GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

CHEMICAL REPORT

OF THE

Soils, Coals, Ores, Clays, Marls, Iron, Slags, Mineral Waters, Rocks, Etc.,

OF KENTUCKY.

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The fifth Report in the New Series, and the ninth since the beginning of the Geological Survey.

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INTRODUCTORY NOTE.

CHEMICAL LABORATORY OF KENTUCKY GEOLOGICAL SURVEY,
STATE A. AND M. COLLEGE, LEXINGTON, Dec., 1883.

JOHN R. PROCTER, *Director of Kentucky Geological Survey:*

DEAR SIR: Herewith I respectfully submit to you the report of the chemical work performed in this laboratory for the Geological Survey since the publication of my last report.

Yours, etc., ROBERT PETER.

CHEMICAL REPORT.

In the present report the results are given of more than two hundred chemical analyses. There are of

Soils and subsoils	16
Coals	112
Cokes	19
Mineral waters	26
Limestones	19
Sandstones	2
Clays	2
Iron ores	15
Pig irons and slags	4
Marls, ochre, coprolite	3
Total	218

The SOILS AND SUBSOILS are from four counties only, viz.: Morgan, Nelson, Shelby, and Spencer, representing, respectively, coal measures, upper silurian, and upper Hudson river formation soils.

The six coal-measures soils from Morgan county, with the exception of the virgin woodland soils, do not probably represent the best average soil of that region, having been collected on the water-shed of the Licking river, where they have been subjected to the leaching action of the atmospheric waters, or on the bottom land bordering the stream. But they all may be profitably cultivated under favorable conditions. It will be seen that the subsoil contains less carbonate of lime than the surface soil, also less of rocky fragments, and the old-field soils show in every case a dimunition of the essential elements of fertility as the result of continued cultivation.

The Shelby county soils, except No. 2436, which is on the upper silurian formation, are located on the upper Hudson river beds. Nos. 2430, 2431, and 3432 contain more than the average proportions of all the essential elements of fertility, and less than the average of sand and silicates, and should therefore be quite fertile under favorable conditions. Numbers

2433 and 2435 are remarkable for their large proportions of organic and volatile matters, alumina, etc., etc., and especially of carbonate of lime, No. 2435 containing as much as 25.245 per cent. of that ingredient, constituting it a kind of marl, and No. 2433 contains 4.695 per cent. more than has been observed in any other Kentucky soil heretofore analyzed. Their proportions of potash, extracted by acids, is also exceptionally large, being 2.015 per cent. in No. 2433 and 1.772 per cent. in No. 2435. They also contain much less than the usual quantity of sand and insoluble silicates, these being in the proportion of 61.045 per cent. in the former and only 47.295 in the latter soil. The former contains 8.2 per cent. of fragments of calcareous fossils and rock fragments, and the latter, which is a subsoil, as much as 41.2 per cent., and should be discounted in these proportions.

A certain small quantity of lime in the soil is essential to productiveness, as this substance is an indispensable element of all vegetable structures, and the influence of very large proportions of carbonate of lime on the soil has been ascertained to a certain extent by practical experiment and observation.

Applied in quantity to a heavy, wet, clay soil, lime, which soon becomes carbonate, makes it more light and friable, lessens its tendency to shrink and swell in dry and wet seasons, and allows water to evaporate from it more freely. But when the carbonate of lime is in too large proportion, untempered by clay, it forms a soil which parts with its water too readily, and becomes so light in times of drought that its surface may be blown away by the wind, conditions unfavorable to vegetation. The chemical relations of carbonate of lime are quite important. In contact with the insoluble silicates of the soil, it favors their decomposition, setting free, in a soluble form, their potash, soda, phosphoric acid, etc. It also greatly aids the decomposition, in the moist soil, of the organic matters present, causing the more rapid formation of carbonic acid and water and favoring the production of ammonia and nitrates—all essential food of plants. It also has the valuable property of absorbing and holding for the nourishment of vegetation, organic matters, ammonia, and other nitrogen compounds, and the phosphoric acid, which may

be in the air or water which penetrate the soil. Within proper limits, therefore, this ingredient of soils is very valuable, and the farmers of England especially, habitually apply it to their cultivated soils.

The old-field soil, No. 2434, from the same locality as these two calcareous soils, is remarkable for containing much smaller proportions of carbonate of lime and of the other essential ingredients than those, although it contains more than average quantities. It differs from them greatly also in its 83.31 per cent. of sand and insoluble silicates, and in containing no calcareous fossils or rock fragments, seeming to show that, although on the same farm, it may be located on a different geological substratum or bed.

The two Spencer county soils, soil and subsoil, from a very old field located on the upper Hudson river beds, yet retain full average proportions of the essential elements, organic matters, or *humus*, excepted. The surface soil contains more than average sand and silicates and phosphoric acid, less than average proportions of organic matters and potash, and about averages of alumina, lime, and magnesia. The subsoil contains more than average proportions of alumina, etc., phosphoric acid and potash, less than average of organic matters and sand and silicates, and about average lime and magnesia. Its proportion of potash is much above the average, and in both organic matters are quite deficient.

More than twenty years ago the late Prof. Liebig, then as now an "authority" on agricultural chemistry, promulgated his opinion, based, as we believe, on imperfect data, that the chemical analysis of soils is of no practical value. At once all the authors at second-hand took up the cry, and to this day copyists and others who have no taste for this kind of investigation, or who had not been trained to appreciate the value of its indications, while in accordance with the progress of agricultural chemistry they are obliged to attach great importance to the presence or absence of certain elements of fertility in soils, still keep up an inconsistent opposition to this mode of interrogating nature in aid of agriculture. One principal argument used by

these objectors is that the acid solvents used by the chemists in their analyses differ from the natural agents of solution by which the soil elements are made available for plant growth. But Liebig himself measurably destroyed the force of this objection when he called attention to the fact that plants do not derive their soil ingredients from the so-called "soil water" alone, but exert, through their rootlets, a direct solvent action on the particles of the soil; and the solvent is proved to be an acid one. The present writer, in experiments detailed in a previous report, proved that strong acids, such as oxalic and phosphoric acids,* enter into the composition of this peculiar solvent or digestive fluid of plants, by means of which solid ingredients of the soil are dissolved and made available for their nourishment and growth.

Time and experience have gradually set aside most of the objections which were made to this mode of studying the character and value of soils, and in a new country no other method is known by which the capabilities of the virgin soil can be so cheaply, speedily and certainly estimated. More especially is this true in Kentucky, where the soils have mostly been formed in place by the disintegration of the subjacent rocks, and not of transported materials.

We may briefly recapitulate some of the peculiar uses of soil analysis:

1. To teach the natural capabilities of the soil; its present probable fertility and durability under existing conditions.

2. To detect elements or conditions injurious to plant growth, and point out available remedies.

3. To show any surplus or deficiency of essential elements, and indicate the best remedies—fertilizers or mechanical agencies.

A good analysis of the soil of a homogeneous field may be beneficial for ages, if properly understood and judiciously taken as a guide in culture and the application of fertilizers.

A good exemplification of these facts appeared in a letter from Charles Bernard to the New York *Evening Post*, in 1871, giving an account of the extraordinary farming operations of

*See Vol. V., Ky. Geological Reports, N. S., pp. 239, 244.

Mr. John Prout, of London, on a worn-out clay farm of four hundred and fifty acres, near the town of Sawbridgeworth, in Hertford county, which were then making quite a stir in England. With underdraining, deep plowing, and the use of chemical fertilizers, bone-dust, superphosphates, etc., etc., without any barn-yard manure, he soon caused the unproductive soil to bear the largest crops ever known in the country.

To obtain this high and profitable improvement, Mr. Prout kept a chemist constantly employed on his farm, who reported regularly the composition of the soil of each field, and directed and superintended the application of the chemicals and fertilizers to make and keep the land fertile and productive. And Mr. Bernard reported the standing crops, which he personally examined, on the several fields to be, "without exception, of most extraordinary vigor and abundance." But the most remarkable novelty of Mr. Prout's management was that as the crops ripened they were all sold at auction and entirely removed by the purchasers from the ground, "so that the harvesting and marketing occupy one day." This plan was successfully continued year after year, and Mr. Prout's books showed a greater net profit than was obtained by any farmer in the country, although he expended $5,750 a year for fertilizers alone. Late reports, if the writer is not misinformed, stated that he was yet successfully carrying out this improved agriculture.

The one hundred and twelve Kentucky COALS analyzed, which are here reported, are from eighteen counties, viz.: Bell, Breathitt, Carter, Elliott, Floyd, Johnson, Knox, Laurel, Lawrence, Letcher, Magoffin, Martin, Morgan, Muhlenberg, Perry, Pike, Pulaski, and Whitley.

For comparison with our Kentucky coals, three samples each from Alabama and Tennessee and one from West Virginia were collected and analyzed, and the analyses of four celebrated Pennsylvania coking coals made by the chemist of the Geological Survey of that State are copied.

Of the samples of Kentucky coals, eighteen were of cannel coals. Of these the *average volatile combustible matters*, including No. 2291, (which, having as much as 20.60 per cent. of ash,

might probably be excluded as belonging rather to the bituminous shales than coals,) was 46.32 per cent. The average *ash* percentage of the *cannel coals* examined, excluding No. 2291, was 9.36: varying from 2.20 per cent. in No. 2369, Letcher county, to 19.50 in No. 2381, of Morgan county. It will be seen by reference to the table that several of the Kentucky cannel coals are more than equal in gas-making or gas-improving power, to the cannel coal of West Virginia, which is much used for that purpose.

The *specific gravity* of the coals, here reported, varies from 1.191 in No. 2354, of Letcher, with an *ash* percentage of only 2.60, to 1.634 in No. 2286, in Carter, with an *ash* percentage of 40.00. This latter, however, should more properly be called a bituminous shale than a coal. It is proposed to draw the line between these shales and coals proper on the ash percentage of 20.00, giving the name shale to all which have a greater percentage than this.

The *volatile combustible matters* of these coals (excluding the cannel coals) varies from 22.70 per cent. in No. 2346, from Letcher, which had an ash percentage of 9.54, to 40.90 per cent. in No. 2354, of Letcher, which had an ash percentage of only 2.60.

The *fixed carbon* in the coke varied from 33.76 per cent. in No. 2381, of Morgan county, to 67.60 per cent. in No. 2404, of Pike.

The *sulphur* varied from 4.527 per cent. in No. 2385, from Morgan county, to 0.390 per cent. in No. 2405, of Pike county.

Those coals which have the largest proportion of fixed carbon with the smallest percentage of sulphur are the best fitted for coking purposes, provided they have enough volatile combustible matters to cause them to soften and become porous in coking, and to afford heat enough by their combustion to effect the process without burning fixed carbon.

Cannel coals do not make good coke for the iron-smelting furnace, because, although they give more volatile combustible matter than most other coals, they do not soften much or become porous in coking. The so-called bituminous or soft coals, gen-

erally soften and swell too much for this use, and their coke consequently will not support the burden in the high furnace.

But the so-called splint, or semi-cannel coal, known in Indiana as "block coal," of which variety there is a vast quantity in Kentucky, characterized by its laminated structure and firm consistence, softens and swells less than the soft bituminous coal when exposed to heat, becoming a dense, firm coke with small pores, and consequently it is largely used without coking in the smelting of iron.

The softer and purer varieties of this coal, such as are found in Pike and other counties, are admirably adapted to the production of good coke, which compares most favorably with the best and most celebrated cokes of Pennsylvania. (See context, Bell and Pike counties, and Table II.)

Cannel coal, when heated, gives off without softening much combustible gas, which burns with a clear, luminous flame, from which it derived its name—cannel (Scotch) or candle coal. It owes this peculiar property to the fact that it contains oxygen in large proportion to its hydrogen and carbon. The soft bituminous coal, on the other hand, contains but little oxygen; its gas, mainly composed of hydro-carbons, burns with a more smoky flame, and it appproaches in physical properties the "bitumens" proper.

Anthracite coal is not to be found in Kentucky. This contains little or no volatile combustible matter, being mainly carbon and of the nature of a dense, compact coke. The Broad Top coking coal of Pennsylvania approaches anthracite in its large percentage of fixed carbon. (See Table III, and under Pike county.)

In the analysis of coals much depends on the collection of *average samples* of the bed. This has been carefully done in most cases, and in some samples of the several benches or layers have been separately collected and analyzed.

Of the nineteen cokes which have been analyzed, sixteen are from eight counties in Kentucky, and two are of the Jellico Mountain Coal and Coke Company's coke. The analysis of the celebrated Connellsville coke of Pennsylvania is copied from the Special Report L, of the second Pennsylvania Geological Survey.

The average percentage of *fixed carbon* in the sixteen Kentucky cokes is 90.61, including the very impure coke, No. 2326, of Hopkins county, which was made of unwashed impure slack coal; or, excluding this very exceptional sample, the fixed carbon average is 91.105 per cent., even when another very impure sample, No. 2325, from the same locality, is included; ranging from 77.20 per cent. in No. 2326, up to 95.70 per cent. in No. 2342, of Laurel county.

The *ash* percentage averages 7.44 per cent., including No. 2326, and 6.60 per cent. when this very impure coke is excluded; ranging from only 2.60 per cent. in No. 2449, of Whitley county, up to 13.80 per cent. in No. 2325, of Hopkins county, while it is 20.80 per cent. in the excluded sample, No. 2326.

The percentage of *sulphur* in these Kentucky cokes is 1.088 per cent., including the very impure No. 2326, or 0.907 per cent. when this sample is excluded; ranging from only 0.517 in No. 2414, of Pike county, up to 3.799 in No. 2326, of Hopkins county, above described.

Table III shows, however, that so far as chemical composition is concerned all of the Kentucky cokes reported, with two or three exceptions only, equal or excel the celebrated Connellsville coke of Pennsylvania, and there is no doubt that Kentucky possesses a large area of coal which is eminently fitted for the smelting of iron ores, either in the coked or uncoked condition.

Of the fourteen *iron ores* reported from Greenup, Johnson, and Pike counties, nothing especially new is to be stated. Numbers 2309, 2310, 2312, and 2316 contain a fair proportion of manganese, but not enough to make them available for the manufacture of *spiegeleisen*, used in the Bessemer steel process. In this connection, however, attention is called to a sample sent to the Chemical Laboratory of the Kentucky Geological Survey for analysis, in 1858 or 1859, by Messrs. Lampton, Nicholl & Co., the proprietors of Star Furnace, Carter county, labeled by them No. 6 and designated as "black ore," which on analysis was found to contain manganese equivalent to 39.677 per cent. of its brown oxide. (See Vol. 4, O. S., Kentucky Geological Reports, pp. 106-7, No. 862.) It is described as a "dark-col-

ored, friable ore; a nodular mass, with a soft brownish-yellow nucleus." If this ore is abundant it might be made useful in the manufacture of Bessemer steel.

The nineteen *limestones* described are from seven counties, viz.: Carter, Fayette, Franklin, Mercer, Nelson, Shelby, and Spencer; from the coal measures, upper silurian, chazy, upper Hudson, and Trenton formations. They vary greatly in their composition, as may be seen in the following comparative statement. Of the eleven samples of phosphatic limestone from the Trenton (lower silurian) formation of Fayette county, only their relative proportion of phosphoric acid was estimated. In the other eight different limestones:

The Carbonate of Lime ranged

From 96.380 per cent. in No. 2290, coal-measures limestone, of Carter county,
To 40.780 per cent. in No. 2437, upper silurian, ... of Shelby county.

The Carbonate of Magnesia ranged

From 30.720 per cent. in No. 2378, chazy limestone, ... of Mercer county,
To 1.135 per cent. in No. 2290, coal-measures limestone, . of Carter county.

The Alumina and Iron Oxide, etc., ranged

From 10.550 per cent. in No. 2379, chazy limestone, ... of Mercer county,
To .980 per cent. in No. 2290, coal-measures limestone, . of Carter county.

The Phosphoric Acid in the Nineteen ranged

From 11.650 per cent. in No. 2292–3, Trenton limestone, . . of Fayette county,
To a trace . . . . . in No. 2290, coal-measures limestone . of Carter county.

And the Silicious Residue in the Eight ranged

From 25.520 per cent. in No. 2437, upper silurian, ... of Nelson county,
To .380 per cent. in No. 2290, coal-measures limestone, . of Carter county.

The alkalies, potash, and soda were determined only in the three limestones from Nelson and Spencer counties, all three from the upper Hudson river beds. The potash in the Nelson county limestones is severally 0.423 and 0.443 per cent., and the soda 0.248 and 0.254 per cent. In that of Spencer county they exist in the proportions of 0.154 per cent. of potash and 0.212 of soda. In this limestone the phosphoric acid is equal to 1.842 per cent.; in that from Franklin county (lower Trenton) the phosphoric acid is 2.968 per cent., and in No. 2394, Nelson county, it is 1.202 per cent.

It will be seen that the coal-measures limestone is a remarkably pure carbonate of lime, which would give nearly 54 per cent. of pure, white quick-lime, containing but little magnesia, alumina, and iron oxide, manganese and silica. The limestones,

No. 2395 and 2437, from Nelson and Shelby counties, would probably yield good hydraulic cements, and those which have a large proportion of phosphoric acid are well fitted for improvement of soils, as well as for all the ordinary uses of lime or limestones.

Of the twenty-six *mineral waters* examined, only twenty were submitted to quantitative analysis; and as these were analyzed in samples sent to the laboratory in bottles, etc., the proportions of the gases in them could not be determined with accuracy. Five, from Anderson, Boyle, and Ohio counties, are *sulphur waters*, so-called from the presence in them of hydrogen sulphide gas, and as in the case with No. 2262, of Anderson county, a small proportion of sodium sulphide. Five, all from Boyle county, are *chalybeate waters*, so-called because they contain a notable quantity of compounds of iron, and ten, from Bell, Boyle, Kenton, and Logan counties, are denominated *saline waters*, from the predominance of alkaline and earthy salts in the composition of their saline materials.

The *sulphur waters* vary considerably in their saline contents, some of them, such as Nos. 2274, 2275, and 2276, are called "black sulphur waters," from the circumstance that the iron carbonate, which they contain in notable proportions, varying in the several springs, undergoes decomposition, together with the hydrogen sulphide gas, when the water is exposed to the atmosphere, and the sulphur of the gas uniting with the iron of the carbonate produce a black sulphide of iron, which forms the deposit from which the water takes its name. The black sulphur waters, which should be used only fresh at the spring, are always somewhat chalybeate. The Boyle county sulphur waters, with the exception of No. 2275, which is simply a chalybeate sulphur water, contain enough saline matters to make them slightly aperient, especially No. 2276. In this respect No. 2379, from Ohio county, resembles them, but it contains much more sulphate of lime. The sulphur water from Anderson county, No. 2262, exceeds them all in its proportion of saline matter, mostly sodium chloride—common salt—and is a stronger and more durable sulphur water because of its sodium sulphide. In this

respect it resembles the celebrated Blue Lick water. It, like most of the others, contains traces of bromine, lithia, etc. The Boyle county sulphur waters are also slightly alkaline, from the presence of carbonate of soda. This is especially the case with black sulphur, No. 2274, which may therefore be more diuretic than the others. No. 2276 comes nearest to it in this respect.

The five *chalybeate waters* are all from Boyle county. They are of two kinds, those which contain bi-carbonate of iron, such as Nos. 2269, 2271, and 2272, and those which contain sulphate of iron, viz.: Nos. 2270 and 2273. The latter, having 10.485 per thousand of saline matters, contains as much as 2.6761 of sulphate of iron and 5.3477 per thousand of sulphate of alumina. It is more properly to be called an *alum* water than a chalybeate, and is too strong in these salts to be commonly used internally. It also, like No. 2270, is acid from the presence of free suphuric acid. The safest chalybeates are those which contain the iron in the form of bi-carbonate, which is the case with Nos. 2269, 2271, and 2272; of these the first named is the weakest. On exposure of these waters to the air, the bi-carbonate of iron, which is held in solution in the carbonated water, is changed into insoluble hydrated peroxide of iron, which falls as a brownish or reddish sediment. Hence such water should always be drank fresh from the spring, unless care is taken to exclude the air perfectly by inclosing it, without much agitation, in bottles with tightly-fitting glass stoppers.

The ten *saline waters*, from Bell, Boyle, Kenton, and Logan counties, may be divided into *chloride* and *sulphate* water. No. 2280 (*a*) is the only one which comes under the first division, and is simply a weak salt water, containing 13.878 per thousand of sodium chloride—common salt—the remainder of its 19.200 of total saline matters is composed of carbonates of lime and magnesia, and sulphates of potash, lime, and magnesia, with traces of lithia and strontia. The other nine saline waters mostly contain sulphates of lime, magnesia, potash, and soda, with a small proportion of chlorides, and carbonates of lime, magnesia, soda, and iron, all in variable proportions. Some, as No. 2263, from Bell county, and No. 2277, from Boyle county, contain so little

saline matters—0.1077 and 0.1021 severally—in a thousand parts of the water, that they can not properly be included under the head of mineral waters, they being remarkably pure potable waters. No. 2280 (*a*), with its 0.686 of *total saline* matters, comes very nearly under the same classification.

According to recent reports of the influence of potable waters upon the health of communities,* a certain amount of saline matter in the water is useful and necessary to health, provided these mineral substances have representatives in the animal economy, which is the case with lime, magnesia, iron, potash, soda, sulphuric acid, phosphoric acid, chlorine, etc., etc.; but if the potable water is too pure—too free from these wholesome saline matters—"the health of the community using it suffers." The recognized healthy proportion of such saline matters "does not exceed 0.500 in the thousand of water, nor fall below 0.130 to the thousand." It is evident, however, that this statement would not apply in all localities.

Notwithstanding these facts it is well known that some of the most celebrated waters in the world—widely known from their great curative action in many cases of disease—are found to be, on analysis, like Nos. 2263 and 2277, *nearly pure water;* and the demonstration is thus given that in certain conditions of the animal economy, where a depurative remedy is necessary or appropriate, the free use of pure water becomes a good curative agency when applied with discretion.

The remainder of these saline waters contain sulphates of lime, magnesia, potash, and soda, etc., in sufficient quantities to make them laxative in their action. Some, as Nos. 2280, 2278, and 2263, contain some carbonate of soda. All have a small quantity of carbonate of iron, especially No. 2371, of Logan county, which has 0.326 of this material, making it notably chalybeate, and No. 2278, of Boyle, which contains 0.102 per thousand.

Under the head of Boyle county is the description of certain coprolites, No. 2281, found at the base of the Waverley beds,

* See article "*Eaux Potables*," par A. Gautier. (*Wurtz: Dictionnaire de Chemie, etc.* T. 1 Part. 2. p. 1200.)

which gave on analysis as much as 29.1 per cent. of phosphoric anhydride (P_2O_5). Under that of Floyd county, No. 2304, are described certain other phosphatic concretions, of irregular conical and somewhat spiral forms, probably coprolites, which are found in apparently a more recent clay, which have the property of changing from their original light-grey to a grey-blue color on exposure to the atmosphere—which gave as much as 8 per cent. of phosphoric anhydride.

A sandstone, No. 2393, from Nelson county, Boston district, collected by Mr. Linney in the black Devonian slate formation, very full of fossil relics of fishes, etc., gave on analysis 11.162 per cent. of phosphoric anhydride—equivalent to 24.372 per cent. of bone phosphate.

ANDERSON COUNTY.

No. 2262—Mineral Water: "*From a bored well, eighty feet deep. Sample sent by Henry S. Carl, of Lawrenceburg.*" *Received October 2, 1883.*

A sulphur water. It had made a slight light-grey deposit in the bottles.

Composition, *in 1000 Parts of the Water.*

Hydrogen sulphide and carbonic acid gases	Not estimated.	
Iron carbonate	0.0046	Held in solution by carbonic acid.
Lime carbonate	.1827	
Magnesia carbonate	.1434	
Lime sulphate	.0700	
Potash sulphate	.0441	
Calcium chloride	.0314	
Magnesium chloride	.1140	
Sodium chloride	4.5000	
Sodium sulphide	.0410	
Silica	.0236	
Lithia, bromine, etc., etc	Not estimated.	
Total saline matters	5.1548 in 1000 parts of the water.	

A good saline sulphur water, very slightly chalybeate, resembling in general properties the celebrated Blue Lick water, but containing somewhat less saline matters than that. The amount of the gases and of the minuter ingredients could only be ascertained by operating on the water fresh at the well and in larger quantities than was furnished for the present analysis.

BELL COUNTY.

No. 2263—"MINERAL WATER: *From Clear Creek Springs, about four miles above Pineville.*" *Collected by Roger C. Ballard, July 11, 1883.*

The water was brought in half-gallon glass preserve bottles, with tight metal covers and rubber collars. It had no perceptible odor when received at the laboratory, although Mr. Ballard states it smells of hydrogen sulphide at the spring. It was almost tasteless and perfectly colorless, with a very slight flocculent, brownish deposit in the bottles. "The inhabitants of the region believe they derive benefit from its use as a mineral water.

COMPOSITION, *in 1000 Parts of the Water.*

Carbonate of lime	0.0356	Held in solution by carbonic acid.
Carbonate of magnesia	Trace.	
Sulphate of lime	.0056	
Sulphate of magnesia	.0246	
Chloride of calcium	.0027	
Carbonate of soda	.0316	
Silica	.0076	
Iron oxide, alumina, etc.,	Trace.	
Total saline matters	0.1077	in 1000 parts of the water.

This is nearly a pure water, which could not strictly be classed with mineral waters proper. This, however, does not prevent it from exerting a curative influence in many cases, as it is well known that several so-called mineral waters celebrated because of the cures attributed to their use have been found, by analysis, to be almost pure water. Pure water in proper quantity is a very good depurative agent.

