GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

CHEMICAL REPORT

OF THE

SOILS, COALS, ORES, IRON FURNACE PRODUCTS, CLAYS, MARLS, MINERAL WATERS, ROCKS, &C.,

OF KENTUCKY,

BY ROBERT PETER, M. D., ETC., ETC.,

CHEMIST TO THE KENTUCKY GEOLOGICAL SURVEY.

ASSISTED BY

JOHN H. TALBUTT, S. B., CHEMICAL ASSISTANT.

SECOND CHEMICAL REPORT IN THE NEW SERIES AND THE SIXTH SINCE THE BEGINNING OF THE SURVEY.

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INTRODUCTORY LETTER.

CHEMICAL LABORATORY OF THE
KENTUCKY STATE GEOLOGICAL SURVEY,
LEXINGTON, February, 1877.

Professor N. S. SHALER, *Chief Geologist, &c.:*

DEAR SIR: I have the pleasure to report the results of the chemical work performed by myself and Mr. Talbutt, for the State Geological Survey, during the past year, or since the preparation of the last report nearly up to the present date.

Very respectfully,
ROBERT PETER.

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CHEMICAL REPORT OF THE SOILS, COALS, ORES, IRON FURNACE PRODUCTS, CLAYS, MARLS, MINERAL WATERS, ROCKS, &c., OF KENTUCKY, BY ROBERT PETER, M. D., ETC.

The chemical analyses of eighty-three *soils*, from twelve counties of the State, are given in the following detailed report. The limits of the variations of their several essential ingredients are shown in the following table, viz:

	Pr. cent.	No.	County.	Per cent.	No.	County.
Organic and volatile matters vary from . . .	11.565	in 1684	in Bell	to 1.052	in 1903*b*	in Muhlenb'rg.
Alumina and iron and manganese oxides vary from.	19.921	in 1783	in Fayette . .	to 2 815	in 1692	in Bell.
Lime carbonate varies from	1.145	in 1781	in Fayette . .	a trace.	in 1871	in Lewis.
Magnesia varies from.	.394	in 1781	in Fayette . .	to .011	in 1853	in Laurel.
Phosphoric acid varies from.	.540	in 1780	in Fayette . .	to .c61	in several.	
Potash varies from	.755	in 1783	in Fayette . .	to .068	in 1680	in Bell.
Soda varies from	.477	in 1903*c*	in Muhlenburg	to traces	in several.	
Sand and insoluble silicates vary from	72.540	in 1783	in Fayette . .	to 95.115	in 1683	in Bell.
Water expelled at 380° F. varies from	2.515	in 1696	in Bell	to .035	in 1684	in Bell.
Water expelled at 212° F. varies from	3 525	in 1783	in Fayette . .	to .435	in 1852*c*	in Knox.
Potash in the insoluble silicates varies from .	2.640	in 1696	in Bell	to .399	in 1852*d*	in Knox.
Soda in the insoluble silicates varies from . .	1.044	in 1728	in Christian to	traces in	several.	

This table of extremes of composition shows wider limits than that of volume I, and may be supposed to exhibit the relative chemical composition of very good and very poor soils. The rich soil being characterized by larger proportions of organic and volatile matters (within certain limits), causing the soil to absorb and retain much hygroscopic moisture (expelled at 212° F.); larger relative quantities of alumina, &c., &c., which hold more water, &c., expelled at 380° F.; but especially being more rich in the available alkalies, potash and soda (particularly potash); by containing more phosphoric acid, lime, &c., and having less sand and insoluble silicates. The poor soil generally contains a larger quantity of sand and insoluble silicates and smaller proportions of the other named ingredients. Exceptions occur to these general statements, of course; for great excess of lime or magnesia carbonates, of organic matters, or of clay, may make a poor soil; or, on the other hand, the absence of any single essential element in it may render unavailable normal proportions of all the others. The study of the soil in relation to its productiveness presents, indeed, a complex problem; many conditions, both physical and chemical, enter into it, all equally important. Even the relative state of division, whether fine or coarse, of two soils otherwise presenting similar chemical, physical, and atmospheric conditions, is found greatly to influence its fertility.

Another varying condition is the influence of water upon the soil, which, in the valley, may bring fertilizing ingredients to the soil from the higher grounds by deposit of suspended mud left by the overflowing fluid, or may carry dissolved elements of plant food into its interior by gradual infiltration. On the other hand the flood, on the higher slopes, not only carries off to the lower levels the richer and finer solid materials, but, by a continued leaching process, may actually dissolve and remove the alkalies, lime, magnesia, phosphates, and organic matters, and even gradually decompose the insoluble silicates and carry off the store of alkalies naturally contained in some of them. The examination of some of the soils of the mountain region seemed to show that underground drainage, through a measurably open subsoil, had thus acted on the silicates contained in them.

In many cases the subsoil in the samples examined was richer in the mineral elements of fertility than the surface soil, and in some few cases it seemed to have had a different origin. The influence of the subsoil, when more or less mixed with the upper soil in the processes of cultivation, was measurably observable in studying the gradual exhaustion produced by cropping. In some cases seemingly making the soil of the old field fully as rich as the virgin soil, supposing both originally to have been similar in composition, which is not always true. The comparison of the old cultivated soil with the virgin soil of the immediate vicinity does not, therefore, in all cases, show an apparent reduction of the elements of fertility in the former; yet, the fact is demonstrated, in a large proportion of cases, where the soil is uniform in the region and care has been taken in the selection of the samples. Superficial impurities, which might greatly interfere with the results, are easily to be avoided in the collection of the soils in most cases.

But the subsoil, although quite rich in potash, soda, phosphates, and other mineral fertilizers, does not always improve the immediate fertility of the soil when brought up to the surface in too large quantity at one time. Indeed gardeners find, generally, that it reduces the fertility of the surface unless it is liberally mixed with organic manures. Hence, while they may loosen the earth to a considerable depth, by a process of *subsoiling*, to favor drainage, the penetration of the atmospheric gases and the free spreading of the roots of their vegetables, they are generally careful not to *trench* the soil so as to throw much of the heavy subsoil upon the surface. Of course subsoils vary in composition; but the subsoils of this region are usually quite rich in potash, soda, and phosphates, held in firm combination, however, in the silicates which are insoluble in the ordinary acids; they contain more of the materials of clay—alumina, iron oxide, &c.—than the surface soil generally, and but a small quantity of organic and volatile matters.

As the organic compounds of the soil are greatly instrumental in bringing the mineral elements of plant food into a soluble or available condition, and as they even act on the insoluble silicates, to set free and make soluble their constituent alkalies and phosphates, &c., the measurable absence of the organic matters from the heavy subsoil may have much to do with its inertness as compared with its chemical composition.

The extensive study which has been made in this laboratory of the insoluble silicates of our soils, during the past year, has thrown much light on this subject, as well as on the probable origin of some of our soils. All of the soils examined were found to have a notable quantity of alkalies in the silicious residue left after a ten,or twelve days' digestion in chlorohydric acid of the density of 1.1, and, as may be seen by reference to the table of extremes of composition given above, this quantity varies from 2.640 per cent. of potash down to 0.399 per cent., which was the smallest proportion found in any, and which, as is universally the case, is much greater than the amount removed from the soil by the action of chlorohydric or nitric acid.

The silicious residue of our Kentucky soils, left after prolonged digestion in the acids, is generally in such a fine state of division that all or most of it will readily pass through fine bolting-cloth. Hence our best Kentucky soil has been popularly said to have no sand in it. Indeed, in the "Blue Grass Region," so-called—the most fertile part of the State—sand is so scarce that it usually must be hauled from the river beds at some distance, and its cost to the builder is quite considerable. But a large proportion of the very fine silicious residue of our soils is really very fine quartzose sand, some grains being clear and colorless, some milky or colored, and only a few, of the same character, separable by the bolting-cloth from some of the soils, are of a somewhat larger size, indicating the fact that our soils, or the rocks from the disintegration of which they are derived, have been deposited under comparatively quiet waters, possibly of a deep sea at a distance from its shores.

But, mixed with the purely silicious grains is quite a considerable quantity of grains of *silicates*, containing the alkalies in considerable proportions, doubtless of the nature of the felspar and mica of the granitic rocks and other minerals analogous in chemical composition, holding in reserve a great treasure of these important elements of organic nourishment, the alkalies.

When we consider the wide diffusion of these finely divided silicates—for it is probable they enter into the constitution of all the soils of the world—we may well be astonished at the vast extent of rock disintegration which was necessary to their production, and admire this wonderful provision for maintaining the productiveness of the soil.

As regards the proportion of *phosphates* contained in these insoluble silicates, it is the design of the writer to institute an investigation, as occasion may favor, during the progress of the Survey.

It has been conclusively established that *mineral* fertilizers alone will not suffice to render soil productive. The greater proportion of vegetable and animal bodies is made up of the so-called *atmospheric elements*, viz: carbon, hydrogen, oxygen, and nitrogen; and the latter element, although entering into their composition in much smaller proportions than the other three, has most attracted the attention of vegetable physiologists and agriculturalists; mainly for the reason, that while the carbon is readily appropriated by the plant, in the decomposition of carbonic acid under the influence of the sun's light—this acid being never absent from the soil or the atmosphere—and water, always present, yields the necessary hydrogen and oxygen, nitrogen cannot, as a general rule, with some exceptions, be directly assimilated from the atmospheric gases by the growing vegetable. With the exception of plants of the clover or pea family, and a few others, all growing vegetables must be supplied with this essential element, nitrogen, in some form of compound, they not seeming generally to be endowed with the force requisite to coerce into the liquid or solid state this gas, which has withstood all the efforts of man, by the use of immense pressure and intense cold, to condense it even into the liquid form.

Under ordinary circumstances of natural vegetable growth, nitrogen is presented to the plant, sometimes in the form of ammonia (composed of nitrogen and hydrogen), or of some of its compounds, resulting from the decomposition of animal bodies and products; sometimes in that of nitrates or analogous compounds, which originate in the union of nitrogen and oxygen and some base; all of which nitrogenous compounds are easily soluble in water, and thus readily enter the vegetable tissues. But the ordinary natural supply of these compounds is limited, and hence, when the soil is to be stimulated to its highest degree of productiveness, and its fertility made continuous, the cultivator necessarily resorts to the admixture of nitrogenous compounds of some sort with his fertilizers. The nitrogenous organic compounds of both animals and plants are always associated with phosphates; and it is believed, that while potash is absolutely necessary in the growing vegetable for the production and transfer of its non-nitrogenous constituents, nitrogenous compounds and phosphates are also mutually dependent—all being equally indispensable. So that the agricultural chemists of the Liebig school, who contend for the exclusive importance of the mineral elements of fertility, and those of the French and English schools, who see no value in manures outside of the nitrogen compounds, are equally too exclusive, and equally in fault.

These questions have long been of vital interest in the older and more thickly populated countries, while in our comparatively new continent the virgin soil still bountifully responds to the labor of the farmer without the aid of artificial fertilizers, and with but little evidence of exhaustion. But here, as everywhere, except where the soil is continually renewed by exceptional and local causes, such as the existence of an unusually rich and readily decomposable sub-stratum, or the periodical fertilizing overflow of rivers, the continued demands of the farmer upon the land inevitably reduces its productiveness—an effect which is increased as population enlarges. And it is even now the fact that, over a large portion of our State and country, profitable farming without the aid of manures is practically at an end. The future of our husbandry will be mainly the application of fertilizers to the soil, as a vehicle of production, by the aid of capital, skill, and industry; which will be the more profitable as the population becomes more dense, and the home market is enlarged by the increase amongst us of other industrial occupations, more especially of the manufactures.

Kentucky is eminently endowed by nature for the support of extensive and most important manufactures. Her immense natural resources in coal, iron ores, clays, limestones, salt, &c., &c.—materials which are essential to almost all the arts of civilization, and give employment to more individuals than any other natural products, those of the field, perhaps, excepted—only await development to make her one of the most powerful Commonwealths of the world. The great wealth and power of Great Britain rest on her coal and iron fields mainly.

During the past year, proximate analyses have been made, in this laboratory, of one hundred and forty-seven several samples of *Kentucky coals*, in addition to those reported in previous volumes of the reports. As might have been expected, these exhibit a considerable variety in their composition, as may be seen by examining the table at the end of this chemical report.

The general average of ash and sulphur in the coals examined this year doubtless falls somewhat below that of the samples examined in the previous year; but, as might be expected, very great differences are to be observed among them. Thus the limits of the ash per centage extend from 2.60 per cent., in Nos. 1908 and 1810, from Ohio county, to 34.72 per cent., in No. 1914, from Ohio county.

The great proportion of the ash of No. 1914 is exceptional, however, and although this coal is called a cannel coal by some, it doubtless should be denominated a bituminous shale. Indeed, where the earthy matters exceed twenty per cent. of the material, the name coal is not as appropriate as the latter term, although the mineral may yet be made quite useful for fuel, or possibly for distillation, in the vicinity of its bed.

The limits of total sulphur in these coals examined this year are from 0.530 per cent., in the cannel coal, No. 1966, from Wolfe county, to 7.959 per cent., in No. 1923, from Ohio county.

A remarkable fact in relation to this latter coal is, that while the sulphur per centage is nearly eight the ash per centage is only a little above twelve, indicating that much of this combustible substance is either in the free state or in some form of organic compound in the coal. Other coals, with a large quantity of sulphur, show the same fact, and the inference is that a considerable proportion of this sulphur may be removed in the operation of coking the coal. Remarks on the probable condition of sulphur in coals, and on its removal, will be found in the succeeding detailed report, especially under the head of Bell county.

