedly soon be extensively worked, to furnish coal for steam boats, and for the southern market where large quantities are used in sugar boiling.

†I am under many obligations to Mr. Livermore, the Engineer of the Green river navigation, to Maj, Dyer and Dr. Johnson, of Rumsey, for much local information and many kindnesses.

Buckner's Iron Works are situated five miles southeast of Greenville. Mr. B. has erected a large blast furnace with the intention of smelting with coke. He has an abundance of coal in the vicinity, and of ore also. One of his main beds is a slaty argillaceous and calcareous carbonate of iron, as I should judge from its aspect, (for I have not analyzed it.) This ore bed is *fifteen feet thick*. He has another heavy ore bed of the oolitic and earthy hydrated per oxide of iron, or limonite, filled with fossil shells. The hills all around Greenville contain indications of iron ore, but no minute explorations have been made to determine the extent or thickness of the beds.

At one of the coal banks, about three quarters of a mile S. W. of Buckner's furnace, and near the slaty ore bank, is a distinct fault of about five feet. There are here two distinct beds of coal; the upper, about sixteen inches, and the lower, about thirty inches thick, separated about four feet. There is more apparent derangement in the stratification of the rocks in this vicinity, than I have seen in any other part of Kentucky.

A coal bed, three feet thick, is in the bottom of Mr. Baker's well, thirteen miles S. E. of Greenville. The country between these places is hilly, with frequent traces of coal and iron ore. This is near the southern limit of the Green river coal field. The limestone is only three or four miles south of Baker's; and no coal is found, south of the edge of the limestone, nearer than Alabama. Buckner's Furnace is also near the southern boundary of the coal field. He has exchanged coal for corn, bushel for bushel; the former being carried south, into the limestone region, for blacksmiths' uses. Mr. Baker lives on Jacob's branch of Clifty creek. The sandstone of the coal measures shows itself in many places in the vallies of both these streams.

Another point on the S. boundary of the coal field of Green river is near Muddy river, on the road from Greenfield to Bowlinggreen.

Coal may perhaps be found in the caps of some of the high hills near Waggoners, where the turnpike from Louisville to Bowlinggreen crosses Green river. It is not to be expected however, where there is not a thickness of 100 feet of sandstone above the limestone.

Somerset, in Pulaski county, is a few miles W. of the western margin of the upper Ohio coal field, and which occupies the eastern part of Kentucky. It is not impossible, however, that there may be coal in the caps of the highest hills within two miles of Somerset. The limestone every where underlies the coal formation in Kentucky in both the coal basins, but it changes in character on the north, and in Ohio becomes a fine grained sandstone. A fine section of these rocks is exposed on the banks of the Cumberland, on the road from Somerset to the South Fork. The hills along the South Fork of the Cumberland contain coal, and all the rocks of this formation are here observed, superposed over the cavernous limestone, which contains all the great caves of Kentucky; and which, in Kentucky, Illinois, Missouri, and Arkansas serves, (as I know from personal observation,) as a floor for the coal formation.

John Beatty, Esq. who lives at the mouth of the Great South Fork, and to whom I am under many obligations, has opened a small seam of coal about 2 miles S. from his house, in the hills. It is believed that there are beds in these hills of a workable thickness. The same terraces occur here in the hills, as in the coal deposits that have before been described. Coal is worked on the South Fork of the Cumberland. A. Snyder, Esq. engineer, has thus

described the worked coal and the associated rocks, in the engineer report of 1837, p. 119, 120:

"Coal is found in great abundance, and is first mined about sixteen and a half miles above the month of the river, where the vein is said to be about three feet thick; it is hauled half a mile to the boat landing.

"Immediately before the mouth of the little South Fork, twenty five and a half miles above the mouth of the great South Fork, a vein, varying from three feet eight inches to four feet six inches in thickness, has been worked for several years. And at about half a mile above the Little Jumps a vein has also been opened, from which several boat loads have been taken.

"Thence to the crossing of the proposed road from Louisville to Knoxville, veins of coal of various thickness may be found; the only one examined was two and a half feet thick.

"It is said that a vein, four feet thick, has been found on Bear creek, which enters the river immediately above the crossing.

"The coal appears to be good, and burns freely in a grate, but is accompanied by sulphuret of iron.

"The formation of the rocks is regular, the strata having a dip which is very nearly the same throughout.

"Bituminous shale is found at the surface of low water, at the mouth of the river, overlaid by limestone, in thin layers, of a light color, with nodules of black flint adhering to the surface of those rocks which are exposed to the action of the water. At three and a half miles up the stream, a vertical cliff of limestone rises three hundred feet above the water, and at fifteen miles, the cliff appeared about two hundred feet high, having some fragments of oolite limestone at its base; at twenty miles the height was not more than seventy feet—it was composed of thin layers, chiefly oolitic; and at twenty three miles the bank, at the edge of the water, was covered by thin fragments of sandstone, and large masses of conglomerate. From thence to the thirty fifth mile, where the limestone was last seen, in a cliff of only about twenty feet high, it is more or less hidden by fragments of fine sandstone, and sandstone conglomerate; the hills having gradually increased in height, with cliffs composed of thick beds of conglomerate on top, and thence, to the crossing of the proposed road, the rocks did not form cliffs sufficiently abrupt to afford an opportunity of tracing them out. Three separate strata or veins of coal are found among these beds of sandstone. The upper one is said to be eighteen inches in thickness, at a distance of about eighteen feet above the second, which is from three feet ten inches to four feet six inches in thickness; the third is about sixty feet below the second, and is only six inches thick.

"The only article of trade is coal—two boat loads, of about two thousand bushels each, have been sent from the lower coal bank; and from the second about sixty thousand bushels have been sent, and twenty thousand more were ready to be sent down the river. Coal has also been sent from the mine above the Little Jumps, but the expense of hauling past them, to the landing, has caused it to be abandoned."

Mr. Snyder has, also, made many observations and measurements along the Cumberland and the Rockcastle, in the coal region, that are deemed of much importance, not only in statistical details, but in affording important data for the geological investigations that may hereafter be made. The following extracts from Mr. Snyder's reports, are quoted from the Engineer report of 1837, pages 114, 116, and 105, 106:

"There appears to be abundance of coal, at different points between the falls and the mouth of Buck creek, a stream which falls into the Cumberland about seven miles above the Great Shoals. There are only three points at which it has been mined, the highest is about half mile above the mouth of Laurel, where there are said to be four veins; one in the bed of the river; another twenty feet above the water, and about two feet thick; a third about thirty five feet above the water—forty inches thick; and a fourth, said to be sixty or eighty feet above the river, being four feet thick.

"The third vein is that from which two boat loads have been mined, and from which they were obtaining coal at the time the survey was made. The second mine is a little more than a mile below the mouth of Laurel, on the left bank of the river, being on the same side, and apparently the same vein which is worked above. It is about thirty five feet above the water, and is forty inches thick. Two boat loads have, also, been sent from this place.

"From this point to the commencement of the principal mines, about eighteen miles below the mouth of Laurel, it does not appear that any coal has ever been mined for market, but in a distance of one and a half miles farther down the river, many mines have been opened; some of which are being worked at present, and others have been abandoned.

"There are said to be three veins of coal; the highest is from four feet to four feet ten inches in thickness, and is about three hundred feet above the level of the river; the second vein is about twenty feet lower than the first, and is one foot six inches in thickness. Coal has been obtained from each of these veins, but the upper one is that from which the coal sent to market has been mined.

"The principal mines are opened on the right side of the river, at the distance of about one and a quarter miles from it, so that the coal must be hauled that distance to be put on board the boats. The large vein has, also, been opened on the left bank of the river, at the distance of ten or twelve hundred feet from it. A small railway has been laid down from the mouth of the mine to the top of the cliff, from whence the coal is sent down to the landing by means of a self-acting inclined plane.

"It is said that in 1827, the first coal was taken from these veins to be sent to market, and that in 1828 only five boat loads arrived at Nashville. In 1829 the first drift, or under ground working, was commenced—all coal previously obtained having been cut from the crop or edge of the vein, where it comes out to the surface of the ground. From 1829 until 1834, probably from twenty five to thirty five boat loads, per annum, averaging seventeen hundred and fifty bushels each, have been sent from the landing; and from 1834 until 1837, from seventy five to one hundred boat loads, per annum, averaging three thousand five hundred bushels each, had been sent down the river.

"Sixty thousand bushels had been shipped previous to the time when the survey was made, and thirty five boats were then loaded and ready for a tide.

"It was found, by leveling up to the tide marks, that a rise of sixteen feet and eight tenths was required, at the coal landing, to enable boats, drawing four feet of water, to pass the Great Shoals with safety; boats of a lighter draft are sometimes sent when the water is only twelve feet above low water mark.

"I was informed that the cost of mining and delivering coal, at the mouth of the mine, is two and a half cents per bushel; hauling to the landing, five and a half cents per bushel; loading, one half of a cent, and baling the boat one half of a cent per bushel: making a total cost of nine cents per bushe in the boat. An average boat carries thirty five hundred bushels; it costs one hundred and forty dollars, and sells for thirty five dollars. The cost of transportation is one hundred and twenty dollars.

3,500 bushels of coal, at 9 cents,	315	3,500 bushels of coal, at 23 cts.	805
1 boat,	140	1 boat,	35
Pay of hands and expenses,	120		
Total cost at Nashville,	$575	Value at Nashville,	$840

Leaving a net profit of two hundred and sixty five dollars—from which must be deducted a proper per centage for risk.

"If the information received is correct, the present prodnce of the mines is three hundred and fifty thousand bushels per annum, equal to eleven thousand six hundred and sixty six tons; and the whole amount sent from the mines since 1828, one million one hundred and forty five thousand bushels, equalling thirty eight thousand one hundred and sixty six tons.

"Iron will, no doubt, become a considerable article of transportation at some future time, as there are abundant indications of the presence of ore at various points along the river.

"The products of agriculture, above the Great Shoals, are very limited in their amount. About one hundred corn boats, carrying four hundred barrels each, and from twenty to twenty five tobacco boats, carrying sixty hogsheads, weighing 1500 lbs. each, are said to be sent annually from the lower part of the river.

"The formation of the rocks is very regular throughout, commencing at the falls with a sandstone, and sandstone conglomerate, in thick beds, with white quartz pebbles, which are more numerous in the upper than in the lower strata. The cliffs rise to a height of four and five hundred feet above the water, and the strata have an inclination in the direction of the stream of a half a degree or more. Near the mouth of Laurel the coal veins before described are found in the face of the cliffs, and two miles below, the limestone rock first makes its appearance level with the surface of the water. From thence it gradually rises, and forms cliffs at various points throughout the whole distance to the Tennessee line.