No. 2264—COAL: "*T. G. Killum's, four and a half miles from Pineville and eight and a half miles from Cumberland Gap.*" *Collected by Roger C. Ballard, August 5, 1883.*

A firm, pure-looking coal, containing very little fibrous coal or mineral charcoal. Fracture generally irregular-cuboidal, with glossy, pitch-like surfaces. A few fragments of shaley coal included in the sample, and a little of bright iron pyrites on some of the surfaces. A portion of a pyritous layer was excluded.

No. 2265—COAL: "*At the house of Benj. A. Rice, six miles above Pineville, on Caney Fork of Straight creek. Collected by Roger C. Ballard, July 3, 1883. Bed of coal thirty-six inches thick without any parting.*"

A remarkably pure looking coal; pitch black and very glossy on most of its surfaces; very little appearance of mineral charcoal or fibrous coal, and no apparent pyrites; fracture irregular.

No. 2266—COAL: "*Daniel Howard's, on Caney Fork of Straight creek, four miles above Pineville. Bed showing forty-eight inches of coal, including a three-inch parting of cannel coal.*"

A pure looking, pitch-black, glossy coal, showing very little fibrous coal and no apparent pyrites.

No. 2267.—COAL: "*Fred. Barner's bank, Yellow creek. Collected by Roger C. Ballard, July 28, 1883. A sample of the coal which would be used in coking on a large scale, throwing out the upper two inches and the seam of iron pyrites.*"

(See next following coal.)

A remarkable bright and and pure-looking, soft coal. Fracture irregular and cuboidal; bright, shining on all the surfaces. Hardly any fibrous coal or pyrites. Its fine powder is of a rich, dark chocolate-brown color.

No. 2268—COAL: "*From same locality and bank as the next preceding sample. An average sample from the entire bed of thirty-four inches. A seam of iron pyrites runs through the bed, twelve inches from the bottom, and another an inch or so from the top; the upper being not so regular as the lower.*"

Resembles the next preceding, but is not so bright as that and shows more iron pyrites.

No. 2269—COKE: "*Made by Roger C. Ballard, from the coal of Fred. Barner's bank, Yellow creek, six miles from Pineville, and seven miles from Cumberland Gap, July 29, 1883.*"

Quite a hard, spongy coke. Most probably if coked in larger quantities its pores would be smaller.

COMPOSITION OF THESE BELL COUNTY COALS AND COKE.

(*Air-dried.*)

	No. 2264	No. 2265	No. 2266	No. 2267	No. 2268	No. 2269
Specific gravity	1.344	1.241	1.254	1.270	1.281	*a* 1.871
Hygroscopic moisture	1.00	1.00	1.10	.86	.86	.06
Volatile combustible matters	32.70	37.46	36.44	36.04	35.60	.60
Coke	66.30	61.54	62.46	63.10	63.54	99.34
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	33.70	38.46	37.54	36.90	36.46	.66
Fixed carbon in the coke	52.80	60.48	59.66	59.20	57.88	93.34
Ash	13.50	1.06	2.80	3.90	5.66	6.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light Spongy.	Spongy.	Spongy.	Light Spongy.	Light Spongy.	Spongy.
Color of the ash	Lt. ch'te-grey.	Salmon-colored.	Lt. ch'te-grey.	Br. lilac-grey.	Br. lilac-grey.	Dk. pur.-brown.
Percentage of sulphur	2.115	.593	.613	2.032	2.455	1.335

a The specific gravity was taken with the coarsely-powdered coke.

With the exception of No. 2264 these coals are remarkably rich and pure, containing much less than the average proportions of ash and sulphur. The coke, No. 2269, prepared from coal No. 2267, contains but little more than one half of the sulphur which was originally in the coal from which it was made, and, except in its sulphur, compares very favorably with the celebrated Connellsville coke of Pennsylvania, which is so extensively used all over the continent that 8,000 coke ovens, of a daily capacity of 15,000 tons of coke, are in constant operation.*

The COMPOSITION OF CONNELLSVILLE COKE, made by Frick & Co., and analyzed by McCreath, at the Chemical Laboratory of Geological Survey of Pennsylvania, is as follows:

Water (at 225° F.), hygroscopic moisture	.030
Volatile matters	.460
Fixed carbon	89.576
Sulphur	.821
Ash	9.113
Total	100.000

*Scientific American, November 18, 1882, p. 323, from which the above analysis is copied. See Pike county for analysis of the Connellsville coking coal.

The Bell county coke contains nearly 4 per cent. more carbon, and more than 3 per cent. less ash than the Connellsville, and only has about half of 1 per cent. more sulphur than that.

BOYLE COUNTY.

Mineral Waters.

No. 2269—CHALYBEATE MINERAL WATER: "*From four miles, E. of N. of Danville, in a deep gorge on Harrod's Run, or Mock's branch, about 300 yards from where it enters Dix river. The cliffs of limestone are about 300 feet high, and the spring runs out about twenty feet above their base from a horizontal crevice in the rock. Clear as crystal when it first issues and colorless, but becomes red and turbid after a few hours. Water sent by Mr. Edward H. Fox, of Danville. Received September 17, 1881.*"

No. 2270—CHALYBEATE MINERAL WATER: "*From a well eight feet deep, at the Camp Ground near Danville Junction. Sent by E. D. Fox, September 29, 1883.*"

No. 2271—OLD CHALYBEATE SPRING WATER: "*From Alum Springs, on the Knoxville branch of the L. & N. R. R., and half a mile from Danville Junction, on the C. S. R. R. Water sent by Joseph Maxwell.*"

No. 2272—CHALYBEATE WATER: "*From so-called Phosphorus Spring. From same locality as next preceding.*"

COMPOSITION OF THESE CHALYBEATE MINERAL WATERS.

In 1000 Parts of the Water.

	No. 2269	No. 2270	No. 2271	No. 2272
Carbonic acid gas, not estimated	....	....	....	....
Held in solution by carbonic acid: Carbonate of iron	0.0298	....	0.1862	0.1654
Carbonate of manganese	....	....	trace.	trace.
Carbonate of lime	.2257	....	.0199	.0307
Carbonate of magnesia	.0102	....	.0093	.0133
Sulphate of iron (Fe SO4)	....	.1977	....	....
Sulphate of potash	.0067	.0235	.0140	.0140
Sulphate of lime	.0313	.2917	....	....
Sulphate of soda	.0275	.1521	....	....
Sulphate of magnesia	....	.2250	....	....
Magnesium chloride	.0068	....	....	....
Sodium chloride	....	....	.0042	.0078
Free sulphuric acid	....	.0082	....	....
Silica	.0071	.0384	.0012	.0033
Undetermined and loss	....	.0874	....	....
Total saline matters in 1000 parts of the water	0.3451	1.0240	0.2348	0.2345

The waters numbered 2269, 2271, and 2272 are good chalybeate waters, containing their iron in the form of ferrous carbonate, which is held in solution by carbonic acid, but which on standing exposed to the air separates as ferric hydrate in a reddish sediment. The water No. 2270 contains its iron in larger proportion, in the form of ferrous sulphate—copperas—and hence should be used with greater caution and only under the advice of a physician. This precaution is yet more necessary in regard to the water next to be described.

No. 2273—Alum Water: "*Dipped from a small basin, about fifty yards from the Chalybeate well, No. 2270. Sent by Edward H. Fox, September 29, 1881.*"

Composition, *in 1000 Parts of the Water.*

Sulphate of iron (ferrous sulphate)	2.6761
Sulphate of alumina	5.3477
Sulphate of lime	.4994
Sulphate of magnesia	.1350
Sulphuric acid	.2871
Alkaline salts, silica, etc. (undetermined)	1.5397
Total saline matters, etc.	10.4850

No. 2274—Sulphur Water: "*Pumped from a bored well, forty feet deep, about 150 yards from the chalybeate well, No. 2270. Sent by E. H. Fox, September 29, 1881.*"

Composition, *in 1000 Parts of the Water.*

Hydrogen sulphide and carbonic acid gases	Not estimated.	
Carbonate of iron	0.0097	Held in solution by carbonic acid.
Carbonates of lime and magnesia	.0314	
Sulphate of potash	.0164	
Sulphate of soda	.1841	
Chloride of sodium	.1204	
Carbonate of soda	.5089	
Silica	.0191	
Total saline matters	0.8900	in 1000 parts of the water.

This is a mild, saline, alkaline sulphur water, slightly chalybeate. On exposure to the air, the iron combines with the sulphur and forms the black sediment.

No. 2275—Black Sulphur Water: "*From Alum Springs, a spring on the Knoxville branch of the L. & N. R. R., half a*

mile from the Danville Junction on the C. S. R. R. Sample sent by Joseph Maxwell."

COMPOSITION, *in 1000 Parts of the Water.*

Hydrogen sulphide and carbonic acid gases	Not estimated.	
Carbonate of iron	0.0342	Held in solution by carbonic acid.
Carbonate of lime	.0396	
Carbonate of magnesia	.0216	
Sulphate of potash	.0066	
Sulphate of soda	.0080	
Chloride of sodium	.0040	
Carbonate of soda	.0870	
Silica	Not estimated.	
Total saline matters	0.2010	in 1000 parts of the water.

This water resembles the next preceding, but is more strongly chalybeate and much less saline and alkaline than that.

No. 2276—BLACK SULPHUR WATER: "*From a spring called Linney's Well, at Linnietta Springs, formerly Central Kentucky Camp Grounds. Sent by J. S. Linney, Danville, Ky.*"

COMPOSITION, *in 1000 Parts of the Water.*

Hydrogen sulphide and carbonic acid gases	Not estimated.	
Carbonate of iron	0.010	Held in solution by carbonic acid.
Carbonate of lime	1.490	
Carbonate of magnesia	.023	
Sulphate of lime	.267	
Sulphate of magnesia	.160	
Sulphate of potash	.192	
Chloride of sodium	.247	
Chloride of potassium	.006	
Carbonate of soda	.288	
Lithia and bromine	Traces.	
Silica	Not estimated.	
Total saline matters	2.683	in 1000 parts of the water.

Also a mild, alkaline, chalybeate sulphur water, containing more of the aperient salts than any of the other sulphur waters described above.

No. 2277—WATER: "*From a well eight feet deep, called Petroleum Spring, at Alum Springs. Locality given above. Sent by Joseph Maxwell.*"

No. 2278—EPSOM MINERAL WATER: "*From so-called Fale's Spring at Linnietta Springs. Sent by J. S. Linney, September, 1883.*"

No. 2279—MINERAL WATER: "*Same locality; from so-called Knott's Spring. Sent by J. S. Linney, September, 1883.*"

No. 2280—MINERAL WATER: "*Same locality; from so-called Peter's Spring. Sent by J. S. Linney, of Danville. Received September 13, 1883.*"

COMPOSITION OF THESE BOYLE COUNTY MINERAL WATERS.

In 1000 Parts of the Water. (Carbonic acid not estimated.)

	No. 2277	No. 2278	No. 2279	No. 2280
Held in solution by carbonic acid. Carbonate of iron	a trace	0.102	0.015	0.010
Carbonate of lime	0.0151	.198	.150	1.490
Carbonate of magnesia	.0278	.006	.017	.023
Sulphate of magnesia	trace	3.124	.930	.160
Sulphate of lime	.0408	1.766	.601	.267
Sulphate of potash	.0024	.249	.050	.192
Sulphate of soda	.0016	.152	1.624	. . . .
Chloride of calcium	.0086	. . . .	. . . .	. . . .
Chloride of potassium	. . . .	. . . .	. . . .	.006
Chloride of sodium	trace	n. e.	. . . .	.247
Carbonate of Soda	. . . .	.078	. . . .	.288
Lithia, (chloride or sulphate)	. . .	traces	* .031	† traces
Silica	.0058	n. e.	n. e.	n. e.
Total saline matters in 1000 parts of the water	0.1021	5.675	3.418	2.683

* Lithium chloride. † Bromine, a trace.

Of these waters No. 2277 is nearly pure water, being only slightly calcareous and chalybeate. It may be used for all domestic purposes although a little "hard." No. 2278 is a moderately strong Epsom water and is also slightly chalybeate. No. 2279 contains more sulphate of soda than of Epsom salt as compared with No. 2278, and might also, like that, prove aperient and alterative. No. 2280, containing less sulphate of magnesia than these, has more common salt (chloride of sodium) and sulphate of potash, and is slightly alkaline from the presence of more carbonate of soda. No doubt it would prove diuretic, alterative, and slightly ant-acid.

No. 2280 (A)—"*Water from a salt well forty feet deep, four and a half inches in diameter, about three or four hundred yards from the yards of the Junction City depot, Danville, and about forty yards from the sulphur well, No. 2274. Owned by J. S. Linney. Sample sent by Edward H. Fox, October, 1881.*"

The water had deposited a slight whitish sediment. It had no sensible odor, but a salty taste, and was neutral with litmus paper.

COMPOSITION, *in 1000 Parts of the Water.*

Carbonate of lime	1.454	Held in solution by carbonic acid.
Carbonate of magnesia	1.367	
Sulphate of lime	.139	
Sulphate of potash	.145	
Chloride of sodium	13.878	
Silica, traces of strontia and lithia n. e., and loss	2.217	
Total saline matters	19.200	in 1000 parts of the water.

A weak salt water; too weak to be profitably used for the production of common salt.

No. 2280 (B)—MINERAL WATER: "*From a well ten feet deep, at Linnietta Springs, called by Mr. Linney, 'Procter's Well.'*"

COMPOSITION, *in 1000 Parts of the Water.*

Carbonic acid gas	Not estimated.	
Carbonate of iron	0.035	Held in solution by carbonic acid.
Carbonate of lime	.118	
Carbonate of magnesia	.014	
Sulphate of lime	.240	
Sulphate of magnesia	.128	
Sulphate of potash	.022	
Sulphate of soda	.112	
Chloride of sodium	.007	
Silica	.010	
Lithia, etc., traces	Not estimated.	
Total saline matters	0.686	in 1000 parts of the water.

This is nearly pure water, very slightly chalybeate, which would be wholesome as ordinary drink.

No. 2281—COPROLITES: "*From the base of the Waverly formation, Boyle county. Collected by William M. Linney. Received October 17, 1882.*

Shapes generally oblong, spheroidal or ovoid, somewhat flattened. Exterior of a dull brownish-grey color; interior darker and irregularly cellular. Some of them contained fragments of fossil bones.

On examination they were found to contain bituminous matter, ferrous carbonate, and a considerable proportion of phos-

phates, which in one analysis gave 29.10 per cent. of phosphoric acid (P_2O_5).

Another specimen, of a dark olive-grey color, sent by Mr. Linney at the same time, found at the base of the Waverly, proved to be semi-crystalline barium sulphate.

BREATHITT COUNTY.

No. 2282—COAL: *"From Haddock's Mines, thirty inches of cannel coal, with ten inches of other coal above, separated by one and a half inch parting. Sample collected by C. G. Blakely. Brought August 30, 1881."*

A pure-looking, firm, tough cannel coal. Fracture satiny in some of the laminæ. Some little pyrites observable, but no fibrous coal.

Two other analyses of this celebrated cannel coal have been made by the present writer; one published in Vol. I, Old Series of Reports of the Geological Survey of Kentucky, page 354, No. 160; the other in Vol. IV., N. S. of same Reports, page 39, No. 1705. These analyses are copied here for comparison.

COMPOSITION OF HADDOCK'S CANNEL COAL.

(*Air-dried.*)

	No. 2282	No. 160	No. 1705
Specific gravity	1.212	1.211	1.2[illegible]
Hygroscopic moisture	1.60	1.10	1.30
Volatile combustible matters	46.60	48.90	47.00
Coke	51.80	50.00	51.70
Total	100.00	100.00	100.00
Total volatile matters	48.20	50.00	48.30
Fixed carbon in the coke	46.80	47.00	44.40
Ash	5.00	3.00	7.30
Total	100.00	100.00	100.00
Character of the coke	Dense Spongy.	....	Dense.
Color of the ash	Lt. bro'h grey.	Buff colored.	Brown'h grey.
Percentage of sulphur	0.824	0.241	1.574

These three several analyses, made in the years 1855, 1876, and 1881, severally, show that the bed has measurably preserved uniformity of composition during the twenty-eight years of working. It is true that sample No. 1705 shows a higher specific gravity and more ash and sulphur than the other two samples; but it was stated at the time that this was a somewhat weathered specimen, soiled somewhat with earthy and ferruginous matters and showing more than the usual quantity of iron sulphide.

CARTER COUNTY.

No. 2283—COAL, NO. 7 OR COALTON COAL: "*Sample from the fifty-eight-inch bed, in about equal quantities from upper, middle, and lower layers, by Mr. Robert Ellwood, who brought the sample to the laboratory, November 18, 1881, from the Straight Creek Coal Company's mine, near Mt. Savage Furnace, by direction of H. W. Bates, Esq.*"

Bright, pure-looking coal, with very little fibrous coal or pyrites, except a few minute scales of bright iron bi-sulphide on one fragment. The sample was pounded up and thoroughly mixed for analysis.

No. 2284—COAL: "*Herron's cannel coal, on Little Sinking creek, near Aden Station; geological position No. 2. Bed twenty-six inches thick. Collected by A. R. Crandall, December 21, 1881.*"

A very tough, dull-black, cannel coal, showing no fibrous coal between its adherent laminæ. On some surfaces are impressions of minute leaves of ferns; a little pyrites on some portions; fracture, on some of the thick layers, broad conchoidal.

No. 2285—CANNEL COAL: "*Sent by J. M. Bent, Aden Station; owned by Mitchell & Bent, Mt. Sterling. Bed thirty inches thick.*"

An exceedingly tough cannel coal, dull black, showing no fibrous coal and very little pyrites; not readily cleaving into laminæ. Resembles the next preceding.

No. 2286—CANNEL COAL OR BITUMINOUS SHALE: "*From same locality as the next preceding; owned by same persons. Bed thirty inches thick; fifty feet below the next preceding.*

Dull-black or dark slate-colored; cleaving into thin, hard, laminæ, with no fibrous coal and very little appearance of pyrites; some ferruginous incrustations on the exposed surfaces.

No. 2287—CANNEL COAL: "*From Little Sandy. Bed twenty-three inches thick. Owned by Mr. Parsons. Sample from the top and bottom layers, sixteen feet from the outcrop. Sent by J. M. Bent, Mt. Sterling, May 11, 1882.*"

A very tough, pure-looking cannel coal; a portion breaks with some difficulty into irregular laminæ, with some reed-leaf-like impressions in the mineral charcoal between, with very little appearance of pyrites. Another portion is quite compact and homogenous, with flat semi-conchoidal fracture, showing no mineral charcoal or pyrites. Exterior surfaces with ferruginous incrustation.

For comparison with these Carter county cannel coals, the following described sample was sent by Mr. J. M. Bent at the same time for analysis. The result is given in the following table:

No. 2288—CANNEL COAL: "*From West Virginia, at Cannelton. Sample sent by Mr. J. M. Bent. Thickness of the bed, from fifteen to thirty-six inches. Owned by the Cannelton Coal Company. This coal is sold for making gas, in combination with eighty per cent. of common gas coal, in New York and Boston.*"

A very firm, pure-looking cannel coal, glossy black on some surfaces, not readily breaking into layers; fracture broad, irregular, conchoidal. Some little bright pyrites in some parts, but no apparent fibrous coal.

By reference to the table of compositions, it will be seen that the Carter county cannel coals Nos. 2284, 2285, and 2287 exceed this in their proportion of volatile combustible matter, while Table II., at the end of this Chemical Report, shows many cannel coals of Kentucky which are superior in many respects to this for gas-making and other purposes.

COMPOSITION OF THESE CARTER COUNTY AND WEST VIRGINIA COALS, ETC. (*Air-dried*).

	No. 2283	No. 2284	No. 2285	No. 2286	No. 2287	No. 2288
Specific gravity	1.299	1.291	1.203	1.634	1.233	1.185
Hygroscopic moisture	6.30	2.80	1.46	2.04	1.46	0.60
Volatile combustible matters . .	35.54	51.20	54.74	25.86	54.04	42.50
Coke	58.16	46.00	43.80	72.10	44.50	56.90
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	41.84	54.00	56.20	27.90	55.50	43.10
Fixed carbon in the coke . . .	54.82	35.30	33.80	32.10	34.76	49.50
Ash	3.34	10.70	10.00	40.00	9.74	7.40
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Pulverulent.	Dense friable.	Pulverulent.	Dense friable.	Dense.
Color of the ash	Lt. ch'te-grey.	Grey-buff.	Lt. buff-grey.	Lt. buff-grey.	Lilac-grey.	Grey.
Percentage of sulphur . . .	0.881	0.753	1.274	0.731	2.164	1.162

Clays from Carter County.

No. 2288—CLAY: "*From the land of Mr. J. M. Bent. (Is it a fire-clay?)*"

A nearly white clay, slightly tinted with greyish, with some irregular ferruginous mottling and infiltrations in the cracks, and minute scales of mica; quite plastic; burns of a very light flesh color, fuses into a light-grey slag before the blow-pipe. It is, therefore, not a fire-clay, but would make good and handsome terra-cotta objects. If purified from the small amount of oxide of iron it contains it would burn white.

No. 2289—FERRUGINOUS MARLY CLAY: "*From Limestone Mining Company, Limestone Station, Carter county. Sample sent by John R. Procter. Received August 23, 1883.*"

In lumps, easily broken, of a chocolate-brown color, containing small rounded grains of hyaline quartz, and small pebbles, more or less rounded, of various quartzose minerals. By washing, about one-fourth its weight of small rounded quartzose pebbles and fine sand was separated. The residue is a tough,

plastic clay, of a light chocolate color, fusing before the blow-pipe into a dark-colored, nearly black slag.

COMPOSITION, *dried at 230°–240° F.* (*Exclusive of the pebbles and sand.*)

Silica	62.680
Alumina	14.803
Iron peroxide	6.160
Lime carbonate	8.280
Magnesia carbonate	1.650
Phosphoric acid (P2 O5)	.217
Potash	3.108
Soda	.149
Water and loss	2.953
	100.00

This clay might be of some service as a marl on poor sandy soil, provided the cost of transportation does not preclude its use. The washed clay, or even the unwashed, might be employed in the manufacture of common pottery of various kinds.

No. 2290—LIMESTONE: "*Just above the Limestone iron ore and under the plastic clay. Willard, Carter county. Collected by A. R. Crandall. Received July 9, 1883.*

A compact limestone of a cream color, or very light buff, nearly white. Hardness=3.5. Fracture flat conchoidal. Does not adhere to the tongue.

COMPOSITION (*Air-dried*).

Lime carbonate,	96.380	= 53.973 per cent. of lime.
Magnesia carbonate,	1.135	
Alumina and iron oxide,	.980	
Phosphoric acid (P2 O5)	a trace.	
Manganese brown oxide,	.480	= 0.953 manganese carbonate.
Silica and silicates,	.380	
Moisture and loss,	.645	
Total,	100.000	

A very pure limestone, which would yield a pure, white lime, or, if slabs of sufficient size homogeneous in texture could be obtained, might answer for lithographic purposes.

ELLIOTT COUNTY.

No. 2291—CANNEL COAL: "*From head of Buck Fork of Middle Fork of Little Sandy river. Sample from a three and half feet bed (weathered). In the branch. Collected by A. R. Crandall.*

Evidently a much weathered sample, with earthy and ferruginous incrustations, which increase the proportion of the ash. Fracture generally dull, with small specks of mica in some parts. Some laminæ more dense and pure, with imperfect satiny luster on the cross fracture. No pyrites or fibrous coal apparent.

COMPOSITION (*Air-dried*). *Specific gravity 1.388.*

Hygroscopic moisture,	2.10	Total volatile matters,	43.44
Volatile combustible matters,	41.34		
Dense coke,	56.56	Carbon in the coke,	35.96
		Light lilac-grey ash,	20.60
Totals,	100.00		100.00
Percentage of suphur,	1.150		

No doubt the proportion of ash would be found much less in the unweathered coal deeper in the bed.

FAYETTE COUNTY.

No. 2292—PHOSPHATIC LIMESTONE: "*From the northern extension, opened July, 1880, of the same quarry, on the Newtown Turnpike, about three miles north of the city limits of Lexington, from which the other samples came, described in Vols. IV. and V., N. S., under the head of Fayette county. Collected by Robert Peter. (Lower silurian formation.)*"

Sample from the lower part of the quarry bed, of a dark, dull, bluish-grey color, showing only a few glimmering specks. Adheres to the tongue when dry. Under the lens many minute irregular granules, apparently of organic origin, are visible, with minute fragments of shells or crusts and some very small specks of pyrites.

By titration with uranic acetate this gave 11.34 per cent. of phosphoric acid (P_2O_5).

Six other samples, from the same locality, some bluish-grey and others weathered to a brownish color, gave of *earthy phosphates* an average of about twenty-seven per cent.

Three other samples from the same quarry, collected later from the quarried rock on the turnpike, having the same general appearance, and showing the minute dark-colored granules and the small fragments of shells described above, gave on an-

alysis by the molybdic-acid process, severally 5.692, 6.010 and 13.048, an average 8.25 per cent. of phosphoric acid (P_2O_5).

No. 2293—PHOSPHATIC LIMESTONE: *"From another quarry on the Newtown Turnpike, about half a mile beyond the first toll-gate beyond Lexington, on the farm of Randall Haley. Samples collected by Robert Peter from the rock used for mending the road."*

This resembles the samples from the other quarry in general appearance, as well as in the fact that it is found in irregular layers between harder and more crystalline, less phosphatic, rock.

On analysis by the molybdic process this yielded 17.651 per cent. of phosphoric acid (P_2O_5).