As was remarked in the previous volume, the coals of the eastern coal field appear to be somewhat less sulphurous, in the average, than those of the western. Recent imperfect investigations into those parts of the eastern coal field which are yet measurably unexplored, and which are beyond the usual channels of communication, have shown the existence there of coals of great value and remarkable purity, some of which, like the celebrated Indiana "Block coal," may be used in the smelting of the abundant iron ore without the preliminary process of coking.

Under the heads of Bell and Breathitt counties, the general correspondence between the specific gravity and the ash per centage was again exhibited; and it is to be noted, that while the density of the coal, as a general rule, increases with the ash per centage, the cannel coals offer a marked exception, or exhibit a ratio of their own. What the ratio is, in the different sorts of coal, cannot well be made out at present, especially because the different varieties shade into each other, and difference of age and the action of physical agencies may affect the relative density, independent of the earthy matters, as well as the various kinds of organic materials from which the coals were derived.

To illustrate more fully this correspondence between specific gravity and ash per centage, another table, viz: that of the coals from Ohio county, is appended, as follows:

Number.	Specific gravity.	Ash per centage.	Number.	Specific gravity.	Ash per centage.
1910	1.251	2.60	1907	1.336	10.30
1915	1.273	4.00	1919	1.340	8.30
1926	1.282	3.16	1927	1.348	7.72
1908	1.295	2.60	1913	1.345	9.28
1917	1.295	5.00	1920	1.356	9.94
1909	1.297	3.40	1921	1.357	8.14
1916	1.305	4.00	1922	1.380	9.34
1924	1.310	5.94	1911	1.382	9.96
1925	1.310	9.92	1918	1.384	14.20
1906	1.310	7.46	1912	1.386	9.24
1904	1.318	7.54	1929	1.411	12.50
1928	1.321	4.36	1923	1.413	12.10
1905	1.331	8.44	1914*	1.593	34.72

* A bituminous shale or impure cannel coal.

It is believed, that notwithstanding the large proportions of ash and sulphur in some of these samples of coals analyzed, the general, or average quality of the coals of the very extensive coal fields of Kentucky will compare favorably with that of the coals of any other region.

Only about twenty-four *iron ores*, of the limonite variety, and five clay iron-stones have been analyzed since the last report. These are from seven counties only, and are found to vary in their proportions of *iron* between the extremes of twenty-three and more than fifty-three per cent. of that metal. Their proportions of *phosphorus* vary from 1.60 to 0.065 per cent., the largest proportion of this injurious element having been found in the "Clinton ore," of Old Slate Furnace, of Bath county.

As is pretty well established, phosphorus is more injurious to the quality of the iron than any other ingredient of the ore, especially in causing it to be "cold-short," or, in other words, diminishing its tenacity or toughness. Silicon, in certain proportions, is also injurious in this respect; but the presence of phosphorus in the ore is more to be deprecated, because it is to be removed with more difficulty from the iron in the subsequent refining processes; silicon being easily oxidated, or burnt out with the excess of carbon and some other impurities of the pig metal, in the puddling or even in the Bessemer process, while phosphorus is believed to maintain more obstinately its union with the metallic iron.

The general belief was, even among modern scientific observers, that all the phosphoric acid in the iron ore, or in the flux material and fuel, used in the ordinary smelting furnace, finds its way into the reduced metal, pig iron, produced, and is held in it, in firm combination, in the form of iron phosphide. Hence, it was claimed, a phosphatic ore necessarily produces a yet more phosphatic iron, because the phosphorus, all of which is supposed to combine with the metal, is, of course, in larger proportion to the iron than to the ore, &c.

But analyses, made by the writer, of samples of iron furnace cinder or slag, published in the volumes of the first series of reports of the Kentucky Geological Survey, as well as in the present report (see Greenup county), show the presence of notable quantities of phosphoric acid in this slag, and thus lead to the conclusion that it is possible, by a proper management of the furnace and of the fluxes used, to eliminate, in this form, a considerable proportion of this injurious ingredient in the smelting of the ore. If the phosphatic iron ore, in the high furnace, be subjected to a very intense heat, in presence of the reducing gases, the phosphoric acid will be reduced to phosphorus, which will unite with the reduced iron when it melts, provided a proper basic flux material be not present to fuse with the phosphoric acid before it is deoxidated, and thus protect it from reduction. But, in the presence of such a basic flux material, it is probable that the iron of the ore, if it be reduced at a more moderate heat, and while yet unmelted, may afterwards melt at a heat not quite high enough to reduce the phosphoric acid, which then would go off in the slag.

The strong affinity which exists between alumina and phosphoric acid justifies the belief that this material, in the flux or in the ore, may be especially useful in this process of purification in the smelting furnace; when used in combination with a sufficiency of lime or other fluxing materials to make a rather fusible basic flux, and with not too high a temperature in the reducing part of the furnace. It is well known that alumina is an essential ingredient of all clays.

It has long been known that the phosphorus of the impure iron may be removed, in great measure, by the aid of oxygen and fluxing materials; and this fact has long been practically applied in the various refining processes, in which the melted pig metal is exposed to the oxygen of the air, or to that which is separated from powdered iron or manganese oxides, or derived from common nitre or nitrate of soda. The oxygen burns out or oxidates the phosphorus (together with the other oxidable ingredients—carbon, silicon, sulphur, &c.), and the phosphoric acid which is formed unites generally with iron or manganese oxides, as phosphates, in the melted cinder. This is the theory of all the various refining processes, including that called puddling and the Bessemer process, which latter process, however, because, probably, of the want of a fluid basic flux to dissolve compounds of phosphoric acid, is not effectual in the removal of phosphorus.

Amongst the modern processes for iron purification is the patent one of Henderson, originated in England, but which seems to have been employed in this country, at the Hamburg Iron Works, Hamburg, Pennsylvania. An English pamphlet, obtained by the writer at the Centennial Exhibition, gives many interesting facts in relation to it and its results. The refining process is, to pour the melted impure pig metal on a mixture of powdered fluor-spar and titanic iron ore (ilmenite), or peroxide of manganese, &c., placed on the floor of the ordinary puddling furnace; "the furnace door being then closed, the powdered mixture fuses, and the iron is allowed to boil for about half an hour; the rabble is then worked for about ten minutes, and the metal is balled up in the usual way. The whole time occupied by one charge, with ordinary grey forge pig iron, being a little under an hour."

It is claimed, that in this time the commonest and most impure pig iron may have most of its phosphorus, sulphur, silicon, and carbon removed; and that it may be brought to a state of purity, toughness, and ductility equal to that of the best Swedish iron. In this pamphlet this claim is corroborated by numerous chemical analyses of the pig metal and of the purified wrought iron, by Dr. Henry M. Noad, F. R. S.; Mr. Edward Riley, F. C. S.; and Mr. W. Matthiew Williams, F. C. S., as well as by many mechanical tests of the metal by Mr. David Kirkaldy.

The chemical analysis of the *slag* produced in this process throws a little light upon the theory of the depurative action of the re-agents used. (See table 19 of the pamphlet.) Some of this slag, analyzed by Mr. Edward Riley, F. C. S., gave the following results:

Silica	11.12	
Titanic acid	5.02	
Protoxide of iron	56.41	} = 58.0 per cent. of *iron*.
Peroxide of iron	18.20	
Alumina	1.73	
Manganese	2.22	
Phosphoric acid	1.19	= .47 per cent. of *phosphorus*.
Sulphur	.09	
Lime	3.51	
	99.49	

The author of the process asserts that most of the phosphorus goes off in the form of vapor; but it is evident that it mostly separates in the slag, after having formed phosphoric acid by union with oxygen. No doubt the manganese oxide aided in the oxidation of the carbon, sulphur, and phosphorus of the pig iron, and the fluorine of the fluor-spar may have combined with the silicon to produce a volatile fluoride of silicon; for we see no statement of any fluorine in the analysis of the slag; but it is believed, that in the ordinary operation of puddling, the atmospheric oxygen, or that derived from a lining of powdered iron ore, &c., may remove all these, if it be carefully performed, more especially if materials be brought in contact with the boiling iron, which may readily melt into a sufficient basic cinder to carry off the fixed impurities, including phosphates which may result from the oxidation of the phosphorus of the iron. That the fluor-spar may both serve to form the flux and quicken the separation of the silicon and phosphorus, was fully established by Carron.

A large quantity of iron oxides appears in this cinder, in the above statement of the analysis, equivalent to fifty-eight per cent. of the whole slag. But it is probable that most of this was derived from the powdered ilmenite (titanic iron oxide) used in the process. In the ordinary puddling slag the large proportion of iron oxide always present is derived from the pig iron. It is very probable that the mixture of the powdered iron ore with the fluor-spar may lessen the loss of metal in the puddling. According to the published statement, the loss in purifying the most common pig iron into fine wrought iron, by the Henderson process, is only ten per cent.

It is generally believed that, in the ordinary refining processes, the agent which is especially effectual in the removal of the phosphorus is the tri-basic silicate of iron, which forms a fluid cinder or slag, and which is produced by the oxidation of the ingredients of the pig metal at a great expense of iron. There can be no doubt that this loss may be measurably prevented, and the purification facilitated, by the use of a "lining" of powdered oxide of iron (iron ore), with some compound of lime (fluor-spar or limestone), to give oxygen and form a fluid basic flux to carry off the phosphoric and silicic acids, &c. Whether the use of similar materials, to furnish oxygen and the ingredients for a somewhat basic flux to carry off phosphoric acid, is possible in the Bessemer process, is well worthy of trial. Fluor-spar commends itself because of its ready fusibility and its power of fluxing earthy materials generally, so that it possibly may dissolve, retain, and protect from reduction the oxidated phosphatic compounds, at a temperature sufficient to melt iron, and thus aid in their removal. The presence of alumina in the cinder seems also to be beneficial in this respect.

Not the least interesting of the iron ores analyzed, during the past year, are those described in the Appendix as Clinton iron ore, dyestone ore, or fossil ore, from very extensive beds in the mountainous region of Tennessee, near the Kentucky State line, in the Cumberland Gap region, which, because of their abundance in the vicinity of our coal beds, their general richness in iron (one sample giving more than fifty-six per cent. of this metal, on analysis), as well as because of their unexpected moderate proportion of phosphorus, in this locality, promise to become of great industrial value.

Some of the iron smelted from this Clinton ore, at the Old Clinton Furnace, at Cumberland Gap, the analysis of which is also given in the Appendix, corroborates this expectation.

The twenty-two samples of pig iron analyzed, from five counties of the State, vary in their specific gravity from 6.163 to 7.435; in their per centage of *iron*, from 89.687 to 94.764; in their per centage of *total carbon*, from 2.800 to 4.720; in that of *phosphorus*, from 1.080 to 0.120; in that of *silicon*, from 5.082 to 0.363, and in that of *sulphur*, from 0.278 to 0.011. This includes samples of hot-blast stone-coal iron, as well as cold-blast charcoal iron. From these and the analyses previously made, it is evident that iron of almost any desirable quality can be manufactured in our State from her natural products, which are unusually abundant, and await only the judicious application of capital, skill, and labor to give to her great prominence as a manufacturing State.

An interesting discovery of a phosphatic layer in the blue limestone (Lower Silurian) is recorded under the head of Fayette county; and some suggestions as to the use of the Bittern water of our salt works, and other means in rendering more available for fertilizers the beds of marls of our State, will be found under the heads of Clay and Grayson counties.

Another interesting fact reported is the existence of barium and strontium chlorides in the brines of Clay and Meade counties.

BATH COUNTY.

Limonite iron ores, labeled as follows:

No. 1652—LIMONITE, *from Slate Furnace ore banks, "Howard's Hill;" Upper Silurian formation. Collected by P. N. Moore.*

In porous, or fine cellular, irregular, thin laminæ; oölitic in parts; of a dark-brown color, with ochreous incrusting material.

No. 1653—LIMONITE, *from Slate Furnace ore bank. Upper part of the bed. Collected by P. N. Moore.*

Mostly of a yellowish-brown color, and somewhat friable, with some darker-brown and denser irregular laminæ. The whole presenting a fine-grained oölitic appearance, from the presence of small spherical cavities, more or less incrusted with whitish and yellowish material.

No. 1654—LIMONITE ORE *at the Chalybeate Springs, Pilot Knob. Collected by P. N. Moore.*

In thin irregular laminæ, of a dark reddish-brown color, with some bright red and yellowish ochreous material.

No. 1655—LIMONITE (*with carbonate*), *said to be eighteen to twenty feet thick, from near Owingsville, on the road to Slate Creek. Collected by P. N. Moore.*

Of a fine oölitic structure. Colors varying from yellowish and reddish-brown to greyish-brown, with greenish-grey infiltration in some parts.

No. 1656—LIMONITE, *from "Old Coaling Bank," head of Clear Creek; in Sub-carboniferous limestone. Average sample collected by P. N. Moore.*

Principally of a dark reddish-brown color, with some little of lighter color.

No. 1657—LIMONITE, *from the "Richardson Bank," Clear Creek; in Sub-carboniferous limestone. Average sample collected by P. N. Moore.*

A dense ore, generally of a dark brown color, with a small proportion of greyish.

No. 1658—LIMONITE, *from the "Pergam Bank," Clear Creek; in Sub-carboniferous limestone. Average sample collected by P. N. Moore.*

A dense ore, generally of a dark brown color, with some little ochreous.

COMPOSITION OF THESE BATH COUNTY LIMONITE ORES, DRIED AT 212° F.