"At four miles below the mouth of Laurel, the upper stratum appeared to be eight feet above the water—it was crystaline, and about two and a half feet thick. At six miles below the mouth of Laurel, it forms a cliff rather shelly, and about ten feet high, the strata being very nearly horizontal. At eight miles it is twenty feet above the water; and sixteen miles the beds of limestone are blue, having petrifactions of shells and plants, together with small nodules of black flint. At the Great Shoals, the cliffs are three and four hundred feet high containing flint petrifactions. These cliffs extend throughout the length of the shoals and to the mouth of the Great South Fork, where a stratum of bituminous shale appears at the surface of the water. Eight miles further down, this bed of shale rises three feet above the surface, and at twelve miles, it is forty feet high. At sixteen and a half miles, a bed of limestone appears at the surface of the water, very full of

petrifactions; and at thirty six miles below the mouth of the Great South Fork, the cliff was composed as follows: base, thirty feet of blue limestone; next above were ninety feet of black slate or shale, surmounted by fifty feet of yellow sandstone; and on the top were eighty feet of blue slate or shale—total 250 feet. At seventy nine miles, the hill appeared to be composed as follows: one hundred and eighty feet of limestone at bottom, overlaid by fifty feet of shale, twenty of yellow sandstone in thin layers, and seventy of shelly limestone—total 320 feet. Thence to the Tennessee line, the cliffs are from two hundred and fifty to three hundred feet high, with numerous shells and other organic remains. Sandstone and shale are not found except at a distance from the river."

On Goose creek, coal is said to abound, and to be dug in many places for the salt works, and for domestic use. The necessity of meeting an appointment on a fixed day, at Irvine, prevented my visiting the coal deposits and salt works of the Cumberland and of Goose creek.

The road from Somerset to Mt. Vernon, passes near the west limit of the coal formation. Most of the rock is the limestone, which is the floor of the coal formation; but sandstone is observed in passing over many of the knobs, and iron ore occurs in many places on this route. It is not ascertained whether it occurs in workable quantities. A thin bed of coal occurs in the hills at Mt. Vernon. Its situation is believed to be similar to that of a thin bed that is very common through the country between this place and Irvine, above the cavernous limestone, or below the conglomerate rock.

At Irvine, on the Kentucky river, the cavernous limestone occurs in the high hills, and the highest are capped by sandstone and conglomerate. It is probable that the thin coal bed, above referred to, may exist between the sandstone and the limestone, but it is scarcely probable that it will ever be worked, so long as the beds on the bank of the river, near the forks, are productive. Irvine may be considered as the extreme westerly boundary of the coal formation, and coal cannot be expected in any quantity there. Slate, with its imbedded hydraulic limestone and iron ores, forms the mass of the hills from the river to an elevation of 200 or 300 feet.

As the strata of rock dip slightly to the E. S. E. in ascending the Kentucky river, from Irvine to the Forks, we pass, in succession, over the rocks that overlie each other, and which are seen in the hills at Irvine. At about 12 or 14 miles above Irvine, we have passed over the slate rock which has plunged below the bed of the river, although at Irvine it formed the mass of the hills for 200 to 400 feet high. Limestone then succeeds in high cliffs along the banks, but this in its turn, also, sinks below the stream after ascending to the rock shoals, about 3 miles below the mouth of the South Fork, and disappears from the banks of the Kentucky and its tributaries.

The limestone is succeeded by high bluffs of sandstone and conglomerate, which also sink below the stream as you continue to ascend. The rock passes along the limestone bluff for a mile or two on the shelf or terrace at the junction of the limestone with the sandstone, and finally the second bluff or shelf of sandstone succeeds, which is 70 to 100 feet thick. Here we evidently came on to the coal measures, although no coal was seen. The hills have all the characters of form, soil, sandstone, slate and decomposed shale of the coal measures, with frequent indications of iron ore, and with occasional traces of black earth from the disintegration of coal. These offer sufficient evidence to satisfy any practised eye. Near the Rock Shoals at the

mouth of Sturgeon creek, a fine coal bank has been opened. Mr. Welch the Chief Engineer of the State has examined it. Coal mines are opened along the Kentucky river near the mouth of the South Fork in great numbers, and in the banks of the small streams which enter the river on the right bank. The coal is from 3½ to 4½ feet thick and is of good quality. Too little care is taken to pick out the pyritons coal, some of which is found among that of good quality, and which when sent to market, may injure the reputation and market price of the coal. The strata dip slightly to the E. S. E. but they are moderately undulating. Some of the mines drain themselves by the natural slope of the rock; others require a drain, or pumping or bailing to keep them dry, even in the same face of the hill, and where the adits are parallel to each other. Some of the mines, in what seems to be the same bed of coal, have a slate roof, and others one of solid sandstone. These mines are situated in the hills near the river, and about 80 or 90 feet above it. It is believed that at least two beds of coal are found in these hills. Coal is found in all the river hills from the mouth of the South Fork for a long distance up the stream.—Few of these mines have been carried more than 60 to 80 feet into the hills.

Passing from Mr. Maguire's, near the Middle Fork, over the hills to the mouth of Troublesome creek, the sandstones and slates of the coal measures were every where observed. Numerous thin seams of coal were seen from 6 to 30 inches in thickness in the banks of the water courses, and in the hills of the river valley. There is some good land for tillage along the water courses, but the valleys are generally very narrow, and appear to have been formed by the erosive action of flowing water, since the layers of rock on the opposite sides of the vallies are at about the same elevation, and their planes coincident, as though they had been once continuous, but since worn through and washed away by the flowing water. The country is but thinly settled, as there is little land adapted to tillage, and it is considered impassable for wagons. Bridle paths are the only roads, and there is no means of transporting any of the produce of the country to a market, except by flat boats at high water, or on pack hoses.

Coal was seen in the valley of Caney creek, and in the fork of the creek between Col. Haddock's and the mouth of Troublesome, but the beds, where exposed, were thin.

The mines of cannel coal are on the left bank of the North Fork of the Kentucky, nearly opposite the mouth of Troublesome creek. Those most extensively worked belong to Mr. Haddock. They are situated in the river hills, about 273 feet above low water of the river.* Openings have been made along the hill, at short intervals, for some hundred yards, but the people have not traced it in the adjoining hills, although it undoubtedly exists in them, in the direction of the continuation of the stratum. The coal bed is 4 to 4½ feet thick. The upper part of the bed is common bituminous coal, from 10 to 16 inches thick, and breaking into cubic or rectangular fragments. This bituminous coal does not cake in burning. The cannel coal forms a thickness of about three feet. It is very similar, in its mineralogical characters, to that of England and Ohio. It kindles very easily, even with a candle, as I have been told; burns very freely, with a brilliant white blaze, and without emitting the black, sooty, and flaky smoke, like that which is given off by the coal of Pittsburg, Wheeling, and Brownsville. This cannel coal is very highly esteemed for domestic use, and very justly so. It makes a very brilliant and clear fire, with little smoke or dust, and is particularly adapted for parlour fires. I saw no sulphur in any of this coal. It is said to be found, however, in the mine, in lumps at the bottom of the bed of coal, but it is not disseminated, and is easily separated.

* Vide Mr. Foster's Engineer Report, 1838, page 72.

This cannel coal is mined with difficulty, on account of its hardness, and its breaking equally well in every direction. There are seams in this coal which divide it into blocks of several hundred pounds weight, but the miners cannot easily get them loose. It costs more to mine this coal than the common coal, and it ought to command a higher price in the market.

A coal bed, about 1 to 1½ feet thick, occurs in the bed of the Kentucky river, near Mr. Haddock's house. It is the common bituminous coal. It dips slightly, and disappears beneath the waters of Troublesome creek. Coal was observed in the valley of Frozen creek, but the seams are thin. Indications of coal were frequently seen in passing from Frozen creek to Hazlegreen, but the country is almost entirely in a state of nature, and impassable, except on foot or on horseback.

Coal is stated to be abundant near Hazlegreen, in all the hills. Thin beds of this combustible were seen in the beds of the creeks, but these were too thin to mine with advantage, except when they are laid bare on the streams, or require but little stripping. Much coal has been loaded into boats, and sent down the Licking, which was taken from the bed of the river, at low water, a little below West Liberty; and several places were seen, and others were mentioned to me, where the same has been done in the beds of the North and Middle Forks of the Kentucky. The expense of mining the coal in this way is very trifling. It is merely prying up so much rock, which is easily effected. At another place, near West Liberty, coal underlies the alluvial bottom a few feet, and a small expense of stripping, uncovers the coal; and each boat, for its load, removes an area of coal from the bed equal to its own area. Each boat carries about 3,000 bushels.

A coal bed was observed in the bank of the Elk Fork, three or four miles from West Liberty. It was about 1 to 1½ feet thick.

"Iron ore is first found in the vicinity of the river, at Ringo's Mill, 140 miles above its mouth. Ore beds of about four feet in thickness occur in the hills on the left bank, and extensive beds are found in the hills on the opposite bank, near Fox creek.

"The iron district, on Slate creek, was accurately described in the report of the Chief Engineer, last year, as also beds of it in the vicinity of Bear creek.

"My own examinations have led me to believe that the iron ore which occurs near the river from Cane creek to Beaver creek, at distances between 180 and 193 miles from the mouth of the river, is more abundant and of as good a quality as in any other part of the State. The ore is found in veins of from five to fifteen feet thick, near the basis of the hills, and in beds of from three to ten feet thick near their summits, and is found overlaying the stratum of limestone which has been above described.

"Iron ore is also found in most of the hills between Slate creek and West Liberty, and near McClure's mill, the beds are very extensive.

"The *coal district* on the upper part of the river was accurately described in the report of the Chief Engineer above referred to.

"My own examinations have led to the discovery of a number of veins which were not known to exist last year, but as yet none have been found of greater thickness than three feet two inches. One mile above the mouth of Blackwater, three veins have been discovered, overlaying the stratum of limestone which passes under the bed of the river at this place. The lowest one is 30 inches thick, and is separated from the limestone by strata of clay-colored slate of about fifteen feet in thickness. The next vein is eighteen inches thick, and is found in a plane about twenty feet high. The third vein is found about ten feet higher up the hill. The two latter veins are separated by strata of sandstone and shale. From Blackwater to West Liberty, veins of coal are found at almost every point where the mountain stream has washed the earth from its bed, and uncovered the rocks which compose the hills. Two miles above Blackwater, three veins occur in the same relative position as those last described; the lower one being three feet thick. One vein three feet thick is found opposite the mouth of Greasy creek, and in the vicinity of West Liberty two veins occur, which are three feet two inches thick. Thinner veins occur all over the country."* On the State road from Owingsville to the mouth of Big Sandy, the coal formation is observed to commence not far from the crossing of Tygart's creek. The iron ores at the base of this formation, were observed in the greatest abundance in the hill tops of the first divide of the western waters of Tygart's creek. Coal was seen cropping out on the road side about two miles from the cross roads, near Carter C. H., near a Mr. Carter's house. Coal in thin beds abounds in the vicinty of Carter C. H., and it is supposed that thick beds may be found by exploration. One seam of coal 3 feet thick, and of excellent quality, is worked near Carter's Salt works.† A coal bed is worked near Hon. David Trimble's, on Little Sandy, for the supply of the Argillite Furnace.‡ It consists of two seams of 18 and 24 inches, separated by 10 inches of slate; they are worked as one bed.