Subsequently, on a visit to the Haley quarry, four other samples were collected, which on careful analysis yielded severally 16.745, 12.268, 14.315, and 5.597, giving an average of 12.231 per cent. of phosphoric acid (P_2O_5).

There is good reason to suppose that these thin layers of rich phosphatic rock are generally to be found in the so-called blue limestone, which underlies the rich territory of the "Blue-grass" region, and help to give to the soil its great and durable fertility.

No. 2294—WATER: *"From a well bored 120 feet deep, in the southern suburbs of Lexington, in high ground, beyond the State A. and M. College, on Tate's-creek road. Collected by the Rev. John L. Smith."*

The water had a slight odor and taste of petroleum, and was said to have a slight sulphurous odor when fresh at the well, but when brought to the laboratory had no other gas but a small quantity of carbonic acid.

It gave, on evaporation to dryness, only 0.335 of a part of saline matters to 1000 parts of the water. These consisted of carbonates of lime, magnesia and soda, and a small proportion of sulphate of potash, and some chlorides of sodium and lithium, the water being very slightly alkaline.

It is quite a pure water, suitable for most uses. Taking into

consideration the depth of the well in the rock, the very small proportion of saline matter contained in the water is quite remarkable.

No. 2295—WATER: "*From a well bored sixty-four feet deep, in the highest ground opposite Ashland (former residence of Henry Clay, deceased), in the suburbs of Lexington, on the old Mentelle Place. Sample brought by Mr. B. Treacy.*"

This water, having no peculiar taste or odor, resembles the next preceding, in being slightly alkaline from the presence of a small proportion of alkaline carbonate. Its total *saline matters*, amounting to only 0.51 of a part in a thousand parts of the water, consist mainly of carbonates of lime, magnesia, and soda, with a small proportion of chlorides. Like that, it contains some carbonic acid gas in solution, and is pure enough for all ordinary purposes and quite wholesome.

No. 2296—WATER: "*From the bored well at the Lexington station of the Cincinnati Southern Railroad. Well 800 feet deep. The water stands in it at thirty feet below the surface of the ground, which is somewhat elevated, and is pumped from a depth of 550 feet. Sample brought to the laboratory by C. M. Johnson, Esq., Mayor of Lexington, March 16, 1883.*

The water is colorless, with a very slight cloudiness, owing perhaps to the new pump. It has a very slight bituminous odor and a very slight ferruginous taste.

COMPOSITION, *in 1000 Parts of the Water.*

Carbonic acid gas	Not estimated.	
Lime carbonate	0.0998	Held in solution by carbonic acid.
Magnesia carbonate	.0074	
Iron carbonate	.0032	
Silica	.0018	
Lime sulphate	.0243	
Potash sulphate	.0418	
Soda sulphate	.0085	
Magnesium chloride	,1184	
Sodium chloride	.0049	
Soda carbonate	.1368	
Silica	.0022	
Traces of nitrates, etc., and loss	.0024	
Total saline matters	0.4510 in 1000 parts of the water.	

Equal to 3.288 grains in the wine pint of 7,290 grains.

This water is also remarkably pure in relation to the considerable depth in the limestone rock strata from which it is obtained. The small amount of saline matters it contains would generally be considered conducive to health when it is used for drink; and although slightly hard, it is probable that the presence in it of carbonate of soda would measurably prevent the formation of a *hard crust* in the steam boiler in which it may be used.

FLOYD COUNTY.

No. 2297—COAL (No. 3): "*From the mouth of Mud creek. Upper eighteen inches. Collected by A. R. Crandall, November 18, 1881.*"

Generally a firm, pure-looking, pitch black coal. (A piece of what seems to be shale in the sample.) Shows no apparent pyrites and very little fibrous coal.

No. 2298—COAL: "*From the same bed. Lower three feet five inches. Collected by A. R. Crandall, etc., as above.*"

A bright, firm, pure, pitch-black coal, showing very little fibrous coal or pyrites.

No. 2299—COAL: "*Laynesville, Floyd county. Middle of the upper part of the opening, measuring twenty-three inches. Collected by Roger C. Ballard, August 24,* 1882.

A splint coal, breaking into irregular laminæ. No apparent pyrites or fibrous coal.

No. 2300—COAL: "*From the same bed, lower portion, measuring forty-five inches. Collected by Roger C. Ballard, etc.*

A rather brighter coal than the next preceding, which it otherwise resembles.

No. 2301—COAL: "*Mouth of Steele creek, branch of Beaver creek. Collected by A. R. Crandall. Average sample of the upper four feet.*

A pitch-black, pretty pure-looking coal. Some portions laminated and dull.

No. 2302—COAL: "*On Flemming's (or Jack's) creek, left fork of Beaver creek. Sample from a new outcrop of five feet four inches in thickness, without the parting. Some clay unavoidable in the sample. Collected by A. R. Crandall, August 8, 1883.*

A weathered sample of splint coal, with some ferruginous clay incrustations on some pieces. No pyrites apparent.

COMPOSITION OF THESE FLOYD COUNTY COALS.

(*Dried at 212° F.*)

	No. 2297	No. 2298	No. 2299	No. 2300	No. 2301	No. 2302
Specific gravity	1.302	1.281	1.359	1.284	1.323	1.350
Hygroscopic moisture	2.04	2.10	1.30	1.90	2.50	3.80
Volatile combustible matters	37.42	37.16	36.70	35.30	32.50	33.80
Coke	60.54	60.74	62.00	62.80	65.00	62.40
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	39.46	39.26	38.00	37.20	35.00	37.60
Fixed carbon in the coke	56.34	57.74	51.70	58.94	56.54	60.60
Ash	4.20	3.00	10.30	3.86	8.46	1.80
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Spongy.	Spongy.	Spongy.	Dense.	Pulvurulent.
Color of the ash	Lilac colored.	Nearly white.	Lt. lilac grey.	Light grey.	Light grey.	Reddish buff.
Percentage of sulphur	1.475	0.596	1.356	0.715	0.651	0.475

These are generally very good coals. Nos. 2299 and 2301 exceed the average proportion of ash somewhat but not excessively, and Nos. 2297 and 2299 show the most sulphur, while the rest of them contain less than the average proportion, and in none of them is this objectionable element excessive.

No. 2303—COKE: "*Made from the Laynesville coal, No. 2299, middle bench, or upper part of the opening. Collected by Roger C. Ballard, August 22, 1882.*"

COMPOSITION (*Air-dried*).

Moisture, driven off at 500° F.	5.00
Fixed carbon	88.50
Reddish-grey ash	6.50
Total	100.00

Its percentage of sulphur is =0.788.

The small proportion of ash in this coke, as compared with the sample analyzed of the coal No. 2299, from which it is said to have been made, seems to show that the sample of coal contained some accidental earthy impurity.

No. 2304—PHOSPHATIC CONCRETIONS: "*Found in tough clay, mouth of Sand branch of Sandy river, five miles above Prestonsburg, Floyd county. Collected by A. R. Crandall, August 20, 1882. 'White, turning to blue.'*"

Small concretions, irregularly spindle-formed, or like two cones joined base to base, sometimes tuberculated and irregularly spiral. Light grey-blue on the exterior surfaces, light grey in the interior, showing some minute spangles of mica.

These singular concretions were found to contain about eight per cent. of phosphoric acid (P_2O_5), and otherwise were mainly composed of silica and sand, alumina and iron oxide—they may possibly be coprolites. The blue color is due to phosphate of iron.

FRANKLIN COUNTY.

No. 2305—PHOSPHATIC LIMESTONE: "*From the Lower Trenton formation, Big Benson creek. Collected by W. M. Linney.*"

A drab-grey rock, mainly made up of small fragments of fossil shells, easily breaking into irregular lamellæ.

COMPOSITION (*Air-dried*).

Lime carbonate	87.780	=49.157 per cent. of lime.
Magnesia carbonate	2.482	
Alumina and iron oxide	3.812	
Phosphoric acid (P_2O_5)	2.968	
Sulphuric acid (SO_3)	n. e.	
Silica and silicates	1.780	
Moisture and loss	1.278	
Total	100.000	

Although this sample does not contain as much phosphoric anhydride as many others from the same geological formation from Fayette county which have been analyzed, it yet shows the general character in this respect of the so-called blue limestone of the lower silurian formation.

No. 2306—WATER: "*From a new reservoir about two miles from Frankfort, situated in a large ravine, across which a dam is built, forming the reservoir, which is said to have an area of an acre and a half, and an average depth of twenty feet. It is supplied by the surface water from the adjoining hills and some two or three low springs.*"

One sample of this water was sent to the laboratory August 12, 1881, by Mr. E. A. Fellmer and Dr. J. Lampton Price, the City Physician; another was sent September 10, 1883, by the City Council.

The first sample had a slight fishy odor, was slightly turbid with a light brownish sediment, and the microscope showed in it the presence of algæ more or less decomposed. The second sample had a more decided disagreeable odor, which resembled that of sewage or of a pig-pen, and on standing a day or two exposed to the air formed a handsome light green scum of living algæ on the surface, while a slight brownish sediment of the dead and decayed organisms had formed at the bottom of the open bottle. The analysis of the first sample gave the following results, viz.:

COMPOSITION, *in 1000 Parts of the Water.*

Total solid matters		0.1000
of which, organic matters	0.0200	
and fixed saline matters	.0800	
Free ammonia		.0006
Albuminoid ammonia		.00058

The fixed saline matters consisted mainly of carbonates and sulphates of lime and magnesia, with traces of iron and the alkalies. No notable chlorine was found in this first sample, and but a small proportion in the second, which, however, was not quantitatively analyzed. No nitrates or nitrites were detected in the quantity of water examined.

Apart from the living algæ and the organic matters resulting from their decay, which produce the offensive odor, and a little saline matter, this water is nearly as pure as ordinary rain water.

The Rivers Pollution Commission, of Great Britain, obtained the following average results from the examination of seventy-three samples of rain water, all but two of which were collected

at the experimetal farm of Lawes & Gilbert, Rothamsted, England:*

Total dissolved solids, ...	3.950 in 100,000 parts, . .	0.0395 in the 1000
Organic carbon, ...	.099 in 100,000 parts, . .	.001 in the 1000
Organic nitrogen, ...	.022 albuminoid ammonia,	.0002 in the 1000
Ammonia, ...	.050	.0005 in the 1000
Nitrogen, nitrites and nitrates, .	.007	
Total combined nitrogen, . . .	.071	
Chlorine, ...	.630	

The algæ, which cause surface water to be so offensive, appear only during the warm season, and especially in shallow water freely exposed to the atmosphere. The odor, which is produced by the decay of the minute organism, has been described as a *musty, fishy, cucumber, green-corn, pig-pen, horse-pond, oily* smell. Sometimes, when the water contains sulphates, the odor is more sewage-like because of the presence of hydrogen sulphides.

The practical question not yet fully answered is, whether or not such offensive water is productive of disease. It is highly probable, however, that the statement of the Massachusetts State Board of Health is true in this relation. They say* the evidence tends to show that the plant (the alga) acts mechanically chiefly, perhaps, like unripe fruit, when affecting health at all, in causing diarrhea, *but that the filtered water is harmless.*

No. 2307—SALT WATER: "*From a bored well one hundred and ten feet deep, four and a half inches bore, through solid limestone; the last three feet probably sandstone. Situated four miles east of Frankfort and one mile from the Georgetown Turnpike. Sample sent by A. Stedman, owner of the well, Stedmantown.*"

Much gas escaped at the well at first. The water stands at about twenty-five feet from the top. It has an odor of petroleum, some little of which is found in the well. The *specific gravity* of the water is 1.02.

Evaporated to dryness it left 29.70 parts to the 1000 of the water of brownish *saline matters*, which are mainly sodium chloride (common salt), with carbonate of iron, lime, and mag-

* Quoted from Nichols' *Water Supply*, p. 48. John Wiley & Sons, N. Y., 1883.

nesia, some sulphates and a little of bromides. The proprietor, believing he may "strike oil," or get a salt water strong enough to be profitable, continues to bore by latest account, although the probabilities seem to be adverse.

GRAVES COUNTY.

No. 2308—MARL: "*Sent by Mr. Frank Bray and Judge A. K. Boone, of Mayfield, June 11, 1883. 'Is it a good fertilizer?'*"

An olive-grey marl, partly in soft, friable lumps, containing many fragments of much decomposed shells, with fine-grained hyaline quartz-sand, about 34 per cent., and a small proportion of small, olive-greenish grains of what seems to be glauconite (so-called green sand).

COMPOSITION (*Air-dried*).

Lime carbonate	38.840	=19.514 lime.
Magnesia carbonate	5.077	
Iron carbonate (some iron oxide and alumina not estimated)	11.500	
Phosphoric acid (P_2O_5)	.180	
Potash	1.002	
Soda	.198	
Silica, sand, etc.	39.540	
Moisture and loss	3.663	
Total	100.000	

It might prove useful on sandy or heavy clay soils which are deficient in lime, but would not bear transportation to any distance. If its silica was not mainly in the form of sand it might probably be calcined into a water cement.

GREENUP COUNTY.

Carbonate Iron Ores.

No. 2309—GREY IRON ORE: "*The blue interior portion of the red limestone ore. From near Hunnewell Furnace. Sample sent by H. W. Bates, Vice President of Eastern Railway Company. May 4, 1880.*"

Ore of a brownish-grey color, compact, fine granular. Does not adhere to the tongue. Under the lens appears to be made

up of minute light-brownish grains, with a small portion of whitish cement. Powder drab color.

No. 2310—GREY IRON ORE: "*Found at the Pennsylvania Furnace, lying near the little block ore, between coals Nos. 3 and 4. Sent by H. W. Bates, Esq. Sample from near the outcrop, from a layer eight to fifteen inches thick.*"

An oolitic carbonate, made up of minute brownish spherules, united by a whitish cement. Weathered light-ferruginous on exposed surfaces.

No. 2311—BLACK BAND IRON ORE: "*From the head of Shultz creek. Base of the coal measures. An average sample from sixteen-inch thickness of layer. Collected by A. R. Crandall, July 12, 1882.*"

In irregular laminæ, with some charred vegetable impressions and very thin, irregular laminæ of coal between. Color varying in the laminæ from light to dark grey-brown, and blackish. Adheres to the tongue.

No. 2312—GREY KIDNEY IRON ORE: "*Hibler's Drift, on Shultz creek. Lower limestone ore. Thickness about five inches. Collected by A. R. Crandall, July, 1882. 'Is this the so-called Spiegel ore?'*"

Sample a very hard, irregular kidney, hard enough to strike fire with steel. Mainly light-grey, fine granular; not adhering to the tongue. Portions fine oolitic and brownish.

No. 2313—GREY IRON ORE: "*From Hibler's Drift, lower limestone ore, accompanying the grey kidney ore. Collected by A. R. Crandall, July, 1882.*"

A portion light slate colored, a portion mottled brownish-grey and blackish. Oolitic in parts. Adheres somewhat to the tongue.

No. 2314—BOYCE'S LIMESTONE ORE: "*From north of Dry Fork of Shultz creek. So-called grey limestone ore. Collected by A. R. Crandall, July, 1882. Determine the iron only.*"

Partly brownish limonite, partly compact granular carbonate ore.

COMPOSITION OF THESE GREENUP COUNTY CARBONATE IRON ORES.

	No. 2309 *	No. 2310 †	No. 2311 †	No. 2312 †	No. 2313 †	No. 2314 †
Iron carbonate	81.432	59.418	80.433	65.545	57.043	. . . .
Iron peroxide	. . . .	15.382	.829	. . . .	. . . .	. . . .
Manganese carbonate	2.758	*a* 1 380	. . . .	*d* 2.096	n. e.	. . . .
Alumina		4.580	3.172	2.752	2.901	. . . .
Lime carbonate	4.140	2.800	1.790	1.360	1.310	. . . .
Magnesia carbonate	2.187	2.134	5.517	1.316	1.370	. . . .
Phosphoric acid (P2 O5)	.207	.690	.128	.128	.179	1.010
Sulphuric acid (SO3)	.587	*b* .486	n. e.	n. e.	n. e.	. . . .
Silica and silicates	7.670	*c* 12.890	1.220	23.790	27.860	. . . .
Organic matters, moisture and loss	1.019	.248	6.911	3.013	9.337	. . . .
Total	100.000	100.000	100.000	100.000	100.000	100.000
Percentage of iron	39.631	34.780	39.400	30.900	27.540	26.580
Percentage of phosphorous	.095	.285	.056	.056	.078	.441
Percentage of sulphur	.234	.486	n. e.	n. e.	n. e.	. . . .
Percentage of silica	5.320	12.890	1.220	. . . .	. . . .	. . . .

a Brown oxide of manganese. *b* Sulphur. *c* Silica. *d* = 1 p. c. manganese. * Dried at 212°. † Air-dried.

Generally good carbonate ores, requiring roasting before they are smelted. The two latter contain the most iron, and Nos. 2310 and 2314 are the most phosphatic.

No. 2315—GREY IRON ORE: "*A roasted sample of No. 2310. Sent by H. W. Bates, Esq.*

COMPOSITION (*Air-dried*).

Iron peroxide	71.680	= 50.180 iron.
Alumina	5.317	
Lime	2.094	
Magnesia	1.326	
Brown oxide of manganese	1.980	= 1.379 manganese.
Phosphoric acid (P2 O5)	.883	= .602 phosphorous.
Sulphur	.580	
Silica	16.040	
Hygroscopic moisture	.100	
	100.000	

Limonite Iron Ores from Greenup County.

No. 2316—IRON ORE: "*From Matthews' drift, Shultz creek, Lower limestone ore. Average sample from the eight-inch face, thirty feet in the drift. Collected by A. R. Crandall, July, 1882.*

In irregular laminæ of different tints of lighter and darker grey-brown, some thin lines nearly black. Adheres to the tongue.

No. 2317—GREYCROFT'S BLOCK ORE: "*Head of Shultz creek. Thickness, about eight inches. Collected by A. R. Crandall, July, 1882.*

A limonite ore, containing soft, ochreous ore within hard brown layers.

No. 2318—RED BLOCK ORE: "*Rockhouse branch of Schultz creek. Collected by A. R. Crandall, July, 1882.*"

Resembles the next preceding.

No. 2319—SO-CALLED LIMESTONE KIDNEY ORE: "*Forty feet above the Waverley Ridge, head of Dry Fork of Schultz creek; six inches thick. Collected by A. R. Crandall, July 1882; Resembles the preceding two.*"

No. 2320—SO-CALLED LIMESTONE KIDNEY ORE: "*Rockhouse branch of Schultz creek. Containing less ochreous ore than the preceding, etc. 'Determine the iron.'*"

COMPOSITION OF THESE GREENUP COUNTY LIMONITE IRON ORES.

(*Air-dried.*)

	No. 2316	No. 2317	No. 2318	No. 2319	No. 2320
Iron peroxide	32.260	39.290	51.170	52.500	. . . .
Manganese peroxide	1.642	n. e.	n. e.	n. e.	. . . .
Alumina	2.765	3.960	4.205	4.018	. . . .
Lime carbonate	.490	.320	.160	trace.	. . . .
Magnesia carbonate	1.318	.439	.660	.287	. . . .
Phosphoric acid (P2 O5)	.499	1.010	.945	1.842	. . . .
Sulphuric acid	n. e.	n. e.	n. e.	n. e.	. . . .
Silica and silicates	50.390	46.480	32.080	30.480	. . . .
Water, loss, etc.	10.636	8.501	10.780	10.873	. . .
Total	100.000	100.000	100.000	100.000	. . . .
Percentage of iron	22.750	27.500	35.820	36.750	36.160
Percentage of manganese	1.037	n. e.	n. e.	n. e.	. . . .
Percentage of phosphorous	.217	.689	.412	.804	. . . .
Percentage of sulphur	n. e.	n. e.	n. e.	n. e.	. . . .
Percentage of silica	n. e.	n. e.	n. e.	n. e.	. . . .

These ores, of which the first is rather meager, and the sec-

ond not very much richer in iron, contain generally pretty large proportions of phosphorus.

Pig Irons from Greenup County.

No. 2321—PIG IRON: "*Labeled Strong Grey Pig Iron. Hunnewell Furnace. Made with hot blast at 350° F. Sample sent by H. W. Bates, Esq. December 11, 1880. (Marked Sample No. 1.)*"

A fine-grained, dark-grey iron. Flattened considerably under the hammer. Yielded easily to the file.

No. 2322—PIG IRON: "*Labeled Weak Close Iron, Sample No. 2. Made with hot blast at 500° F. at Hunnewell Furnace. Sent by H. W. Bates, Esq., December 11, 1880.*"

Somewhat lighter grey and a little coarser grained than the preceding. Flattens somewhat under the hammer, but seems to break more readily. Yields easily to the file.

COMPOSITION OF THESE HUNNEWELL FURNACE PIG-IRONS.

	No. 2321	No. 2322
Specific gravity	6.944	6.839
Iron	93.490	92.180
Graphite	3.300	3.000
Combined carbon	.180	.490
Aluminum and manganese	n. e.	n. e.
Silicon	.624	1.760
Slag	2.380	1.780
Phosphorus	.972	.932
Sulphur	.450	.576
Total	101.396	100.718
Total carbon	3.480	3.490

The larger proportions of combined carbon, silicon and sulphur in No. 2322 may possibly account for the difference in the tenacity of the samples.

No. 2323—CINDER, OR FURNACE SLAG: "*Of sample No. 2, Hunnewell Furnace, etc. Sent by H. W. Bates, Esq., etc.*

A homogeneous glass, resembling glassy obsidian, smoky black and only transparent-smoky in very thin splinters. Fuses easily, before the blow-pipe, into a white, blebby glass, in the oxidating flame.

No. 2324—CINDER, OR FURNACE SLAG: "*Of sample No. 2. Same as the preceding, etc. Hot blast 500° F. Weak, close iron made.*"

Generally of a brownish-grey color, full of air-bubbles; only translucent in thin splinters. Fuses easily in the oxidating flame of the blow-pipe into a white, blebby glass.

COMPOSITION OF THESE HUNNEWELL FURNACE SLAGS.

(*Dried at 212° F.*)

	No. 2323	No. 2324
Silica	55.080	55.000
Alumina, iron oxide, etc.	23.980	23.240
Brown oxide of manganese	.580	.680
Lime	19.376	19.152
Magnesia	1.686	1.773
Total	100.702	99.845

These slags are practically similar in composition. According to Mons. P. Hautfeuille, in Wurtz' *Dictionnaire de Chimie, etc.*, a normal iron slag should contain 45 to 60 per cent. of silica, 20 to 35 per cent., of lime, and 12 to 25 per cent of other bases (such as magnesia, oxides of manganese, alumina, etc).

"Alumina makes the *least* fusible silicate and should not exceed 15 per cent.. Magnesia, more fusible, may be 25 per cent. oxide of manganese, is yet more fusible; but if it exceeds 15 per cent., the iron becomes manganiferous." (*Loc. cit.*)

HOPKINS COUNTY.

No. 2325—COKE: "*From the St. Bernard Coal Company mines, Earlington. Sent by John R. Procter, April 4, 1882. Sample in the large bag is made from the washed slack coal. This coke was made at the request of Mr. Procter, the company sending two car-loads to the ovens. Samples carefully taken.*"

No. 2326.—COKE: "*From the same source, made from the unwashed slack coal. A smaller sample.*"

The two samples resemble each other in their external characters, being bright, cellular, and light coke.

COMPOSITION OF THESE TWO HOPKINS COUNTY COKES.
(*Air-dried.*)

	No. 2325	No. 2326
Hygroscopic moisture, etc.—*loss on ignition*	0.86	2.00
Fixed carbon	86.34	77.20
Purplish-grey ash	12.80	20.80
Total	100.00	100.00
Percentage of sulphur	2.233	3.799

It is to be seen that a great improvement in the quality of the coke is made by washing the "slack coal" before coking.

JOHNSON COUNTY.

No. 2327—CANNEL COAL: "*Smith's branch of Paint creek. Average of the cannel coal from the bench opening near the house of Daniel Smith; eighteen inches of cannel overlaid by eighteen inches of common coal; clay and shale below Collected by A. R. Crandall.*"

Coal in thin laminæ, some curved; cross-section generally glossy and pure-looking. Some layers dull. No pyrites or fibrous coal apparent. Seems to be a much-weathered sample.

No. 2328—CANNEL COAL: "*From one mile north of the mouth of Little Paint creek. Upper twenty-two inches of cannel coal. Dr. W. T. Hagar. Collected by A. R. Crandall, August 23, 1882.*"

A dull-black, tough, laminated cannel coal.

No. 2329—CANNEL COAL: "*From same bed as the next preceding, etc. Lower eight inches of cannel coal of Dr. Hagar.*"

Resembles the next preceding. Rather more dull and in thinner laminæ.

COMPOSITION OF THESE JOHNSON COUNTY CANNEL COALS.

(*Air-dried.*)

	No. 2327	No. 2328	No. 2329
Specific gravity	1.279	1.248	1.223
Hygroscopic moisture	3.00	1.80	1.80
Volatile combustible matters	49.80	49.10	49.20
Coke	47.20	49.10	49.00
Total	100.00	100.00	100.00
Total volatile matters	52.80	50.90	51.00
Fixed carbon in the coke	37.94	41.16	44.00
Ash	9.26	7.94	5.00
Total	100.00	100.00	100.00
Character of the coke	Dense.	Dense friable.	Dense friable.
Color of the ash	Lt. grey brown.	Lt. buff grey.	Lt. buff grey.
Percentage of sulphur	2.609	0.816	0.846

Good cannel coals; especially Nos. 2328 and 2329. As frequently noticed before, the specific gravity of the coals increases with the ash proportion.