	No. 1652	No. 1653	No. 1654	No. 1655	No. 1656	No. 1657	No. 1658
Iron peroxide	70.060	69.728	47.321	39.068	59.621	66.329	65.310
Iron carbonate	. . .	. . . .	. . . .	11.479	. . . .	. .	. . . .
Alumina	4.540	8.642	5.418	8.346	12.370	12.532	11.947
Manganese peroxide	not est.	not est.	not est.	not est.	not est.	not est.	not est.
Lime carbonate	.040	.170	.690	18.710	.500	a trace.	.730
Magnesia	.021	.045	.079	6.159	.144	.173	.140
Phosphoric acid	1.620	1.154	.161	.868	.709	.709	.825
Sulphuric acid	.031	.134	.376	.185	a trace.	a trace.	a trace.
Combined water	12.300	12.630	12.030	7.835	10.400	9.580	11.000
Silicious residue	11.530	7.930	33.330	7.350	15.830	9.720	9.580
Total	100.142	100.453	99.425	100.000	99.574	99.043	99.532
Iron, per cent.	49.042	48.809	33.125	30.734	41.735	46.440	44.570
Phosphorus, per cent.	0.707	.504	.070	.379	.309	.309	.360
Sulphur, per cent.	.012	.053	.150	.074	a trace.	a trace.	a trace.
Silica, per cent.	11.530	7.760	27.600	7.560	13.960	9.060	9.580
Specific gravity	3.470	3.405	not est.	not est.	not est.	not est.	not est.

All of these ores are sufficiently rich for profitable smelting. Nos. 1652, 1653, and 1657 are more than usually rich in iron. The first two contain more phosphorus than is desirable, but much of this may be removed in the slag, if there be much alumina present; moreover, it would not be seriously objectionable in ordinary castings. No. 1655, containing quite large proportions of lime and magnesia, might profitably be mixed with more silicious and richer ores for smelting. Sulphur is not superabundant, except in No. 1654.

PIG IRON FROM BATH COUNTY.

No. 1659—LABELED "*No. 1 Cold-blast Charcoal Iron; Bath Furnace. Collected by P. N. Moore.*"

A dark-colored, moderately coarse-grained iron. Yields readily to the file; flattens considerably under the hammer.

No. 1660—"*Pig Iron from Old Slate Furnace.*" *Collected by P. N. Moore.*

Finer-grained, harder, and less tough than the preceding, but yields to the file and extends somewhat under the hammer.

No. 1661—LABELED "*No. 1 Cold-blast Charcoal Car-wheel Iron," from Cottage Furnace. Sent by G. S. Moore & Co., of Louisville.*

Moderately coarse-grained; somewhat dark grey. Yields with difficulty to the file; extends somewhat under the hammer.

No. 1662—"*No. 2 Cold-blast Charcoal Pig Iron," from Bath Furnace. Collected by P. N. Moore.*

A moderately fine-grained grey iron. Yields to the file; extends considerably under the hammer.

No. 1663—"*No. 3 Cold-blast Charcoal Pig Iron," from Bath Furnace. Collected by P. N. Moore.*

Finer-grained than the preceding. Yields to the file; extends rather more under the hammer than the preceding.

No. 1664—"*No. 4 Cold-blast Charcoal Pig Iron, from Bath Furnace. Collected by P. N. Moore.*"

Finer-grained than the preceding. Quite fine-grained, and dark grey. Yields to the file; extends somewhat under the hammer.

COMPOSITION OF THESE BATH COUNTY PIG IRONS.

	No. 1659.	No. 1660.	No. 1661.	No. 1662.	No. 1663.	No. 1664.
Iron	92.631	92.056	93.106	91.924	93.472	93.004
Graphite	3.840	3.640	3.860	3.440	3.100	2.700
Combined carbon	.710	.310	.590	1.060	1.510	1.410
Silicon	1.520	1.760	.914	1.319	.652	1.007
Slag	.100	.100	.160	.260	.160	.260
Calcium	.090	.116	not est.	not est.	not est.	not est.
Phosphorus	.363	1.080	.527	.220	.290	.262
Sulphur	.278	.218	.011	.107	.121	.172
Total	99.532	99.280	99.168	98.330	99.305	98.815
Total carbon	4.550	3.950	4.450	4.500	4.610	4.110
Specific gravity	7.070	7.067	7.142	7.017	7.092	7.168

The pig iron of the Bath Furnace has a well deserved reputation for yielding iron of great tenacity, and hence is preferred for railroad axles. Its small proportion of phosphorus* does not seem to injure it in this respect. It, as well as the other specimens from Bath county, contains more than the usual proportion of carbon. The iron of the Old Slate Furnace, prepared from the phosphatic ores of the Upper Silurian Group, contains more phosphorus than is desirable in the manufacture of tough bar iron or steel. This impurity does not prevent it from being available in almost all ordinary castings.

BARREN COUNTY.

No. 1665—"*Marly Deposit in Proctor's Cave. In the cavernous Sub-carboniferous limestone, Barren county." Said to be good for polishing metals.*

The dried lumps are very fine-grained, and are light-grey, nearly white. Adhere to the tongue.

COMPOSITION, DRIED AT 212° F.

Lime carbonate	66.160
Magnesia carbonate	14.083
Alumina and iron and manganese oxides, and phosphoric acid	5.800
Water, alkalies, and loss	5.097
Silica and insoluble silicates	8.860
Total	100.000

If in sufficient quantity. it might not only be useful for polishing the soft metals, but might be used as a fertilizer, or, very probably, it would make a hydraulic cement, if properly calcined.

No. 1666—"NITRE EARTH. *From Grand Avenue Cave, three miles northwest of Glasgow Junction, Barren county. Collected by Prof. N. S. Shaler.*"

A light cinnamon-colored earth, containing excrements of bats, &c., &c.

*It is believed by the writer that, in consequence of the difficulties attending the estimation of the phosphorus in iron, this ingredient has been often under-estimated by chemists, and, consequently, its evil influence has been over-estimated.

Qualitatively examined, it was found to contain ammonia salt, or some nitrogenous matter which yields this alkali under the action of lime; also much lime sulphate.

Quantitative analysis showed, however, that it only contained of nitric acid 0.0025 per cent.; of potash, .0129 per cent.; of soda, .0024; so that it would not prove valuable as a source of nitre, although, if in sufficient quantity, it might be useful as a fertilizer.

BELL COUNTY.

COALS OF BELL COUNTY.

No. 1667—"*Coal, from Abraham Lock's coal bank, Straight Creek, Bell county. Collected by A. R. Crandall.*"

A somewhat soft, pure-looking splint coal. Very little fibrous coal and no pyrites apparent. Some ferruginous stain in the seams.

No. 1668—"*Cannel Coal, from Col. John G. Eve's land, Fork Ridge, near Stony Creek. Fourteen inches thick. Taken from the bed of Mountain Creek. It is probably better beyond the opening.*"

Tough; fracture somewhat conchoidal; lustre satiny. No appearance of pyrites. Some ferruginous stain on the surface.

No. 1669—"*Hignite Coal, from Hignite Branch of Yellow Creek. Upper bed. Collected by A. R. Crandall.*"

A splint coal, with very little fibrous coal or granular pyrites between the laminæ.

No. 1670—"*Coal, from the same locality as the last sample. Middle bed. Collected by A. R. Crandall.*"

Does not differ much in appearance from the preceding.

No. 1671—"*Coal, from the same locality. Lower bed. Collected by A. R. Crandall.*"

No. 1672—"*Coal, from Little Clear Creek. In the shales above the Conglomerate. Bed two feet thick; fifteen feet above the creek. Collected by A. R. Crandall.*"

A semi-cannel or splint coal. Very little fibrous coal and no apparent pyrites between the laminæ. Lumps slightly soiled with mud.

No. 1673— *Coal, from Little Clear Creek, &c., &c. Bed two feet thick, in the bed of the creek. Collected by A. R. Crandall.*"

Resembles the last. Some little ferruginous stain on exterior surfaces.

1674—"*Coal, from Fork Ridge, on Stony Creek. A four-feet bed, above the cannel coal. Collected by A. R. Crandall.*"

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

No. 1675—"*Coal, from James Barnett's bank, six miles north of Cumberland Gap, on a branch of Clear Fork, which runs into Big Yellow Creek. Bed forty inches thick, with no shale parting. Average sample collected by Jno. H. Talbutt. (Three other beds in the same hill; one below, eighteen inches thick; two above—one eighteen inches, the other, on the top, about three to four feet thick.)*"

A pure, glossy, pitch-black coal. Has very little fibrous coal or pyrites.

No. 1676—"*Coal, from the same locality as the last. A sample from such as is sent to market.*" *Collected by John H. Talbutt.*"

Resembles the preceding.

COMPOSITION OF THESE BELL COUNTY COALS, AIR-DRIED.

	No. 1667.	No. 1668.	No. 1669.	No. 1670.	No. 1671.	No. 1672.	No. 1673.	No. 1674.	No. 1675.	No. 1676.
Specific gravity.	1.276	1.262	1.346	1.290	1.277	1.360	1.325	1.344	1.282	not est.
Hygroscopic moisture. . .	1.90	1.00	1.80	2.04	2.96	1.02	1.76	1.26	1.36	1.50
Volatile combus'ble matters	37.50	43.60	35.50	36.64	35.28	37.76	38.90	33.96	35.80	37.94
Coke	60.60	55.40	62.70	61.32	61.76	61.22	59.34	64.78	62.84	60.56
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters . . .	39.40	44.60	37.30	38.68	38.24	38.78	40.66	35.22	37.16	39.44
Carbon in the coke.	57.90	47.80	52.20	58.02	59.40	48.22	52.54	55.42	59.54	58.40
Ash	2.70	7.60	10.50	3.30	2.36	13.00	6.80	9.36	3.30	2.16
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke. . .	*Lt. sp.	Dense sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.
Color of the ash	Light brown.	Buff-grey.	Very light grey.	Light lilac-grey.	Brownish-grey.	Lilac-grey.	Lilac-grey.	Light lilac-grey.	Buff-grey.	Brownish-buff.
Per centage of sulphur . .	1.519	0.590	0.956	0.736	0.420	1.670	2.027	2.672	0.975	1.038

* Lt. sp. — Light spongy.

These coals are all good, and some of them would rank amongst the very best, and might be made available in the smelting of iron ores without the preliminary process of coking, like the so-called "Block coal" of Indiana, which they resemble. The proportion of sulphur, it will be seen, is generally sufficiently low, but varies in the different samples from 0.42 per cent., in No. 1671, up to 2.672, in No. 1674. It must be remembered that these proportions given in the table represent the *total sulphur* of the coals, in whatever form it may exist in them, and that, in the practical use of the coal for smelting or manufacturing purposes, a considerable proportion of this total sulphur is removed in the preliminary heating in the upper part of the furnace, or in the coking of the coals, or is in such a state of combination in them as to be harmless.

As shown in volume I, new series, of these reports (lower page 287), some of this sulphur is in the free or uncombined condition, especially in the fibrous coal, or mineral charcoal, which is found between the laminæ. When in this state this injurious element is quite easily removable. Indeed, it is continually undergoing oxidation, when the coal is exposed to the air, even at the ordinary temperature, forming, with the atmospheric oxygen and moisture, sulphurous acid, which, being gaseous, is constantly escaping, causing the well-known sulphurous odor of the coal mine or coal heap, and enabling us to understand how it is that coals gradually become less sulphurous on exposure to the air. When the coals are heated the rate of the evaporation and oxidation of the sulphur is rapidly increased, so that at 300° F. or below it takes fire. Hence, none of the free sulphur of the coals used in the smelting of iron ever gets much below the top of the furnace, where it can do no harm, and all of it is burnt out even before the heat is sufficiently great to coke the coal. Possibly much of it escapes in the process of heating the coals to 212° F., with a view to ascertain the proportion of hygroscopic moisture, thus increasing the apparent quantity of that ingredient

—a supposition which will be made subject of further investigation.*

Some of the sulphur of coals exists in combination with iron, as sulphide or bi-sulphide. When it is in the form of bi-sulphide, one half of the sulphur of the compound is always burnt out in the process of coking, or in the upper part of the smelting furnace.

It will be seen, therefore, that while a portion of the sulphur of coals may, in the ordinary process of analysis, cause an error of excess in the estimation of the hygroscopic moisture, another portion increases the quantity of so-called volatile and combustible matters. Still another portion may, on incineration of the coke, be miscounted as fixed carbon.

That portion of the sulphur of coals which is not removed by the process of coking or preliminary heating is either in combination with iron, as iron proto-sulphide, which may injure the quality of the metal smelted with it, or it is most probably in combination with calcium, magnesium, or the alkaline metals, in which form it probably exerts little or no injurious action. Hence, as practical experience has measurably demonstrated, a coal may show a pretty large proportion of total sulphur in its chemical analysis, and yet answer for the smelting or working of iron when properly managed.

Even the iron proto-sulphide, which is the most injurious of all the forms of sulphur in coals or coke, may be easily removed, because it speedily oxidates into iron proto-sulphate when exposed to a moist atmosphere; and this salt, being quite soluble in water, is readily to be washed out.

It is interesting again to notice in this series of coals the pretty constant relation between the specific gravity and the ash per centage, as follows:

* As stated by Berzelius, all the sulphur may be burnt out of gunpowder at the heat of boiling water without exploding the powder. Examined in the dark, a faint flame appears above it, in this experiment.

Number.	Ash per centage.	Specific gravity.	Number.	Ash per centage.	Specific gravity.
1667	2.70	1.276	1668*	7.60	1.262
1671	2.36	1.277	1674	9.36	1.344
1675	3.30	1.282	1669	10.50	1.346
1670	3.30	1.290	1672	13.00	1.360
1673	6.80	1.325			

*A cannel coal.

Bell county, undoubtedly, is endowed with great wealth of coal of every good quality, as well as of iron ores, &c.; which only await development.

SOILS AND SUBSOILS OF BELL COUNTY.

No. 1677—"*Virgin Soil, John Turner's land, in the valley of Big Yellow Creek, three and a half miles west of Cumberland Gap. Bell county crawfish land; subject to overflow in high water. Timber: some trees five feet in diameter; burr-oak, beech, sweet gum, maples, poplar, sycamore, &c., &c. On the coal measures. Collected by John H. Talbutt.*"

Soil a light buff-grey color when dry; cloddy; clods mottled with light-ferruginous.