Of the coal of Greenup county, Mr. Eastin, of the State Engineers, remarks: "There is at all the furnaces, except Raccoon,‖ owned by D. Trimble & Co., mines of stone coal; they lie below the iron and in the same ridges; the coal is highly bituminous, of second quality, but burns well, and is in large quantities; the engines at the furnace are driven with it, and it is used for all the purposes of the manufacture of iron except smelting. The coal beds vary in thickness from 2 feet to 3 feet 10 inches, and in all instances the drift or entrance to the coal has a declination of one foot in about 30. The strata above the coal is sand or slatestone, and under it slate and blue clay; the colliers can dig about 70 bushels per day each, and deliver it at the entrance of the drift. Its average cost per bushel, delivered at the engines, is from 3 to 7 cents."

The details here mentioned are brought forward to show merely, that if a casual glance, by rapidly traversing through the country, can exhibit such an abundance of coal deposits, we may expect much more to come to light by a careful examination.

* Vide Report of Mr. Buford, one of the State Engineers, page 95, 1137. †Idem, page 100.
‡ Idem, page 99.
‖ Mr. Trimble has lately opened a fine coal bed near the Roccoon Furnace,

I have already had occasion to remark upon some of the iron ores of Kentucky. They are found in four different geological positions in the State.

The most recent is *bog ore;* it occurs in marshy grounds, and near mineral springs, which are more or less charged with iron. The waters of these springs deposit it as they lose the power of holding it in solution, either by evaporation, or by the extrication of carbonic acid.

This ore is not so common or abundant as the others.

The next in order, is the ore of the coal formation. It is in some places, clay iron stone, or carbonate of iron, in layers, or else in courses of nodules, in the shales and fine sandstones of the coal measures; in others, it is limonite, or hydrated peroxide of iron, in composition. The latter ore is very extensively used in the furnaces in Greenup county, where it is exceedingly abundant. It is known by the names of block ore, and kidney ore, according to its form. When it forms strata, it breaks out in rectangular masses or blocks, and when in courses of nodules, it comes from the ore bed in round lumps, from a pound to 100 pounds in weight.

Limonite, also, forms extensive beds in connection with the limestone at the base of the coal measures, which overlie the slate rock of Kentucky. It is extensively worked for furnaces.

The ore of the slate formation has been already described as a calcareous clay iron stone, or a carbonate of iron and lime.

There are, also, many beds of limonite, or hydrated peroxide of iron, at, or near the junction of the slate with the subjacent limestone.*

All the iron ores in the various geological positions above named, are worked for furnaces in some one or more localities, in different parts of the State. Iron ore is not confined to the coal district of Kentucky, but is diffused more or less abundantly in every section of the Commonwealth.

In the coal regions of eastern and western Kentucky it abounds, and can never be exhausted. It is supposed, from the observations already made, that on 12,000 square miles, there may be an average depth of one yard of iron ore, in the coal formation alone, without counting the slate and limestone regions, where there is probably as much more. Each cubic yard of this ore will yield, on an average, one ton of bar iron, or 5000 tons to the

* A fine example of this may be seen at the ore bed, near the Slate Furnace, about four miles from Owingsville. The ore, at the first glance, presents an appearance resembling confused and contorted stratification; but, on close examination, it is found to be owing to the close aggregation of a great number of huge geodes, with concentric irregular layers, each having a cavity in the centre. In many parts of the ore bed, the ore is a perfect ferruginous oolite, composed of an aggregate of small, spherical grains, of the size of mustard seed, cemented by a matrix of the same composition. The ore is limonite, or a hydrated peroxide of iron in chemical composition. Its junction with the subjacent limestone was not seen. It has been worked around the edge of the swell of ground of which it forms a cap, to the depth of 12 to 15 feet, without reaching the bottom, and many suppose it to be 30 feet thick. Estimating its thickness at 15 feet, every acre of this bed will yield at least 25,000 tons of bar iron. The area underlaid by this ore bed was not ascertained, but it is estimated that at least 20 or 30 acres exist there, and if we take the surrounding hills into account, which probably contain the same bed, there may be several hundred acres. This ore bed has been worked since the first settlement of Kentucky.

acre, or 3,200,000 tons to the square mile, or 38,400,000,000 tons on the 12,000 square miles, a quantity sufficient to supply a ton of iron, annually, to every individual in the United States, (estimating our population at 15,000,000 of people,) for 2,560 years.

Our ores too, instead of being accumulated in one mountain mass, like those of Missouri and Sweden, where but few furnaces can be supplied with the combustible necessary for their reduction, are spread over a great area of country, where the fuel, the water power, and every facility for manufacture, exists.

In the part of the State, on which the calculation is based, when the population shall become too dense to permit *charcoal* to be the reducing agent, bituminous coal, of the best quality, may be substituted and dug on the spot; it may be used without coking, as it does not cake and run together in masses which might clog the furnace, but each piece keeps separate, and forms porous lumps of beautiful coke. The coking takes place at the trundle head of the furnace, and the heat arising from the burning bitumen may be economized in heating a large air chamber, through which the tubes for the hot blast may pass. This method, in part, is already practised in the high furnaces, in the highlands of New York, where much wood is thrown in with the charcoal of the charge, and its blaze serves to increase the high temperature of the hot blast.

Charcoal-made iron, is better than that made with coke; but the period is believed to be not far distant when the coal formations of the valley of the Ohio, like that of South Wales, shall be illuminated by their iron furnaces, and that they will be the great workshops of our country.

The counties of Greenup, Lawrence and Scioto, bordering on the Ohio at the western outcrop of one of these formations, already show the fires of more than 20 furnaces, and these are considered only as the beginning of the iron business, in even this limited area.*

LOCALITIES OF IRON ORE.

Iron ore is said to abound in the hills on Rough creek. Maj. Dyer of Rumsey, who gave me this information, showed me a piece of lead ore (galena) from the same hills. A vein of this ore is said to occur there.

Traces of iron ore were observed in the hills between Lewisburg and Rumsey, and important beds may probably be found by a careful examination; also, near Lewisburg; also in connection with the coal beds at Vaught's mills on Pond creek. The lower ore bed consists of a bed of shale, with

* Hon. David Trimble made an able report to the last Legislatnre on the coal and iron interests of Kentucky, and to that gentleman I am under obligations for many interesting and important facts observed in the N. E. part of the State. I may here be allowed, also, to express, publicly, my sincere thanks to Sylvester Welch, Esq., chief engineer of Kentucky, for the aid he afforded me in the prosecution of my labors. He has not only been a close observer, personally, of the mineral resources of Kentucky, but has also given instruction to the corps of engineers of the State to make particular notes of the mineral products of the lines of surveys of streams. roads, &c. with measurements of the thickness, &c. of the different rock formations, and these are entered on the maps plotted in the Engineer's office. They will afford important aid in prosecuting the geological survey, should the Legislature authorize it.

nodules and thin strata of iron stone imbeded. It is exposed on the road side, about 20 feet above the lower coal mine. Ore was also observed in the decomposed shale above the coal mine above. It did not seem to be sufficient in qantity to justify exploration. This ore was mostly limonite, and some of the masses contained some blende.

Iron ore abounds in the hills 5 miles S. E. of Greenville, near Buckner's Iron Works, in Muhlenberg county. Some of the beds are very thick, and, undoubtedly, they are extensive. One of Mr. Buckner's ore beds is 15 feet thick. Mr. B. has another heavy ore bed, the ore of which is oolitic, and filled with fossil shells. The latter bed I did not see, although I saw specimens of the ore, which is limonite, and appears like an easy working ore. Indications of iron ore were seen in the hills about Greenville, and on the road from that place to Glasgow, in many places.

Argillo calcareous carbonate of iron, or clay iron stone, abounds in the slate hills east and north of New Haven in Nelson county. It occurs in balls, nodules, and layers, in the slate, and this rock is here interstratified with the limestone. Where the slate formed the caps of the hills, and has decomposed into clay, the balls and nodules of ore lie upon the surface, or in the soil, varying from a few pounds to a ton in weight. They are also frequently found in great numbers in the ravines, where the water has washed and crumbled away the slate leaving them unchanged. They are heavy, gray in the inside on a fresh fracture, and brownish on the outside. This ore is extensively used for making iron in the Nelson Furnace.

About 2 or 2½ miles from New Haven, on the grade of the new turnpike, the ore was seen in its natural position in the slate rock, which was partially decomposed, and the nodules already beginning to tumble out. The hills had been cut down to form the grade only a year or two, yet the rock was in a state of rapid disintegration, and crumbling to pieces to form a clay.*

Iron ore in small quantity was seen 13 miles from Bardstown, on the turnpike towards Louisville.

Near Frankfort, on the hills, small nodules of iron ore were observed, but there are no apparent indications of its existing in such quantities as to be of any importance.

About one and a half miles from Standford, on the road to Danville, large masses of iron ore, like bog ore, were observed by the road side. They had been dug up in excavating for the grade of the turnpike. It was not ascertained whether it existed in large quantities. At a salt lick about 1½ miles from Standford, iron ore is said to occur.

Slate was seen interstratified with the limestone a mile or two from the foot of Muldrow's hill, on the road from Standford to Somerset, and iron ore was seen near the same place. It appeared from the surface indications, to be rather abundant, but whether it exists in any valuable quantities is not known, and is a fair subject of investigation.

*This material, slate, may, without doubt, be usefully employed as a stimulant manure, or as a marl to many of our soils. It possesses several of the requisites of a good marl, viz: it crumbles readily by exposure to the weather and frost, and it contains calcareous matter mixed with the argillaceous material that forms its base; and besides, it was observed in several places to contain veins of crystalized sulphate of lime or gypsum. It also contains pyrites and lime, which, by decomposition of the rock, will form gypsum, which is well known as an important mineral manure for clovering, as a preparation for other crops.

Indications of iron ore were seen about three miles from Somerset, on the road to Standford.

A layer of brown oxide of iron, (limonite,) analogous to the more compact varieties of hematite, of about one foot thick, was seen about 1 or 1½ miles from Stigall's ferry, on the road from Somerset to Monticello. It is in Wayne county.