No. 2330—IRON ORE (CARBONATE): "*Fourteen inches thick, below Wheeler's creek, one and a half miles below Paintsville, Johnson county, below coal No. 1, fifty feet above low water in Big Sandy river. Collected by John R. Procter, August 23, 1882.*

A concretion of small nodules of grey iron carbonate, more or less converted into limonite on the exterior surfaces.

COMPOSITION (*Air-dried*).

Iron carbonate	27.740	Containing 26.04 per cent. of iron.
Iron peroxide	18.159	
Alumina	8.565	
Lime carbonate	1.780	
Magnesia carbonate	1.970	
Phosphoric acid (P_2O_5)	1.205	Containing 0.526 of phophorus.
Silicious residue	35.780	Containing 32.480 of silica.
Moisture, loss, etc.	4.801	
Total	100.000	

Not quite as rich in iron as the average carbonate ores and containing a rather large proportion of phosphorus, it may yet be made available for common iron under favorable conditions.

KENTON COUNTY.

No. 2331—MINERAL WATER: "*From a spring flowing out of the hill through which the tunnel goes, in the "Big Bend" of the Licking river, one hundred and forty rods from the north end of the tunnel, and about the same distance from Grant's Station, ten miles from Covington. Water sent by Mrs. Julia V. McVean, July 24, 1883.*"

COMPOSITION, *in 1000 Parts of the Water.*

Lime carbonate	0.3558	Held in solution by carbonic acid.
Magnesia carbonate	.0082	
Iron carbonate	a trace	
Lime sulphate	1.0039	
Magnesia sulphate	1.3311	
Potash sulphate	.0267	
Soda sulphate	.3944	
Sodium chloride	.1126	
Silica	.0018	
Total saline matters	3.2345	in 1000 parts of the water.

A saline, slightly chalybeate water.

KNOX COUNTY.

No. 2332—COAL: "*From J. N. Wiggins' coal bank, three miles southeast of Barboursville. Collected by R. C. Ballard, May 16, 1883.*

A pure-looking coal, showing very little fibrous coal and no appearance of pyrites.

No. 2333—COAL: "*From head of Dean's branch, near the mouth of Greasy creek. Collected by R. C. Ballard, May 17, 1883.*

A pure-looking coal, showing some little fibrous coal but no apparent pyrites.

No. 2334.—COAL: "*From the same bed as the next preceding; lower portion of the bed, thirty-five inches. Collected by R. C. Ballard, May 17, 1883.*

Like the preceding in general appearance. More firm: seems to be a good so-called "block coal."

No. 2335. COAL: *"From head of Sandy branch, a mile to a mile and a quarter from Flat Lick, on the land of O. P. Ely. Collected by R. C. Ballard, May 29, 1883.*

A pure-looking coal, showing very little fibrous coal and no apparent pyrites.

COMPOSITION OF THESE KNOX COUNTY COALS.

(*Air-dried.*)

	No. 2332	No. 2333	No. 2334	No. 2335
Specific gravity	1.289	1.332	1.281	1.300
Hygroscopic moisture	1.80	1.60	1.66	2.00
Volatile combustible matters	34.00	33.80	36.34	35.00
Coke	64.20	64.60	62.00	63.00
Total	100.00	100.00	100.00	100.00
Total volatile matters	35.80	35.40	38.00	37.00
Fixed carbon in the coke	59.40	57.14	58.04	56.70
Ash	4.80	7.46	3.96	6.30
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Lt. sp'gy	Lt. sp'gy	Lt. sp'gy
Color of the ash	Lt. lilac grey.	Lt. lilac grey.	Nearly white.	Lilac g'y
Percentage of sulphur	0.981	1.110	0.651	1.091

All remarkably good coals, especially Nos. 2332 and 2334.

LAUREL COUNTY.

No. 2335—*"From a bed on Wood's creek, near John Pitman's, on the line of the Knoxville Branch of the L. & N. R. R., in a hill about three hundred and fifty feet high. Bed three feet two inches thick. Three samples, from top, middle, and bottom of the bed. Brought by J. R. Carrigan, of Danville.*

The samples resembled each other greatly, and were all ground together for an average sample.

Coal of a handsome pitch-like, glossy black color, with very little appearance of fibrous coal or pyrites; only a few bright scales on some of the seams. Fracture cuboidal and irregular; some "bird's-eye" structure in some of the pieces; not soiling the hands.

No. 2337—COAL (CANNEL): "*Brought by Captain W. C. Crozier, of Covington, from one and a half miles southwest of London, Laurel county. W. H. Hayden's; bed fifty-three inches thick.*"

No. 2338—COAL: "*From the head of Raccoon creek, one mile from East Bernstadt, Laurel county, three hundred yards from the house of Dr. Ferris. Sample sent by John R. Procter. Received May 30, 1882.*"

A pure-looking, pitch-black, glossy coal, showing very little fibrous coal or granular pyrites. Fracture of some portions conchoidal.

No. 2339—COAL No. 1: "*Pitman Coal Company, Pitman Station. Bed thirty-six inches and a half thick. Fifty yards from the edge of the hill. Sample collected by R. C. Ballard, October 20, 1882.*"

A pure-looking, pitch-black coal. No appearance of pyrites and very little of fibrous coal.

No. 2340—COAL No. 1: "*Laurel Coal Company mine, Pitman Station. A separate piece of two inches of the upper part of the bed, resembling cannel coal in part, not included in the analysis. Collected by R. C. Ballard.*"

Resembles the next preceding.

No. 2341—SLACK: "*Of the Laurel Coal Company coal (coal No. 1). Taken from the dump-pile—(a) the unwashed and (b) the washed sample. Collected by R. C. Ballard, October 23, 1882.*"

COMPOSITION OF THESE LAUREL COUNTY COALS.

(*Air-dried.*)

	No. 2336	No. 2337	No. 2338	No. 2339	No. 2340	No. 2341 (*a.*)	No. 2341 (*b.*)
Specific gravity . . .	1.221	1.496	1.245	1.277	1.267	n. e.	n. e.
Hygroscopic moisture	2.60	1.30	3.30	2.80	2.72	2.60	2.64
Vol. com'ble matters .	35.30	31.00	34.44	35.30	35.32	29.46	34.00
Coke	62.10	67.70	62.26	61.90	61.96	67.96	63.36
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters .	37.90	32.30	37.74	38.10	38.04	32.06	36.64
Fixed carb. in the coke	60.30	43.96	60.96	59.10	58.60	52.54	58.70
Ash	1.80	23.74	1.30	2.80	3.36	15.40	4.66
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Dense friable.	Light spongy.	Spongy.	Spongy.	Spongy.	Spongy.
Color of the ash . .	Nearly white.	D'k purplish g'y	Brown'h grey.	Lt. lilac grey.	Nearly white.	Brown'h grey.	Lt. lilac grey.
Percentage of sulphur	1.000	4.500	1.055	0.650	0.679	1.241	0.825

With the exception of No. 2337 and 2341 (*a*), which exceed in ash proportion and sulphur, these are all remarkably good pure coals. The so-called cannel coal has so large a proportion of ash material in its composition that it might probably be classed as a rich bituminous shale. While it might be used for ordinary domestic fires its large proportion of sulphur renders it improper for working iron.

No. 2342—Coke of Coal No. 1: "*Laurel Coal Company, Pitman Station. Sample obtained from the pile, made of coal from all parts of the bed. Collected by R. C. Ballard, October 21, 1882.*"

A moderately fine-grained firm coke.

No. 2343—Coke of Coal No. 1: "*Laurel Coal Company, Pitman Station. This was made from the slack coal, and is the best I could obtain here. Collected by R. C. Ballard, October 22, 1882.*"

Coke fine-grained and firm; irregularly columnar.

No. 2344—COKE: "*From the Laurel Coal Company's Peacock coal, Pitman Station. Collected by R. C. Ballard, October 22, 1882.*"

A dense, firm, and bright coke.

COMPOSITION OF THESE LAUREL COAL COMPANY'S COKES.

(*Air-dried*).

	No. 2342	No. 2343	No. 2344
Moisture driven off at 480° F.	1.20	0.90	2.40
Fixed carbon in the coke	95.70	92.60	89.20
Ash	3.10	6.50	8.40
Total	100.00	100.00	100.00
Color of the ash	Light bro'nish.	Light bro'nish.	Bro'nish grey.
Percentage of sulphur	0.659	0.739	0.939

Judging from their composition these cokes are both very good, and applicable to all the ordinary uses of coke. Compared with the celebrated Connellsville coke (see Bell county) Nos. 2342 and 2343 contain much less ash and sulphur and a larger percentage of carbon than that. No. 2344 approaches nearer in these respects to the Connellsville coke.

LAWRENCE COUNTY.

No. 2345—COAL: "*Peach Orchard Coal, on Miller's branch of Nat's creek. Entry No. 2. Upper bench of fourteen inches. Collected by A. R. Crandall, June, 1882.*"

A splint coal, splitting into laminæ of variable thickness, with not much fibrous coal between, and very little appearance of granular pyrites. Some of the laminæ are bright and pitch-black, and soften somewhat on being heated; others are more like cannel coal.

No. 2346—COAL: "*From same bed; new entry; middle bench, etc. Collected by A. R. Crandall, June, 1882.*"

Mostly in glossy, pitch-black layers. A pure coal, containing hardly any fibrous coal and no apparent pyrites. Swells up somewhat in the flame of the lamp.

No. 2347—COAL: "*From same bed and entry. Lower bench of twenty-eight inches. New entry No. 2. Collected by A. R. Crandall, June 24, 1882.*"

A firm, pure-looking coal, mostly pitch-black and glossy. Some parts more dull and like cannel coal. Some portions splitting into thin laminæ, with fibrous coal, but no apparent pyrites between; other portions more compact and uniformly pitch-black and glossy on the fractured surfaces. These portions soften and swell considerably in the flame; the others are less changed in form by the heat.

No. 2348—COAL: "*Bone coal of the Peach Orchard coal. Eight inches at the top of the lower bench. Same bed and entry as the preceding. Collected by A. R. Crandall, June, 1882.*"

A dull-black splint coal, breaking with difficulty into irregular laminæ. Mostly cannel-like; softens but little in the flame.

No. 2349—COAL: "*Headley's coal, head of McHenry's branch of Levisa Fork of Big Sandy river. Sample from forty-eight inches in the middle of the bed. Collected by A. R. Crandall, August 1882.*"

A pure, pitch-black, bright coal, with no appearance of fibrous coal, but some bright pyritous scales in portions.

No. 2350—COAL: "*From the Headley coal bed, on the west side of the Levisa Fork of Big Sandy river, five miles above Louisa and two miles and a half from the Chattaroi Railroad. Sample from the face of the central member of the bed, which is four feet eight inches thick. Sent by W. J. Headley. The whole bed is six feet two inches thick, including two slate partings, two and four inches severally.*"

Quite a pure-looking, pitch-black and generally-glossy coal, breaking irregularly, with a tendency to a cuboidal form; very little fibrous coal or granular pyrites apparent, but the sample contained a small portion of a pyritous layer; some ferruginous and earthy incrustations on the exterior surfaces.

COMPOSITION OF THESE LAWRENCE COUNTY COALS.
(*Air-dried*).

	No. 2345	No. 2346	No. 2347	No. 2348	No. 2349	No. 2350
Specific gravity	1.295	1.325	1.287	1.490	1.333	n. e.
Hygroscopic moisture	3.20	3.30	3.90	2.20	4.14	4.50
Volatile combustible matters	37.74	22.70	36.80	28.60	33.06	33.70
Coke	59.06	74.00	59.30	69.20	62.80	61.80
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	40.94	26.00	40.70	30.80	37.20	38.20
Fixed carbon in the coke	55.06	64.46	56.30	46.60	54.50	54.38
Ash	4.00	9.54	3.00	22.60	8.30	7.42
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Dense.	Spongy.	Friable.	Light spongy.	Light spongy.
Color of the ash	Light grey.	Lilac-grey.	Nearly white.	Nearly white.	Purpls'h grey.	Bro'nish grey.
Percentage of sulphur	0.720	1.132	0.756	0.550	1.722	1.708

As may be seen from these analyses, as well as from those published in volume IV., N. S., and by Dr. Owen's analysis, volume I., O. S., the so-called Peach Orchard coal varies somewhat in different localities. It is a "splint" or semi-cannel coal, resembling the "block coal" of Indiana. Its best samples could no doubt be used with advantage in smelting iron ore without previous coking. It is an excellent coal for domestic and many manufacturing purposes, and for the production of steam. The so-called "bone coal," however, contains too much ash to be profitable.

No. 2351—COKE: "*From Peach Orchard coal, Williams' branch, Lawrence county. Collected by R. C. Ballard, Aug. 15, 1882.*"

A bright, firm, dense coke.

COMPOSITION (*Air-dried*).

Moisture, expelled at 220° F.	5.10
Volatile combustible matters, expelled at red heat	.90
Fixed carbon	90.06
Ash (brownish-grey)	3.94
Total	100.00

Its percentage of sulphur is =0.824.

It is purer than the celebrated Connellsville coal, of Pennsylvania, which has 9.113 per cent. of ash. (See Bell county, *anti*).

LETCHER COUNTY.

No. 2352—COAL: "*Holcomb's coal, head of Big Laurel branch, near the head of North Fork of Kentucky river, three miles from Pound Gap. Bed seven feet six inches thick, with an eight-inch parting two feet from the top. Sample from the outcrop, soiled with dirt—hence the ash-finding may be too high. Collected by A. R. Crandall, August 3, 1881.*"

Sample much weathered; weathers in small cuboidal blocks.

No. 2353—COAL: "*Field's coal, on King's creek. Splint and cannel coal, six feet thick. Average sample from a five-feet face. Collected by A. R. Crandall, August, 1881.*"

A mixed sample, partly of bright, pure-looking splint coal, of pitch-black color; partly of tougher, brownish-black, dull, cannel coal, some small ferruginous stains on the exterior surfaces, no appearance of pyrites, and very little of fibrous coal.

No. 2354—COAL: "*J. N. Thompson's coal, on Sandy Lick, a mile and a half from Whitesburg. Sample from the upper layer, twenty to twenty-eight inches thick. A parting of two to sixteen inches separates it from the lower layer, which is thirty to thirty-eight inches thick. Collected by J. Shackelford, August, 1881.*"

(See next number).

A pure-looking, pitch-black splint coal, quite brilliant on the fractured surfaces and on some of the faces of the laminæ. Very little fibrous coal apparent, and no visible pyrites.

No. 2355—COAL: "*Sample from the lower layer of J. N. Thompson's coal, etc.*"

This sample contains some dull layers, with a thin, pyritous laminæ and more fibrous coal than in the preceding sample.

No. 2356—COAL: "*From Mr. Nickel's coal-bank, below Whitesburg, on the Kentucky river. Collected by A. R. Crandall, August 3, 1881.*"

A much-weathered sample of splint coal. Shows some fibrous coal in the form of reed-leaf-like impressions between the irregular laminæ; no pyrites apparent, but a red-ochreous incrustation on some of the exterior surfaces.

No. 2357—COAL: "*J. M. Collins' coal, on Rockhouse creek. Bed three feet eight inches thick. Average sample. Collected by A. R. Crandall, August, 1881.*"

A pure-looking splint coal.

No. 2358—COAL: "*From Caudell's bank, a mile and a half below Whitesburg, on the Kentucky river. A sample of the upper layer, twenty-five inches thick, a slate parting below of eight to fourteen inches, including a thin coal. Collected by A. R. Crandall.*"

Appears to be a pure sample of splint coal, some fibrous coal between the laminæ, but no apparent pyrites.

No. 2359—COAL: "*From the same bank. A sample of the lower layer, twenty-eight inches thick. Collected by A. R. Crandall.*

A weathered sample; approaches cannel coal in some of the laminæ.

No. 2360—COAL: "*From Laurel branch of Kentucky river. Upper two feet. Sample from the weathered face of the bed. Collected by A. R. Crandall, November 10, 1881.*"

Sample much weathered and somewhat friable, the seams covered generally with a greyish incrustation, part of which seems to be clay, which may increase the apparent ash percentage. Some fibrous coal between the laminæ, but no pyrites apparent.

No. 2361—COAL: "*From the same bed as next preceding. Sample from the lower sixty-eight inches. Thickness of the whole bed, eight feet.*"

Generally a bright, pitch-black, pure-looking coal, except in the somewhat weathered portions. A little fibrous coal and fine granular pyrites between the laminæ, and a few bright, thin pyritous scales in some of the seams.

No. 2362—COAL: "*From Cowan Ridge, opposite Whitesburg. A splint coal, four hundred and ninety feet above the bed of the river. Bed of coal forty-one inches thick without parting. Entry driven in twenty feet. Collected by A. R. Crandall.*"

Quite a pure-looking, pitch-black coal. Some fibrous coal between the laminæ, but very little granular pyrites. Quite a firm coal.

No. 2363—COAL: "*Camp Branch of Rockhouse creek. Dr. S. H. Breeding's coal. The lower forty-five inches. Collected by A. R. Crandall, July 20, 1883.*"

A pure-looking, pitch-black coal. Fracture irregular and cuboidal, with generally brilliant surfaces. No fibrous coal and very little granular pyrites apparent.

No. 2364—COAL: "*On J. Q. Benthey's farm, Rockhouse creek. Collected by J. A. Shackelford, July 24, 1883.*"

A cannel coal. Sample much soiled with argillaceous material. No apparent pyrites. It seems to be a weathered sample.

No. 2365—COAL: "*On Sam Kiser's place, on Love Branch of Rockhouse creek. Collected by J. A. Shackelford, July 24, 1883.*"

A much weathered sample of what seems to be a splint coal. Much soiled with ferruginous and argillaceous material.

No. 2366—COAL: "*On Sam Kiser's land, Love Branch of Rockhouse creek. From a big slip from an upper bed just below the other Kiser sample. Thickness six feet. Not driven into the hard coal. Collected by J. Shackelford, July 27, 1883.*"

A much weathered sample, much soiled with clay, etc. In small pieces.

No. 2367—COAL: "*From John Amberger's farm, on Wolf-pen creek of Carr's Fork of Kentucky river. Upper thirty-four inches of the cannel coal bed. The remaining thickness of the bed is represented by the next sample.*"

A much weathered sample, in small lumps and powder. Soiled with clay.

No. 2368—COAL: "*Same locality and bed as next preceding. Thickness twenty-six inches. Lower part of the cannel bed. Collected by A. R. Crandall, July 27, 1883.*"

A firm, pure-looking cannel coal.

No. 2369—COAL: "*On Marion Hale's farm, Trace Branch of Rockhouse creek. Upper part of the cannel coal. Thickness thirty-two inches.*"

A very pure-looking, pitch-black coal. Fracture generally irregular, with brilliant surfaces. Small bird's-eye structure in parts. No fibrous coal apparent, and very little of bright pyrites.

COMPOSITION OF THESE LETCHER COUNTY COALS. (AIR-DRIED.)

(I.—The eleven samples collected in 1881).

	No. 2352	No. 2353	No. 2354	No. 2355	No. 2356	No. 2357	No. 2358	No. 2359	No. 2360	No. 2361	No. 2362
Specific gravity	1.291	1.292	1.191	1.279	1.286	1.242	1.277	1.286	1.355	1.319	1.320
Hygroscopic moisture	3.26	1.10	1.10	1.10	1.84	1.46	1.30	1.60	8.00	2.86	1.34
Volatile combustible matters	32.24	34.30	40.90	34.30	33.26	35.84	39.60	36.40	30.06	31.54	34.16
Coke	64.50	64.60	58.00	64.60	64.90	62.70	59.10	62.00	61.94	65.60	64.50
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	35.50	35.40	42.00	35.40	35.10	37.30	40.90	38.00	38.06	34.40	35.50
Fixed carbon in the coke	61.60	58.10	55.40	57.20	59.70	58.60	55.20	56.60	57.60	62.10	56.70
Ash	2.90	6.50	2.60	7.40	5.20	4.10	3.90	5.40	4.34	3.50	7.80
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Dense.	Spongy.	Spongy.	Spongy.	Dense.	Light Spongy.	Light Spongy.	Light Spongy.	Pulverulent.	Dense.	Spongy.
Color of the ash	Lt. buff.	Lt. buff-grey.	Brow'h-grey.	Lt. grey.	Lt. buff-grey.	Brow'h-grey.	Brownish.	Brow'h-grey.	Lt. buff.	Lt. buff.	Cho'l'te-grey.
Percentage of sulphur	.656	.890	1.453	.889	.678	1.068	2.812	1.060	.494	.535	1.318

These are remarkably good coals, containing less than the average of ash and sulphur, except that No. 2358 shows more than the average of sulphur, and Nos. 2355 and 2362 exceed somewhat the average ash proportion.

COMPOSITION OF THESE LETCHER COUNTY COALS. (AIR-DRIED.)

(II.—The seven samples collected in 1883).

	No. 2363	No. 2364	No. 2365	No. 2366	No. 2367	No. 2368	No. 2369
Specific gravity	1.317	1.305	1.373	1.483	1.385	n. e.	n. e.
Hygroscopic moisture	1.26	1.90	7.70	6.66	5.46	0.26	1.30
Volatile combustible matters	40.30	39.32	35.50	31.00	31.68	47.94	38.10
Coke	58.44	58.78	56.80	62.34	62.86	51.80	60.60
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	41.56	41.22	43.20	37.66	37.14	48.20	39.40
Fixed carbon in the coke	52.70	51.88	51.96	46.94	57.46	44.86	58.40
Ash	5.74	6.90	4.84	15.40	5.40	6.94	2.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Dense.	Dense.	Pulver-ulent.	Pulver-ulent.	Pulver-ulent.	Dense.	Light Spongy.
Color of the ash	Gr.-pur-plish.	Purpl'h-grey.	Lt. gryh-brown.	Purpl'h-grey.	Lt. purp-grey.	Buff-grey.	Purpl'h-grey.
Percentage of sulphur	2.752	1.115	.832	.488	.488	.751	.710

These are also good coals, although No. 2363 gives more than the average proportion of sulphur. No. 2369 is remarkably pure, giving only 2.20 per cent. of ash. The apparent ash percentage in Nos. 2365, 2366, and 2367, the weathered samples, from the outcrop of the beds, is probably much greater than would be found in the unaltered coal deeper in the bed; these samples being no doubt much contaminated with earthy matters.

The effects of exposure to the atmospheric agencies—weathering—are shown in these samples by the great increase of hygroscopic moisture, owing to the disintegration of the coal; the diminution of their volatile combustible matters; the decrease of their proportion of sulphur by oxidation and otherwise; the increase of their ashy or earthy constituents, and consequently of their specific gravity. Their coke made from the powdered coal is also pulverulent or non-coherent.

LOGAN COUNTY.

No. 2370—MINERAL WATER: "*From a spring, owned by Abram Sharp, five miles northwest of Lewisburg, on Raw-hide creek; three miles west of O. & W. Railroad. (N. W. part of Logan Co.) The water flows about forty gallons per hour. Sample sent by B. G. Williams, of Lewisburg, July 27, 1883.*"

No. 2371—MINERAL WATER: "*From a spring, owned by C. P. Burgher; called by him 'Fountain of Life;' three miles northwest of Russellville. Sample sent by John W. Caldwell, of Russellville, October 6, 1883.*

COMPOSITION OF THESE MINERAL WATERS.

In 1000 Parts of the Water.

	No. 2370	No. 2371
Iron carbonate	.0561	* .3260†
Lime carbonate	.0504	* .3485
Magnesia carbonate	.0094	* .0101
Lime sulphate	.3134	1.1886
Magnesia sulphate	.0000	.9373
Iron sulphate	.0000	a trace.
Soda sulphate	.1066	.0000
Potash sulphate	.0142	.0000
Magnesium chloride	.0170	.0000
Sodium chloride	.0000	.0900
Lithia	.0000	m'rk'd traces.
Silica	.0100	.0048
Total saline matters, in 1000 parts of the water	.5771	2.9053

* Held in solution by carbonic acid. † Contains manganese.

These two mineral waters have a general similarity of composition; being both saline chalybeate waters. But No. 2371

is much the stronger, especially as a chalybeate. The iron of this water is also accompanied by a small proportion of manganese, and lithia is present in it in notable small proportion.

MAGOFFIN COUNTY.

No. 2372—COAL: "*From Stone's bank, on Oakley creek, half a mile from the mouth. Whole thickness thirty-five inches. Sample from the lower twenty inches. Collected by A. R. Crandall, November, 1881.*"

Quite a firm coal, cleaving with some difficulty into irregular laminæ, with some fibrous coal between, but no apparent pyrites. Generally pitch-black and glossy on the fractured surfaces.

No. 2373—COAL: "*From same bank as next preceding. Sample from the upper fifteen inches. Collected by A. R. Crandall, November, 1881.*"

Apparently a weathered sample. Friable, cleaving in thin laminæ. Of a dark-slate color on the exterior surface (caused by weathering?); black in the interior. No apparent pyrites.

COMPOSITION OF THESE MAGOFFIN COUNTY COALS.
(*Air-Dried.*)

	No. 2372	No. 2373
Specific gravity	1.303	1.482
Hygroscopic moisture	2.16	6.92
Volatile combustible matters	36.98	29.28
Coke	60.86	63.80
Total	100.00	100.00
Total volatile matters	39.14	36.20
Fixed carbon in the coke	53.86	46.80
Ash	7.00	17.00
Total	100.00	100.00
Character of the coke	Light spongy.	Pulverulent.
Color of the ash	Nearly white.	Light grey.
Percentage of sulphur	0.535	0.541

The upper layer seems to have been much "weathered," hence probably its larger proportion of hygroscopic moisture and its smaller proportion of volatile combustible matters. The lower layer gives very good coal, and further in the bed the upper layer may be found to improve in quality.

MARTIN COUNTY.