No. 1678—"*Old Field Soil, sixty years in cultivation, mostly in corn; John Turner's land. Same locality as virgin soil. Sample taken to the depth of thirteen inches. Field lies at the base of Fork Ridge of Canada Mountain, between Bennett's Fork and Stony Fork. An ancient mound exists on the same land, which is said to have had the remains of ancient earthworks on it. Many flint implements found on it. Collected by J. H. Talbutt.*" *Substratum of rounded sandstone boulders and pebbles; on coal measures.*

Soil of a light umber color.

No. 1679—"*Subsoil of the preceding, &c. Collected by J. H. Talbutt.*"

Subsoil of a light grey-buff color.

No. 1680—"*Virgin Soil to depth of three inches. Woods. B. F. Turner's land, three miles west of Cumberland Gap, on the foot-hills of Big Yellow Creek. Slope to the south. Timber: oak, beech, poplar, with underbrush. Coal measures. Collected by John H. Talbutt.*"

No. 1681—"*Subsoil to the preceding. Collected by J. H. Talbutt.*"

Subsoil of a buff color.

No. 1682—"*Soil from a field which has been cleared ten years. Has been six years in corn and four in pasture. Average yield thirty bushels of corn. Surface soil. The land slopes gently to the south. Woodland above it and to the north. Coal measures. Collected by John H. Talbutt.*"

Soil of a light buff-umber color.

No. 1683—"*Subsoil of the preceding. Collected by J. H. Talbutt.*"

Subsoil of a light buff-grey color.

No. 1684—"*Virgin Surface Soil, from the narrow plateau on the highest point of Brison Mountain, a fork of Mingo Ridge, near the line of Bell county. Eleven miles south-southeast of Cumberland Gap. Sample taken to the depth of nine inches. Underlying rock sandstone. Has on it a fair growth of chestnut, oak, sugar-tree, poplar, hickory, &c., &c. Collected by John H. Talbutt.*"

Soil of a dark grey-brown or umber color when dry; nearly black when wet.

No. 1685—"*Subsoil of the preceding. Collected by John H. Talbutt.*"

Subsoil of a lighter color and more sandy than the surface soil.

No. 1686—"*Vigin Soil, from the foot-hills of Mingo Mountain, Big Yellow Creek Valley. Land of William T. Moss. Slope to the north. Timber: black oak, dogwood, maple, chestnut, &c., &c. Sampled to the depth of ten inches by John H. Talbutt.*"

Soil of a dirty grey-buff color.

No. 1687—"*Soil from an old field fifty years in cultivation—thirty-five in corn without change, seven years thereafter in clover and grass, and then two years in corn; now in wheat. Average yield: of corn, forty bushels; of wheat, ten bushels. Timber was black walnut, burr-oak, poplar, gum, maple, sycamore, &c. Land of William T. Moss. In Big Creek Valley, near the head of Big Yellow Creek. Carboniferous formation. Top soil seventeen inches deep. Collected by John H. Talbutt.*"

Soil of a light, grey-umber color.

No. 1688—"*Subsoil to the preceding; taken eighteen inches below the surface. Collected by John H. Talbutt.*"

Subsoil lighter colored than the surface soil preceding.

No. 1689—"*Soil from an old field in cultivation seventy years. Farm of Henry Lane. Foot-hills of Mingo Mountains, Big Yellow Creek Valley, three and a half miles from Cumberland Gap. Cultivated for the last ten years in corn and wheat alternately; previous to which in corn for twenty-five years; now in wheat. Originally covered with a dense forest of black walnut, burr-oak, beech, poplar, sycamore, and gum. Yield of corn, thirty to forty-five bushels; of wheat, fifteen bushels. Value of the land, fifty dollars per acre. On the carboniferous formation. Sampled to the depth of fifteen inches, by John H. Talbutt.*"

Soil of a yellowish-grey, light umber color.

No. 1690—"*Subsoil of the preceding. Collected by John H. Talbutt.*"

Subsoil of a lighter and more yellowish color than the surface soil preceding.

No. 1691—"*Soil to the depth of nine inches from an old field now in corn, on John Colson's land, foot of Cumberland Range, near Cumberland Gap. Slope to the west. On coal measures. Collected by J. H. Talbutt.*"

Dried soil of a light, brownish-umber color. Contains many small fragments of decaying vegetable roots, &c., and some small rounded quartz pebbles, and fragments of ferruginous sandstone.

No. 1692—"*Subsoil of the preceding*," *&c., &c.*

Of an orange-grey-buff color. Much lighter colored and more cloddy and adhesive than the preceding, and containing fewer pebbles. The silicious residue of both of these, after digestion in acids, contained a considerable quantity of small, rounded, clear quartz grains.

No. 1693—*Surface Soil to five inches in depth, from a field ten years in cultivation; now in corn, of which it yields about twenty bushels. J. C. Colson's land, one mile west of Cumberland Gap; foot-hills of Dark Ridge. Slope to the southeast. Carboniferous formation. Collected by John H. Talbutt.*"

Soil of a dirty buff-grey color. The coarse sieve removed from it some small fragments of ferruginous sandstone. The silicious residue all passed through fine bolting-cloth, except a very few small clear quartz grains.

No. 1694—"*Subsoil of the preceding. Collected by John H. Talbutt.*"

Resembles subsoil No. 1692, but is a little lighter colored and more cloddy. Contains no silicious sand.

No. 1695—"*Top Soil to depth of nine inches, from an old field fifty years in cultivation. For the last twenty-five years in corn, wheat, oats, and clover; two thirds of time in corn. Average yield of which, thirty bushels per acre. Does not produce good wheat or oats. J. C. Colson's land. North side of Big Yellow Creek Valley, near the foot-hills of Log Moun-*

tain, three miles northwest of Cumberland Gap. Carboniferous formation. Collected by John H. Talbutt."

Soil resembles No. 1693.

No. 1696—"*Subsoil of the preceding, taken one foot below the surface. By John H. Talbutt.*"

Subsoil of a reddish-brown, grey-buff color. Contains very few grains of fine quartz sand.

COMPOSITION OF THESE BELL COUNTY SOILS AND SUBSOILS, DRIED AT 212° F.

	No. 1677	No. 1678	No. 1679	No. 1680	No. 1681	No. 1682	No. 1683	No. 1684	No. 1685	No. 1686
Organic and volatile matters	4.700	5.575	2.600	5.725	2.750	5.050	1.800	11.565	5.750	4.050
Alumina, Iron peroxide, Manganese oxide	4.817	4.015	1.710	4.339	4.137	3.557	2.474	4.615	4.662	4.197
Lime carbonate	.190	.190	.115	.065	.065	.265	.115	.145	.145	.095
Magnesia	.338	.069	.045	.050	.042	.131	.060	.098	.079	.068
Phosphoric acid	.093	.220	.125	.096	.073	.093	.061	.125	.108	.093
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.
Potash	.164	.160	.056	.068	.106	.212	.086	.139	.131	.128
Soda	.115	.217	.006	.035	.032	. . . .	.014	.074	.039	not est.
Sand and insoluble silicates	89.390	88.875	93.940	89.390	92.090	90.215	95.115	84.040	88.540	90.440
Water, expelled at 380° F.	.600	.775	.900	.650	.850	.750	.750	.035	.900	.750
Loss	. . . .	. . . .	.503	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	.179
Total	100.407	100.096	100.000	100.418	100.145	100.273	100.475	100.836	100.354	100.000
Moisture, lost at 212° F.	1.825	2.550	1.350	1.800	0.875	1.875	0.850	3.700	2.275	1.475
Potash in the insoluble silicates	2.568	.735	.850	.568	.713	.347	.501	.583	.717	1.387
Soda in the insoluble silicates	.389	.018	.082	.119	.137	.167	.216	.090	.150	.213
Character of the soil	Virgin soil.	Old field	Subsoil.	Virgin soil.	Subsoil.	Old field	Subsoil.	Virgin soil.	Subsoil.	Virgin soil.

COMPOSITION OF THESE BELL COUNTY SOILS AND SUBSOILS, DRIED AT 212° F.—(Continued.)

	No. 1687	No. 1688	No. 1689	No. 1690	No. 1691	No. 1692	No. 1693	No. 1694	No. 1695	No. 1696
Organic and volatile matters	5.925	4.850	5.525	4.725	3.500	2.450	4.125	4.025	7.175	5.675
Alumina }										
Iron peroxide }	8.846	8.120	7.339	7.013	2.913	2.815	5.990	6.997	9.626	12.816
Manganese oxide }										
Lime carbonate	.280	.095	.095	.095	.290	.275	.225	.225	.265	.115
Magnesia	.052	.088	.088	.088	.070	.044	.080	.081	.155	.322
Phosphoric acid	.124	.093	.061	.077	.093	.125	.125	.093	.189	.294
Sulphuric acid	not est.	not est.	not est.	not est	.007	.003	.007	.007	.007	.013
Potash	.139	.191	.143	.243	.158	.203	.109	.368	.429	.443
Soda	.085	.117	.063	....	.050	.013	.177	....	.190	....
Sand and insoluble silicates	83.140	86.040	85.140	87.125	92.090	92.040	87.590	86.815	80.040	78.240
Water, expelled at 380° F.	1.100	.750	1.200	1.000	1.100	1.050	1.450	1.250	2.075	2.025
Loss	.309	....	.346	....	....	.982	.122	.139	....	.057
Total	100.000	100.344	100.000	100.366	100.271	100.000	100.000	100.000	100.151	100.000
Moisture, lost at 212° F.	2.450	1.875	2.225	1.900	1.150	1.175	1.500	1.515	2.500	2.525
Potash in the insoluble silicates	2.509	2.275	2.362	2.351	.496	.674	1.831	1.964	2.519	2.640
Soda in the insoluble silicates	.344	.251	.273	....	.169	.186	.561	.348	.303	.464
Character of the soil	Old field	Subsoil.	Old field	Subsoil.	Old field	Subsoil.	Field 10 years in cultiv'n.	Subsoil.	Old field	Subsoil.

As might have been expected, considerable local differences are exhibited by the chemical analyses of these mountain soils, caused, probably, in most cases, by the action of the drainage; as may be seen by comparing the relative proportions of the potash, phosphoric acid, the organic and volatile matters, lime, magnesia, and alumina, &c., &c., with the silex and insoluble silicates, as well as by the relative quantities of alkalies in the insoluble silicates.

Thus the soils of the valley, or those subject to overflow, as for example, Nos. 1687–'8–'9–'90, as well as 1693–'4–'5–'6, located in the valley, are richer than those on the mountain slopes. A remarkable difference in the proportions of phosphoric acid can be observed in soils Nos. 1677 and 1678, which may possibly have been caused by the residence on the latter of the prehistoric people who built and occupied the ancient earth-works located there.* The subsoil No. 1679, underlying the latter, is by no means as rich as the surface soil, based as it is on a substratum of rounded sandstone boulders and pebbles, and no doubt offering quite a free drainage to the waters from above, which tend to wash away the soluble ingredients.

The soil from the plateau, at the summit of Brison Mountain, No. 1684, is much richer than might have been expected. Its large proportions of organic and volatile matters, as well as of alkalies in the insoluble silicates, indicate the influence of the primeval forest growth, with which it is yet covered, in retaining the elements of fertility on the surface. The unusually large proportion of silicates, rich in alkalies, in the rock material from whence the soil was derived, may have been another cause.

BOONE COUNTY.

No. 1697—"CLAY, *from three miles west of Burlington. Sent by W. W. Walton.*"

Presents thin stratified layers of various tints of light-brownish-grey and light dove color. Burns hard, and of a

*A similar increase in the proportion of phosphates on and near the site of these prehistoric earth-works was observed in Fayette county, on the farm of the writer.

handsome light brick color. Melts at a high temperature; hence, is not a fire-clay.

COMPOSITION, DRIED AT 212° F.

Alumina, with iron and manganese oxides and phosphoric acid	33.060
Silica	48.360
Lime	3.057
Magnesia	.367
Potash	4.664
Soda	1.706
Combined water and loss	8.786
Total	100.000

While its large proportions of alkalies and of lime, as well as of iron oxide, prevent it from withstanding the melting influence of a high heat, it may yet be quite available for so-called *terra cotta* articles. It is probable, also, that, if found in sufficient quantity, it may be quite useful in the improvement of worn-out sandy soils in its vicinity.

BOYD COUNTY.

No. 1698—"GREY LIMESTONE ORE, *from J. P. Jones' drift, near Ashland. Collected by P. N. Moore.*"

Interior portion—Grey clay iron-stone, made up of fine light-brownish granules, embedded in a whitish material. *Exterior portion*—Generally dark reddish-brown, with some little lighter ferruginous and ochreous, the whole exhibiting a fine granular or oölitic structure, and showing the same whitish material observed in the grey interior portion.

The analyses of the interior and exterior portions were made separately, with a view to the study of the changes which occur when clay iron-stone is changed into limonite.

Similar comparative analyses are recorded under Carter county.

No. 1699—"YELLOW KIDNEY ORE. *Point of hill. Catlettsburg, Boyd county. Collected by A. R. Crandall. A cabinet specimen.*"

A kidney of fine-grained iron carbonate, invested with thin layers of reddish and yellowish-brown and brownish-yellow limonite.

Interior and exterior portions separately analyzed.

COMPOSITION OF THESE ORES, DRIED AT 212° F.