In the hills, bordering the South Fork of the Cumberland, indications of iron ore were seen. The ore was of fine quality, and easy to smelt, but the quantity could not be ascertained without minute explorations. Mr. Snyder, the Engineer, who made the survey of the South Fork of the Cumberland, in eighteen hundred and thirty seven, found small quantities of ore in many places. He was told that extensive beds had been discovered about eight miles above the mouth of this stream. Should these beds be ascertained to be extensive and of good quality, as well as those indications which I observed in that vicinity, they would be valuable, as there is every facility for manufacturing iron with advantage. There is an abundance of water power in the river, and besides, there are several limestone springs that have an abundance of water for carrying all the machinery for iron works, and located on the immediate banks of navigable streams. Furnaces might be erected next the face of the vertical limestone cliffs at Beaty's, and at Long's, and have the trundle head at the general level of the country, and with a fall of water between the springs and river, sufficient to be used twice over, on wheels of the largest kind; while the pigs of iron could be slid directly to the boats below. As to fuel, wood and coal are in great abundance and near, and limestone for a flux, in inexhaustible quantities, forms almost all the cliffs of the river banks for miles.

Iron ore, in considerable quantity, occurs at Blue Lick, and Joe's Lick, in Madison county. These licks result from the disintegration of the slate rock into a clay, which is frequently incrusted, in dry weather, with a thin incrustation of saline matter, which has, in some places, the taste of alum, in others of copperas, or sulphate of iron. Cattle and wild animals resort to these places to lick and eat the clay. The iron ore occurs in layers, and courses of nodules in the slate rock; and as the slate crumbles away by the action of the weather, and by the crystalization of the saline matter, the masses of iron ore tumble down the slopes, and are thickly strewed on the naked barren surface of the lick. In some places, these masses of iron ore are gradually crumbled down also into a gravel by scaling off in concentric coats, in consequence of a change of composition, and the action of the frost; in others they change colour on the exterior, from a blueish grey to reddish brown, and remain unchanged. It is thought probable, that investigation may demonstrate, that such an abundance of the ore exists naked on the surface, and in the ravines, as to justify the erection of iron works in this vicinity, should the demand, or means of transport render it expedient. This ore resembles a hard, compact, bluish grey limestone, but its weight is so great that the close observer will not be deceived. The people of the vicinity with whom I conversed, did not know it was iron ore. This ore is perfectly similar to that observed near New Haven, and it abounds through all the slate region of Kentucky. It has the same geological relations as the nodules of septaria of the same slate rock in Ohio, only, the composition is changed. In Ohio, these nodules or round masses in the slate, are a carbonate of lime containing some carbonate of iron. In Kentucky, they are carbonate of iron, containing some carbonate of lime. It is

the kind of ore that is called in some parts of Kentucky "limestone ore."—This term, however, is also used for ores that are different in aspect, and from a different geological position, viz: in the rocks of the coal formation.

The same calcareous iron ore as that at the Blue and Joe's Licks was seen in a great number of places in the valley of Red Lick Fork, on the route from Joe's Lick post office to Irvine. Throughout all these hills, the slate containing this iron ore, underlies the limestone, and this the conglomerate of the coal formation, which caps the highest hills.

The slate hills about Irvine, and particularly between Irvine and the Forks of the Kentucky river abound in the same ore, and it is thought that research may here discover enough to justify the erection of furnaces and forges. Wood and coal are abundant and cheap, and water transport convenient.

Iron ore, similar to the common brown iron stone, (limonite,) called "limestone ore," was seen in some abundance near the junction of the limestone and its superincumbent sandstone and conglomerate about 13 or 14 miles from Irvine.

Frequent indications of iron ore were observed after reaching the hills of the coal formation near the Forks of the Kentucky. It is not ascertained whether workable beds of ore occur there. As iron ore abounds along the western limit of this coal field across Ohio, and a part of Kentucky, it is highly probable that geological research would point out the particular locations of the beds in the other parts.

Iron ore is said to abound near Hazlegreen. I saw slight indications of it in many places, and it may, probably, be abundant.

Iron ore was observed in the hills in several places on the route from Hazlegreen to West Liberty, and it probably abounds.

On the road from West Liberty to Owingsville, and between the former place and Yoakum creek, on the ridge along which the road passes, great quantities of iron ore were observed. The place where it was seen most abundantly, is from 7 to 10 miles from West Liberty. It was limonite in various states of aggregation. It corresponds in geological position with some of the thick beds of similar ore in the north part of Kentucky and in Ohio, viz: above the conglomerate and sandstone rocks, and below the coal beds that are generally wrought. As far as surface indications are to be trusted, the bed varies from 2 to 8 feet thick.

Mr. Utterback, who lives near the junction of Yoakum creek with the North Fork, told me that all the hills tops above the limestone,* abounded with iron ore. From the geological character of this vicinity, the conclusion may, perhaps, be drawn, that the ore bed above the sandstone conglomerate, must form the caps of many of these hills, while that which lies above the limestone, and below the sandstone conglomerate, must be found in the caps of the hills several miles to the westward. In fact we

* Geological section, showing the order of superposition:

1st. Coal formation, embracing the usual rocks.
2d. Conglomerate and sandstone, abounding in nitre, grottos, and rock houses.
3d. Limestone, cavernous, abounding in springs, with few fossils.
4th. Fine grained sandstone.
5th. Slate abounding in layers and courses of nodules of iron ore.
6th. Great limestone abounding in fossils.

found this to be so the next day, when travelling to the north west towards Owingsville. This ore is limonite, in various states of aggregation. Mr. Welch, the Chief Engineer of Kentucky, has been a close observer of the geology of this part of the State, and he informed me that these ore beds are found in nearly all the knobs to the foot of the Narrows of the Licking. The Narrows commence a few miles below West Liberty, and continue down the Licking below the North Fork. They seem to be caused by the physical characters of the contiguous rocks. The conglomerate sandstone, which is the base of the coal formation, emerges at the level of the river, a few miles below West Liberty, and gradually attains a greater elevation, forming the hill tops about Yoakum creek and the North Fork. This rock, as well as the subjacent limestone which is seen in the valleys, is wasted away with difficulty by the weather and the action of water, and these rocks, or their equivalents, form cliffs and precipices along almost the whole boundary of the coal formation in Kentucky and Ohio. The same cause would prevent the formation of wide bottoms along the river, as there are undoubted evidences, that almost all our valleys have been formed by the action of running water, and the crumbling action of the weather. At the lower end of the Narrows, the slate rocks emerge from below the slaty sandstone that underlies the limestone, and here the valley widens and gives broad and beautiful bottom lands. The slate rock crumbles rapidly away into clay by exposure to the weather, and most of the earth resulting from its disintegration, is removed by the action of water. The broad and rich alluvial valleys of the streams in the slate region, are undoubtedly due to this wasting action of the weather on these rocks. The slate rock gradually attains a higher elevation in the hills to the westward of the Narrows, until, near Gill's mills, it is 100 to 200 feet above the river. The calcareous iron stone which has so frequently been mentioned as occurring in the slate rocks, was observed to abound in the cliffs along the Licking. In one cliff, on the bank of the river, the slate was crumbling rapidly away, and the slope was thickly strewed with blocks and nodules of the ore which had slidden down from their original position.

Three distinct courses of nodules were observed in the hill, within a thickness of 40 feet. One of the layers of ore was at least one foot thick, and was of good quality. The abundance of the slate ore, together with the ores of the limestone and conglomerate of this region, must, before many years, cause the erection of numerous iron works. Sandstone for the stacks and hearths, slate for the inn walls, coal and wood for the combustible and steam power, limestone for the flux, a variety of ores for mixture with each other, and water transport, which are necessary elements, are all combined in this region, and point with perfect certainty to the future wealth, and to the kinds of industry that will employ its population.

A furnace is being erected, or may perhaps now be in operation, about one and a half miles from Gill's mills, on the road to Owingsville. It is supplied with ore from the vicinity. The ore lies on the limestone, and just beneath the surface. Its extent is not known. It is stated to be from one to four feet thick. It is a limonite, which seems to have lost a part of its water of combination. It is reddish brown, compact, earthy, columnar, and of various imitative forms.

Iron ore was seen abundantly about ten miles from Owingsville, on the road to Gill's mills. It is visible in many of the hills.

N. B. Buford, Esq. one of the State Engineers, in his report, says—

"Iron ore is first found in the vicinity of the river, at Ringo's mill, 140 miles above its mouth. Ore beds, of about four feet in thickness, occur in the hills on the left bank, and extensive beds are found in the hills on the opposite bank, near Fox creek.

"The Iron district on Slate creek was accurately described in the report of the Chief Engineer last year, as also the beds of it in the vicinity of Beaver creek.

"My own examinations have led me to believe that the iron ore which occurs near the river, from Cane creek to Beaver creek, at distances between 180 and 193 miles from the mouth of the river, is more abundant, and of as good quality, as in any other part of the State. The ore is found in veins of from five to fifteen feet thick, near the bases of the hills, and in beds of from three to ten feet thick, near their summits, and is found overlaying the stratum of limestone, which has been above described.

"Iron ore is also found in most of the hills between Slate creek and West Liberty, and near McClure's mill the beds are very extensive."*

The bed of iron ore near the Slate Furnace, has already been described. Its geological position is on the fossiliferous limestone, which underlies the slate rock so often mentioned. It is therefore lower, in geological position, than any of the other great iron deposits of the State. These are—

1st. Bog ore, which is of limited extent, and local.
2d. The various ore beds of the coal formation.
3d. The ore bed between the conglomerate and the cavernous limestone.
4th. The calcareous ores of the slate formation.
5th. The ore bed between the slate and the fossiliferous limestone.

Iron ore was seen in small quanties, near the junction of the slate with the lower or fossiliferous limestone, a few miles from Owingsville, on the road to the mouth of the Big Sandy river. It was limonite.

The nodular calcareous ore was seen in the slate cliffs, on the banks of the Licking, and of Triplett's creek, in several places, from six to eighteen miles from Owingsville.

Iron ore was observed abundantly in all the hills of the first divide of the western waters of Tygart's creek. This includes the bed below the conglomerate, and also those above the conglomerate, at the base of the coal measures. From this region, to the mouth of the Little Sandy, almost every hill that was examined was found to contain iron ore, in the greatest abundance. It lies in beds parallel to the strata, which dip very slightly to the east and east-south-east, with a variable thickness of from one inch to several feet. The resources of this region, in this mineral, are perfectly inexhaustible. Several furnaces are already in successful operation, and the time cannot be far distant, when it will be considered one of the most valuable iron districts in the country.

* Engineer's Report, 1837—page 95.

STATEMENT *of Blast Furnaces and Forges in the State of Kentucky, extracted from the Report of the Honorable D. Trimble to the Legislature of Kentucky, at the session of* 1337–'8, *page* 20.