No. 2374—COAL: "*G. W. Ward's, head of Lick Branch of Cold Water Fork of Rockcastle creek. Sample from the upper two feet, the lower one foot being covered. Collected by A. R. Crandall, June 22, 1882.*"

A pure looking splint coal (block coal), splitting with some difficulty into thin laminæ, with some fibrous coal, but no apparent pyrites between.

No. 2375—COAL: "*From Scaffold Lick Branch of Rockcastle creek. Six feet bed; five and a half feet, exclusive of parting. Collected by A. R. Crandall, June 24, 1882.*"

A firm splint or block coal, with very little fibrous coal and no appearance of pyrites between the irregular laminæ. Some of these, dull black, are of the nature of cannel coal; others are glossy and pitch-black, and soften somewhat in the flame of the lamp.

No. 2376—COAL: "*On Beech Fork of Rockcastle creek. (Coal No. 2.) Bed three feet eight inches thick, with a five-inch parting. Collected by A. R. Crandall.*"

A pure-looking coal; partly pitch-black, with shining fracture; a portion more dull and cannel-coal-like.

No. 2377—COKE: "*Of the next preceding coal, No. 2. Made in an open fire. Collected by A. R. Crandall.*"

COMPOSITION OF THESE MARTIN COUNTY COALS AND COKE.

(*Air-dried*).

	No. 2374	No. 2375	No. 2376	No. 2377
Specific gravity	1.291	1.341	1.342	n. e.
Hygroscopic moisture	2.60	3.54	2.20	0.80
Volatile combustible matters	35.50	31.36	33.10	. . . .
Coke	61.90	65.10	64.70	. . . .
Total	100.00	100.00	100.00	. . . .
Total volatile matters	38.10	34.90	35.30	. . . .
Fixed carbon in the coke	56.86	56.30	55.10	90.20
Ash	5.04	8.80	9.60	9.00
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Dense.	Spongy.	. . . .
Color of the ash	Nearly white.	Lt. lilac grey.	Light grey.	Redish brown.
Percentage of sulphur	0.608	0.565	0.578	0.582

These are good coals, containing less than the average proportion of sulphur; but Nos. 2375 and 2376 contain more than the average ash proportion. It is probable, however, that this will be less in the coal deeper in the bed.

MERCER COUNTY.

No. 2378—LIMESTONE: "*Chazy Limestone* (*Sample No. 1*), *from Kentucky river cliffs. Collected by Wm. M. Linney. Received February 23, 1883.*"

A compact, very fine granular limestone of a warm-grey color. Does not adhere to the tongue. Contains no apparent fossils.

No. 2379—LIMESTONE: "*Chazy Limestone* (*Sample No. 2*), *from Kentucky river cliffs. Collected by W. M. Linney. Received February 23, 1883.*"

A compact limestone of a grey color, irregularly mottled with lighter grey in consequence of the presence of fossil remains. Does not adhere to the tongue.

COMPOSITION OF THESE MERCER COUNTY CHAZY LIMESTONES.
(*Air-dried.*)

	No. 2378	No. 2379
Lime carbonate	62.860	83.040
Magnesia carbonate	30.720	10.550
Alumina in iron oxide with traces of phosphoric acid	1.220	.980
Sllicious residue (insoluble in acids)	5.000	5.560
Moisture, etc.	0.130	2.30
Total	99.930	100.360

No. 2378 contains 35.20 per cent. of lime, and No. 2379 contains 46.50 per cent. They are both magnesian limestones, and would calcine into very good white lime. Possibly No. 2378, which contains the most magnesia, might, if properly calcined, be found to produce a hydraulic cement, but not of so durable character as that prepared from more silicious limestones. No doubt they are both good durable building stones.

MORGAN COUNTY.

No. 2380—CANNEL COAL: "*From Williams' bank, Rush branch of Elk Fork of Licking river. Average sample of the fifty-eight-inch bed. Collected by A. R. Crandall.*"

Quite a tough cannel coal, with imperfect lamination. Fracture dull or brownish-black, with a few minute specks of mica on some of the surfaces. No appearance of pyrites and very little of fibrous coal. Ferruginous stain on the exterior surfaces.

No. 2381—COAL NO. 2: "*Forty-inch cannel coal, opposite the house of Joel Adkins, head of North Fork of Licking river. Sample from the outcrop. The whole thickness is in the bed of the branch. Collected by A. R. Crandall, June, 1881.*"

A tough, dull-black cannel coal; laminated. Some of the thicker and more dense laminæ break with a flat-conchoidal fracture. Not much fibrous coal or granular pyrites apparent but there are some small pyritous lumps in the body of the coal. Some of the laminæ are quite shaley. Ferruginous stains on the exterior surfaces.

No. 2382—COAL No. 2: "*Three feet cannel coal, left branch of Mordecai creek. Average sample from the upper thirty-two inches. Collected by A. R. Crandall, June 13, 1881.*"

Resembles the preceding, but darker colored than that, with less ferruginous incrustation and showing no pyrites.

No. 2383—COAL No. 2: "*Another average sample from the upper thirty inches of the same bed. (One foot uncovered, the lower six inches more slatey.) Brought by A. R. Crandall, April 6, 1882.*"

Resembles the preceding.

No. 2384—COAL: *Prater's cannel coal, on Stone Coal branch of Caney creek, one mile above Walnut Grove. Thickness two feet. Collected by A. R. Crandall, June, 1881.*"

A pure-looking, firm, jet-black coal, showing only a few small scales of pyrites between some of the laminæ. Some ferruginous stain on some of the exposed surfaces.

No. 2385—COAL No. 1: "*On a fork of Smith's creek. Bed thirty inches thick. Average sample of the whole thickness. Collected by A. R. Crandall.*"

Apparently a splint coal, breaking into thin laminæ, with some fibrous coal and granular pyrites between.

COMPOSITION OF THESE MORGAN COUNTY COALS.

(*Air-dried.*)

	No. 2380	No. 2381	No. 2382	No. 2383	No. 2384	No. 2385
Specific gravity	1.332	1.348	1.373	1.303	1.294	1.358
Hygroscopic moisture	1.60	4.26	3.90	2.02	2.20	2.90
Volatile combustible matters	44.00	42.48	39.30	41.98	40.50	39.10
Coke	54.40	53.26	56.80	56.00	57.30	58.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	45.60	46.74	43.20	44.00	42.70	42.00
Fixed carbon in the coke	38.36	33.76	38.80	44.06	50.30	51.34
Ash	15.54	19.50	18.00	11.94	7.00	6.66
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Dense.	Pulverulent.	Friable.	Dense.	Dense.	Dense spongy.
Color of the ash	Buff-grey.	Fawn-colored.	Grey-brown.	D'k purplish g'y.	Nearly white.	D'k lilac grey.
Percentage of sulphur	0.961	1.535	1.106	0.810	0.805	4.527

With the exception of Nos. 2384 and 2385, these coals greatly exceed the average ash proportion. Most probably this is partly owing to the fact that the samples in these cases were taken from the weathered outcrop of the bed. No. 2385 contains quite a large proportion of sulphur. Whether the sample was exceptional in this respect, can only be ascertained by the analysis of other samples from the same bed.

Morgan County Soils.

No. 2386—VIRGIN SOIL: "*From woods, with a northern exposure, one hundred and twenty-five feet above Spaw's creek, near Licking river. Timber, oak and maple, undergrowth the same, with dogwood, hickory, etc. Geological position, coal No. 3. Collected by A. R. Crandall, July 19, 1881.*"

Dried soil, of brownish dark-grey color, with small friable clods, containing fragments of sandy and ferruginous shale or concretions, mostly of irregular, flattened forms.

The coarse seive* removed from it 37.73 per cent. of hard sandy, ferruginous, shaley fragments, flattened, and with angles rounded. Its silicious residue all passed through the fine seive,† except a very few small rounded quartzose grains.

No. 2387—SUBSOIL: *Of the next preceding.*

The dried subsoil is mostly in moderately firm sods, generally of a light orange-brown color, light-grey in the course of the vegetable rootlets which penetrated it. Contains some fragments of soft ferruginous and sandy shale or concretions.

The coarse seive removed from it 13.09 per cent. of ochreous concretions or ferruginous shale, containing fine sandy particles, flattened but rounded on all the angles, softer than those of the preceding sample. Its silicious residue all passed through the fine seive except a few small rounded quartz grains.

No. 2388—SOIL: "*From an old field, taken three to six inches from the surface. Bottom land on Spaw's creek, near Licking river. Geological position, coal No. 2. Soil derived from the rocks above. Collected by A. R. Crandall, July 18, 1881.*"

The dried soil is friable, of a brownish-yellowish grey color. Contains but few shaley fragments or concretions.

The coarse seive* removed from it 2.31 per cent. of ferruginous or shaley concretions, etc. The fine seive† separated from its silicious residue 21 per cent. of small rounded white quartz grains.

No. 2389—SUBSOIL: "*Of the next preceding, etc., etc., taken one foot six inches below the surface. Collected by A. R. Crandall.*"

The dried subsoil is mostly in clods, of a lighter and brighter tint than the next preceding. (Light brownish-grey yellow.) Contains but few concretions or shaley fragments.

The silicious residue left on the fine seive 21.80 per cent. of fine rounded white quartz grains. The coarse seive removed from it only 2.11 per cent. of ochreous and ferruginous concretions or fragments.

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*The coarse seive has 64 meshes to the square centimeter.
†The fine seive has 1600 meshes to the square centimeter.

No. 2390—OLD-FIELD SOIL: "*From the land of Amos Fugit, two miles above West Liberty, near the Licking river. Geological position, coal No. 3. On the hillside, western exposure, one hundred and fifty feet above the river. The hill is one hundred and fifty feet higher. Collected by A. R. Crandall, July 19, 1880.*"

The dried soil is friable, of a warm brownish-grey color. The coarse seive removed from it 11.85 per cent. of brownish ochreous concretions, etc. The fine seive separated from its silicious residue 12.65 per cent. of fine white sand in rounded grains.

No. 2391—SUBSOIL: *Of the next preceding, etc., etc.*

The dried subsoil is mostly in friable clods of a handsome light brownish-yellow ochre color. This and the three preceding soiis contain fine quartz sand. The coarse seive removed from it only 0.51 per cent. of brownish ochreous concretions. The fine seive separated from its silicious residue 13.60 per cent. of fine rounded grains of white quartz sand.

COMPOSITION OF THESE MORGAN COUNTY SOILS.
(*Dried at 212° F.*)

	No. 2386	No. 2387	No. 2388	No. 2389	No. 2390	No. 2391
Organic and volatile matters	6.595	4.240	3.305	2.650	3.415	3.225
Alumina and iron and manganese oxides	8.429	6.577	3.655	4.121	3.505	5.262
Lime carbonate	.325	.120	.335	.245	.170	.120
Magnesia	.718	.699	.412	.232	.261	.299
Phosphoric Acid, (P2 O5)	.156	.118	.115	.124	.140	.108
Potash, extracted by acids, (K2O)	.236	.153	.104	.043	.082	.121
Soda, extracted by acids, (Na2 O)	. . . .	.308	.156	.071	. . . .	. . . .
Water, expelled at 380° F.	1.570	.835	.810	.600	.860	.625
Sand and insoluble silicates	82.170	87.570	91.450	91.682	91.485	90.180
Total	100.199	100.620	100.342	99.768	99.918	99.940
Hygrocopic moisture	2.415	1.600	1.150	0.960	0.885	1.115
Potash in the insoluble silicates	2.384	2.757	1.727	1.911	1.410	1.723
Soda in the insoluble silicates	.350	.380	.490	.410	.316	.286
Fine sand in the insoluble silicates	.000	.000	21.000	21.800	12.650	13.600
Rock fragments or concretions	37.730	13.09	2.310	2.110	11.850	0.510
Character of the soil	Virgin soil.	Subsoil.	Old-field soil.	Subsoil.	Old-field soil.	Subsoil.

The virgin soil No. 2386 is of rather more than average fer-

tility, although it is to be discounted by 37.73 per cent. of rock fragments or ferruginous concretions. Most of these, however, may be gradually disintegrated into soil by the process of weathering. The subsoil seems to be less rich in the mineral elements of fertility, as well as in organic matters, than the surface soil. The old-field soils No. 2388, as well as No. 2390, show a diminution of the essential elements as compared with the virgin soils. With the exception of Nos. 2389 and 2390, which are somewhat deficient in immediately available potash, these soils may be considered as of average fertility under favorable conditions, and they all may be made permanently productive by judicious management and the proper use and economy of fertilizers.

MUHLENBERG COUNTY.

No. 2392—COAL: "*From the 'Mud River Mines.' Sample clipped from three large blocks taken from the middle and bottom of the bed. Sent by John R. Procter, June 22, 1882.*"

A pure-looking, pitch-black coal, glossy on most of the fractured surfaces. Very little appearance of fibrous coal. Some little bright scales of pyrites in some of the seams. Large fracture, in cuboidal blocks; smaller fracture irregular, with shining facets. Softens somewhat in the flame, and swells up into a spongy coke.

COMPOSITION (*Air-dried*).

Specific gravity			1.268
Hygroscopic moisture	6.46	Total volatile matters	40.50
Volatile combustible matters	34.04		
Spongy cake	59.50	Fixed carbon in the coke	55.50
		Light lilac-grey ash	4.00
Total	100.00	Total	100.00

Its percentage of sulphur is 0.802.

A very good, pure coal, which seems to possess coking qualities. The large proportion of moisture in this sample is somewhat exceptional, and probably accidental.

NELSON COUNTY.

No. 2393—SANDSTONE (PHOSPHATIC): "*From the black Devonian slate, in the Boston district. Locally ten inches thick. Con-*

tains fish and other organic remains. Collected by W. M. Linney. Received June 29, 1883."

A grey sandstone, mostly made up of hyaline grains of quartz, somewhat rounded, mixed with dark-colored granules and broken organic remains.

On analysis this rock was found to contain 67.04 per cent. of silicious material, with smaller proportions of alumina, oxide of iron, lime, and magnesia, not determined, with which was combined 11.162 per cent. of phosphoric acid (P_2O_5), equivalent to 24.372 per cent. of bone phosphate. It also contained traces of the alkalies, in which was potash equal to 0.019 per cent. of the rock.

No. 2394—LIMESTONE (FERRUGINOUS): "*From near the top of the upper Hudson river beds. Cumberland sandstones and shales. Collected by W. M. Linney, near the farm of S. P. Stiles, four miles north of Bardstown, May 5, 1883.*"

A fine granular rock of a dull-grey color; brownish-yellow on the weathered portions. Not adhering to the tongue.

No. 2395—LIMESTONE (FERRUGINOUS): "*From near S. P. Stiles'. Cumberland sandstones and shales. Upper part of upper Hudson river beds. Collected May 5, 1883, by W. M. Linney.*"

A fine granular rock of a brownish-yellow ochre color. Not adhering to the tongue.

COMPOSITION OF THESE NELSON COUNTY FERRUGINOUS LIMESTONES.
(*Air-dried.*)

	No. 2394	No. 2395
Lime carbonate	81.580	61.240
Magnesia carbonate	1.501	8.915
Alumina and iron oxide	2.978	4.317
Phosphoric acid (P_2O_5)	1.202	.563
Potash	.423	.443
Soda	.248	.254
Silicious residue	11.120	22.520
Moisture and loss	.948	1.748
Total	100.000	100.000
Percentage of lime	45.685	34.294

Judging by the composition of sample No. 2395, it is probable that by skillful management in calcination it might furnish hydraulic cement. No. 2394, containing less silicious matter, might be made available in all the ordinary uses of lime for building purposes; and both, if to be obtained in proper shape, would make good building stones. They would yield fertile soil by the slow process of weathering.

No. 2396—SOIL: "*From the farm of S. P. Stiles, four miles north of Bardstown. Derived from the Cumberland shales. Geological position, upper part of the upper Hudson river beds. Collected by W. M. Linney, May 5, 1883. Said to be quite poor, soft, light soil. Has been cultivated for a long time, perhaps forty years. Does not wash badly.*"

Soil of a light brownish-buff color. Clods friable. All passed through the coarse seive, which has 64 meshes to the square centimeter, except a small quantity of ferruginous concretions—shot iron ore. Its silicious residue, from digestion in acids, all passed through the fine seive with 1600 meshes to the centimeter square, except two or three small quartzose particles.

COMPOSITION. (*Dried at 212° F.*)

Organic and volatile matters	3.020	
Alumina and oxides of iron and manganese	9.772	
Lime carbonate	.145	
Magnesia	.305	
Phosphoric acid (P_2O_5)	.173	
Potash, extracted by acids (K_2O)	.438	
Soda, extracted by acids (Na_2O)	..	
Water expelled at 340° F.	.612	
Sand and soluble silicates	84.820	containing 1.200 p. c. potash. and .646 p. c. soda.
Total	99.285	

Hygroscopic moisture=2.350 per cent.

No reason appears, except perhaps its small proportion of organic matters—*humus*—why this soil might not yet be reasonably productive under favorable conditions and good husbandry. A two-years' rest in clover pastured on the ground and then plowed under would greatly improve its fertility.

OHIO COUNTY.

No. 2397—MINERAL WATER: "*From a spring on the hillside, two miles from Haynesville and three miles from Fordsville—farm of J. M. Royal, on the Hartford and Hawesville road. Sample sent by J. M. Royal.*"

COMPOSITION, *in 1000 Parts of the Water.*

Iron and manganese carbonates	Small quantities not estimated.	Held in solution by carbonic acid.
Lime sulphate	0.938	
Magnesia sulphate	1.530	
Potash sulphate	.023	
Soda sulphate	.185	
Sodium chloride	.200	
Silica	.078	
Total saline matters	2.954 in 1000 parts of the water.	

A good weak saline, chalybeate water.

PERRY COUNTY.

No. 2398—COAL: "*From J. H. Comb's bank, below and opposite Hazard. Bed three feet thick without parting. One hundred feet above the river. Collected by A. R. Crandall. Brought August 3, 1881.*"

A pure-looking, pitch-black splint coal. Shows very little fibrous coal and no visible pyrites between its irregular laminæ.

No. 2399—COAL: "*From the mouth of Sassafras creek. Average sample, from near the outcrop, from the whole face of the bed, of four and a half feet thickness, excluding two and a half inches of 'bone coal' near the middle. Collected by A. R. Crandall, July 13, 1883.*"

Generally a bright splint coal. No apparent pyrites and very little fibrous coal between its laminæ. Some little incrusting clay on some of the pieces, which will increase the ash percentage.

COMPOSITION OF THESE PERRY COUNTY COALS.

(*Air-dried*).

	No. 2397	No. 2398
Specific gravity	1.272	1.305
Hygroscopic moisture	1.50	1.30
Volatile combustible matters	36.10	34.70
Coke	62.40	64.00
Total	100.00	100.00
Total volatile matters	37.60	36.00
Fixed carbon in the coke	59.06	56.10
Ash	3.34	7.90
Total	100.00	100.00
Character of the Coke	Spongy.	Spongy.
Color of the ash	Light grey.	Buff-grey.
Percentage of sulphur	0.618	0.437

These are both good pure coals, more especially No. 2397. The apparent ash percentage of No. 2398 is no doubt increased by the adherent dirt in the sample. When the bed is opened out deeper the ash percentage will probably be found to be much less.

PIKE COUNTY.

"*Elkhorn Coals*" (*so-called*).

No. 2399—COAL: "*On Big Elkhorn. Seven feet bed, with a two-inch parting six inches above the middle. Sample of an average of the whole bed Collected by A. R. Crandall, November 12, 1881.*"

A firm, pitch-black, pure-looking coal, showing very little fibrous coal and no apparent pyrites.

No. 2400—COAL: "*From Isaac Patton's new bed, on branch, head of Elkhorn creek. Two feet thick or more. Collected by A. R. Crandall, November, 1881.*"

A pure-looking, pitch-black coal. Shows but little fibrous coal or granular pyrites.

No. 2401—COAL: "*On Big Elkhorn creek, at Mullen's branch, head of Kentucky river. Bed nearly four feet thick. Average sample of the lower part. Collected by A. R. Crandall, November 12, 1881.*"

Resembles the next preceding.

No. 2402—COAL: "*Elkhorn coking coal. (Rice's coal.) On Mill branch of Elkhorn creek. (Coal No. 1?) Whole thickness one hundred and one inches. (Sample I.) From lower forty-four inches. Collected by Roger C. Ballard, August 28, 1882.*"

A pure-looking, pitch-black coal, breaking easily; fracture generally irregular cuboidal. No appearance of pyrites or fibrous coal. (Some portions of this coal were light enough to float on water, so that its specific gravity was taken by the use of alcohol.

No. 2403—COAL: "*From same bed. Sample II. (of the upper part of the bed), etc., etc.*

Resembles the preceding.

No. 2404—COAL: "*Slack Coal, from Elkhorn creek of Big Sandy, from which the coke No. 2413 was made at Connellsville, Pa.*"

No. 2405—COAL: "*From Cane branch of Elkhorn creek. Geological position, 'Main coal.' Sample from the upper five feet five and a half inches, above the six-inch parting. Collected by A. R. Crandall, August 22, 1883.*"

A bright, pure-looking, soft coal, with very little appearance of fibrous coal or pyrites. A very free burning coal.

No. 2406—COAL: "*From the same bed as the next preceding. Sample from the lower three feet seven inches. Collected by A. R. Crandall, August 22, 1883.*"

Resembles the next preceding.

No. 2406 A—BONE COAL (SO-CALLED): "*From the lower stratum of the above. Collected by A. R. Crandall, August 22, 1883.*"

Resembles a splint coal. This gave a dense friable coke, and left only 4.40 per cent. of very light buff ash.

COMPOSITION OF THESE PIKE COUNTY ELKHORN COALS.

(*Air-dried*).

	No. 2399	No. 2400	No. 2401	No. 2402	No. 2403	No. 2404	No. 2405	No. 2406
Specific gravity	1.282	1.307	1.271	1.278	1.271	n. e.	1.355	1.314
Hygposcopic moisture	2.60	2.60	2.00	1.60	1.60	1.80	6.00	2.54
Volatile combustible matters	34.20	33.40	33.50	32.10	29.36	26.80	31.26	32.26
Coke	63.20	64.00	64.50	66.30	69.04	71.40	62.74	65.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	36 80	36.00	35.50	33.70	30.96	28.60	37.26	34.80
Fixed carbon in the coke	60.80	61.30	60.54	64.64	67.40	67.60	59.34	62.20
Ash	2.40	2.70	3.96	1.66	1.64	3.80	3.40	3.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Dense.	Dense.	Light Spongy.	Very lt Spongy.	Inflated.	Dense Spongy.	Pulverulent.	Dense, hard.
Color of the ash	Light buff.	Light buff.	Light grey.	Lt. reddish-br.	Lt. reddish-br	Brownish-red.	Lt.fawn col'd.	Lt.pit buff.
Percentage of sulphur	.412	.467	.429	.711	.610	.967	.390	.547

Remarkably good coals, containing but small proportions of ash and sulphur. The "slack coal," No. 2404, of course contains more of these ingredients than most of the others.

From the Coke Report of F. Platt, Second Geological Survey of Pennsylvania, Special Report L, 1875, p. 120, we for comparison give the analysis of "three types of the best coking coals of Pennsylvania," including that of the celebrated Connellsville coal, as follows:

	a Connellsv'e.	*b* Bennington.	Broad Top.	
	Pitts'g Seam.	Miller.	*b* Barnett.	*c* Miller.
Volatile matters	31.360	22.380	16.00	19.68
Fixed carbon	59.620	68.500	74.65	71.12
Ash	8.230	8.000	7.50	7.50
Sulphur	.784	1.120	1.85	1.70
Total	99.994	100.000	100.00	100.00
Coke	68.000	76.000	81.00	78.00

Analysts—*a*, McCreath. *b*, *c*, T. T. Morall.

According to F. Platt, the requirements of a good coking coal are as follow:

"1. Pure semi-bituminous coal.

"2. Must contain enough volatile matters to supply heat in coking without expenditure of carbon.

"3. Its coke must be tenacious enough to sustain, without crumbling, the burthen and blast of the furnace, and have an open cellular structure to facilitate its penetration by the carbonic acid gas in the furnace."

It will be seen that the Elkhorn coal and other coals of Kentucky compare very favorably with these celebrated Pennsylvania coals.

Other Pike County Coals.

No. 2407—COAL: "*From Stone Coal creek, four and a half miles below Pikeville. Upper two feet eight inches. Average sample. Collected by A. R. Crandall, September 4, 1882.*"

A pure-looking, pitch-black coal. Some portions showing scales of bright pyrites and fibrous coal. One portion has irregular fracture; another portion breaks into irregular laminæ.

No. 2408—COAL: "*From the same bed. Average sample from the lower three feet. Collected by A. R. Crandall, September 4, 1882.*"

A considerable portion of the sample is in tough laminæ, and like cannel coal, of a dull black, showing fibrous coal between the layers; another portion is of bright pitch-black and of irregular fracture.

No. 2409—COAL: "*Head of Chloe creek, two miles and a half south of Pikeville. Average sample from the lower four feet eight inches. Entry driven thirty feet.*"

A pure-looking, pitch-black coal, showing very little fibrous coal and no apparent pyrites.

No. 2410—COAL: "*From three-quarters of a mile above Pikeville, on Little Chloe creek. An average sample from Sykes bank. Collected by A. R. Crandall, September 3, 1882.*"

Mostly laminated, and showing a weathered appearance Some little fibrous coal apparent, but no pyrites.

COMPOSITION OF THESE OTHER PIKE COUNTY COALS.