	No. 1698.		No. 1699.	
	Interior.	Exterior.	Interior.	Exterior.
Iron carbonate	62.002	none.	69.912	none.
Iron peroxide	none.	65.395	none.	61.142
Alumina	2.900	3.484 }	6.128	7.964
Manganese carbonate	.553	. . . . }		. . .
Manganese oxide	. .	not est.	not est.	not est.
Lime carbonate	6.880	8.580	8.280	3.530
Magnesia	*2.243	1.938	*3.314	.424
Phosphoric acid	.149	.441	.686	.414
Sulphuric acid	.302	.336	.147	.199
Combined water	. . . . .	9.346	. . . . .	12.600
Silicious residue	22.660	10.480	8.930	14.180
Total	97.689	100.000	97.397	100.453
Per centage of iron	29.932	45.775	33.751	42.799
Per centage of phosphorus	.065	.192	.299	.181
Per centage of sulphur	.121	.134	.059	.080
Per centage of silica	16.360	9.360	7.460	11.860

* Carbonate.

Taking for a basis of comparison the relative quantities of *iron* in the two portions, which are nearly in the proportions of one in the interior part to one and a half in the exterior in No. 1698, and somewhat less in No. 1699 (or as 1 : 1.27), we find that in the former there has been a notable increase of phosphorus, a slight increase of lime, a great diminution in the proportion of silica, and slight diminutions in the proportions of sulphur, magnesia, and alumina; in specimen 1699, a decrease in the phosphorus, and an increase in the sulphur, silica, and alumina. The lime and magnesia are also greatly diminished. So that there seems to be no regular law in relation to the changes which occur; which may be effected by very varying conditions of chemical action and infiltration.

PIG IRONS FROM BOYD COUNTY.

No. 1700—"*Pig Iron. Hot-blast. Mill iron, from Bellfonte Furnace. Collected by P. N. Moore.*"

A fine-grained, dark-grey iron. Yields readily to the file. Extends quite considerably under the hammer.

No. 1701—"*Hot-blast, Silver-grey Iron, Bellfonte Furnace. Collected by P. N. Moore.*"

Coarser grained than the preceding; somewhat harder and more brittle. Of a light silver-grey color.

COMPOSITION OF THESE PIG IRONS.

	No. 1700.	No. 1701.
Specific gravity	6.921	6.163
Iron	92.962	89.902
Graphite	2.100	2.900
Combined carbon	1.310	.070
Silicon	2.525	5.082
Slag	.220	.280
Phosphorus	.568	.417
Sulphur	.114	.114
Other ingredients	not est.	not est.
Total	99.799	98.765
Total carbon	3.410	2.970

The principal difference in the composition of these two samples is in the much larger proportion of silicon and somewhat smaller amount of iron in No. 1701.

BREATHITT COUNTY.

COALS FROM BREATHITT COUNTY.

No. 1702—"*Coal, from Roberts' bank, on Troublesome Creek. Upper seam. The so-called bituminous coal. Collected by P. N. Moore.*"

A splint coal, splitting into very thin laminæ, with fibrous coal between, but with no appearance of pyrites. The sample has a weathered and tarnished appearance, showing ferruginous and earthy stains. Hence, the ash per centage found is greater than that of the clean coal of the interior of the bed.

No. 1703—"*Coal, from Roberts' bank, Troublesome Creek. Sample from the lower part of the bed, called cannel coal. Averaged by P. N. Moore.*"

A pure-looking coal, with but little fibrous coal and no apparent pyrites. Sample somewhat mixed in character. Some pieces of cannel coal; others splint coal; others apparently shaly.

No. 1704—"*Coal, from the same bank. Sample from the middle part of the seam. Called bituminous. Collected by P. N. Moore.*"

Rather a dull-looking coal. Apparently pretty pure, having but little apparent fibrous coal or pyrites between its laminæ. Exterior of some of the lumps covered with ferruginous incrustation.

No. 1705—"*Cannel Coal. Haddock's bed. North Fork of Kentucky river, above the mouth of Troublesome Creek. Collected by P. N. Moore.*"

A very tough coal. Sample somewhat tarnished by weathering, &c., showing ferruginous and clayey incrustation on parts of the surfaces, which may probably make the ash per centage found greater than that of the bed. It has but little fibrous coal, but some evident pyrites.

See volume I, page 354, old series, &c., for other analyses of this coal.

No. 1706—"*Cannel Coal. G. W. Johnson's. Nichol's Fork of Frozen Creek. Sample from near the outcrop. Collected by P. N. Moore.*"

A dull-black coal, very difficult of fracture. Has some little appearance of bright pyrites, and some ferruginous incrustation. No fibrous coal. Some of the seams beautifully polished.

No. 1707—"*Cannel Coal. G. W. Johnson's. Same locality as the preceding. From another outcrop. Sample from hand specimen only.*"

Similar in appearance to the preceding.

No. 1708—*Coal, from Frozen Creek, a quarter of a mile above Wm. Day's. Collected by P. N. Moore.*"

A pure-looking splint coal. Has very little fibrous coal and some little fine granular pyrites between the laminæ; is easily fractured.

No. 1709—"*Cannel Coal. Quicksand Creek. Alfred Little's drift. Collected by John R. Procter.*"

Contains some small bright scales of pyrites. Some portions give an imperfect bird-eye fracture; others show an imperfect fibrous structure, somewhat like that of lignite. Coal generally tough.

No. 1710—"*Coal, from Jackson Wells' bank. Near the mouth of Troublesome Creek. Sample from the outcrop, where the coal is dirty, and hence will give somewhat more than the average ash per centage. Collected by P. N. Moore.*"

A splint coal, with thin partings of fibrous coal containing fine granular pyrites.

No. 1711—"*Cannel Coal, from George's Creek. Collected by P. N. Moore.*"

A pure-looking coal. Has some ferruginous stain on the exterior surfaces, but no apparent pyrites.

No. 1712—"*Coal, from Simon Holland's bank. Collected by P. N. Moore.*"

A pure-looking, splint coal, with not much fibrous coal between the laminæ, and no apparent pyrites. Easily fractured.

No. 1713—"*Coal, from Wolf Creek bank. Collected by J. R. Procter and P. N. Moore. Sample from coal long weathered.*"

A pure-looking, soft splint coal, in thin laminæ, which have quite a glossy cross fracture. Very little fibrous coal or fine granular pyrites between the laminæ.

No. 1714—"*Coal, from William Spencer's mine. North Fork of Kentucky river. Collected by P. N. Moore.*"

A bright, pure-looking coal, showing very little fibrous coal or granular pyrites.

COMPOSITION OF THESE BREATHITT COUNTY COALS, AIR-DRIED.

	No. 1702.	No 1703.	No. 1704.	No. 1705.	No. 1706.	No. 1707.	No. 1708.	No. 1709.	No. 1710.	No. 1711.	No. 1712.	No. 1713.	No. 1714.
Specific gravity	1.405	1.280	1.290	1.265	1.360	1.180	1.300	1.328	1.398	1.280	1.290	1.290	1.297
Hygroscopic moisture	3.30	3.40	2.20	1.30	1.60	1.20	2.50	2.10	2.78	0.94	4.90	2.76	3.56
Volatile combustible matters	31.44	43.40	39.20	47.00	43.20	58.80	41.10	43.10	35.52	52.38	35.30	36.68	33.56
Coke	65.26	53.20	58.60	51.70	55.20	40.00	56.40	54.80	61.70	46.68	59.80	60.56	62.88
Total	100.00	100.00	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	34.74	46.80	41.40	48.30	44.80	60.00	43.60	45.20	38.30	53.32	40.20	39.44	37.12
Fixed carbon in the coke	49.76	46.96	51.14	44.40	33.80	35.30	49.22	43.36	44.94	35.54	55.50	56.50	58.38
Ash	15.50	6.24	7.46	7.30	21.40	4.70	7.18	11.44	16.76	11.14	4.30	4.06	4.50
Total	100.00	100.00	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 friable.	Friable.	Spongy.	Dense.	Pulverulent.	Dense.	Light spongy.	Spongy.	Dense spongy.	Dense.	Spongy.	Light spongy.	Light spongy.
Color of the ash	Pinkish-grey.	Light buff-grey.	Lilac-grey	Brownish-grey.	Light buff.	Light grey-buff.	Dark lilac.	Light grey	Light lilac-grey.	Light lilac-grey.	Light grey	Light yellowish-grey.	Light lilac-grey.
Per centage of sulphur	0.991	0.630	2.525	1.574	2.549	not est.	0.818	4.609	1.423	1.423	3.153	0.865	1.381

These coals are, generally, superior in quality to the average. Some few of them contain an inordinate proportion of ash; but this will not prevent them from being quite valuable as fuel. The per centage of sulphur in them is generally low. Some, however, exceed somewhat in this respect, especially No. 1712, which contains much more than is indicated by its external appearance, amounting to about three fourths of the weight of the ash—a fact which shows that much of it is in a free state, or in organic combination in the coal.

The usual relationship of specific gravity to ash per centage is shown in these coals, as follows:

Number.	Ash per centage.	Specific gravity.	Number.	Ash per centage.	Specific gravity.
1713	4.00	1.290	1704†	7.46	1.290
1712	4.30	1.290	1711*	11.14	1.280
1714	4.50	1.297	1709*	11.44	1.398
1707*	4.70	1.180	1702	15.50	1.405
1703	6.24	1.280	1710	16.76	1.398
1708	7.18	1.300	1706*	21.40	1.360
1705*	7.30	1.265			

* A cannel coal. † Partly cannel.

The cannel coals are well known to be less dense than the splint and bituminous, and hence show a discrepancy in the comparison instituted. They contain a much larger quantity of hydrogen also, as exhibited in their large proportion of volatile combustible matters, as shown in the above table.

CARTER COUNTY.

No. 1715—"BLOCK ORE. *Joe Harris'. Jordan Branch of Tygert's Creek. Collected by A. R. Crandall." A cabinet specimen.*

A kidney of dark-grey, fine granular iron carbonate, invested with concentric layers of limonite ore (hydrated peroxide) of various tints, from dark-brown to brownish yellow.

The interior and exterior parts were submitted to analysis separately, as were Nos. 1698 and 1699 (which see), for the purpose of studying the causes of the change from carbonate to limonite.

COMPOSITION, DRIED AT 212° F.

	Interior.	Exterior.
Iron carbonate	33.189	. . . . .
Iron peroxide	5.616	42.548
Alumina and manganese oxide	27.105	22.984
Lime carbonate	12.180	5.180
Magnesia carbonate	1.095	. . . . .
Magnesia	. . . . .	.119
Phosphoric acid	2.060	2.218
Sulphuric acid	a trace.	a trace.
Water and loss	4.375	7.671
Silicious residue	14.380	19.280
Total	100.000	100.000
Per centage of iron	19.953	29.953
Per centage of phosphorus	.899	.968
Per centage of sulphur	a trace.	a trace.
Per centage of silica	14.300	19.280

The relative proportion of iron is notably increased in the limonite; the water, phosphoric acid, and silica are also increased; while the lime, magnesia, and alumina are diminished: indicating, like the previous analyses above referred to, no regular order of change.

PIG IRON OF CARTER COUNTY.

No. 1716—"*Hot-blast Mill Iron, from Mount Savage Furnace. Collected by P. N. Moore.*"

A dark-grey, fine-grained iron. Yields to the file; extends considerably under the hammer.

No. 1717—"*Hot-blast No. 2 Foundry Iron. Mount Savage Furnace. Collected by P. N. Moore.*"

A moderately fine-grained iron. Yields to the file; extends somewhat under the hammer.

No. 1718—"*Hot-blast, Silver-grey Iron, from Mount Savage Furnace. Collected by P. N. Moore.*"

Whiter, coarser grained, and more brittle than the preceding.

COMPOSITION OF THESE MOUNT SAVAGE PIG IRONS.

	No. 1716.	No. 1717.	No. 1718.
Specific gravity	6.930	7.042	7.435
Iron	93.268	91.584	89.687
Graphite	3.950	2.600	2.300
Combined carbon	.770	1.070	.500
Silicon	1.799	3.058	5.575
Slag	.160	.620	.660
Phosphorus	.680	.609	.609
Sulphur	.081	.152	.136
Total	100.708	99.693	99.467
Total carbon	4.720	3.670	2.800

A regular diminution in the proportions of iron and carbon from No. 1716 to 1718, together with a similar increase in the proportions of silicon, slag, and sulphur, as well as of the specific gravity, may be noticed in these samples, corresponding with the quality of the iron. The phosphorus, which is in full average quantity, seems more constant.

CHRISTIAN COUNTY.

COALS.

No. 1719—"*Coal I, from Coalton banks. Sample from the stock pile. Collected by C. J. Norwood.*"

A glossy, black splint coal, breaking into thin laminæ, with very little fibrous coal and some little granular pyrites between them.

No. 1720—"*Coal L, from two miles south of Petersburg. Sampled for analysis by C. J. Norwood.*"

A splint coal, showing fibrous coal and some pyrites. Sample appears to have been weathered.

No. 1721—"*Coal J. At Petersburg Station. St. Louis and Southeastern Railroad. Miners' Coöperation Mine. Average sample by C. J. Norwood.*"

A dull-looking splint coal, but glossy on the cross-fracture of the thin laminæ, between which there is some fibrous coal and granular pyrites.

COMPOSITION OF THESE CHRISTIAN COUNTY COALS, AIR-DRIED.

	No. 1719.	No. 1720.	No. 1721.
Specific gravity	1.307	1.332	1.398
Hygroscopic moisture	4.60	5.10	3.70
Volatile combustible matters	31.94	32.50	32.56
Coke	63.46	62.40	63.74
Total	100.00	100.00	100.00
Total volatile matters	36.54	37.60	36.26
Fixed carbon in the coke	54.36	55.70	50.04
Ash	9.10	6.70	13.70
Total	100.00	100.00	100.00
Character of the coke	Dense.	Very dense	Light spongy.
Color of the ash	Light lilac-grey.	Light lilac-grey.	Greyish-brown.
Per centage of sulphur	1.469	1.277	3.716

MINERAL WATER OF CHRISTIAN COUNTY.