OWNERS' NAMES.	Names of Furnaces in Greenup Co.	Tons of metal per annum.	Charcoal per ton, in bushels.	Tons of ore per ton of metal.	Forges in Greenup.
Shreve, Paul & Co. -	Bellefonte, -	1200	283	2.72	1
Shreve, Poage & Co. -	Amanda, - -	1000	283	2.80	
Trimble, Woodrow & Co	Raccoon, - -	1300	280	2.50	
D. & J. Trimble, -	Argillite, - -	800	280	2.50	1
Wm. Ward, - -	Hopewell, - -	600	280	2.50	1
G. W. Darlington, -	Globe Furnace, -	600	275	3.00	
M'Coy, Poage & Co. -	Clinton, - -	950	260	3.15	
Stewart, Greene & Co.	Caroline, - -	750	300	2.75	1
Do. do. - -	Kentucky Steam,	650	300	2.75	1
Cuddy, Lathrop & Co.	Oakland, - -	600	300	3.50	
Ward & M'Murtrey, -	Pactolus, - -				

The quantities of metal made at the following furnaces and forges is not known.

OWNERS' NAMES.	COUNTIES.	Furnaces.	Forges.	REMARKS.
Robert Wickliffe, -	Bath, - -	1	1	Calcareous oolitic limonite; oldest fur. in the S.
Jackson & Wheeler, -	Estill, - -	1	1	Valuable works.
John H. Baker, - -	Bullitt, - -	2	1	One rolling mill on Salt river.
Miller & Irvine, -	Nelson, -	1		
Holderman's heirs, -	Green, - -		1	
Do. do. -	Hart, - -	1		
Harrison & Co. - -	Green, - -	1	1	
Buckner, Churchill & Co.	Hart, - -	1		
Buckner & Churchill,	Muhlenburg, -	1	1	
———— ———, -	Bath, - -	1		
Total, - -	- - -	21	11	

TABLE *showing the iron manufactured in Greenup County, annually, from information collected by Henry J. Eastin, Engineer, from the Engineer Report of* 1837, *page* 145–146.

OWNERS' NAMES.	FURNACES.	Days in blast.	Stone coal used.	Price per bushel.	Charcoal used.	Price per bushel.	Limestone used.	Price per ton.	Ore used.
		No.	Bushels.	Cents.	Bushels.	Cts.	Tons.	Dolls. Cts.	Tons.
Shreve, Paul & Co. -	Bellefont, -	132	15,840	7	178,690	3½	126½	1 00	1,613½
Shreve, Paul & Co. -	Bellefont, -	118	10,170	7	155,400	3½	157½	1 00	1,453
Shreve, Paul & Co. -	Amanda, -	300	–	–	364,000	3½	550	2 00	3,250
D. Trimble & Co. -	Raccoon, -								
D. Trimble & Co. -	Sandy, -	270	372,501	3	190,000	2½	–	–	3,000
McKoy, Ponge & Co. -	Clinton, -								
McCuddey & Co. -	Oakland, -	202	32,640	4½	181,220	3½	214	1 25	1,626
Wm. Stewart & Co. -	Caroline, -								
Col. Watd, - -	Little Sandy, -								

TABLE—Continued.

OWNERS' NAMES.	FURNACES.	Price per ton.	Ore per ton of iron.	Charcoal used per ton of iron.	Stone coal per ton of iron.	Limestone per ton of pig iron.	Iron made per day.	Total tons of pig iron made during the blast.	Total made in Greenup Co. per annum.
		D. C.		Bushels.	Bushels.	Tons.	Tons.	Tons.	Tons.
Shreve, Paul & Co.	Bellefont,	3 25	2.72	283.1	25.00	0.21	4½	594	
Shreve, Paul & Co.	Bellefont.	3 25	2.72	283.1	25.00	0.21	5.07	599	
Shreve, Paul & Co.	Amanda,	-	-	-	-	-	-	1,100	
D. Trimble & Co.	Raccoon,	1 75	2.50	332.	-	0.42	4.33	1,300	
D. Trimble & Co.	Sandy,	-	-	-	-	-	-	800	
McKoy, Poage & Co.	Clinton,	2 50	3.15	200.	39.2	-	3.52	950	
McCuddy & Co.	Oakland,	-	-	-	-	-	-	500	
Wm. Stewart & Co.	Caroline,	3 00	2.75	302.	54.33	0.36	3.0	600	
Col. Ward,	Little Sandy,	-	-	-	-	-	-	600	7,043

The slate rock and its valuable mineral contents, such as iron ore, mineral springs, salt licks, &c., have been frequently referred to. This rock, and its sub-jacent limestone, which has been described as the "great limestone," are the rocks that underlie most of that portion of the State called the garden of Kentucky. The character of the country underlaid by this rock varies very greatly, according to its thickness above the limestone, and the contiguity of large streams. Near the rivers, the country underlaid by the slate is very broken, in consequence of the tendency of this rock to crumble by exposure to the weather, while the rills and streams wash it away, and thus cut down deep and narrow valleys. At a greater distance, where the drainage is not so rapid, it forms level, fine lands, of the best quality. The soils resulting from the mixed fragments of the slate and limestone, are not excelled in fertility, probably, in any part of our country.

The slate contains pyrites in many places, and by the decomposition of the rock, and of this mineral, copperas and alum are formed, and it is not improbable that localities will be discovered, where these materials may be manufactured with profit for commercial purposes.

The slate frequently contains small quantities of gypsum, and this material is frequently formed by the combination of lime from the rock, and sulphuric acid derived from the decomposition of pyrites. The decomposed slate rock is well adapted in many parts of the State for use as a mineral manure, and it cannot be many years before it will be extensively employed for this purpose.

NITRE. SALTPETRE. NITRATE OF POTASSA.

This substance has been made in considerable quantities in Kentucky, but it is believed that but little is now manufactured, although there are abundant means. The nitre occurs in two different geological situations in Kentucky, viz: in the cavernous limestone, and in the superincumbent conglomerate.

In the first, it is found in the earth of the caverns, in the form of nitrate of lime, and perhaps other nitrates, which are decomposed by leaching the ley from these earths through wood ashes. The nitrates are thus converted into nitrate of potassa, which is called nitre or saltpetre. The nitrates in the caverns are sometimes in an unctuous clay, which, when wet, becomes very plastic, and from which water will separate but a small quantity of the nitre. This is the most difficult to work.

The "nitre" of the conglomerate sandstone above the limestone, is frequently a nitrate of lime, which requires the addition of wood ashes or of potassa, before the nitre of commerce can be procured. The situations in which the nitrous earth is found, are very striking. This kind of sandstone forms precipitous ledges of rock, which frequently overhang their basis, along almost the whole of the western edge of the coal formation of Kentucky and Ohio. The rock crumbles away below, by the crystalization of the nitrous particles, and these, with the sandy grains fall below. The rock overhangs its base, and grottos of greater or less extent are formed. Some have been seen from 100 to 300 feet in length, and with the rock overhanging from 10 to 40 feet.

The earth beneath them is more or less impregnated with nitre, and even the rock seems sometimes cemented by it.

These grottoes are commonly, and very appropriately, called rock houses. They afford a fine retreat for wild and domestic animals during storms, and not unfrequently the traveller makes his camp in them.

Rock houses and nitre deposits are also found in the sandstones of the coal formation, but they are not so numerous as in the conglomerate sandstone at the base of the coal series.

MINERAL SPRINGS.

The mineral springs already known in Kentucky, are numerous and important, and to many of them a high value is justly attached. Others, that are known to the inhabitants of the vicinity, are not generally appreciated as they would be, were they brought properly before the public. All the mineral waters of the State, as well as the various mineral substances, that may be of scientific or economical interest, ought to be carefully analyzed by an analytical chemist of the highest attainments, in whose results the most implicit confidence can be reposed. The results of such investigations would, undoubtedly, tend to improve the modes of application of some of our materials, and introduce more perfect methods in the manufactures of many of the mineral products. The purification of salt waters, the graining of salt in the form of alum salt, and improvements in the iron manufacture, may be anticipated as results to be derived from such investigations. Of all our mineral springs, the salt springs are of more economical importance than all the others. They are numerous, and already furnish large supplies of salt for the consumption of the State. They do not seem to be confined to a particular geological position, as has been supposed the case in some other States, but the brine is found in the coal measures, and in the subjacent slate and limestone formations, of such strength as to warrant the manufacture of salt, where there is a sufficient demand, or means of easy transport.

I have not yet been able to procure the details to show the statistics of the salt manufacture of Kentucky, but it is estimated that from 500,000 to 1,000,000 bushels of salt are made annually at the different salines of the Commonwealth. The salines on Goose creek, near Manchester, alone, manufacture about 200,000 bushels per annum.*

Burning springs and gas springs are not uncommon. Of the former, the petroleum (which is the oily scum that is inflamable) is occasionally saved, but it ought to be made a business to save this material for commercial purposes. It is applied to several uses, and commands a high price in the eastern markets. Many hundred, and probably many thousand, barrels might be annually collected at the different springs in the State, and would produce an amount worth noticing as one of our mineral products.

The gas springs are also not uncommon. Those evolving carburetted hydrogen, which takes fire and burns with a white flame, are most numerous, and are capable of useful applications. They are natural "gas works," and in New York some of them are already economized, so as to light villages, light-

*Mr. Snyder, Engineer, Report of Kentucky, 1837, page 124.

houses, &c., and they might, also, where abundant, in connection with salt springs, be economized in boiling salt, or for warming houses, and a variety of other purposes.

The more common mineral springs, such as chalybeate springs, sulphur springs, &c., are numerous, and many of them are known, although few are appreciated. They are natural medicinal everflowing fountains, appointed by an allwise Creator to cure, or allay many of the diseases incident to the climate, and as the country becomes more densely peopled, they will, doubtless, be more fully appreciated. Some, as the Olympian springs, Harrodsburg springs, &c., are already the annual resort of the invalid, and of much of the wealth and fashion of the country.

None will be mentioned in this report that have been before made known.

A copious chalybeate spring was seen on the left bank of the North Fork of the Kentucky, about 1½ miles above the mouth of Troublesome creek.

Another was seen within 100 yards of Mr. Haddock's house, near the mouth of Troublesome creek.

A small chalybeate spring was seen at Joe's Lick.

Chalybeate springs are particularly numerous in the slate region of Kentucky, and many of the more noted licks are in this rock.

LIMESTONE.

This rock underlies a large portion of the State, and in different parts, gives great variety to the physical aspect of the country, as well as the agricultural character of the soil. The limestones of Kentucky are as various in their appearance, and fossil and mineral contents, as in their geological position.

The principal masses of limestone rocks occupy three distinct geological positions in this State. They are all more or less fossiliferous, containing the remains of marine animals. They are—

1st. The limestone beds in the coal formation.
2d. Cavernous, below the conglomerate and above the slate rock.
3d. Great limestone below the slate.

1st. The LIMESTONE BEDS OF THE COAL FORMATION are not very thick, but are adapted for building, for lime, for a flux with ores in the iron furnaces, and in some places, perhaps, for an ornamental stone or marble.