(*Air-dried.*)

	No. 2407	No. 2408	No. 2409	No. 2410
Specific gravity	1.279	1.293	1.273	1.367
Hygroscopic moisture	2.20	2.40	1.40	5.06
Volatile combustible matters	36.10	35.40	33.66	29.84
Coke	61.70	62.20	64.94	65.10
Total	100.00	100.00	100.00	100.00
Total volatile matters	38.30	37.80	35.06	34.90
Fixed carbon in the coke	58.10	58.26	58.60	57.50
Ash	3.60	3.94	6.34	7.60
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Spongy.	Spongy.	Pulverulent.
Color of the ash	Lt. buff grey.	Lt. buff grey.	Lt. greyish.	Nearly white.
Percentage of sulphur	0.651	0.692	0.825	1.038

These also are good coals, containing generally only a little more sulphur and ash than the average Elkhorn coals. No. 2410 shows the effects of weathering in the increase of its moisture, ash, etc. The coal is no doubt purer deeper in the bed.

Elkhorn (Pike County) Cokes.

No. 2411—COKE: "*Made of the Elkhorn coking coal, from Elkhorn creek, six miles above the mouth of Mill branch. Rice's opening.*

No. 2412—COKE: "*Of the Elkhorn coal, made in an oven in Cincinnati. Sent by Mr. Jno. R. Procter, December 7, 1882, who wrote: 'I see some small bits of slate in the coke, which will doubtless make the percentage of ash larger than were the coal carefully mined.'*"

A firm, bright coke.

No. 2413—COKE: "*Made from the Elkhorn slack coal (No. 2404), coked at Connellsville, Pa., by inclosing the coal in a*

wooden box, nailed up, and putting it in the midst of the Connellsville coal in a coking oven. Sent from Cincinnati January 18, 1883, by H. W. Bates, Vice President of Eastern Railway Company."

This coke is bright and firm and of moderate porosity. (The specific gravity was taken of a lump.)

No. 2414—COKE: *"Of Elkhorn coal, Wm. Mullens, on Elkhorn creek. Made from a sample taken from the upper part of the bed. Sent by R. C. Ballard, September 8, 1883."*

A firm columnar coke.

No. 2415—COKE: *"Of coal from the same bed. Made from a mixed sample of the coal. Sent by R. C. Ballard, September 5–10, 1883."*

A little more porous than the preceding.

COMPOSITION OF THESE PIKE COUNTY (ELKHORN COAL) COKES.
(*Air-dried.*)

	No. 2411	No. 2412	No. 2413 *c*	No. 2414	No. 2415
Moisture, etc., lost on ignition	2.86*a*	0.20*b*	1.20	1.10	1.06
Fixed carbon in the coke	88.44	93.20	94.14	95.40	90.40
Ash	8.70	6.60	4.66	3.50	8.54
Total	100.00	100.00	100.00	100.00	100.00
Color of the ash	Lt. lilac grey.	Brown'h red.	Brown'h red.	D'k lilac grey.	Lt. purplish g'y.
Percentage of sulphur	0.844	0.734	1.484	0.517	0.598

(*a*) Moisture lost at 500° F.; (*b*) at 220° F. (*c*) Specific gravity 0.937.

Another sample of No. 2412 sent by Mr. Bates, gave on analysis, moisture 0.06 per cent., fixed carbon 94.34, brownish-red ash 5.60 and sulphur 0.788.

These cokes compare very favorably with the celebrated coke of Connellsville, Pa., which is exported to all parts of the country in immense quantities.*

**The Scientific American* of November 18, 1882, page 323, states, that eight thousand coke ovens are in use at Connellsville, of a daily capacity of 15,000 tons, and that the coke is prized because of its high proportion of carbon, its freedom from impurities, and its hardness. (See *Bell County* and a following page for the official analysis of the Connellsville Coke.)

Some experiments were made with Coke No. 2413 to ascertain its porosity; by first finding the cubic contents of a number of weighed fragments; by immersion in water in a specific gravity bottle; then placing them, immersed in water, in the vacuum of an air-pump for several hours, to remove the air from the pores and fill them with water; then, by weighing them again, after wiping dry the superfices, to ascertain the quantity of water absorbed into the pores, etc. In this imperfect manner the cell space was found to be 41.46 per cent. of the volume of the coke. As, in the first immersion of the coke, to get its cubic volume, some water necessarily entered its pores, this estimation is evidently only approximative.

In experiments made by the officers of the Second Pennsylvania Geological Survey (See F. Platt's Coke Report of 1875, Special Report L, p. 130), "the cellular space of coke was obtained by immersing an accurately cut cubic inch of the coke in a glass of distilled water under the receiver of an air-pump, exhausting the air and weighing the cube dry and wet, the difference indicating the cellular space, as the specific gravities of coke and water are very nearly alike." (Not always.)

According to that author, the best cokes have the cell space to the whole mass very nearly as one to two; but he states "these proportions can differ widely in cokes, giving equally good results in furnace use; 38 to 62 is obtained from a coke of a first-class order in strength and purity."

The much larger surface exposed to the penetrating water in the small fragments used in our experiments, as compared with that of the solid cubic inch used in the Pennsylvania determination, would expose more cells to be filled by the water, and hence increase the apparent cell space.

No. 2416—IRON ORE: "*On Elkhorn creek, sixteen miles from its mouth, at Levi Potter's, Pike county. One hundred and fifty feet above the bed of the creek. In large blocks. Average sample from a large block. Collected by A. R. Crandall, August 28, 1882.*"

A dark-colored, dull-brownish, cellular conglomerate or concretion.

COMPOSITION, *Dried at 212° F.*

Iron peroxide	59.630=41.74 per cent. of iron.
Alumina, etc.	7.927
Phosphoric acid (P_2O_5)	.563=0.234 per cent. of phosphorus.
Combined water	.560
Silicious residue	29.720 containing 21.98 per cent. of silica.
Undetermined and loss	1.600
Total	100.000

No. 2416 (*a*)—SO-CALLED "BRECCIATED OR DYE ORE." "*Sample from a large block on the surface. Mr. Gibson's place on Pigeon Roost branch, Pike county. Collected by A. R. Crandall, August 20, 1882.*"

A friable breccia, mainly of argillaceous material, colored more or less reddish brown with iron oxide, and mottled with grey material, involving numerous fragments of ferruginous and grey sandstone or shale and chert.

It contains too little iron oxide to be of value as an ore, and its finer, ochreous material is of too dull color to be of much value as a pigment.

No. 2416 (*b*)—"CLAY ORE," "DYE ORE," SO-CALLED: "*On Mr. Roberts' place on Jackson branch, Pike county. Overlying the place of the so-called brecciated ore of other localities. Collected by R. C. Ballard, August 27, 1882.*"

A bright red ochre or bole, slightly mottled with small yellowish-grey portions; friable, involving fragments of silicious-ferruginous shale, which are rounded on the edges; also some irregular fragments of greyish sandstone.

Some of this bole, exclusive of the silicious fragments, pulverized of a bright venetian-red color. No doubt if ground and washed from the silicious material it might serve for a pigment.

PULASKI COUNTY.

No. 2417—COAL: *From Childer's opening, Capt. Geary's land, branch near the head of Indian creek. Average sample. Bed thirty-three inches thick. Six inches of the top semi-cannel; a parting an inch from the top. Thick sandstone rock next above it. Collected by A. R. Crandall, May 24, 1880.*"

A firm, bright, pure-looking, pitch-black splint coal, showing ferruginous stains on some of the exterior surfaces. Breaks irregularly, some portions in irregular laminæ, with fibrous coal and reed-like impressions between. Some portions show a bird's-eye structure. Shows very little granular pyrites.

No. 2418—COAL: "*Forty-two inch coal, under a sandstone cliff. Head of Barren Fork of Indian creek, three and a half miles from Flat Rock station, on the Cincinnati Southern Railroad. Collected by A. R. Crandall.*"

Resembles the preceding. Shows a little bright pyrites.

No. 2419—COAL: "*Bird's-eye cannel coal, from near the head of Barren branch of Indian creek. Nine inches thick. The whole bed is thirty inches thick. Collected by A. R. Crandall.*

Quite a tough cannel coal, breaking irregularly, with a hackly fracture across the laminæ, and showing the bird's-eye structure in the direction of the very irregular laminæ. Some of the exterior surfaces much coated with reddish-brown ochreous material. Shows no fibrous coal and very little pyrites.

No. 2420—COAL: "*From the 'Big Vein Coal Company's mine,' between the Cincinnati Southern Railroad and the South Fork of Cumberland river. Average sample. Sent by Mr. Procter, May 8, 1882.*"

No. 2421—COAL: "*From the Barren Fork Coal Company, near Flat Rock station on the Cincinnati Southern Railroad. (Conglomerate?) Sample of the marketable coal (thirty-five and a half inches). There is also above in some places two to four inches of splint coal, and below ten to twelve inches of very slatey coal. Collected by R. C. Ballard, November 18, 1882.*"

A pure-looking, pitch-black coal. Some portions breaking with irregular and sub-cuboidal fracture with brilliant surfaces; other portions showing lamination, with some little fibrous coal. No apparent pyrites, except a very few granules in the fibrous coal.

No. 2422—COAL: "*From Flat Rock mines, Flat Rock Station on the Cincinnati Southern Railroad. Collected by R. C. Ballard, November 20, 1882. (This is from the mine, including slack and all.)*"

Mostly dull, and apparently weathered, and fine laminated, with fibrous coal between the laminæ. No bright pyrites apparent.

No. 2423—COAL: "*From Cumberland Coal Company, Greenwood. (Coal No. 1.) Collected by R. C. Ballard, November 23, 1882.*"

A firm, pure-looking, pitch-black coal, breaking generally into thin laminæ, with some little fibrous coal between, but no apparent pyrites, except some small bright scales on one portion. A splint coal, resembling so-called "block coal."

No. 2424—COAL: "*From Beaver Creek Coal Company. Entry No. 1. Lower twelve inches. Bed forty-eight inches thick. Conglomerate. Collected by R. C. Ballard, November 20, 1882.*"

Much of the sample is bright, pitch-black coal, with glossy, irregular sub-cuboidal fracture. A portion more dull, breaks into thin laminæ, with dense mineral charcoal between, and specks of bright pyrites.

No. 2425—COAL: "*From same bed. Entry No. 2. Conglomerate. Bed forty-six inches thick. Collected by R. C. Ballard, November 20, 1882.*"

A pure-looking, pitch-black coal. Sample contains more of that with irregular cuboidal fracture and glossy surfaces than the preceding one, and a smaller proportion of the dull thin laminated coal, etc.

No. 2426—COAL: "*From same bed. Entry 6. Conglomerate. Sample of the middle thirty-one inches. Collected by R. C. Ballard, November 20, 1882.*"

Sample firm "splint" or "block coal." Breaks into irregular thin laminæ, with but little mineral charcoal, and some little granular pyrites between.

No. 2427—COAL: "*Same bed. Entry 6. Conglomerate. Sample from the lower seventeen inches of the bed. Collected by R. C. Ballard, November 20, 1882.*"

Sample contains rather more of the laminated or splint coal than the next preceding samples. Some granular pyrites apparent and a little dense mineral charcoal between the thin irregular laminæ.

COMPOSITION OF THESE PULASKI COUNTY COALS. (AIR-DRIED).

	No. 2417	No. 2418	No. 2419	No. 2420	No. 2421	No. 2422	No. 2423	No. 2424	No. 2425	No. 2426	No. 2427
Specific gravity	1.309	1.354	1.294	1.236	1.312	1.315	1.315	1.425	1.372	1.314	1.323
Hygroscopic moisture	3.03	2.68	1.67	2.20	1.54	1.76	2.50	2.14	2.06	2.20	2.34
Volatile combustible matters	35.04	35.44	45.46	36.24	33.80	36.24	36.20	31.46	34.04	36.56	34.32
Coke	61.83	61.88	52.87	61.56	64.66	62.00	61.30	66.40	63.90	61.24	63.34
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	38.07	38.12	47.13	38.44	35.34	38.00	38.70	33.60	36.10	38.76	36.66
Fixed carbon in the coke	55.98	55.18	46.07	56.96	58.26	55.26	52.10	47.74	52.50	53.14	56.14
Ash	5.95	6.70	6.80	4.60	6.40	6.74	9.20	18.66	11.40	8.10	7.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Spongy.	Dense spongy.	Light spongy.	Light spongy.	Spongy.	Spongy.	Dense.	Dense spungy.	Light spongy.	Spongy.
Color of the ash	Grey.	Lt. lilac grey.	Lt.br'n'h yellow.	Lt. buff grey.	Light grey.	Light grey.	Lt. lilac grey.	Lt. lilac grey.	D'k lilac-grey.	Lilac-grey.	Lt. buff grey.
Percentage of sulphur	1.236	2.334	3.035	0.742	1.540	1.286	2.601	2.140	4.250	3.645	1.265

Except No. 2424, which has a large proportion of ash, all these coals are good for all ordinary purposes. Even this may be profitably used when the large ash residue does not prove objectionable. The sample analyzed was only from the lower twelve inches of the bed. For all uses where sulphur would be injurious all these coals which contain more than two per cent. of that substance would not probably be applicable.

No. 2427—MARLY SHALE: "*From south of the Cumberland river, on the line of the Cincinnati Southern Railroad. Collected by W. H. Pettus, October, 1880.*"

A very friable marlite, generally of a light-chocolate color. Adheres slightly to the tongue.

COMPOSITION (*Dried at 212° F.*)

Alumina and iron and manganese oxides	15.814	
Lime	3.475	
Magnesia	.542	
Phosphoric acid	a trace.	
Potash, extracted by acids	1.666	
Soda, extracted by acids	.033	
Combined water	4.927	
Carbonic acid and loss	3.603	
Silicious residue	69.940	containing potash, 2.360 containing soda, . .230
Total	100.000	

Total potash, 4.026 per cent., total soda, .263 per cent.

Notwithstanding the rather more than four per cent. of potash contained in this shale, it could not profitably be used as a fertilizer, because most of the potash is in firm chemical combination with the silicates, and the proportion of phosphoric acid is very small.

No. 2428—YELLOW OCHRE: "*From one mile north of Somerset. Collected by W. H. Pettus.*"

In friable lumps which are mottled with various tints, from light yellowish to slightly brownish yellow. The general tint is a good yellow-ochre color. It contains a considerable proportion of fine sand.

If it is in a very large deposit, where there are facilities for cheaply washing it, a cheap pigment might possibly be made of it.

ROWAN COUNTY.

No. 2429—SANDSTONE: "*From the base of the Waverley formation. Sample supplied by the Freestone Company; Tyler, President. Taken from quarry near Farmer's Station, on the Chesapeake & Ohio Railroad, thirty-five miles beyond Mt. Sterling. Brought by Mr. W. W. Monroe.*"

A fine-grained sandstone of a handsome light-grey color on the recently exposed surfaces, showing a few minute spangles of mica. Adheres to the tongue. Stained light ochreous and brownish on the weathered surfaces. Showing no fossil remains, but *Spirophyton cauda-galli* (Hall) on one of its surfaces. This rock is used in the construction of the new court house at Lexington.

Specific gravity about 2.50. (This is somewhat difficult to take in lump, because it absorbs water.)

COMPOSITION (*Air-dried*).

Sand and insoluble silicates,	93.128
Iron carbonate,	2.386
Lime carbonate,	.578
Magnesia carbonate,	.256
Alumina, phosphoric acid, etc.,	1.188
Moisture and loss,	2.514
Total,	100.000

A small cube of this rock, measuring little more than a cubic inch, weighed 44.760 grammes, air-dried.

Immersed in water for twenty-five minutes and wiped, it had gained	1.744	grammes.
Immersed for forty-eight hours more, it gained only	.314	" more.
In all	2.058	"

Equal to 4.59 per cent.

After thorough drying at 212° F. it weighed 44.009 grammes, having lost 0.757 grammes, equal to 1.02 per cent. of its original weight, which probably represented hygroscopic moisture evaporated at this temperature. Again immersed in water for four hours, it absorbed 2.5 grammes.

In Vol. 4, *Reports of the Kentucky Geological Survey, O. S., p. 252*, the present writer gave an analysis of another sample of this sandstone, from the mouth of Triplett creek, on Licking river, which contained somewhat less sand and more of the other ingredients than that described above; and in Vol. 3 of the same series the late Dr. D. D. Owen notices the rock in place, remarking: "There is an excellent opportunity of opening fine quarries of fine-grained knob freestone without much stripping. The ledges are from one foot eight to two feet or more, and appear to be of good quality, as they form bold projecting ledges along the declivities of the hills."

That this freestone proves to be durable in masonry which has been exposed to the weather for several years, and presents such bold enduring outlines in its original ledges, seems inconsistent with the fact of its porosity and its property of absorbing water to a considerable amount on its fresh surfaces. Its composition, however, explains this apparent discrepancy.

It is composed of fine grains of transparent, colorless quartz—pure silica—united by a cement composed of carbonates of iron, lime and magnesia, with a little silicate of alumina, and, as already stated, is quite absorbent of water on its freshly exposed surfaces; but the exterior surfaces of the bed or rock, which have been exposed for some time to the atmospheric agencies, are less porous and absorb much less water. The rock is comparatively soft and easily worked when fresh from the quarry, but it becomes harder and less porous in the course of time when exposed to the weather, its color changing at the same time to a light buff or a light brownish tint on the exposed surfaces.

These changes depend on the chemical properties of the cementing material of the stone. The carbonates which mainly compose this cement are to a certain extent soluble in the atmospheric water, which contains free carbonic acid, and which dissolves and holds them in solution as bicarbonates. But when this watery solution evaporates on the surface of the rock, the free carbonic acid and that of the bicarbonate of iron escapes and is replaced by oxygen and water; so that a hydrated per-

oxide of iron, mixed with the alumina and the carbonates of lime and magnesia, is formed on the surface, which gradually fills up the pores and is not soluble to any extent in water, thus increasing the superficial hardness of the stone and its power of withstanding the action of the elements.

This stone is of the same formation as that of the quarries of Berea, which is much used for constructions of various kinds.

SHELBY COUNTY.

No. 2430—VIRGIN SOIL: "*From the farm of John Davis, two miles east of Shelbyville. (Same as the soil from John Glen's.) Timber: Maple, walnut, yellow poplar, blue ash, white oak and white elm. Geological position, lower part of the upper Hudson river beds. Collected by W. M. Linney.*"

The dried soil is of umber-grey or dark-drab color. In friable clods.

The coarse seive removed from it about 3.5 per cent. of shot-iron ore. The silicious residue from digestion in acids all passed through the fine seive after crushing the small soft concretions which it contained.

No. 2431—SURFACE SOIL: "*From a field which had been cultivated for some years and then set in grass. Farm of John Davis, etc., etc. (Same locality as the next preceding.) Collected by W. M. Linney.*"

Soil darker colored than the preceding. Light snuff colored. Quite friable.

The coarse seive removed from it a very small proportion of shot-iron ore. The silicious residue of this left a considerable proportion of small rounded concretions of partly decomposed silicates, soft enough to be crushed under the finger, when all passed through the fine seive when thus crushed.

No. 2432—SOIL: "*Mixed to the depth of ten inches, from a field over twenty years in cultivation, on the farm of John Glen, two miles east of Shelbyville. Same geological position as the preceding. Collected by W. M. Linney.*"

This soil resembles the next preceding in color, but is slightly lighter colored. Clods more firm than of that.

The coarse seive removed a very small proportion of shot-iron ore. Its silicious residue was like that of the preceding."

No. 2433—VIRGIN SOIL: "*From the top of the upper Hudson river beds, five miles east of Shelbyville. Timber: Walnut, white and red oak, elm and honey locust. Collected by W. M. Linney.*"

Soil of a dark-brown color, containing fossil shells and portions of Chætetes. Clods quite firm.

The coarse seive removed 8.2 per cent. of calcareous fossil remains. The silicious residue resembled that of the preceding. Concretions harder.

No. 2434—SOIL: "*From an old field. Same locality as the next preceding. Collected by W. M. Linney.*"

Soil in very firm clods, of a brownish-buff or drab color. The coarse seive removed a very small proportion of shot-iron ore. On the fine seive the silicious residue was similar to the preceding.

No. 2435—SUBSOIL: "*Of the next preceding, taken one foot to fourteen inches below the surface. Collected by W. M. Linney.*"

Subsoil of a light dirty brown color, lighter color than No. 2473. The firm clods contain many fragments of calcareous fossils, limestone fragments and shot-iron ore, of which the coarse seive removed 41.2 per cent. On the fine seive the silicious residue resembled the preceding, all finally passing through it,

No. 2436—VIRGIN SOIL: "*From Jeptha Knobs, five miles south-east of Shelbyville. Upper silurian formation. Collected by W. M. Linney.*"

Dried soil of a brownish drab color. Clods quite firm. The coarse seive removed about 18 per cent. of silicious and ferruginous fragments. On the fine seive the silicious residue resembled the preceding.

COMPOSITION OF THESE SHELBY COUNTY SOILS.

(*Dried at 212° F.*)

	No. 2430	No. 2431	No. 2432	No. 2433	No. 2434	No. 2435	No. 2436
Organic and volatile matters	5.000	4.840	4.250	14.075	4.970	11.315	5.015
Alumina and iron and manganese oxides	9.044	8.852	9.494	16.158	9.490	14.380	6.590
Lime carbonate	.320	.645	.420	4.695	.720	25.245	.245
Magnesia	.246	.322	.247	1.373	.389	.805	.250
Phosphoric acid (P2 O5)	.268	.268	.211	.412	.365	.415	.230
Potash (K2 O) extracted by acids	.347	.418	.384	2.015	.591	1.772	.256
Soda (Na2 O) extracted by acids	.082	.061	.000	.000	.064	trace.	.000
Water expelled at 380° F.	.515	.420	.365	.750	.280	.315	.570
Sand and insoluble silicates	83.995	83.945	84.245	61.045	83.310	47.295	86.545
Total	99.857	99.771	99.616	100.523	100.179	101.542	99.701
Hygroscopic moisture	1.885	1.865	1.635	4.125	1.800	2.520	1.165
Potash in the insoluble silicates	1.773	1.385	1.429	2.131	1.509	1.677	1.401
Soda in the insoluble silicates	.473	.348	.382	.150	.241	.075	.383
Rock fragments or concretions	3.500	....	....	8.200	....	41.200	18.000
Character of the soil	Virgin soil.	Cultiv'd field.	Cultiv'd field.	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.

All of these soils contain more than the average proportions of essential mineral plant food, and would be classed among the very fertile soils if all other conditions are favorable. Nos. 2433 and 2435 excel especially in their very large proportions of organic and volatile matters, phosphoric acid and potash. They are also quite calcareous, especially No. 2435, which approaches the marls in this respect. They contain more alumina and oxide of iron than any of the other soils, and a smaller quantity of sand and soluble silicates. They are to be discounted, however, with the percentage of rocky fragments and fragments of fossil remains they contain.

No. 2437—LIMESTONE ROCK: "*From the Jeptha Knobs, five miles southeast of Shelbyville. Upper silurian formation. Supposed to be from the horizon of the Louisville cement rock. Collected by W. M. Linney.*"

A fine granular rock of a dull olive-grey color. Adheres to the tongue.

COMPOSITION (*Air-dried*).

Lime carbonate	40.780	equal to 22.837 per cent. of lime.
Magnesia carbonate	24.511	
Alumina and oxide of iron, etc.	5.917	
Phosphoric acid (P2 O5)	.563	
Sulphuric acid (SO3)	.941	
Silicious residue	25.120	
Moisture, alkalies, loss, etc.	2.168	
Total	100.000	

It would probably yield a rich soil on disintegration by weathering.

The composition of this rock closely resembles that of the hydraulic limestone at the Falls of the Ohio in Jefferson county, an analysis of which was given in Vol. 2 of Old Series of Reports of the Geological Survey of Kentucky, p. 220, published in 1857.

For comparison the analysis of the Jefferson county rock and that of Jephtha Knobs, calculated as dried at 212° F., is here given:

	Jeptha Knobs Rock.	Jefferson County Rock.
Lime, carbonate	41.612	50.430
Magnesia, carbonate	25.010	18.670
Alumina and oxides of iron and manganese	6.378	2.930
Phosphoric acid (P2 O5)	.564	.060
Sulphuric acid (SO3)	.960	1.580
Potash	n. e.	.320
Soda	n. e.	.130
Silica and insoluble silicates	25.521	25.780

There is but little doubt that this rock would give a good hydraulic cement on proper calcination.

SPENCER COUNTY.

No. 2438—PHOSPHATIC LIMESTONE: "*From the lower part of the upper Hudson River beds. Collected by W. M. Linney, received July 5, 1883. Timber: Blue ash, walnut, chinquepin, oak (quercus prunus), wild cherry, hackberry, etc.*"

A coarse-grained semi-crystalline rock; grey, mottled with yellowish-brown, or ferruginous. Containing many broken organic remains.

COMPOSITION (*Air-dried*).

Lime carbonate	87.320=48.889 per cent. of lime.
Magnesia carbonate	.787
Alumina and iron oxide	2.478
Phosphoric acid (P2 O5)	1.842
Potash	.154
Soda	.212
Silicious residue	1.680
Moisture, loss, etc.	5.527
Total	100.000

Contains more than the ordinary proportion of phosphoric acid, and would yield a fertile soil on disintegration.

No. 2439.—SOIL: "*Of an old field which has been in cultivation about seventy-five years. Eight inches of the surface soil on D. B. Wigginton's farm, two miles north of Fairfield. Geological position, upper Hudson river beds, near the top of the Lynx beds.*" *Collected by W. M. Linney. Received July 5, 1883.*

Soil with friable clods; of a light-grey-brown color. All passed through the coarse seive except a very small quantity of small ferruginous concretions. Its silicious residue all passed through the fine seive.