No. 1722—"*Salt Sulphur Water, from a bored well five inches in diameter; bored one hundred and thirty-four feet deep; on the premises of Mr. John B. Trice, Hopkinsville.*" *Bored through solid rock, except through the first sixteen feet.*

The water stands at about one hundred feet higher in the well than the level of the lowest part of the town.

The sample of the water, although brought to the laboratory in a well-corked stone jug, had lost its free hydrosulphuric acid. It smelt slightly sulphurous, and tasted pleasantly saline. It had a light greenish-yellow tint, indicative, probably, of the presence of a little sulphuretted sulphide. It exhibited a slightly alkaline reaction with reddened litmus.

SPECIFIC GRAVITY = 1.005 TO 1.006.

COMPOSITION IN 1000. PARTS.

Lime carbonate	0.1223	Held in solution in the water by carbonic acid.
Magnesia carbonate	.0253	
Iron and manganese carbonates, with a trace of alumina	.0013	
Silica	.0112	
	0.1601	In the sediment formed on boiling.
Sodium chloride	3.3647	
Sodium sulphide	not estimated.	
Soda carbonate	.2366	
Soda sulphate	.5347	
Potassium chloride	a trace.	
Lime sulphate	.1156	
Magnesia sulphate	.4329	
Magnesium iodide	.0018	
Lithia and bromine	marked traces.	
	4.6863	In the boiled water.
Total saline contents	4.8464	In 1000. parts of the water.

The water at the well contains free hydrosulphuric and carbonic acids, the proportions of which can only be found by operation on the freshly drawn water.

The analysis of this water shows it to be quite a good *salt sulphur water*, which may be made available in the treatment of many diseases under proper medical advice.

SOILS OF CHRISTIAN COUNTY.

No. 1723—"*Virgin Soil, from woods adjoining the cultivated field from which the next described soil was taken. Farm of H. C. McCord. Crofton Station. On the flats. Underlying rock sandstone. Collected by C. W. Beckham.*"

Dried soil of an ashy-grey color. It contains a small quantity of shot iron gravel. The silicious residue, after digestion in acids, all passed through bolting-cloth, except a few small angular grains of white and red quartz.

No. 1724—"*Surface Soil, from a field fifteen years in cultivation, adjoining the woodland from which the preceding sample was taken. (Principal crops cultivated, corn and tobacco.) Collected by C. W. Beckham.*"

Dried soil of a brownish-grey color; much darker colored than the preceding. Contains a little iron gravel. Silicious residue contained fewer quartz grains.

No. 1725—"*Subsoil of the next preceding. Collected by C. W. Beckham.*"

Dried soil of a grey-buff color; contains a little iron gravel. Silicious residue like next preceding.

No. 1726—"*Virgin Soil; farm of S. W. Williams. St. Louis and Southeastern Railroad. Petersburg. Forest growth principally oaks. Collected by C. W. Beckham.*"

Dried soil of a light brownish-grey color; contains very little iron gravel. Silicious residue passed through bolting-cloth, except a few fine round grains of clear quartz.

No. 1727—"*Surface Soil, from an old field forty-five years in cultivation in corn and tobacco; on same farm, and about a quarter of a mile distant. Field about thirty feet above the flats. Collected by C. W. Beckham.*"

Dried soil of a grey-buff color; contains no gravel. No quartz grains in the silicious residue.

No. 1728—"*Subsoil of the next preceding,*" *&c.*

Dried soil of a light yellowish-brown color; contains no gravel or quartz grains.

No. 1729—"*Virgin Soil, from the farm of Mr. Durty, near Hopkinsville. Forest growth: cedar, white and red oak, black jack, white walnut, &c. Underlying rock very compact limestone. Collected by C. W. Beckham.*"

Dried soil of a light-greyish color; contains no gravel. The silicious residue passed through bolting-cloth, with the exception of a few small angular quartz grains.

No. 1730—"*Surface Soil, from an old field about fifty years in cultivation in corn, tobacco, and wheat. From the same farm as the next preceding. Collected by C. W. Beckham.*"

Dried soil of a light yellowish-grey-brown color. The bolting-cloth separated but few small angular quartz grains from the silicious residue.

No. 1731—*Subsoil of the next preceding, &c., &c.*

Dried soil of a light brick color. Silicious residue contains a few small angular quartz grains.

No. 1732—"*Virgin Soil; farm of E. F. Kelly. Kelly's Station, on the L. & E. E. Railroad, eight miles north of Hopkinsville. Underlying rock, sandstone. Principal forest growth: white, black, and post oaks and hickory. Collected by C. W. Beckham.*"

Soil of a dirty-buff color. All passed through the coarse sieve, except two small ferruginous concretions. The silicious residue all passed through bolting-cloth, except a few small grains of clear quartz and of reddish silicate.

No. 1733—"*Surface Soil, from a field fifty years in cultivation; principal crops tobacco and corn. From the same farm as the next preceding. Collected by C. W. Beckham.*"

Dried soil of a light grey-brown color; contains no gravel. Silicious residue contains a few more small quartzose grains than preceding.

No. 1734—"*Subsoil of the next preceding. Collected by C. W. Beckham.*"

Dried soil of a dark grey-buff color; contains no gravel and very few fine quartzose grains.

No. 1735—"*Virgin Soil, from woods. Farm of Mr. Campbell, near Hopkinsville. Underlying rock, limestone. Collected by C. W. Beckham.*"

Dried soil of a dirty, dark-grey color; contains no gravel. The silicious residue all passed through the bolting-cloth, except a few quartzose grains, clear and reddish and blackish, and a small silicified entrochite.

No. 1736—"*Surface Soil, from an adjoining field, about forty years in cultivation, in corn and tobacco and meadow. Collected by C. W. Beckham.*"

Dried soil of a light-grey-brown color; contains no gravel. The bolting-cloth separated more fine quartzose and entrochi from the silicious residue than from that of the preceding.

No. 1737—"*Subsoil of the next preceding,*" *&c.*, *&c.*

Dried soil of a light brick color; contains no gravel. Silicious residue contains about the same proportion of quartzose grains, &c., as that of the preceding.

COMPOSITION OF THESE CHRISTIAN COUNTY SOILS, DRIED AT 212° F.

	No. 1723	No. 1724	No. 1725	No. 1726	No. 1727	No. 1728	No. 1729	No. 1730	No. 1731	No. 1732	No. 1733	No. 1734	No. 1735	No. 1736	No. 1737
Organic and volatile matters	4.200	4.360	3.135	3.300	4.330	4.065	5.165	4.065	3.600	2.625	2.925	2.775	4.675	3.115	3.500
Alumina and iron and manganese oxides	4.810	6.467	9.310	3.922	6.402	12.155	5.540	4.618	11.193	4.036	5.992	9.052	4.127	5.834	12.727
Lime carbonate	.065	.125	.120	.095	.220	.160	.270	.270	.295	.130	.170	.070	.190	.270	.295
Magnesia	.155	.151	.139	.115	.106	.164	.178	.124	.142	.097	.153	.156	.167	.151	.232
Phosphoric acid	.125	.068	.150	.038	.108	.080	.070	.042	.093	.124	.093	.108	.108	.086	.108
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.
Potash	.135	.176	.083	.121	.247	.637	.385	.256	.457	.121	.125	.174	.260	.210	.707
Soda	....	.261	.116	.172	.153	.084	....	....	....	.125	....	....	....	....	.289
Water expelled at 380° F.	.475	.500	.375	.250	.325	.450	.595	.445	.400	.450	.550	.600	.725	.550	.750
Sand and insoluble silicates	89.940	88.710	86.290	91.850	87.925	81.890	88.615	88.915	83.645	92.625	89.755	86.575	89.765	89.815	81.890
Loss	.095	....	.282	.137	.184	.315	....	1.265	.175	....	.237	.490	....	....	....
Total	100.000	100.818	100.000	100.000	100.000	100.000	100.818	100.000	100.000	100.333	100.000	100 000	100.017	100.081	100.498
Hygroscopic moisture	1.725	1.740	1.900	0.925	1.500	2.800	1.710	1.590	3.000	1.050	1.365	2.165	1.600	1.400	3.135
Potash in the insoluble silicates	0.925	.980	1.131	1.462	1.457	1.367	1.669	1.642	1.516	1.421	1.166	1.368	1.304	1.263	.707
Soda in the insoluble silicates	.434	479	.561	.569	.875	1.044	.478	.605	.662	575	.420	.461	.545	.325	.289
Character of the soil	Virgin soil.	Cultivated field.	Subsoil.	Virgin soil.	Old field soil.	Subsoil	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.

Several facts may be noticed, in a comparative view of these soils; especially that the soils based on limestone are richer in essential mineral ingredients than those on the sandstone; that the soil on the very compact limestone is not so rich as that on the more friable rock; and that the subsoil, as a general rule, containing more alumina and iron oxide, &c., in proportion to the insoluble silicates, is generally richer in potash, phosphoric acid, and other essential ingredients, than the surface soil. Another fact, very generally to be noticed in the comparative analyses of soils is, that, except in certain anomalous cases, and where a richer subsoil has been mixed with the surface soil by the processes of culture, the old field soil generally exhibits, in its analysis, a diminution of the proportions of the essential mineral ingredients, as well as of organic and volatile matters, and an increase of the proportion of sand and insoluble silicates.

CLAY COUNTY.

SALT WATER.

No. 1738—"*Salt water, from Goose Creek Salt-works, as it is pumped from the well. Sent by General T. T. Garrard, of Manchester.*"

The water came in a stone-ware jug, which was stopped with a corn-cob. It was slightly turbid or opalescent, probably because of the escape of some of its carbonic acid, and the consequent precipitation of part of its earthy carbonates, &c.

COMPOSITION IN 1000. PARTS.

SPECIFIC GRAVITY = 1.065.

Lime carbonate	0.0048	Held in solution by carbonic acid, and precipitated on boiling the water.
Magnesia carbonate	a trace.	
Iron and manganese carbonates	.0038	
Alumina, phosphoric acid, and silica	.0140	
Sodium chloride (common salt)	65.0000	
Calcium chloride	18.8960	
Magnesium chloride	5.0080	
Barium chloride	.3930	
Strontium chloride	.0843	
Lithium chloride	a trace.	
Potassium chloride	a trace.	
Iodine and bromine	a trace.	
Total saline matters (dried at 212°)	89.4039	In 1000. parts of the water.

A remarkable circumstance is the existence, in this Goose creek brine, of notable quantities of barium and strontium chlorides. The former salt is present in quantity equal to nearly twenty-three grains to the wine gallon of the water, and the latter in the proportion of nearly five grains. As it is well known that the soluble salts of barium exert an injurious influence on the animal economy, it is important that this should be removed in the manufacture of the salt. It is fortunate that this may be very easily and economically done by the addition of sulphate of soda, Glauber's salt, which, added in the quantity of about forty-five to fifty grains of this crystalline salt to the gallon of the fresh brine, will completely precipitate all the barium and strontium in the form of insoluble sulphates, and doubtless also aid in the clarification of the brine.

The cheap salt, sulphate of alumina, in equivalent quantity, would produce the same effect, and perhaps aid more completely in the clarification. Soda ash, carbonate of soda, would be equally effectual.

Barium and strontium salts are also present in the brine of the Glenfont Salt-works of Meade county, but in somewhat smaller proportions. Of course, where these salts are present we find no sulphates in the water.

No. 1739—"*The Bittern Water, left after graining the salt.*" *Goose Creek Salt-works.*

COMPOSITION IN 1000. PARTS.

SPECIFIC GRAVITY = 1.309.

Calcium chloride	350.49
Magnesium chloride	92.38
Sodium, potassium, and lithium chlorides	24.53
Barium and strontium chlorides	not est.
Sodium bromide	5.27
Sodium iodide	not est.

Various useful applications have been made of the bittern water of Salt-works; as in the preparation of bromine and the manufacture of artificial stone. Doubtless it might also be used (if, like this, it contains much calcium chloride) in setting free the alkalies, contained in the form of insoluble silicates, in some of our marls and clays of the character of the Leitchfield marls. This may probably be done by mixing the marl with a considerable quantity of lime or powdered limestone, making the mixture up into a plastic mass, with the bittern water sufficiently concentrated by evaporation, and then calcining, at a low red heat, the properly prepared lumps or bricks of the mixed materials. These lumps or bricks, if properly calcined, will slack into a crumbling mass when exposed to moisture, in which the alkaline ingredients will be in a soluble condition, available for plant nourishment.

No. 1740—"*The deep-brownish or Spanish-brown colored deposit adhering to the interior of the wooden tube (or "gum") which conducts the brine from the well to the pans. Goose Creek Saltworks.*"

COMPOSITION, DRIED AT 212° F.

Iron peroxide	74.304
Alumina, phosphoric acid, &c.	7.016
Lime carbonate	.280
Magnesia carbonate	.680
Silicious residue	6.890
Saline matters and loss	10.830
Total	100.000

CLINTON COUNTY.

No. 1741—"MARLY CLAY. *Cumberland City mines. Chester Group. (Leitchfield marls.) Collected by N. S. Shaler.*"

A dull olive-grey, indurated marly clay.

COMPOSITION, DRIED AT 212° F.

Silica	70.800
Alumina, with a little iron and manganese oxides and phosphoric acid	18.840
Lime	*.594
Magnesia	4.358
Phosphoric acid	not est.
Sulphuric acid	not est.
Potash	4.240
Soda	.794
Total	99.626

* Equal to 1.060 per cent. of lime carbonate.

(See Grayson county in this and the preceding Chemical Report for similar marls.)

No. 1742—"COAL, *from the Cumberland mines. Conglomerate main coal. Collected by N. S. Shaler.*"

A pure-looking, pitch-black coal, with very little fibrous coal or pyrites.