2d. The CAVERNOUS LIMESTONE occupies an extensive area, and its general limits may be understood by remarking, that it is the rock under the "Barrens" of Kentucky. These Barrens were so called from the fact that no trees grew there, while the other parts of the State were overshadowed by a dark forest of heavy timber, and covered in many parts by an almost impenetrable cane brake. The Barrens were covered with a growth of fine grass. The subjacent limestone is so cavernous, that almost all the water sinks into the caves and fissures of the rocks, and flows in streams beneath the surface, which occasionally emerge and soon sink again to renew their subterranean course. Water is rarely seen, and it is often exceedingly difficult to procure it, even for ordinary domestic uses. The soil is highly productive, and nothing tends so much to prevent its occupation, and productive and extensive tillage, as the want of an abundant supply of water for domestic uses, and

for farm stock. It is believed, after examining the country, that this defect may be remedied to a certain extent, and perhaps entirely, by boring artesian wells in the same way as salt wells are bored. It is believed that the water will probably rise to, or near the surface, and perhaps overflow in many places, so as to supply perpetual springs, which will be as valuable as the natural ones. Should the augur pass into any fissures of the rock during the boring, it would be necessary to tube the well below that point, and have the tube fit so closely, that there would be little leakage.

The reason that the Barrens were not covered with timber, is supposed to have been due to the dryness of the soil, and the sweeping of the praire fires over them annually, thus scorching and destroying the tender shoots of the young trees that might yearly spring up. It is still so in the great western prairies, in which the praire fires annually sweep over almost the whole of the open country, where the soil is not so wet as to arrest the progress of the fire, and there no trees are to be found. except in the vicinity of such wet places.

Since the settlement of Kentucky, the praire fires (which were often made for the purpose of driving out the game,) have ceased, and the Barrens are now covered by a thick growth of timber, where they are not occupied as farms.

This limestone, which I have called the cavernous limestone, occupies an area of some 5,000 to 8,000 square miles in Kentucky. In most places it makes lime of a superior quality, and it will be used in future to a much greater extent than it has been, not only for mortar, but for supplying lime to the soil, as a mineral manure.*

This limestone is, also, well adapted for use as a bnilding stone, and in some places for a variegated and clouded marble.

A stratum of silicious matter which varies in its texture from a hornstone to a porous material like buhrstone, is found in many places in the cavernous limestone. The compact variety of this material was long used by the early settlers for flints for their rifles. Another form of it is used for hones. The coarser varieties are frequently seen of such a quality and texture, as to fit them for millstones. The localities of these materials are frequently called flint knobs, and their surfaces are thickly strewed with silicious masses. However repulsive such lands may appear for agricultural purposes, they are found to yield fine crops, to repay the husbandman for his labor.

3d. The GREAT LIMESTONE as I have called it, from its extensive distribution, not only in Kentucky, but over a great area of the western country, is more slaty as a mass, than the cavernous limestone, and abounds in fossils. Many of its layers disintegrate on exposure to the weather, and form a soil of almost unequalled fertility. Fossil shells abound in the soils resulting from the decomposition of this rock, and may be collected in great

*The importance of liming soils that have been long cultivated, is beginning to be appreciated in the New England States, and in New York, New Jersey, and Pennsylvania. Some millions of bushels are consumed annually in those States, as a mineral manure, and the limestone beds where they are near water transportation, have become very valuable. They are sold at from $100 to $1,000 per acre. The manufacture of lime, for agricultural purposes, has there become an important business.

numbers.* The general aspect of the country, underlaid by this rock, is level or gently undulating, and covered with heavy crops where it is cultivated, and by a dense forest where the land is wild.

Many of the strata of this rock make good lime.† Some of them seem to be adapted to the manufacture of hydraulic cement; some of them make a beautiful building stone; some are clouded, and would make a fine marble, and some of them seem to be of uniform texture, and sufficiently compact for lithography. These varied uses of this rock must, at no distant period, give employment to many people and much capital: and the sooner the important locations, for these various branches of business, shall be discovered, the sooner may the citizens of Kentucky expect to reap the benefits to be derived from such developments of the mineral resources of the State.

The citizens of Kentucky, as a body, are agriculturists, producers of a *single kind*, and as a consequence, the mass of their products must seek a distant market. It is necessary for the interest of the State, that the citizens should be more nearly equalized in their relative numbers, all of which should be producers in their respective occupations. More iron masters and colliers are needed, with their numerous dependents; more manufactories of every kind, for which there are the greatest natural facilities to produce the varied materials required for the comfort, convenience, and necessities of the population, and to furnish a *home market* for a large share of the agricultural products.

Land in many parts of Kentucky is sold for a small fraction of its value, and frequently far below its worth for agricultural purposes. The advantage is altogether on the side of the buyer of landed property, not only in Kentucky, but in most parts of the United States. The land is valued, bought and sold according to its location and agricultural productiveness, regardless of its mineral wealth, which is often of far greater importance. A gentleman in Henderson informed me that he sold several hundred acres of land, on the Green river, underlaid by a bed of coal three feet thick, perfectly accessible, for fifty cents per acre. He did not realize until told, that by making a liberal allowance for waste, and allowing a profit of one cent only per bushel, it ought to have given him a clear profit of $1,000 per acre. Similar instances might be multiplied, but a single example will suffice to illustrate the value of our mineral deposits, where they are accessible to cheap transport.

*Among these are several species of the Productus, Spirifer, Terebratula, Pentamerus, Encrinus, Pentremite, Eschara, Cyathophyllum, Turbinolia, Fungites, Millepora, and many others which will be specifically noted and described during the progress of the geological survey, should the Legislature authorize it.

†Geodes of quartz are very abundant in a part of the great limestone. They occur in a particular layer of the rock and as this disintegrates, they remain in loose masses. The surface of the country where this stratum emerges, is thickly strewed with them. They are generally hollow, lined with chalcedony or agate, and with crystals of quartz, amethyst, or calcareous spar, and they vary in size from a grape shot to the heaviest bomb shells. Beautiful specimens of the abovementioned minerals may be procured. They may be applied to use as ornamental stones and gems.

Among the minerals found in veins in this limestone, sulphate of baryta, carbonate of baryta, galena, and fluor spar may be mentioned, but no veins of such a size as to warrant mining, have yet been observed.

In some parts of Europe, the mineralogical and geological survey of estates is considered as important as the ordinary survey to ascertain the number of acres. A long period cannot elapse in the United States, before a knowledge of the mineral products, or the probability of mineral wealth, of particular kinds, beneath the soil, will be considered necessary in the valuation of landed property.

RESULTS TO BE ANTICIPATED FROM THE SURVEY.

Should the Legislature see fit to authorize a geological and mineralogical survey of the State of Kentucky, it is believed that if it be executed in the manner contemplated, it will result in apprizing landed proprietors of resources in mineral wealth, of which they are now ignorant; enable them to appreciate and profit by those already known; inform the people what particular mineral substances may be expected in the various sections of the State; indicate the best means of searching for them, and recognizing them when found; tend to encourage mining enterprizes, where there is a certainty of success, and to repress and expose their fallacy, where there are not sufficient indications to justify expenditure; diffuse the various kinds of knowledge necessary in mining and metallurgic operations; attract public attention to the mineral wealth of the State; cause an additional influx of population and capital, to extract the mineral substances for use, and transport them to a market; raise the value of lands far above their present value; and, finally, it will give an additional impulse to the enterprize and industry, which are, even now, adding millions to the wealth of the community.

Another effect consequent upon the preceding, will be an increased demand for subsistence, for mechanical and professional labor of every kind, and all the necessaries and wants of civilized life, giving a tone and vigor to every branch of business.

The beneficial effects of such surveys are already felt in the various States that have authorized them, the impulse is given, it is progressive, and no State can long consent to remain with her natural resources hidden and unknown, when the expenditure of a few thousands of surplus capital, will return millions to her citizens.

W. W. MATHER,
Geologist and Mining Engineer.

Jackson C. H., Jackson County, Ohio,
December 28th, 1838.

APPENDIX.

In the preceeding *Report*, the reconnoisance of the mineral districts of Kentucky, and the results that are likely to flow from a prosecution of the Geological and Mineralogical survey of the State have been discussed. In order to conform to the joint resolution of the General Assembly of the Commonwealth, in relation to the Geological survey, it is necessary for me to submit a plan for conducting the survey, and estimates of the amount of funds necessary to execute it.

PLAN SUGGESTED FOR CONDUCTING THE SURVEY.

1st. That the Governor appoint a Chief Geologist, who shall have the general charge and supervision of the Geological and Mineralogical survey of the State.

2d. That the Geologist report annually, on or before the 1st of February to the Legislature, the ecomical results of the survey, in order that the people may reap some of the benefits during its progress.

3d. It shall be the duty of the Chief Geologist to have all mines, quarries, mineral beds, ores, &c., examined during the progress of the survey, if application be made by their proprietors, and to give an opinion, on consultation, as to the probable success of working any particular mine, mineral, quarry, &c.

4th. The Chief Geologist shall prepare a geological map of the State, after the completion of the field duties of the survey, with suitable sections, diagrams, &c., to illustrate the general geological structure of the State; and he shall, also, prepare a detailed report after the completion of the survey, calculated to describe and illustrate the geology and mineralogy, both economical and scientific of the State, together with the results of the analyses of such minerals, ores, salts, soils. mineral waters, &c., as shall have been analyzed during the progress of the survey.

5th. That the Chief Geologist be empowered to employ such persons to assist him in the varied duties of the survey, as may be most conducive to its rapid and perfect accomplishment, and that he prescribe their duties, and have them accountable to him for their faithful performance.

6th. That an appropriation of $12,500 per annum* be made for four years, to complete the Geological survey of the State. This amount is deemed sufficient, while the disbursement of a less amount would tend to cramp the operations of the survey.

7th. That the funds be paid by the Treasurer of State, on the order of the Chief Geologist, specification being made to whom, and for what purpose, it shall be paid.

W. W. MATHER,
Geologist and Mining Engineer.

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* As the details for the execution of the contemplated geological survey, are not specified above, I will proceed to give them, lest some should think the above amount a prodigal expenditure; and prefix to the organization proposed, a sketch of the organization of the geological boards of some other States. The Geological Board of the State of New York, of which I have the honor to be a member, was the first that was organized with a view to a *complete survey of a State in all its natural resources*. This Board is composed of eight persons, each the head of a separate department, viz: one Botanist, 1 Zoologist, 1 Palaeontologist, 1 Chemist and Mineralogist, and 4 Geologists.

The Botanist is charged with a botanical survey of the State, and his duties involve not only a description of all the plants of natural growth, but also every thing connected with the best modes of culture and of obviating the various diseases of plants, and particularly those that are extensively cultivated as grains, fruits, and esculent roots.

The Zoologists duties, involve a description of all the animals, insects, fishes, shells, &c., of the State, with the best modes of rearing and breeding those that are useful, and of destroying, or obviating the effects of noxious insects, which frequently, from a lack of knowledge of their species and habits, disappoint the hopes of the agriculturist, by destroying or injuring his crops.