No. 2440—SUBSOIL: "*Ten inches. On the same farm as the preceding.*

Subsoil of a brownish-buff color; lighter colored than the preceding. Clods more firm. All passed through the coarse seive except a very small quantity of small ferruginous concretions. Its silicious residue all passed through the fine seive except two or three very small quartzose particles.

COMPOSITION OF THESE SPENCER COUNTY SOILS.

(*Dried at 212° F.*)

	No. 2439	No. 2440
Organic and volatile matters	3.550	3.205
Alumina and iron and manganese oxides	7.809	11.849
Lime carbonate	.320	.295
Magnesia	.250	.274
Phosphoric acid (P_2O_5)	.236	.221
Potash (K_2O) extracted by acids	.228	.470
Soda (Na_2O) extracted by acids	.192	.117
Water, expelled at 380° F.	.727	.830
Sand and insoluble silicates	86.175	82.320
Total	99.487	99.581
Hygroscopic moisture	1.850	2.875
Potash in the insoluble silicates	1.063	1.206
Soda in the insoluble silicates	.473	.384
Rock fragments in the soil	.000	.000
Character of the soil	Old field soil.	Subsoil.

Notwithstanding the long time during which this soil has

been in cultivation, it yet retains more than average proportions of most of the essential mineral elements of fertility. It is somewhat deficient in organic matters—*humus*—and would be benefited by rest in clover, which, after being pastured for two years, should be plowed under.

WHITLEY COUNTY.

No. 2441—COAL: "*From the land of J. R. Ryan, on Marsh creek, near the line of Whitley county, Ky., and Scott county, Tenn. Sample from the mouth of the mine, taken from different parts of the bed, which is thirty-six inches thick. Collected by W. C. Crozier. Received June, 1882.*

A glossy, pitch-black, pure-looking coal, showing very little fibrous coal or granular pyrites. Softens and swells into a light spongy coke when heated.

No. 2442—COAL: "*From Bryvan's opening, on Worley branch of the South Fork of the Cumberland river. Conglomerate coal. Collected by R. C. Ballard, November 17, 1882. Upper part of the coal fifty-five inches thick. It was from this that the coke was made.*"

A pure-looking coal; fracture mostly irregular cuboidal, with shining surfaces; partly breaking into thin laminæ, with more or less fibrous coal between. No apparent pyrites.

No. 2443—COAL: "*From Devil's Jump opening, on the South Fork of Cumberland river. Bryvan's coal; conglomerate series. This sample is of the forty-six inches opened up. The ten inches of coal below it is not included. Collected by R. C. Ballard, November 16, 1882.*"

Resembles the next preceding.

No. 2444—COAL: "*From Bryvan's opening, Worley branch of South Fork of Cumberland river. Conglomerate. Lower part of the bed, fourteen inches. Collected by R. C. Ballard, November 17, 1882.*"

Appears to have more of the laminated coal than the preceding and more fibrous coal, but no apparent pyrites.

No. 2445—COAL: *"From Bryvan's Coal Company, etc., etc. Collected by R. C. Ballard, November 16, 1882."*

Resembles No. 2442; fracture generally irregular, with shining surfaces. Very little fibrous coal, and no apparent pyrites.

No. 2446—COAL: *"From J. S. Berry's, five miles north of Williamsburg, one mile north of Mahon's Station. Sample from the lowest twenty-two inches of the fifty-six-inch bed. Collected by R. C. Ballard, October 2, 1882.*

A firm, pitch-black, pure-looking coal, generally breaking with irregular shining surfaces. Some little fibrous coal on some of the pieces.

No. 2447—COAL: *"From the same locality as the next preceding. Sample from the upper seam of twenty-six inches. Collected by R. C. Ballard, October 26, 1882."*

A firm, pitch-black coal, breaking into irregular laminæ with generally shining irregular surfaces. Somewhat cuboidal in its large fracture. Very little fibrous coal apparent.

COMPOSITION OF THESE WHITLEY COUNTY COALS.

(*Air-dried.*)

	No. 2441	No. 2442	No. 2443	No. 2444	No. 2445	No. 2446	No. 2447
Specific gravity . . .	1.275	1.295	1.306	1.368	1.321	1.254	1.289
Hygroscopic moisture.	2.08	1.40	0.94	1.34	1.50	2.00	2.00
Volatile comb. matters	35.58	36.74	39.86	33.06	39.40	34.54	33.40
Coke	62.34	61.86	59.20	65.60	59.10	63.46	64.60
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters .	37.66	38.14	40.80	34.40	40.90	36.54	35.40
Fixed carb. in the coke	58.90	54.20	47.30	53.88	53.70	61.92	61.90
Ash	3.44	7.66	11.90	11.72	5.40	1.54	2.70
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Light Spongy.	Spongy.	Dense Spongy.	Spongy.	Spongy.	Light Spongy.
Color of the ash . .	Lt.yel'h-grey.	Brow'h-grey.	Lt. grey-brown.	Nearly white.	Brow'h-grey.	Lt. fawn-colored.	Light buff.
Percentage of sulphur	0.567	1.201	3.741	0.555	1.089	0.830	0.637

In these coals the ash percentage varies from 1.54 in No. 2446 up to 11.72 and 11.90 in Nos. 2444 and 2443, and the sulphur from 0.555 in No. 2444 up to 3.741 in No. 2443, which is exceptional in this respect and may be accidental, owing possibly to some pyrites in the sample which might probably be excluded. With the exception of those which exceed in ash and sulphur, the coals are very good, and even these are valuable for most ordinary uses.

No. 2448—COKE: "*Made of Coal (A), or the lowest of this series. From the mouth of Worley; South Fork of Cumberland river; Captain Crozier's mines. Sub-conglomerate. Collected by R. C. Ballard, November 18, 1882. This was made from the upper part of the bed and was coked in August at Rockwood, Tenn., in a box placed in an oven.*"

A firm, compact coke.

No. 2449—COKE: "*Of J. S. Berry's coal, five miles north of Williamsburg, one mile north of Mahon's Station. Collected by R. C. Ballard, October 2, 1882. Coke made of the coal of the entire bed.*"

A bright, firm coke, moderately porous.

COMPOSITION OF THESE WHITLEY COUNTY COKES.

(*Air-dried.*)

	No. 2448	No. 2449
Moisture, etc., expelled at red heat	2.10	4.80
Fixed carbon in the coke	90.46	92.60
Ash	7.44	2.60
Total	100.00	100.00
Color of the ash	Chestnut brown.	Lt. br'n-ish gr'y.
Percentage of sulphur	0.665	0.665

No. 2449 is a remarkably pure coke. No. 2448, containing more ash material, is not quite so valuable in equal weights. Its rather large proportion of moisture and volatile matters may be only accidental.

No. 2450—IRON ORE: "*From J. S. Berry's, five miles north of Williamsburg, one mile north of Mahon Station. Collected by R. C. Ballard, October 28, 1882.*"

Mostly concretions of impure concentric limonite layers, or irregular forms of the same, frequently with an internal cavity. Color from dark-brown to ochreous.

COMPOSITION (*Air-dried.*)

Iron peroxide	63.380=44.36 per cent. of iron.
Alumina	3.776
Lime and magnesia	Traces.
Phosphoric acid (P2 O5)	.946
Silica	15.280
Carbonic acid, water, etc., etc	16.618
Total	100.000

Although it contains more than average phosphoric acid, this ore might be available for iron production if it is found in sufficiently large quantities and under other favorable conditions.

WOODFORD COUNTY.

No. 2451—MINERAL WATER: "*Sulphur water from a well bored seventy feet deep, on the farm of Mr. Charles Alexander, a mile and a half from Versailles. Water brought up in a sand bucket.*"

The water, when brought to the laboratory had a yellowish color and a strong smell and taste of sulphides. Evaporated to dryness at 212° F., it left 7.124 parts per 1000 of saline matters, which were found to consist of bicarbonates of lime, magnesia, soda, and a small proportion of lithia; sulphates of potash, lime and magnesia; chlorides of sodium, calcium and magnesium, with traces of bromides and iodides, a notable quantity of sodium sulphide and a small trace of strontia. In short, it resembles the Blue Lick water in composition. A quantitative analysis was not made of it, and its proportions of hydrogen sulphide and carbonic acid gases were not ascertained.

APPENDIX.

For the sake of comparison with our Kentucky coals, some analyses, made at the Laboratory of the Survey of coals from other States are here appended.

ALABAMA.

No. 2452—COAL: "*From Gaines' bed, Wolfe creek, Walker county, Alabama. Sample of the bed taken by Jno. R. Procter.*"

A pure-looking, pitch-black coal, breaking generally with shining fracture. Shows very little fibrous coal and no apparent pyrites.

No. 2453—COAL: "*From Mt. Carmel bed, one hundred yards from Mt. Carmel Church, Walker county, Alabama. Sample of the bed by J. R. Procter, February 1, 1883.*"

A remarkably bright, pitch-black coal. Has very little fibrous coal between its laminæ and no appearance of pyrites.

No. 2454—COAL: "*From the Townley bed. Sample from the top of the bed above the four feet parting. Sampled by J. R. Procter, February 2, 1883.*"

Generally breaking into thin laminæ, with some little fibrous coal between, but no appearance of pyrites.

COMPOSITION OF THESE ALABAMA COALS.

(*Air-dried.*)

	No. 2452	No. 2453	No. 2454
Specific gravity	1.259	1.307	1.351
Hygroscopic moisture	1.30	1.34	1.94
Volatile combustible matters	37.10	29.76	30.46
Coke	61.60	68.90	67.60
Total	100.00	100.00	100.00
Total volatile matters	38.40	31.10	32.40
Fixed carbon in the coke	54.46	58.10	55.04
Ash	7 14	10.80	12.56
Total	100.00	100.00	100.00
Character of the coke	Light spongy.	Light spongy.	Dense friable.
Color of the ash	Grey-buff.	Light buff.	Very li't buff.
Percentage of sulphur	1.425	0.665	0.473

Nos. 2453 and 2454 exceed the general average of ash proportion; otherwise all these coals could be classed with the best, for all ordinary uses.

TENNESSEE COALS.

No. 2455—COAL: "*From Jellico Mountain Coal and Coke Company's mine, Emmett, Campbell county, Tennessee. Five feet bed. Sample from the lower layer, which is two to two and a half feet thick. Analyzed for Col. S. L. Wooldridge, President of the Company, April 11, 1882.*"

A bright, pure-looking coal, showing very little pyrites or fibrous coal. Firm, so that it may be mined in large blocks. Fracture shining on all the faces. Small shining facets irregularly disposed on some of the cross fractures, approaching what is called bird's-eye structure.

No. 2456—COAL: "*From the same Company's mines. Mine on*

Crooked creek, Campbell county, Tennessee. Sample collected by R. C. Ballard, November 8, 1882."

Generally jet-black, breaking with irregular glossy surfaces; some portions with small bird's-eye structure; other portions dull-black, and breaking into laminæ, showing some granular pyrites, but very little fibrous coal.

No. 2457—COAL: "*From the same locality. Collected by R. C. Ballard, November 7, 1882. Coal twenty-two inches thick; one hundred and seven inches below the main seam.*"

Resembles the darker and brighter portions of the next preceding sample.

COMPOSITION OF THESE TENNESSEE COALS.

(*Air-dried.*)

	No. 2455	No. 2456	No. 2457
Specific gravity	1.256	1.311	1.289
Hygroscopic moisture	2.36	2.10	2.90
Volatile combustible matters	35.44	30.84	33.80
Coke	62.20	67.06	63.30
Total	100.00	100.00	100.00
Total volatile matters	37.80	32.94	36.70
Fixed carbon in the coke	60.60	61.56	61.80
Ash	1.60	5.50	1.50
Total	100.00	100.00	108.00
Character of the coke	Spongy.	Dense.	Dense Spongy.
Color of the ash	Salmon-color.	Brow'h-grey.	Lt.yel'h-brown.
Percentage of sulphur	1.162	2.285	.670

These are all very good coals. No. 2457 has a remarkably small proportion of ash, and contains less than the average amount of sulphur. No. 2455 also gives a very small quantity of ash. No. 2456 contains more than the average amount of sulphur.

No. 2458—COKE: *"From the Jellico Mountain Coal and Coke Company mine. Upper layer, etc., etc. Collected by R. C. Ballard."*

A bright, firm coke; quite porous.

No. 2459—COKE: *"From same mine; lower layer."*

A bright, firm coke; seems somewhat more dense than the preceding.

COMPOSITION OF THESE JELLICO MOUNTAIN COAL AND COKE COMPANY'S COKES. (*Air-dried.*)

	No. 2458	No. 2459
Moisture, expelled at 220° F.	2.90	3.70
Volatile matters expelled at red heat	1.10	1.00
Fixed carbon in the coke	91.80	92.60
Light yellowish-brownish ash	4.20	2.70
Total	100.00	100.00
Percentage of sulphur	1.027	.725

These are remarkably pure cokes, equaling in this respect the best samples of the Kentucky Elkhorn coke and the celebrated Connellsville coke of Pennsylvania. They have doubtless been made of the pure coal of the mine, and not of the slack coal, which is always more impure.

(See, under the head of Carter county, the analysis of a cannel coal from West Virginia.)

TABLE I.—SOILS AND SUBSOILS. (DRIED AT 212° F.)

Number	County.	Organic and volatile matter	Alumina, iron oxide, etc.	Lime carbonate.	Magnesia	Phosphoric acid (P_2O_5)	Potash extracted by acids	Soda extracted by acids	Water expelled at 390° F.	Sand and insoluble silicates	Moisture expelled at 212° F.	Potash in insoluble silicates	Soda in insoluble silicates	Rock fragments or gravel	Remarks.
2386	Morgan	6.595	8.429	0.325	0.718	0.156	0.236	. . . .	1.570	82.170	2.415	2.384	0.350	37.730	Virgin soil; woods; Shaw's ck, nr. L'king r.
2387	Morgan	4.240	6.577	.120	.090	.118	.153	.308	.835	87.570	1.600	2.757	.380	13.090	Subsoil of the same.
2388	Morgan	3.305	3.055	.335	.412	.115	.104	.156	.810	91.450	1.150	1.727	.400	2.310	Soil, old field; bottom land, near Licking r.
2389	Morgan	2.650	4.121	.245	.232	.124	.043	.071	.000	91.082	.900	1.911	.410	2.110	Subsoil of the same.
2390	Morgan	3.415	3.505	.170	.201	.140	.082	. . . .	.800	91.485	.855	1.410	.316	11.850	Old-field soil; 2 m. ab. W. Lib'y, nr Lick'g r.
2391	Morgan	3.225	5.262	.120	.299	.108	.121	. . . .	.625	90.180	1.115	1.723	.286	.510	Subsoil of the same.
2396	Nelson	3.020	9.772	.145	.305	.173	.438	. . . .	.612	84.820	2.350	1.200	.646	. . . .	Fm S. P. Stiles; very old field; 4 m. n. Bds'n
2430	Shelby	5.000	9.044	.320	.286	.268	.347	.082	.515	83.995	1.855	1.773	.473	3.500	Virgin soil; Jno. Davis', 2 m. e. Shelbyville.
2431	Shelby	4.840	8.852	.615	.322	.208	.418	.061	.420	83.945	1.865	1.385	.348	. . . .	From a cultivated field 2 m. e. Shelbyville.
2432	Shelby	4.250	9.494	.420	.247	.211	.304	.000	.365	84.245	1.635	1.429	.382	. . . .	From a field 20 yrs in cultiv'n; John Glen's.
2433	Shelby	14.075	16.158	4.695	1.373	.412	2.015	.000	.750	61.045	4.125	2.131	.150	8.200	Virgin soil; top upper Hudson river beds.
2434	Shelby	4.970	9.490	.720	.389	.305	.591	.064	.280	83.310	1.800	1.500	.241	. . . .	From an old field, same locality.
2435	Shelby	11.315	14.380	25.245	.805	.415	1.772	trace.	.315	47.295	2.520	1.077	.075	41.200	Subsoil of next preceding.
2436	Shelby	5.015	6.590	.215	.250	.230	.256	.000	.570	86.545	1.165	1.401	.383	18.000	Virgin soil; Jeptha Knobs; up. silurian.
2439	Spencer	3.550	7.809	.320	.250	.236	.228	.102	.727	80.175	1.850	1.063	.473	.000	Soil of 75 yr-old field 2 m. n. of Fairfield.
2440	Spencer	3.205	11.849	.285	.274	.221	.470	.117	.830	82.320	2.875	1.206	.384	.000	Subsoil of same; D. B. Wigginton's.

TABLE II.—COALS. (AIR-DRIED.)

Number	County.	Specific gravity	Hygroscopic moisture	Volatile combustible matter	Coke.	Total volatile matters	Fixed carbon in the coke	Ash.	Character of the coke	Color of the ash	Percentage of sulphur	Remarks.
2284	Bell	1.341	1.00	32.70	66.30	33.70	52.80	13.50	Light spongy	Lt. choc'te-grey	2.115	J. Killam's coal.
2285	Bell	1.241	1.00	37.46	61.54	38.46	60.48	1.06	Spongy	Salmon colored	0.503	Coal near house of B. G. Rice, on Caney f'k.
2286	Bell	1.251	1.10	36.44	62.46	37.54	59.66	2.80	Spongy	Lt. choc'te-grey	0.613	Coal, Daniel Howard's, on Caney fork.
2287	Bell	1.270	0.86	36.04	63.10	36.90	59.20	3.90	Light spongy	Brown'h li'c-g'y	2.032	Coal, Fred. Burner's bank, Yellow creek.
2288	Bell	1.281	0.86	35.60	63.54	36.46	57.88	5.66	Light spongy	Brown'h li'c-g'y	2.454	Coal from same locality.
2282	Breathitt	1.212	1.60	46.60	51.80	48.20	46.80	5.00	Dense spongy	Lt. brown'h-g'y	.824	Haddock's cannel coal.
2283	Carter	1.290	6.30	35.51	58.16	41.84	54.82	3.34	Spongy	Lt. choc'te-grey	.881	Coal No. 7, Coalton coal; Straight Creek Co.
2284	Carter	1.291	2.80	51.20	46.00	54.00	35.30	10.70	Pulverulent	Grey buff	.753	Herrin's cannel coal, on Sinking creek.
2285	Carter	1.203	1.16	54.74	43.80	56.20	33.80	10.00	Dense friable	Light buff-grey	1.274	Cannel coal, Aden Station, Brent's.
2286	Carter	1.634	2.04	25.86	72.10	27.90	32.10	40.00	Pulverulent	Light buff-grey	0.731	Cannel coal, or bituminous shale, Aden's St'n.
2287	Carter	1.233	1.46	54.04	44.50	55.50	34.76	9.74	Dense friable	Lilac grey	2.164	Cannel coal, Little Sandy R., Parson's.
2291	Elliott	1.388	2.10	41.34	56.56	43.44	35.06	20.00	Dense	Light lilac-grey	1.150	Cannel coal, Buck f. of Mid. f. Lit. San. r.
2297	Floyd	1.302	2.04	37.42	60.54	39.46	56.34	4.20	Spongy	Lilac colored	1.475	From mouth of Mud creek; upper 18 inc's.
2298	Floyd	1.281	2.10	37.16	60.74	39.26	57.74	3.00	Spongy	Nearly white	.596	From same bed; lower 3 feet 5 inches.
2299	Floyd	1.350	1.30	30.70	62.00	38.00	51.70	10.30	Spongy	Light lilac-grey	1.356	From Laynesville, middle of upper part.
2300	Floyd	1.284	1.90	35.30	62.80	37.20	58.94	3.86	Spongy	Light grey	.715	From same; lower 45 inches.
2301	Floyd	1.323	2.50	32.50	65.00	35.00	56.54	8.46	Dense spongy	Light grey	.651	From mouth of Steel cr.; av. of upper 4 ft.
2302	Floyd	1.350	3.80	33.80	62.40	37.60	60.60	1.80	Pulverulent	Reddish buff	.475	From Flemming's or Jack's cr.; new outc'p.
2327	Johnson	1.270	3.00	49.80	47.20	52.80	37.94	9.26	Dense	Lt. gray-brown	2.009	Cannel coal, Smith's br. of Paint creek.
2328	Johnson	1.248	1.80	49.10	49.10	50.90	41.16	7.94	Dense friable	Lt. buff-grey	.816	Can. c'l, 1 m. n. m'th Lit. P't cr.; up. 22 in.
2329	Johnson	1.223	1.80	49.20	49.00	51.00	44.00	5.00	Dense friable	Lt. buff-grey	.846	Cannel coal, same bed, lower 8 inches.
2332	Knox	1.289	1.80	34.00	64.20	35.80	59.40	4.80	Spongy	Lt. lilac-grey	0.981	Fm G. N. Wiggin's bk, 3 m. s.e. Barbourav'e.
2333	Knox	1.332	1.60	33.80	64.60	35.40	57.14	7.46	Light spongy	Lt. lilac-grey	1.110	Head of Dean's br., n'r m'th of Greasy ck.
2334	Knox	1.281	1.66	36.34	62.00	38.00	58.04	3.96	Light spongy	Nearly white	.651	From same bed; lower 85 inches.
2335	Knox	1.300	2.00	35.00	63.00	37.00	56.70	6.30	Light spongy	Lilac grey	1.091	Head of Sandy Br., 1 m. from Flat Lick.
2336	Laurel	1.221	2.60	35.30	62.10	37.90	60.30	1.80	Light spongy	Nearly white	1.000	On Wood's creek, near John Pitman's.
2337	Laurel	1.496	1.30	31.00	67.70	32.30	43.96	23.74	Dense friable	D'k purpl'h-grey	4.500	"Cannel coal," or bit. shale, W. H. Hayden's, 1½ m. s.w. of London.
2338	Laurel	1.245	3.30	34.44	62.26	37.74	60.96	1.30	Light spongy	Brownish grey	1.055	Head of Raccoon cr., 1 m. from E. Bernstadt.
2339	Laurel	1.277	2.80	35.30	61.90	38.10	59.10	2.80	Spongy	Lt. lilac-grey	.650	Coal No. 1, Pitman Station.
2340	Laurel	1.266	2.72	35.32	61.96	38.04	58.60	3.36	Spongy	Nearly white	0.79	Coal No. 1, Pitman Station, upper part.
a2341	Laurel	n. e.	2.60	29.46	67.94	32.06	52.51	15.40	Spongy	Brownish grey	1.241	Slack coal, Pitman Station; unwashed.
b2341	Laurel	n. e.	2.64	34.00	63.36	36.64	58.70	4.66	Spongy	Lt. lilac-grey	.825	Slack coal, Pitman Station; washed.
2345	Lawrence	1.295	3.20	37.74	59.06	40.94	55.06	4.00	Light spongy	Light grey	.720	Peach Or. c'l, Miller's br.; ont. No. 2, up. b.
2346	Lawrence	1.325	3.30	22.70	74.00	26.00	64.46	9.54	Dense	Lilac grey	1.132	Peach Orchard coal, middle bench.
2347	Lawrence	1.287	3.90	38.80	59.30	40.70	56.30	3.00	Spongy	Nearly white	.756	Peach Orchard coal, lower bench.
2348	Lawrence	1.490	2.20	28.60	69.20	30.80	46.60	22.60	Friable	Nearly white	.550	Peach Orchard bone coal of lower bench.
2349	Lawrence	1.393	4.14	33.06	62.80	37.20	54.50	8.30	Light spongy	Purplish grey	1.722	Headley's coal, head of McHenry branch.
2350	Lawrence	n. e.	4.50	33.70	61.80	38.20	54.38	7.42	Light spongy	Brownish grey	1.703	From same bed, etc.
2352	Letcher	1.291	3.26	32.24	64.50	35.50	61.60	2.90	Dense	Light buff	.656	Holcomb's c'l, h'd Big Laurel br. (outcrop).
2353	Letcher	1.292	1.10	34.30	64.60	35.40	58.10	6.50	Spongy	Light buff-grey	.890	Field's c'l, King's cr.; av. sample of face.

TABLE II.—COALS. (AIR-DRIED.)—CONTINUED.