SPECIFIC GRAVITY = 1.329.

COMPOSITION, AIR-DRIED.

Hygroscopic moisture	1.56
Volatile combustible matters	37.74
Coke	60.70
Total	100.00
Total volatile matters	39.30
Carbon in the coke	50.20
Ash	10.50
Total	100.00
Character of the coke	Light spongy.
Color of the ash	Light lilac-grey.
Per centage of sulphur	2.911

DAVIESS COUNTY.

MINERAL WATERS OF DAVIESS COUNTY.

No. 1743—"*Chalybeate Water, from Murray's Spring, near Lewis. (E., O. & N. R. R.) Collected by Capt. R. S. Triplett.*"

It came to hand in a stone-ware jug, stopped with a corn-cob, which may have somewhat altered the character of the water. The reaction of the water is neutral. No effort was made to estimate its gases.

COMPOSITION IN 1000. PARTS OF THE WATER.

Lime carbonate	0.1155	Held in solution in the water by carbonic acid, and precipitated on boiling.
Magnesia carbonate	.0046	
Iron carbonate	.0229	
Alumina	.0027	
Phosphoric acid	.0004	
Silica	.0107	
Lime sulphate	.0204	
Magnesia sulphate	.0768	
Potash sulphate	.0403	
Soda sulphate	.0476	
Sodium chloride	.0146	
Lithium chloride	.0013	
Silica, &c.	.0142	
Total saline matters	0.3720	Dried at 212° F.

It is doubtless a valuable saline chalybeate water.

MINERAL WATERS *from Dr. Hickman's Springs. Crow's Station (E., O. & N. R. R.). Coal measures. Daviess county. Collected by C. J. Norwood, as follows:*

No. 1744—"*Alum Spring*" (*labeled No.* 1).

This water has a brownish color and a strong acid reaction. The cork of the jug was blackened by the presence of iron salt.

No. 1745—"*Alum Spring*" (*labeled No.* 2).

This water resembles the preceding, but is of a lighter color.

No. 1746—"*Alum Spring*" (*labeled No.* 6). "*Sweet Spring.*"

Resembles No. 2 in the appearance of the water.

No. 1747—"*Sulphur Spring*" (*labeled No.* 3).

Reaction neutral. Has no peculiar taste or smell, having lost all its sulphuretted hydrogen gas.

No. 1748—"*Brick Spring*" (*labeled No.* 4).

Resembles the next preceding.

No. 1749—"*Yellow Spring*" (*labeled No.* 5).

The water has a slightly astringent taste; no color. In reaction is neutral.

All the alum waters deposited a brownish ochreous sediment on standing, which is mainly basic persulphate of iron, as shown by the following analysis (made by my son, Alfred Meredith Peter, who also made the analyses of the several waters, under my general supervision), as follows:

One thousand parts of the water. No. 1 (*i. e.*, No. 1744) gave on boiling 0.1938 part of brownish precipitate, dried at 212°, which became bright red on ignition, and had the following described

COMPOSITION, DRIED AT 212° F.

Iron peroxide	78.64
Combined water	14.74
Sulphuric acid (anhydride)	5.24
Silica	.64
Loss	.74
Total	100.00

COMPOSITION OF THE ALUM WATERS IN 1000. PARTS.

	No. 1744(1)	No. 1745(2)	No. 1746(6)
Basic iron persulphate (Fe_2O_3, $2SO_3$)	0.8756	0.0484	0.1460
Alumina sulphate	1.2468	.3303	.3500
Manganese sulphate	.0032	.0102	.0721
Lime sulphate	.5996	.3947	.3271
Magnesia sulphate	.3330	.3315	.2513
Potash sulphate	.0005	.0068	.0074
Soda sulphate	.0724	.2959	. . . . .
Copper sulphate	.0009	. . . . .	. . . . .
Sodium chloride	.0031	.0127	.0651
Lithia	a trace.	a trace.	a trace.
Silica	.0013	.0014	.0022
Organic matters and loss	. . . . .	.0279	.1878
Total saline matters, dried at 212° F.	3.1364	1.4598	1.4090
Specific gravity of the water	1.00304	1.00164	1.00162

COMPOSITION OF THE "SULPHUR," "BRICK," AND "YELLOW" SPRING WATERS IN 1000. PARTS.

	No. 1747(3)	No. 1748(4)	No. 1749(5)
Iron and manganese oxides	traces.	0.0004	0.0018
Lime carbonate	0.1106	.1196	.0256
Magnesia carbonate	.0196	.0331	.0211
Lime sulphate	.1306	.0838	.1379
Magnesia sulphate	.1594	.1057	.0651
Potash sulphate	.0035	.0129	.0103
Soda sulphate	.4567	.5019	.2082
Sodium chloride	.0809	.0213	.0127
Lithia	traces.	traces.	traces.
Copper	. . . . .	. . . . .	a trace.
Silica	.0174	.0254	.0298
Organic matters and loss	.0373	. . . . .	.0357
Total saline matters, dried at 212° F.	1.0160	0.9041	0.5482
Specific gravity of the water	1.00115	1.00120	1.00086

These alum waters, doubtless of analogous composition with others of the name in Virginia and elsewhere, are highly astringent, and are doubtless too strong for internal use without dilution, in most cases. They will find their remedial applications, however, under the advice of the educated physician. The saline and sulphur waters would prove alterative, slightly aperient, diuretic, or sudorific and hence depurative, according to the manner of their administration, under medical advice. The small amount of copper in the alum waters will not materially affect their influence.

SOILS OF DAVIESS COUNTY.

No. 1750—"*Virgin Soil, from the farm of H. Riley, on the E., O. & N. R. R., fifteen miles from Owensboro. On a hill-top. Collected by C. W. Beckham.*"

Soil of a light grey-brown color; contains no gravel. The bolting-cloth sieve separated from its silicious residue a considerable quantity of fine, rounded quartz grains, both hyaline and opaque.

No. 1751—"*Surface soil, from an old field sixty-five years in cultivation, in corn and tobacco principally; now overgrown with sassafras. Same locality as the preceding. Collected by C. W. Beckham.*"

Soil of a lighter and more yellowish light-grey-brown color; has no gravel. Silicious residue contained very few small quartz grains.

No. 1752—"*Subsoil to the next preceding,*" *&c., &c.*

Soil of a brownish-yellow ochre color; contains no gravel. Very few fine quartz grains.

No. 1753—"*Virgin Soil. Upland. From the farm of the Rev. A. Hopkins. Crow's Station, E., O. & N. R. R., nine miles from Owensboro. Collected by C. W. Beckham.*" *Coal measures.*

Soil of a brownish umber-grey color; contains no gravel nor fine quartz grains.

No. 1754—"*Surface Soil, from an old field about forty years in cultivation. Same locality as preceding. Substratum; sandstone. Collected by C. W. Beckham.*"

Soil of a dirty buff color; contains no gravel or fine silicious sand.

No. 1755—"*Subsoil of the next preceding,*" *&c. &c.*

Soil of a brownish-orange-buff color; contains no gravel or fine quartzose sand.

COMPOSITION OF THESE DAVIESS COUNTY SOILS, DRIED AT 212° F.

	No. 1750	No. 1751	No. 1752	No. 1753	No. 1754	No. 1755
Organic and volatile matters	5.475	3.150	2.715	5.875	2.550	3.175
Alumi'a and iron and mang. oxides	6.174	7.065	10.654	5.349	5.502	12.958
Lime carbonate	.120	.245	.095	.220	.085	.075
Magnesia	.016	.034	.021	.044	.133	.080
Phosphoric acid	.141	.125	.061	.086	.083	.102
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.
Potash	.134	.053	.244	.407	.265	.474
Soda	.301	....	....	....	....	.075
Sand and insoluble silicates	86.605	88.390	85.415	86.590	90.890	81.300
Water expelled at 380° F.	.975	.925	.910	1.450	.600	1.175
Total	99.941	99.987	100.115	100.021	100.108	99.414
Hygroscopic moisture	1.775	1.515	1.565	1.700	0.875	3.500
Potash in the insoluble silicates	.887	1.122	1.386	.975	1.396	1.457
Soda in the insoluble silicates	.581	.709	.680	.403	.729	.639
Character of the soil	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.

The comparative analyses of these soils show the usual influence of continued exhaustive culture in the diminution of some of their essential mineral ingredients. The soils are of full average natural fertility; the subsoils would doubtless benefit the surface, if gradually brought up in the cultivation, and organic matters supplied by the ameliorating influence of clover and other green crops wholly or partly plowed in. A considerable reserve of the alkalies is seen to be present in the insoluble silicates, which will add greatly to the durability of the soil; but, doubtless, the application of available phosphates, and the use of wood ashes, would be beneficial in increasing the productiveness of the old field soils.

No. 1756—"CLAY, *from the same locality; twenty feet from the railroad and ten feet below the surface of soil No.* 1754. *Below the coal at Dr. Hickman's Springs. The layer is about thirteen inches thick.*"

A sandy clay; generally of a light-grey color, with ferruginous infiltrations in the fissures, and some old obscure vegetable impressions. It contains about fifty per cent. of fine clear sand. It burns quite hard, and of a handsome light-salmon color, and hence may be quite valuable for *terra cotta* work or bricks or tiles.

The air-dried clay lost 1.500 per cent. of moisture at 212° F.; .005 per cent. of moisture at 380°, and 1.500 per cent. of combined water at the red heat. It would probably shrink less in the fire than most clays, but would not answer for a fire-clay.

COALS OF DAVIESS COUNTY.

No. 1757—"*Coal No. D? Montgomery's coal mine, about one and a half miles above Owensboro. Collected by C. J. Norwood.*"

A pure pitch-black coal. Has but little fibrous coal. Some thin scales of pyrites in the seams.

No. 1758—"*Coal D. Dutch mine, about one and a half miles above Owensboro. Average thickness about three feet. Average sample by C. J. Norwood.*"

A splint coal; some reedy fibrous coal between the laminæ, and much show of bright pyritous scales in the seams.

No. 1759—"*Coal D. Bon Harbor mines. Barrett's new bank. Average thickness four feet and a half. Sample by C. J. Norwood.*"

A splint coal, with much fibrous coal between the laminæ, and granular and bright lamellar pyrites. Iridescent on some of the seam faces.

No. 1760—"*Coal D. Dean's mine, about one and a half miles above Owensboro. Collected by C. J. Norwood.*"

Resembles the preceding.

No. 1761—"*Coal, from Duncan's bank. Richardson's property. Friendly Grove, near Knottsville. Collected by P. N. Moore.*"

Mostly splitting easily into thin laminæ, with considerable fibrous coal and some granular pyrites between. Some bright scales of pyrites in the seams.

COMPOSITION OF THESE DAVIESS COUNTY COALS, AIR-DRIED.

	No. 1757.	No. 1758.	No. 1759.	No. 1760.	No. 1761.
Specific gravity	1.323	1.340	1.318	1.337	1.285
Hygroscopic moisture	6.20	4.10	5.80	5.12	6.20
Volatile combustible matters	36.20	38.50	35.06	34.72	41.90
Coke	57.60	57.40	59.14	60.16	51.90
Total	100.00	100.00	100.00	100.00	100.00
Total volatile matters	42.40	42.60	40.86	39.84	48.10
Carbon in the coke	50.90	51.00	50.40	51.44	47.40
Ash	6.70	6.40	8.74	8.72	4.50
Total	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Spongy.	Light spongy.	Light spongy.	Light spongy.
Color of the ash	Lilac-grey.	Lilac-grey.	Light lilac-grey.	Light lilac-grey.	Grey-lilac.
Per centage of sulphur	1.519	1.538	3.985	3.513	3.743

EDMONSON COUNTY.

LIMONITE IRON ORES.

No. 1762—"*Ore, from Still-house Branch of Bear Creek. Average sample by P. N. Moore.*"

In irregular curved laminæ, of a deep brown color; frequently inclosing nuclei of softer yellowish and reddish ochreous ore.

No. 1763—"*Ore, from the south side of Dismal Creek, near Thomas Meredith's. Average sample by P. N. Moore.*"

Mostly in dense dark brown irregular curved laminæ, with some softer and lighter colored ore.

No. 1764—"*Ore, from the head of Sycamore Branch of Bear Creek. Average sample by P. N. Moore.*"

Much like the preceding.

No. 1765—"*Ore above the coal. Mill Branch of Bear Creek. Average sample by P. N. Moore.*"

In thin irregular laminæ, cellular in parts, of a brown color; mixed with yellowish-brown ochreous ore.

No. 1766—"*Limestone Ore. Jacob Snider's. Cane Branch of Gulf Creek. In the Chester Group. Cabinet specimen. Collected by P. N. Moore.*"

Mostly dense dark-colored ore, in carved laminæ or cellular masses, with some little brownish-ochreous softer ore.

COMPOSITION OF THESE EDMONSON COUNTY LIMONITE ORES, DRIED AT 212° F.

	No. 1762.	No. 1763.	No. 1764.	No. 1765.	No. 1766.
Iron peroxide	40.798	47.724	49.906	32.820	77.871
Alumina	. . . . .	. . . . .	. . . . .	. .	1.444
Manganese oxide	1.293	2.501	3.330	2.356	not est.
Lime carbonate	a trace.	a trace.	a trace.	a trace.	a trace.
Magnesia	a trace.	a trace.	a trace.	a trace.	.070
Phosphoric acid	1.019	.697	.694	.984	.505
Sulphuric acid	.360	.315	.395	.285	a trace.
Combined water	7.250	8.250	9.320	8.330	11.050
Silica and insoluble silicates	50.030	41.145	36.780	55.180	8.660
Moisture and loss	. . . . .	. . . . .	. . . . .	.045	.400
Total	100.750	100.632	100.425	100.000	100.000
Per centage of iron	28.559	33.407	34.407	22.974	54.510
Per centage of phosphorus	.445	.304	.303	.430	.221
Per centage of sulphur	.207	.125	.158	.114	a trace.
Per centage of silica	46.760	39.560	33.460	48.960	8.660

With the exception of No. 1766, which is quite good and rich, these are rather poor, highly silicious ores, with a full amount of phosphorus, which might be profitably used with richer aluminous ores.