The duties of the Mineralogist and Chemist, involve a description of all the localities of the various minerals of the State, with their uses and practical applications, and also, an analysis of all the minerals, mineral waters, soils, &c., with a view to improve modes of application, manufacture, or cultivation.

The Palaeontologist, is charged with the examination of all the fossil remains and petrifactions found in the rocks of the State. This might seem to many a matter of little *practical* importance,

GLOSSARY OF WORDS USED IN THIS REPORT.

Alluvial. The adjective of Alluvium.

Alluvion. A synonim of Alluvium.

Alluvium. Recent deposits of earth, sand, gravel, mud, stones, peat, shell banks, shell marl, drift sand, &c., resulting from causes now in action. This term is generally applied to those deposits in which water is the principal agent.

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but it has, notwithstanding, an important bearing in tracing out the deposites of particular minerals of great economical value, and the want of the results of the labors in this department of geological science, has, in several parts of the country, led to the expenditure of thousands upon thousands of dollars, in fruitless research after particular mineral substances, where the observations of the practical geologist, aided by the palaeontologist, would at once say, there was not the least probability of finding the objects of their search.

Each of the four Geologists has charge of the investigations over his particular district, which embraces about one fourth of the area of the State. He examines county by county, observing and examining all the rocks, minerals, soils, springs, every thing natural that is inanimate; traces out the mineral deposits, rocks, quarries, mines, marbles, peat, marl, and their extent; estimates the quantity, facilities for working and mining, transport to market; and, in fact, every thing that may render them available and valuable to their owners; and he informs the owner of his discoveries on his estate, before any information upon the subject is communicated to any other individual; and, finally, at the close of each season, the economical results of his examinations are communicated to the Legislature, through the Governor.

The Geological Board is organized upon the principle of division of labor, by which each head of a department of the survey shall confine his observations to a limited sphere of inquiry, and thus be enabled to carry out the details of his department, with a much greater degree of perfection, that if his attention was diverted by many branches of investigation.

There is but one fault in this organization. The geological branch has no head, and there cannot, under such circumstances, be that unity of design, and perfection of execution, that there would be under the mode proposed.

The vote authorizing the Geological survey of New York was unanimous, and an appropriation was made, of $104,000 for its execution. Nearly $80,000 of this sum is believed to have been expended.

The oraganization of the Geological Board of Ohio, scarcely differs from that of New York, except that there is a head, styled the "Principal Geologist," who has the general superintendence of the survey, and who gives unity and concert of action in all the details of its operations. There is, however, a Topographical Engineer attached to the Board, whose duty it is, under the direction of the Principal Geologist, to execute a survey, and make a complete map of the State, as a basis for an accurate geological map, which shall shew the extent and distribution of each of the rocks, minerals, mines, quarries, mineral springs, &c. &c. of the State. The only defect in this oganization, is, that the assistants deriving their appointments and commissions from the Governor, that system of accountability, control and efficiency, cannot be attained, that is so desirable for the rapid and perfect execution of the survey, and that could be, if they were selected by, and dependent on, the head of the Geological Board.

Ohio made an appropriation of $12,000 in 1837, and a bill is now reported for an annual appropriation of $12,000 for the continuance of her Geological survey.

Pennsylvania is having a Geological survey executed, and the organization of her Board is upon nearly the same basis as that which I have suggested. A Chief Geologist is appointed and commissioned by the Governor. He superintends and directs the general operations of the survey, examines with the assistants the more important points, and gives tone and vigor to every part. The assistants are selected and appointed by him, and so it should be, for he alone is responsible for the faithful execution of his trust, and a man of reputation, will, of course, select for assistants, only such as are well qualified to discharge the various duties of the survey. Pennsylvania has, it is believed, appropriated $20,000 per annum for her Geological survey.

The proposed organization would be as follows: One Principal Geologist; threo Geologists, each in separate sections of the State; one Chemist for the analysis of minerals, ores, &c.; one Botanist and Zoologist; and if the Legislature see fit, one Agricultural Department.

The Chemical Laboratory for the analysis of the minerals, ores, soils, mineral waters, &c. &c., ought, in my opinion, to be located at the seat of Government of the State, and be put in such a state of efficiency, that the various mineral substances that may be sent there, by individubls from the different counties, by the members of the Legisature, shall be analyzed during the session, and the results made known on their return to their constituents.

Alum rocks. Rocks which, by decomposition, form Alum.

Amorphous. Bodies devoid of regular form.

Amygdaloid. A trap rock which is porous and spongy, with rounded cavities scattered through its mass. Agates and simple minerals are often contained in these cavities.

Anthracite. A species of mineral coal, hard, shining, black, and devoid of bitumen.

Anticlinal. An anticlinal ridge or axis is where the strata along a line dip contrariwise, like the sides of the roof of a house.

Arenaceous. Sandy.

Argillaceous. Clayey.

Augite. A simple mineral of variable color, from black through green and gray to white. It is a constituent of many volcanic and trappean rocks, and is also found in some of the granitic rocks.

Avalanche. This term is usually applied to masses of ice and snow which have slidden from the summits or sides of mountains. It is now also applied to slides of earth and clay.

Basalt. One of the common trap rocks. It is composed of Augite and feldspar, is hard, compact, and dark green or black, and has often a regular columnar form. The palisades of the Hudson show the columnar aspect of trap rocks. The Giants' causeway is cited as an example of Basaltic rocks, and the columnar structure is there very strikingly displayed.

Bitumen. Mineral pitch, which is often seen to ooze from fossil coal when on fire.

Bituminous Shale. A slaty rock, containing bitumen, and which occurs in coal measures.

Blende. Sulphuret of Zinc. A common shining zinc ore.

Bluffs. High banks of of earth or rock with a steep front. The term is generally applied to high banks forming the boundaries of a river, or river alluvions.

Botryoidal. Resembling a bunch of grapes in form.

Boulders. Rocks which have been transported from a distance, and more or less rounded by attrition or the action of the weather. They lie upon the surface or loose in the soil, and generally differ from the underlying rock in the neighborhood.

Breccia. A rock composed of angular fragments cemented together by lime or other substances.

Calc Sinter. A German term for depositions of limestone from springs, and waters which contain this mineral in solution.

Calcareous rocks. A term synonimous with limestones.

Calcareous Spar. Crystallized carbonate of lime.

Carbon. The combustible element of coal.

Carbonates. Chemical compounds containing carbonic acid, which is composed of oxygen and carbon.

Carbonic Acid. An acid gaseous compound, incapable of supporting combustion, and deleterious to animal life. It is common in caves and wells, and many incautions persons loose their lives in consequence of descending, without first ascertaining its presence by letting down a lighted candle. Man cannot live where a candle will not burn freely.

Carboniferous. Coal bearing rocks. This term has been applied to a formation belonging to an ancient group of secondary rocks which contains coal.

The term is now u ed in a more enlarged sense, and may be applied to any rocks containing coal.

Chert. A siliceous mineral, approaching to chalcedony, flint and hornstone. It is usually found in limestone.

Chlorite. A soft green scaly mineral, slightly unctuous.

Chloritic Slate. Slate containing chlorite.

Clinkstone. A slaty feldspathic or basaltic rock, which is sonorous when struck.

Cleavage. The separation of thin laminae of rocks and minerals in certain constant directions. They are not always parallel to the planes of stratification, but are often mistaken for them.

Coal formation. Coal measures. These terms are considered synonimous, and refer to the great deposit of coal in the older secondary rocks, which has been called the "independent coal formation." There are, however, deposits of carbonaceous matter in all the geological periods, and several of them might also be called coal formations.

Conformable. When strata are arranged parallel to each other, like the leaves of a book, they are said to be conformable. Other strata lying across the edges of these may be conformable among themselves, but *unconformable* to the first set of strata.

Conglomerate, or Puddingstone. Rocks composed of rounded masses, pebbles and gravel cemented together by a siliceous, calcareous, or argillaceous cement.

Cretaceous. Belonging to the Chalk formation.

Crop out and out crop. Terms employed by Geologists and Mining Engineers, to express the emergence of rock, in place, on the surface of the earth at the locality where it is said to crop out.

Crystalline. An assemblage of imperfectly defined crystals, like loaf sugar and common white marble.

Delta. Alluvial land formed at the mouths of rivers.

Denudation. A term used to express the bare state of the rocks over which currents of water have formerly swept, and laid the rocks bare, or excavated them to form valleys of denudation.

Deoxidize. To separate oxygen from a body.

Dyke. A kind of vein intersecting the strata, and usually filled some unstratified igneous rock, such as granite, trap or lava. These materials are supposed to have been injected in a melted state into great rents or fissures in the rocks.

Diluvium and *Diluvion.* Deposits of boulders, pebbles, and gravel, which many geologists have supposed were produced by a diluvial wave or deluge sweeping over the surface of the earth.

Dip. Where strata are not horizontal, the direction in which their planes sink or plunge, is called the direction of the dip, and the angle of inclination, the angle of dip.

Dolomite. A magnesian limestone belonging to the primary class. It is usually granular in its structure, and of a friable texture.

Dunes. Sand raised into hills and drifts by the wind.

Earth's Crust. The superficial parts of our planet which are accessible to human observation.

Eocene. The strata deposited during the oldest of the tertiary epochs, as, for example, the Paris Basin.

Estuaries. Inlets of the sea into the land. The tide and fresh water

streams mingle and flow into them. They include not only the portion of the sea adjacent to the mouths of rivers, but extend to the limit of tide water on these streams.

Exuviæ. In Geology, fossil remains.

Fault. A dislocation of strata, at which the layers on one side of a dyke or fissure have slidden past the corresponding ones on the other. These dislocations are often accompanied by a dyke. They vary from a few lines to several hundred feet.

Feldspar. One of the simple minerals, and, next to quartz, one of the most abundant in nature.

Ferruginous. Containing iron.

Fluviatile. Belonging to a river.

Formation. A group of rocks which were formed during a particular period, or which are referred to a common origin.

Fossils. The remains of animals and plants found buried in the earth, or enclosed in rocks. Some of these are but slightly changed, others are petrified and the organic replaced by mineral matter; some have decayed and left the impression of the bodies, while others have been formed by mineral matter deposited in the cavities left by the decay of the organic body. The form and structure of the original body both remain. In casts, the exterior form alone is preserved. Fossils are also called organic remains.

Fossiliferous. Containing organic remains.

Galena. An ore of lead composed of lead and sulphur.

Garnet. A simple mineral, which is usually red and crystallized. It is abundant in most primitive rocks.

Gneiss. A stratified primary rock, composed of the same materials as granite, but the mica is distributed in parallel layers, which give it a striped aspect.

Geology. A science which has for its object to investigate the structure of the earth, the materials of which it is composed, the manner in which these are arranged, with regard to each other; and it considers the action of all natural causes in producing changes, such as the effects of frost, rain, floods, tides, currents winds, earthquakes and volcanos.