Number	County.	Specific gravity	Hygroscopic moisture	Volatile combustible matter	Coke.	Total volatile matter	Fixed carbon in the coke	Ash.	Character of the coke	Color of the ash	Percentage of sulphur	Remarks.
2354	Letcher	1.191	1.10	40.00	58.00	42.00	55.40	2.60	Spongy	Brownish grey	1.453	J. N. Thompson's c'l, Sandy Lick; up. lay'r.
2355	Letcher	1.279	1.84	34.30	64.60	35.40	57.20	7.40	Spongy	Light grey	.889	J. N. Thompson's c'l, Sandy L'k, lower lay'r.
2356	Letcher	1.286	1.46	33.26	64.90	35.10	59.70	5.20	Dense	Light buff-grey	.678	McNickel's coal, below Whitesburg.
2357	Letcher	1.242	1.30	35.84	62.70	37.30	58.60	4.10	Light spongy	Brownish-grey	1.068	J. M. Collins' coal, Rockhouse creek.
2358	Letcher	1.277	1.30	39.60	59.10	40.90	55.20	3.90	Light spongy	Brownish	2.812	Caudell's coal; upper layer.
2359	Letcher	1.286	1.60	38.40	62.00	38.00	56.60	5.40	Light spongy	Brownish-grey	1.060	Caudell's coal; lower layer.
2360	Letcher	1.355	8.00	30.06	61.94	38.06	57.60	4.34	Pulverulent	Light buff	.494	From Laurel br. of Ky. river; upper 2 feet.
2361	Letcher	1.319	2.86	31.54	65.60	34.40	62.10	3.50	Dense	Light buff	.535	From Laurel br. of Ky. river; lower 68 ins.
2362	Letcher	1.320	1.34	34.16	64.50	35.50	56.70	7.80	Spongy	Chocolate-grey	1.318	From Cowan's ridge.
2363	Letcher	1.317	1.26	40.30	58.44	41.56	52.70	5.74	Dense	Grey-purplish	2.752	From Camp br. of Rockhouse cr.; lower 45 in.
2364	Letcher	1.305	1.90	39.32	58.78	41.22	51.88	6.90	Dense	Purplish-grey	1.115	From J. Q. Bentley's farm on Rockhouse cr.
2365	Letcher	1.373	7.70	35.50	56.80	43.20	51.96	4.84	Pulverulent	Lt. grey-brown	.832	On Sam Kiser's place, Love br. Rockhouse c.
2366	Letcher	1.483	6.66	31.00	62.34	37.66	46.04	15.40	Pulverulent	Purplish-grey	.488	On Sam Kiser's place, Love br. Rockhouse c.
2367	Letcher	1.385	5.46	31.68	62.80	37.14	57.46	5.40	Pulverulent	Lt. Purpl'h-grey	.488	F'm J. Amberger's farm, Wolf-pen cr., up. prt
2368	Letcher	n. e.	.26	47.94	51.80	48.20	44.86	6.94	Dense	Buff grey	.751	F'm J. Amberger's farm, lower prt cannel bd.
2369	Letcher	n. e.	1.30	38.10	60.60	39.40	58.40	2.20	Light spongy	Purplish-grey	.710	On M. Hale's farm, Trace br., up'r p't can. c.
2372	Magoffin	1.303	2.16	36.98	60.86	39.14	53.86	7.00	Light spongy	Nearly white	.535	F'm Stone's br. on Oakley cr.; lower 20 ins.
2373	Magoffin	1.482	6.92	29.28	63.80	36.20	46.80	17.00	Pulverulent	Light-grey	.541	F'm Stone's br. on Oakley cr.; upper 15 ins.
2374	Martin	1.291	2.60	35.50	61.90	38.10	56.86	5.04	Spongy	Nearly white	.608	G. W. Woods' coal; upper 2 feet.
2375	Martin	1.341	3.54	31.36	65.10	34.90	56.30	8.80	Dense	Light-lilac-grey	.565	From Scaffold Lick br. Rockcastle cr. 6 ft bd.
2376	Martin	1.342	2.20	33.10	61.70	35.30	55.10	9.60	Spongy	Light grey	.578	Coal No. 2, on Beech fork of Rockcastle cr.
2380	Morgan	1.332	1.60	44.00	54.40	45.60	38.86	15.54	Dense	Buff grey	.961	Can. c. Williams' b'k, Rush br. Elk f. Lkg r.
2381	Morgan	1.348	4.26	42.48	53.26	46.74	33.76	19.50	Pulverulent	Fawn colored	1.535	Cannel coal; 42″ head n. fork of Licking r.
2382	Morgan	1.373	3.90	39.30	56.80	43.20	38.80	18.00	Friable	Grey-brown	1.106	Cannel coal; 36″ Left br. of Mordecai cr.
2383	Morgan	1.303	2.02	41.98	56.00	44.00	44.06	11.94	Dense	D'k purpl'h grey	.810	Cannel coal; 36″ sample from upper 30″.
2384	Morgan	1.294	2.20	40.50	57.30	42.70	50.30	7.00	Dense	Nearly white	0.805	Can'l c'l, Prater's, Stone Coal br. of Caney cr.
2385	Morgan	1.358	2.90	39.10	58.00	42.00	51.34	6.66	Dense spongy	Dark lilac-grey	4.527	Coal No. 1; 30″; on a fork of Smith's cr.
2392	Muhlenberg	1.268	6.46	34.04	59.50	40.50	55.50	4.00	Spongy	Light lilac-grey	.802	From Mud River mines; middle and bottom.
2397	Perry	1.272	1.50	36.10	62.40	37.60	59.06	3.34	Spongy	Light grey	.618	F'm J. H. Comb's b'k, below and op Hazard.
2398	Perry	1.305	1.30	34.70	64.00	36.00	56.10	7.90	Spongy	Buff grey	.437	F'm mouth Sassafras cr., av. near outcrop.
2399	Pike	1.282	2.60	34.20	63.20	36.80	60.80	2.40	Dense	Light buff	.412	On Big Elkhorn, av. of 7 feet bed.
2400	Pike	1.307	2.60	33.40	64.00	36.00	61.30	2.70	Dense	Light buff	.467	Issac Patton's new bed, head of Elkhorn cr.
2401	Pike	1.271	2.00	33.50	64.50	35.50	60.56	3.96	Light spongy	Light grey	.429	On Big Elkhorn cr., Mullen's br. n'rly 4 ft.
2402	Pike	1.278	1.60	32.10	66.30	33.70	64.64	1.66	Very l't spongy.	Lt. redish bro'n	.711	Elkhorn coking coal, Rice's Mill br. of Elkhorn r, lower 45 inches.
2403	Pike	1.271	1.60	29.36	69.04	30.96	67.40	1.64	Inflated	Lt. redish bro'n	.610	Same bed; upper part.
2404	Pike	n. e.	1.80	28.80	71.40	28.60	67.60	3.80	Dense spongy	Brownish red	.967	Slack c'l f'm which coke No. 2413 was made.
2405	Pike	1.355	6.00	31.26	62.74	27.26	59.34	3.40	Pulverulent	Lt. fawn color'd	.390	From Cane br. Elkhorn cr., upper 5′ 5½″.
2406	Pike	1.314	2.54	32.26	65.20	34.80	62.20	3.00	Dense, hard	Lt. purpl'h buff	.547	From same bed, lower 3′ 7″.
a2406	Pike	n. e.	n. e.	...	...	...	...	4.40	Dense friable	...	...	"Bone coal," from lower layer of same bed.
2407	Pike	1.279	2.20	36.10	61.70	38.30	58.10	3.60	Spongy	Light buff-grey	.651	From Stone Coal cr., av. of upper 2′ 8″.

TABLE II.—COALS. (AIR-DRIED.)—CONTINUED.

Number	County.	Specific gravity	Hygroscopic moisture.	Volatile combustible matter	Coke.	Total volatile matter	Fixed carbon in the coke	Ash.	Character of the coke	Color of the ash	Percentage of sulphur	Remarks.
2408	Pike	1.293	2.40	35.40	62.20	37.80	58.20	3.91	Spongy	Light buff-grey	.692	From same bed, av. of lower 3 feet.
2409	Pike	1.273	1.40	33.66	64.94	35.06	58.60	6.34	Spongy	Light greyish	.825	Head of Chloe cr., av. of lower 4′ 8″.
2410	Pike	1.367	5.06	29.81	65.10	34.90	57.50	7.60	Pulverulent	Nearly white	1.038	F'm ¾ m. above Pikeville, av. Sycke's b'k.
2417	Pulaski	1.309	3.03	35.04	61.93	38.07	55.98	5.95	Spongy	Grey	1.230	F'm Childer's open'g, br. near h'd Ind'n cr.
2418	Pulaski	1.354	2.68	35.41	61.88	38.12	55.18	6.70	Spongy	Light lilac-grey	2.334	42 inch coal, 8½ miles from Flat Rock sta'n.
2419	Pulaski	1.294	1.67	45.46	52.87	47.13	46.07	6.80	Dense spongy	Lt. Br'n'h yel.	3.035	Bird's eye cannel coal, near head Barren br.
2420	Pulaski	1.233	2.20	36.21	61.56	38.44	56.96	4.60	Light spongy	Light buff-grey	.742	From Big View Coal Company's mine.
2421	Pulaski	1.312	1.54	33.80	64.66	35.34	58.26	6.40	Light spongy	Light grey	1.540	F'm Barren Fork C'l Co., nr. Flat Rock St'n
2422	Pulaski	1.315	1.76	36.24	62.00	38.00	55.26	6.74	Spongy	Light grey	1.286	From "Flat Rock" mines.
2423	Pulaski	1.315	2.50	36.20	61.30	38.70	52.10	9.20	Spongy	Light lilac-grey	2.601	F'm Cumberland C'l Co. (c'l No.1), Greenw'd.
2424	Pulaski	1.425	2.14	31.46	66.40	33.60	47.74	18.66	Dense	Light lilac-grey	2.140	F'm Beaver Cr. C'l Co. entry No 1, low'r 12″
2425	Pulaski	1.372	2.06	34.04	63.90	36.10	52.50	11.40	Dense spongy	Dark lilac-grey	4.250	F'm same bed, en'y No. 2, (conglomerate) 40′.
2426	Pulaski	1.314	2.20	36.56	61.24	38.76	53.14	8 10	Light spongy	Lilac gray	3.645	From same bed, entry No. 4, middle 31″.
2427	Pulaski	1.323	2.34	34.32	63.34	36.66	56.14	7.20	Spongy	Light buff-grey	1.265	From same bed, entry No. 6, lower 17″.
2441	Whitley	1.275	2.08	35.58	62.34	37.66	58.90	3.44	Spongy	Lt. yell'sh-grey	.567	G. R. Ryan's, Marsh creek, av. of 36″ bed.
2442	Whitley	1.295	1.40	36.74	61.86	38.14	54.20	7.66	Light spongy	Brownish-grey	1.201	F'm Bryvan's op'g, Worley br. up. p't (cong.)
2443	Whitley	1.306	.94	39.86	59.20	40.80	47.30	11.90	Spongy	Lt. grey-brown	3.741	F'm Devil's Jump op'ng, S. F'k Cumberl'd.
2444	Whitley	1.368	1.34	33.06	65.60	34.40	53.88	11.72	Dense spongy	Nearly white	.555	From Bryvan's opening, lower part.
2445	Whitley	1.321	1.50	39.40	59.10	40.90	53.70	5.40	Spongy	Brownish-grey	1.089	From Bryvan's Coal Company.
2446	Whitley	1.254	2.00	34.54	63.46	36.54	61.92	1.54	Spongy	Lt. fawn-colored	.830	F'm G S. Berry's, 5 m n. of W'l'msb'g, low pt.
2447	Whitley	1.289	2.00	33.40	64.60	35.40	61.90	2.70	Light spongy	Light buff	.637	From same locality, upper part.
2452	State of Ala.	1.259	1.30	37.10	61.60	38.40	54.56	7.14	Light spongy	Grey-buff	1.425	Gaines' bed, Wolf creek, Walker county.
2453	State of Ala.	1.307	1.34	29.76	68.90	31.10	58.10	10.80	Light spongy	Light buff	.665	Mt. Carmel bed, Walker county.
2454	State of Ala.	1.351	1.94	30.46	67.60	32.40	55.04	12.56	Dense friable	Very light buff	.473	Townley bed, top of the bed.
2455	State of Tenn.	1 256	2.36	35.44	62.20	37.80	60.60	1.60	Spongy	Salmon colored	1.162	Jellico Mt. C'l Co., Emmett, Campb. Co., l. layr
2456	State of Tenn.	1.311	2.10	30.84	67.06	32.94	61.56	5.50	Dense	Brownish-grey	2.285	Same company, mine on Crooked creek.
2457	State of Tenn.	1.289	2.90	33.80	63.30	36.70	61.80	1.50	Dense spongy	Lt. yell'sh-bro'n	.670	Same locality.
*	State of Pa.	n. e.	....	31.36	68.00	....	59.62	8.23	.....	.....	.784	Connellsville coking coal, Pittsburg seam.
*	State of Pa.	.....	.....	22.38	76.00	....	68 50	8.00	.....	.....	1.120	Bennington coking coal.
*	State of Pa	.....	.....	16.00	81.00	....	74.65	7.50	.....	.....	1.850	Broad Top coking coal. (*b*)
*	State of Pa.	.....	.....	19.68	78.00	....	71.12	7.50	.....	.....	1.700	Broad Top coking coal. (*c*)
2288	W. Virginia	1.185	0.60	42.50	56.90	43.10	49.50	7.40	Dense hard	Grey	1.162	Cannelton cannel coal.

* Quoted from the "Coke Report," of F. Platt, Second Geological Survey of Pennsylvania, Special Report L, 1875. Page 120.

TABLE III. COKES. (AIR-DRIED.)

Number	County.	Moisture expelled below 250° F.	Moisture expelled at red heat.	Fixed carbon	Ash	Sulphur	Color of the Ash.	Remarks.
2269	Bell	0.06	0.60	93.34	6.00	1.335	Dark purplish brown	Made of the coal of Fred. Barner's bank, Yellow creek.
2303	Floyd		5.00	88.50	6.50	.788	Reddish grey	Made of the Laynesville coal, No. 1, No. 299.
2325	Hopkins		0.80	86.34	12.80	2.233	Purplish grey	From St. Bernard Coal Co.'s mines, of washed slack coal.
2326	Hopkins		2.00	77.20	20.80	3.799	Purplish grey	From St. Bernard Coal Co.'s mines, of the unwashed slack coal.
2342	Laurel		1.20	95.70	3.10	.659	Light brownish	Of coal No. 1, average of bed, Putnam Station, Laurel Coal Co.
2343	Laurel		.90	92.60	6.50	.739	Light brownish	Of the slack coal, same mines.
2344	Laurel		2.40	89.20	8.40	.939	Brownish grey	Of the Peacock coal, same mines.
2351	Lawrence	5.10	.90	90.06	3.94	.824	Brownish grey	Of Peach Orchard coal, on Williams' branch.
2377	Martin	.80		92.20	9.00	.582	Reddish brown	Coke of coal No. 2376, made in an open fire.
2411	Pike		2.80	88.44	8.70	.844	Lilac grey	Made of Elkhorn coking coal, Rice's opening.
2412	Pike	.20		93.20	6.60	.734	Brownish red	Made of Elkhorn coking coal, made in an oven in Cincinnati.
2413	Pike		1.20	94.14	4.66	1.484	Brownish red	Made from the Elkhorn slack coal, No. 2404, at Connellsville, Pa.
2414	Pike		1.10	95.40	3.50	.517	Dark lilac grey	Made of Elkhorn coal, Wm. Mullin's, upper part of the bed.
2415	Pike		1.00	90.40	8.54	.598	Light purplish grey	Made of Elkhorn coal, Wm. Mullin's, from mixed sample of coal.
2448	Whitley		2.10	90.46	7.44	.665	Chestnut brown	Made of coal A (sub-conglomerate), mouth of Worley river.
2449	Whitley		4.80	92.60	2.60	.605	Light brownish grey	Made of J. Berry's coal, of the entire bed.
2458	State of Tennessee	2.90	1.10	91.80	4.20	1.027	Light yellowish brown	Jellico Mt. Coal and Coke Co.'s coal, upper layer.
2459	State of Tennessee	3.70	1.00	92.60	2.70	.725	Light yellowish brown	Jellico Mt. Coal and Coke Co.'s coal, lower layer.
*	State of Pennsylvania	.03	.46	89.576	9.113	.821		Connellsville coke, analyzed by McCreath.

* Second Pennsylvania Geological Survey; Special Report L.

TABLE IV. IRON ORES—CARBONATES. (AIR-DRIED.)

Number	County.	Iron carbonate.	Iron peroxide.	Manganese carbonate	Lime carbonate	Magnesia carbonate	Alumina	Phosphoric acid (P_2O_5)	Sulphuric acid (SO_3)	Silica and silicates	Organic matter and moisture.	Percent'ge iron.	Percentage silica	Remarks.
2309	Greenup	81.432	. . . .	[a] 2.758	4.140	2.187	. . . .	0.207	0.587	7.670	1.019	39.631	5.320	Grey iron ore, near Hunnewell Furnace.
2310	Greenup	59.418	15.382	[b] 1.380	2.800	2.134	4.580	.690	.486	[c] 12.890	.240	34.780	12.890	Grey iron ore, near Pennsylvania Furnace.
2311	Greenup	80.433	.820	. . . .	1.790	5.517	3.172	.128	n. e.	1.220	6.911	39.400	1.220	Black band, head of Schultz creek.
2312	Greenup	65.545	. . . .	2.096	1.360	1.316	2.752	.128	n. e.	23.790	3.013	30.900	n. e.	Grey kid'y ore, Hibler's drift, h'd Schultz c'k.
2313	Greenup	57.045	. . . .	n. e.	1.310	1.370	2.901	.179	n. e.	27.860	9.337	27.540	n. e.	Grey iron ore, Hibler's drift, h'd Schultz c'k.
2314	Greenup	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.	1.010	n. e.	n. e.	n. e.	26.580	n. e.	Boyce's limestone ore, 1½ m. bel'w Paintville.
2330	Johnson	27.740	15.159	. . . .	1.780	1.970	8.565	1.205	. . . .	35.780	4.801	26.040	33.480	Carbonate iron ore.

[a] With alumina. [b] Brown oxide of manganese. [c] Equal to 1 per cent. of manganese. [d] Sulphur. [e] Silica.

TABLE V. IRON ORES—LIMONITES. (AIR-DRIED.)

Number	County.	Iron peroxide.	Br. oxide manganese	Alumina	Lime carbonate	Magnesia carbonate	Phosphoric acid	Sulphuric acid.	Silica, etc.	Water, loss, etc.	Percent'ge iron.	Remarks.
2316	Greenup	32.260	1.642	2.765	0.490	1.318	0.490	n. e.	50.390	10.636	22.750	From Matthews' drift, Schultz creek.
2317	Greenup	39.290	n. e.	3.960	.320	.439	1.010	n. e.	46.480	8.501	27.500	Greycroft's block ore, head of Schultz creek.
2318	Greenup	51.170	n. e.	4.205	.160	.660	.945	n. e.	32.080	10.780	35.820	Red block ore, Rockhouse br. of Schultz creek.
2319	Greenup	52.500	n. e.	4.018	trace.	.287	1.842	n. e.	30.480	10.873	36.750	Limestone kidney ore, head of dry f. of Schultz creek.
2320	Greenup	n. e.	n. e.	n. e.	n. e.	n. e.	n, e.	n. e.	n. e.	n. e.	36.160	Limestone kidney ore, Rockhouse br. of Schultz creek.
2416	Pike	59.630	n. e.	7.927	n. e.	n. e.	.563	n. e.	n. e.	.560	29.720	On Elkhorn creek, 16 m. from its mouth; in blocks.
2450	Whitley	63.380	n. e.	3.776	—— traces ——		.946	n. e.	15.280	16.618	44.380	J. S. Berry's, five miles north of Williamsburg.

TABLE VI. LIMESTONES. (AIR-DRIED.)

Number	County.	Lime carbonate	Equal to lime	Magnesia carbonate	Iron carbonate	Alumina and iron oxide	Phosphoric acid (P2 O5)	Sulphuric acid (SO3)	Potash	Soda	Manganese carbonate	Silicious residue	Moisture, etc.	Remarks.
2290	Carter	96.380	53.973	1.135	. . .	0.980	Trace.	n. e.	n. e.	n. e.	0.953	0.380	. . . .	Compact limestone, just above the limestone ore.
2292 } 2293 }	Fayette	. . . .	. . . .	. . . .	. . .	. . . .	{ 5.69 to 11.65	. . . .	. . .	. . .	. . . .	. . . .	. . . .	{ Phosphate limestone layers (eleven samples).
2305	Franklin	87.780	49.157	2.482	. . .	3.812	2.968	n. e.	n. e.	n. e.	n. e.	1.780	1.178	Phosphatic limestone, Lower Trenton formation.
2378	Mercer	62.880	35.200	30.720	. . .	1.220	Trace.	n. e.	n. e.	n. e.	n. e.	5.000	.130	Chazy limestone, Kentucky river cliffs.
2379	Mercer	83.040	46.500	10.550	. . .	10.550	Trace.	n. e.	n. e.	n. e.	n. e.	5.560	2.30	Chazy limestone, Kentucky river cliffs.
2394	Nelson	81.580	45.685	1.501	. . .	2.978	1.202	n. e.	.423	.248	n. e.	11.820	.918	Ferruginous limest'e, near top of upper Hudson beds.
2395	Nelson	61.240	34.294	8.915	. . .	4.317	.563	n. e.	.443	.254	n. e.	22.520	1.748	Ferruginous limestone.
2437	Shelby	40.780	22.837	24.511	. . .	5.917	.563	.941	n. e.	n. e.	. . . .	25.120	2.168	From Jeptha Knobs, Upper Silurian.
2438	Spencer	87.320	48.889	.787	. . .	2.478	1.842	n. e.	.154	.212	. . . .	1.680	5.527	"Phosphatic limestone," lower part of up. Hud. beds.

TABLE VII.—A. MINERAL WATERS—SULPHUR WATERS—*In 1000 Parts of the Water.*

Number	County.	Hydr. sulphide and carbonic acid gases	Iron carbonate.	Manganese carbonate	Lime carbonate	Magnesia carbonate	Soda carbonate.	Lime sulphate.	Magnesia sulphate	Potash sulphate	Soda sulphate.	Calcium chloride	Magn'm chloride	Potass'm chloride	Sodium chloride	Sodium sulphide	Total saline matter	Remarks.
2262	Anderson	n. e.	.0046	. . . .	.1827	.1434	. . .	.0700	. . .	.0441	. . .	.0314	.1140	. . .	4.500	.0410	5.1548	Silica—0.0236; lithia, brom., etc., tr'cs
2274	Boyle	n. e.	.0097	. . . .	.0314		.5089	. . .	. . .	.0164	.1841	. . .	. . .	. . .	.1204	. . .	.8900	Black sulphur; silica —.0191.
2275	Boyle	n. e.	.0342	. . . .	.0896	.0216	.0870	. . .	. . .	.0066	.0080	. . .	. . .	. . .	.0040	. . .	.2010	Black sulphur.
2276	Boyle	n. e.	.0100	. . . .	1.4900	.0230	.2880	.2670	.1600	.1920	. . .	. . .	. . .	.0060	.2470	. . .	2.6830	Black sulphur; traces lithia and brom.
2397	Ohio	n. e.	—small quantities not estim'd—				. . .	.0938	.1530	.0230	.1850	. . .	. . .	. . .	.2000	. . .	2.954	Silica—0.0780.

TABLE VII.—B. MINERAL WATERS—CHALYBEATE—*In 1000 Parts of the Water.*

Number	County.	Carbonic acid gas	Iron carbonate.	Manganese carbonate	Lime carbonate.	Magnesia carbonate	Soda carbonate.	Iron sulphate.	Lime sulphate.	Magnesia sulphate	Potash sulphate.	Soda sulphate.	Calcium chloride	Magn'm chloride	Sodium chloride	Potass'm chloride	Total saline matter	Remarks.
2269	Boyle	n. e.	.0298	. . .	.2257	.0102	. . .	. . . .	.0313	. . .	.0067	.0275	. . .	.0068	. . .	. . .	.3451	Silica—0.0071; sulphuric acid, 0.0082.
2270	Boyle	n. e.	. . .	. . .	. . .	. . .	. . .	.1977	.2917	.2250	.0235	.1521	. . .	. . .	. . .	. . .	1.0240	Silica—0.0384.
2271	Boyle	n. e.	.1862	trace.	.0199	.0093	. . .	. . .	. . .	. . .	.0140	. . .	. . .	. . .	.0042	. . .	.2384	Silica—0.0012.
2272	Boyle	n. e.	.1654	trace.	.0307	.0133	. . .	. . .	. . .	. . .	.0140	. . .	. . .	. . .	.0078	. . .	.2345	Silica—0.0033.
2397	Boyle	n. e.	. . .	. . .	. . .	. . .	. . .	2.6761	.4904	.1350	n. e.	n. e.	. . .	. . .	. . .	. . .	10.4850	Alum'nm sulph., —5.3477; sulp. acid—.2871.

TABLE VII.—C. MINERAL WATERS—SALINE—*In 1000 Parts of the Water.*

Number	County.	Lime carbonate	Magnesia carbonate	Soda carbonate.	Iron sulphate.	Lime sulphate.	Magnesia sulphate	Potash sulphate	Soda sulphate.	Alumina sulphate	Calcium chloride	Sodium chloride	Magn'm chloride	Total saline matter	Remarks.
2263	Bell	.0356	traces.	.0316	...	.0056	.0246	...	...	...	.0027	...	...	.1077	Traces of iron and alumina; silica, 0.0076.
2277	Boyle	.0151	.0278	...	...	.0408	trace.	.0024	.0016	...	.0086	...	...	.1021	Traces of iron carbonate; silica, not estimated.
2278	Boyle	.1980	.0060	.0780	...	1.7660	3.1240	.2490	.1520	...	...	n. e.	...	5.6750	Iron carbonate, 0.1020; trace of lithia.
2279	Boyle	.1500	.0170	...	...	.6010	.9300	.0500	1.621	...	...	...	...	3.4180	Iron carbonate, 0.0150; lithia, salt, 0.310.
2280	Boyle	1.4900	.0230	.2880	...	.2670	.1600	.1920	...	...	...	.2470	...	2.6830	Iron carbonate, 0.0100; potassium, chloride, 0.0060.
a2280	Boyle	1.4540	1.3670	...	...	.1390	...	.1450	...	...	...	13.8780	...	19.2000	Traces of lithia and strontia.
b2280	Boyle	.1180	.0140	...	...	.2400	.1280	.0220	.1120	...	...	.0070	...	.686	Iron carbonate, 0.035; traces of lithia.
2331	Kenton	.3558	.0062	...	...	1.0039	1.3311	.0267	.3944	...	...	.1126	...	3.2345	Iron carbonate, a trace; silica, 0.0018.
2370	Logan	.0504	.0094	...	.0000	.3134	.0000	.0148	.1066	...	...	.0000	.0170	.5771	Iron carbonate, 0.0561; silica, 0.100.
2371	Logan	.3485	.0101	...	trace.	1.1886	.9373	.0000	.0000	...	...	.0900	.0000	2.9053	Iron carbonate, 0.3260; traces of lithia.