Economical Geology refers to the applications of geological facts and observations to the useful purposes of civilized life.

Granite. An unstratified rock, composed generally of quartz, feldspar and mica, and it is usually associated with the oldest of the stratified rocks.

Graywacke Grauwacke. A group of strata in the transition rocks; but the term has been so indefinitely applied, that other names will probably be substituted.

Greenstone. A trap rock, composed of hornblende and feldspar.

Grit. A coarse-grained sandstone.

Gypsum. A mineral, composed of sulphuric acid and lime, and extensively used as a stimulant manure, and for making stucco and plaster casts, &c. It is also called Plaster of Paris.

Hornblende. A mineral of a dark green or black color, and which is a constituent part of greenstone.

Hornstone. A siliceous mineral, approaching to flint in its characters.

In Situ. In their original positions where they were formed.

Laminae. The thin layers into which strata are divided, but to which they are not always parallel.

Lacustrine. Belonging to a lake. Depositions formed in ancient as well as modern lakes, are called lacustrine deposits.

Landslip. It is the removal of a portion of land down an inclined surface. It is in consequence of the presence of water beneath, which either washes away the support of the superincumbent mass, or so saturates the materials that they become a slippery paste.

Line of Bearing, is the direction of the intersectionof the planes of the strata with the plane of the horizon.

Lignite. Wood naturally carbonized and converted into a kind of coal in the earth.

Littoral. Belonging to the shore.

Loam. A mixture of sand and clay.

Mural Escarpment. A rocky cliff with a face nearly vertical like a wall.

Mammillary. A surface studded with smooth small segments of spheres like the swell of the breasts.

Mammoth. An extinct species of the elephant.

Marl. By this term an argillaceous carbonate of lime is usually implied. By custom, its signification is much more extended, and means mineral substances, which act as stimulating or fertilizing manures. There are clay marls, shell marls, and various others.

Mastodon. A genus of extinct fossil animals allied to the elephant. They are so called from the form of the grinders which have their surfaces covered with conical mammillary crests.

Matrix. The mineral mass in which a simple mineral is imbedded, is called its *matrix* or *gangue.*

Megatherium. A fossil extinct quadruped resembling a gigantic sloth.

Mechanical origin, Rocks of. Rocks composed of sand, pebbles or fragments, are so called, to distinguish them from those of a uniform crystalline texture, which are of chemical origin.

Mica. A simple mineral having a shining silvery surface, and capable of being split into very thin elastic leaves or scales. The brilliant scales in granite and gneiss are mica.

Mica Slate. One of the stratified rocks belonging to the primary class. It is generally fissile, and is characterized by being composed of mica and quartz, of which the former either predominates, or is disposed in layers, so that its flat surfaces give it the appearance of predominating.

Miocene. One of the deposites of the tertiary epoch. It is more recent then the *eocene* and older than the pliocene.

Mollusca. Molluscous animals. "Animals, such as shell fish, which, being devoid of bones, have soft bodies."

Mountain Limestone. "A series of limestone strata, of which the geological position is immediately below the coal measures, and with which they also sometimes alternate."

Muriate of Soda. Common Salt.

Naphtha. A fluid volatile inflamable mineral, which is common in volcanic districts, and in the vicinity of the Salt Springs of the United States.

New Red Sand-stone. "A series of sandy and argillaceous, and often calcareous strata, the prevailing color of which is brick red, but containing portions which are greenish grey. These occur often in spots and stripes, so that the series has sometimes been called, the variegated sand-stone. The European, so called, lies in a geological position immediately above the coal measures."

Nodule. A rounded, irregular shaped lump or mass.

Old Red Sand-stone. "A stratified rock, belonging to the carboniferous group of Europe."

Oolite. "A limestone, so named, because it is composed of rounded particles like the roe or eggs of fish. The name is also applied to a large group of strata characterized by peculiar fossils."

Organic Remains. See *Fossils.*

Orthoceratite. The remains of an extinct genus of molluscous animals, called Cephalopoda. The orthoceratites are long, straight, conical chambered shells.

Out-crop. See *Crop-out.*

Out-liers. Hills or ranges of rock strata, occurring at some distance from the general mass of the formations to which they belong. Many of these have been caused by denudation, having removed parts of the strata which once connected the out-liers with the main mass of the formation.

Oxide. A combination of oxygen with another body. The term is usually limited to such combinations as do not present active acid or alkaline properties.

Palaeontology. A science which treats of fossil remains.

Pisolite. A calcareous mineral, composed of rounded concretions like peas.

Pliocene. The upper, or more recent tertiary strata. This group of strata is divided into the older and newer pliocene rocks.

Petroleum. A liquid mineral pitch. It is common in the region of salt springs in the United States.

Porphyry. A term applied to every species of unstratified rock, in which detached crystals of feldspar are diffused through a compact base of other mineral composition.

Productus. An extinct genus of fossil bivalve shells.

Plastic Clay. One of the beds of the Eocene period. The plastic clay formation is mostly composed of sands with associated beds of clay.

Pudding Stone. See *Conglomerate.*

Pyrites. A mineral composed of sulphur and iron. It is usually of a brass yellow, brilliant, often crystalized, and frequently mistaken for gold.

Quartz. A simple mineral, composed of silex. Rock crystal is an example of this mineral.

Rock. All mineral beds, whether of sand, clay, or firmly aggregated masses, are callen rock.

Sand-stone. A rock composed of aggregated grains of sand.

Saurians. Animals belonging to the lizard tribe.

Schist. Slate.

Seams. "Thin layers which separate strata of greater magnitude.

Secondary Strata. "An extensive series of the stratified rocks, which compose the crust of the globe, with certain characters in common, which distinguish them from another series below them, called primary, and another above them, called tertiary."

Sedimentary Rocks.—Are those which have been formed by their materials having been thrown down from a state of suspension or solution in water.

Selenite. Crystallized gypsum.

Septaria. Flattened balls of stone, which have been more or less cracked

in different directions, and cemented together by mineral matter which fills the fissures.

Serpentine. A rock composed principally of hydrated silicate of magnesia. It is generally an unstratified rock.

Shale. An indurated slaty clay, which is very fissile.

Shell Marl—Fresh water Shell Marl. A deposit of fresh water shells, which have disintegrated into a grey or white pulverulent mass.

Shingle. The loose, water-worn gravel and pebbles on shores and coasts.

Silex. The name of one of the pure earths which is the base of flint, quartz, and most sands and sand-stones.

Silt. "The more comminuted sand, clay and earth, which is transported by running water."

Simple Minerals—Are composed of a single mineral substance. Rocks are generally aggregates of several simple minerals cemented together.

Slate. A rock dividing into thin layers.

Stalactite. Concreted carbonate of lime, hanging from the roofs of caves, and like icicles in form.

Stalagmites. Crusts and irregular shaped masses of concreted carbonate of lime, formed on the floors of caves, by deposits from the dripping of water.

Stratification. An arrangement of rocks in strata.

Strata. Layers of rock parallel to each other.

Stratum. A layer of rocks; one of the strata.

Strike. The direction in which the edges of strata crop out. It is synonymous with *line of bearing*.

Syenite and *Sienite.* A granitic rock, in which hornblende replaces the mica.

Synclinal line and *Synclinal axis.* When the strata dip downward in opposite directions, like the sides of a gutter.

Talus. In geology, a sloping heap of broken rocks and stones at the foot of many cliffs.

Tertiary Strata. "A series of sedimentary rocks, with characters which distinguish them from two other great series of strata—the secondary and primary—which lie beneath them."

Testacea. "Molluscous animals, having a shelly covering."

Tepid. Warm.

Thermal. Hot.

Thin out. Strata which diminish in thickness until they disappear, are said to *thin out*.

Trap—Trappean Rocks. Ancient volcanic rocks, composed of feldspar, hornblende and augite. Basalt, greenstone, amygdaloid and dolerite, are trap rocks.

Travertin. "A concretionary lime-stone, hard and semi-crystalline, deposited from the water of springs."

Tufa, Calcareous. "A porous rock, deposited by calcareous waters on exposure to air, and usually containing portions of plants and other organic substances incrusted with carbonate of lime."

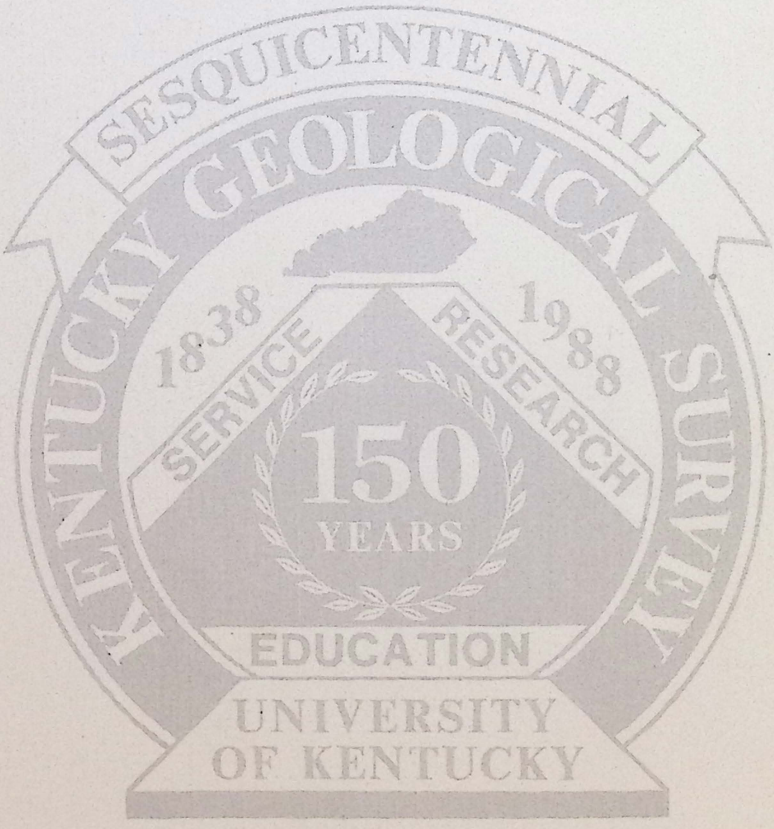
Tufaceous. A texture of rock like that of tuff.

Tuff or Tufa. "An Italian name for a volcanic rock of an earthy texture."

Unconformable. See conformable.

Veins. Cracks and fissures in rocks filled with stony or metallic matter. Most of the ores are obtained from metallic veins.

Zoophytes. Corals, sponges, and other aquatic animals allied to them.


SESQUICENTENNIAL
KENTUCKY GEOLOGICAL SURVEY
1838
1988
SERVICE
RESEARCH
150
YEARS
EDUCATION
UNIVERSITY
OF KENTUCKY