EDMONSON COUNTY CLAYS.

No. 1767—"*Silicious Clay, from Sowder's farm, near Green river. Chester Group. Bed four to six feet thick. Collected by John R. Procter.*"

In irregular lumps; friable; of an olive and brownish-grey color. Powder light grey.

No. 1768—"*Clay, from Sowder's farm, on Caney Branch, one mile from Green river. Bed seven to eight feet thick; in layers of various colors. Collected by John R. Procter.*"

(*a*) The upper or light-dove-colored layer.

(*b*) The second, light grey, nearly white layer.

(*c*) The third, grey layer.

(*d*) The lowest layer. Olive-grey, mottled with yellowish-grey.

COMPOSITION OF THESE EDMONSON COUNTY CLAYS, DRIED AT 212° F.

	No. 1767.	No. 1768 *a*.	No. 1768 *b*.	No. 1768 *c*.	No. 1768 *d*.
Silica	80.160	77.660	74.460	71.560	67.560
Alum'a and iron and mang. ox's	11.600	16.800	20.440	22.860	22.540
Lime carbonate	.760	.480	.640	.680	.980
Magnesia	.560	not est.	not est.	not est.	.671
Phosphoric acid	not est.	not est.	not est.	not est.	.025
Potash	3.854	1.002	not est.	not est.	2.470
Soda	.583	.484	not est.	not est.	.058
Water and undetermined	2.483	4.340	4.460	4.900	5.696
Total	100.000	100.766	100.000	100.000	100.000

While these clays would not prove very refractory in the fire, they may be made very useful for common pottery ware.

ESTILL COUNTY.

No. 1769—CLAY IRON-STONE. "*Carbonate ore, from Tubb's bank, near Estill Furnace. Has been weathered two years. Collected by P. N. Moore.*"

A granular carbonate ore, of various tints of grey, with more or less of limonite. In some parts somewhat oölitic.

COMPOSITION, DRIED AT 212° F.

Iron carbonate	76.491	= 39.758 per cent. of iron.
Iron peroxide	4.049	
Alumina	2.014	
Manganese carbonate	not est.	
Lime carbonate	5.400	
Magnesia carbonate	.514	
Phosphoric acid	.409	= 0.178 phosphorus.
Sulphuric acid	.267	= .107 sulphur.
Silicious residue	9.330	Containing 7.660 silica.
Undetermined and loss	1.526	
	100.000	

Quite a good ore of its kind.

ESTILL COUNTY LIMONITE ORES.

No. 1770—"*Ore, from Luster drift. Thacker Ridge. Railroad west of Fitchburg. Sample has been exposed to the weather for some time. Collected by P. N. Moore.*"

In irregular, dense, dark-colored, curved laminæ, with some soft ochreous ore between.

No. 1771—"*Limestone Ore. Logan Ridge. Estill Furnace. Has been weathered two years. Collected by P. N. Moore.*"

Resembles the preceding. Ochreous matter brownish.

No. 1772—"*Ore, from Tubb's bank. Estill Furnace. Has been weathered two years. Collected by P. N. Moore.*"

Resembles the preceding.

No. 1773—"*Ore, from Horse-ridge banks. Cottage Furnace. In sub-carboniferous limestone. Average sample from a pile of ore weathered more than a year. Collected by P. N. Moore.*"

Mostly in dense, dark-colored laminæ, irregularly curved or forming a cellular structure, with some whitish and light-brown softer material.

COMPOSITION OF THESE ESTILL COUNTY LIMONITES, DRIED AT 212° F.

	No. 1770.	No. 1771.	No. 1772.	No. 1773.
Iron peroxide	74.127	65.535	75.598	65.591
Alumina	3.542	2.798	1.971	5.762
Manganese oxide	not est.	not est.	not est	not est.
Lime carbonate	.390	.450	.540	traces.
Magnesia	.461	1.073	.258	.248
Phosphoric acid	.601	.537	.601	.447
Sulphuric acid	not est.	not est.	not est.	traces.
Combined water	11.270	9.800	11.730	11.000
Silica and silicates	9.580	20.480	8.910	16.230
Moisture and loss	.029		.392	.722
Total	100.000	100.673	100.000	100.000
Iron per centage	51.889	45.874	52.918	45.914
Phosphorus per centage	.262	.234	.262	.195
Sulphur per centage	not est.	not est.	not est.	traces.
Silica per centage	7.860	18.260	7.260	14.160

PIG IRONS OF ESTILL COUNTY.

No. 1774—"*No. 3 Cold-blast Charcoal Pig Iron. Red River Furnace. Fitchburg. Collected by P. N. Moore.*"

A moderately fine-grained, somewhat dark-colored iron. Yields to the file and extends a little under the hammer.

No. 1775—"*No.* 5 *Cold-blast Charcoal Pig Iron. Red River Furnace, &c. Collected by P. N. Moore.*"

A silvery-white iron. Hard, brittle; but the small fragments extend a little under the hammer.

No. 1776—"*Car-wheel Iron. No.* 1 *Cold-blast Charcoal Iron. Red River Iron Works, at Fitchburg. From G. S. Moore & Co., of Louisville.*"

A moderately coarse-grained, dark-grey iron. Yields with difficulty to the file; extends somewhat under the hammer.

No. 1777—"*Car-wheel Iron. No.* 1 *Cold-blast Charcoal Iron. Estill Furnace. From G. S. Moore & Co.*"

Resembles the preceding, but is somewhat coarser-grained, with some spots of finer-grained in the centre of the pig.

COMPOSITION OF THESE ESTILL FURNACE IRONS.

	No. 1774.	No. 1775.	No. 1776.	No. 1777.
Iron	93.728	93.963	94.174	92.582
Graphite	3.520	2.000	3.340	3.500
Combined carbon	.780	2.550	1.110	1.200
Manganese	.389	.181	not est.	not est.
Silicon	1.202	.363	.447	.960
Slag	.360	.320	.360	.360
Aluminum	.264	.648	not est.	not est.
Phosphorus	.290	.338	.402	.444
Sulphur	.080	.104	.182	.066
Undetermined and loss	. . . . .	. . . . .	. . . . .	.888
Total	100.613	100.467	100.015	100.000
Total carbon	4.300	4.550	4.450	4.700
Specific gravity	7.168	not est.	7.226	7.272

The high character of these pig metals for producing tough malleable iron is well established.

FAYETTE COUNTY.

No. 1778—"PHOSPHATIC LIMESTONE. *Forming a thin layer in the Lower Silurian (Blue) limestone (Cincinnati Group?). McMeekin's quarry. Newtown Turnpike, about three miles north of Lexington. Said by the quarryman to be sometimes as much as a foot in thickness. Collected by R. Peter.*"

A somewhat friable rock of a bluish-grey color; brownish-grey on the weathered surfaces. Containing many microscopic marine univalve shells. Adheres strongly to the tongue.

COMPOSITION, DRIED AT 212° F.

Phosphoric acid, lime, magnesia, alumina, iron oxide	85.270
Fluoride of calcium	not est.
Carbonate of lime	9.180
Carbonate of magnesia	.371
Silica and insoluble silicates	4.780
Alkalies, organic matters, &c., not estimated	.399
Total	100.000

The phosphates in this limestone were found to contain as much as 31.815 per cent. of the weight of the rock of phosphoric acid, equal to 69.452 per cent. of tribasic phosphate of lime!

This remarkable rock, on a pile thrown out for turnpiking purposes, attracted the attention of the writer, while riding along the road. Although it has been long known that the friable layers of our "Blue limestone" are quite rich in phosphates, a fact which the writer brought to the attention of the agricultural public as early as April, 1849, in the Albany Cultivator, of New York, yet no one up to this time, as far as is known to him, has found any so rich in them as this.

The subject is worthy of further investigation, especially in view of the agricultural and commercial value of the phosphates for use as fertilizers. As is well known, the abundant phosphates of the rock substratum is one of the main causes of the great and durable fertility of our "blue grass soil," so-called, as well as of the superior development of the animals reared and nourished on its products.

SOILS OF FAYETTE COUNTY.

No. 1779—"*Virgin Soil, taken from one half inch to six inches below the surface. From woodland pasture, which has been grazed for about seventy years. On elevated ground, near the remains of the old earth-works of the mound-builders. (Described in Collins' History of Kentucky and elsewhere as on* *the farm of Col. Meriditlı, who was the earliest proprietor of the farm.) On the farm of R. Peter. Same as described in No. 27 in volume I, old series, Kentucky Geological Reports. On the Lower Silurian formation. Collected by B. D. Peter."*

A rich grey-brown loam, containing a little fine-grained shot iron ore, and some small silicious particles. The bolting-cloth separated from the insoluble silicates, left after digestion of the soil in acids, a small portion of small roundish-whitish grains of partly decomposed silicates, but no pure quartz grains.

No. 1780—"*Subsoil of the preceding, taken from six to fourteen inches below the surface.*"

Soil rather more reddish than the surface soil. Contains, like that, a few small grains of shot iron ore and silicious particles. The bolting-cloth separated a rather larger quantity of small rounded grains of undecomposed silicates; some appearing as casts of minute globular shells.

No. 1781—"*Virgin Soil. Open pasture. J. H. Talbutt's farm ("The Meadows"), late Warfields: half a mile northeast of Lexington. From the top of a hill to the east of the house, heavily set with blue grass. Sample taken to the depth of sixteen inches. Primitive growth: black walnut, black, blue, and white ash, elm, hickories, oaks, sugar-tree, &c. Has been long cleared. Lower Silurian formation. Sample collected by John H. Talbutt.*"

Dried soil of an umber color; contains no gravel, but some little shot iron ore, &c.

No. 1782—"*Subsoil of the next preceding; taken to the depth of three feet from the surface,*" *&c., &c.*

No. 1783—"*Underlying clay of the same; taken at the depth of three feet below the surface. Contains shot iron ore, manganese oxide,*" *&c.*

Dried subsoil of a dirty light-brown color. The silicious residue contained a few small quartzose grains.

COMPOSITION OF THESE FAYETTE COUNTY SOILS, DRIED AT 212° F.

	No. 1779.	No. 1780.	No. 1781.	No. 1782.	No. 1783.
Organic and volatile matters . .	4.676	3.085	7.800	4.410	4.400
Alum'a and iron and mang. ox's	9.570	*10.445	12.286	14.427	19.921
Lime carbonate.	.230	.220	1.145	.545	.130
Magnesia	.140	.140	.394	.340	.376
Phosphoric acid	444	.540	.364	.358	.364
Sulphuric acid	not est.	not est.	not est.	not est.	not est.
Potash	.287	.343	.735	.402	.755
Soda.	not est.	.192	.084	.301	. . . .
Sand and insoluble silicates . .	82.860	83.260	76.690	77.440	72.540
Water, expelled at 380° F.. . .	1.824	1.234	1.300	.925	1.200
Undetermined and loss	. . . . .	.541	. . . . .	.852	.314
Total	100.031	100.000	100.798	100.000	100.000
Hygroscopic moisture	2.165	1.965	2.975	3.135	3.525
Potash in the insoluble silicates.	1.274	1.314	.718	.910	.644
Soda in the insoluble silicates .	.211	.583	.200	.212	.167
Character of the soil	Woodland pasture.	Subsoil.	Virgin soil.	Subsoil.	Under clay.

* Containing: of alumina, 6.093; iron peroxide, 4.330; and manganese oxide, .020 per cent.

The analyses demonstrate the richness of these soils, more especially of Nos. 1781–'2–'3, which is shown in the small relative quantity of silicious residue, and the comparatively large proportions of phosphoric acid and potash, &c. Although they may not have been submitted to the plow, they yet cannot be considered virgin soils, having been for a long time grazed, and been thus altered in composition. The "Meadows" has been mostly cultivated as a stock farm, mainly for the raising of fine race-horses and improved cattle; and there is reason to believe, from the large proportion of potash in the soluble form in this pasture land, that it was improved rather than deteriorated by the feeding of the stock upon it: the loss by grazing being more than compensated by the additional food supplied to the animals, in winter as well as other times.

FLOYD COUNTY.

COALS.

No. 1784—"*Coal. Snipe's bank. Branch of Abbott's Creek. Average sample from the outcrop. About two feet shown. Collected by A. R. Crandall.*"

A pretty pure splint coal. Some fibrous coal and fine granular pyrites between the laminæ, and some external ferruginous stain.

No. 1785—"*Coal, from Harris' bank, on Muddy Creek, one mile from Prestonsburg. Forty-four inches thick. Average sample by A. R. Crandall.*"

A bright, pitch-black coal, with some bright pyritous scales, and but little fibrous coal. A somewhat hard coal.

No. 1786—"*Coal. Jas. H. Hatcher's bank. Mouth of Abbott's Creek. Bed forty-two to forty-six inches thick. Average sample by A. R. Crandall.*"

A bright-looking, somewhat firm coal, with very little fibrous coal or pyrites.

COMPOSITION OF THESE FLOYD COUNTY COALS, AIR-DRIED.

	No. 1784.	No. 1785.	No. 1786.
Specific gravity	1.289	1.274	1.307
Hygroscopic moisture	3.20	2.50	2.50
Volatile combustible matters	38.80	40 80	38.56
Coke	58.co	56.70	58.94
Total	100.00	100.00	100.00
Total volatile matters	42.00	41.30	41.06
Fixed carbon in the coke	55.04	56.70	53.44
Ash	2.96	3.24	5.50
Total	100.00	100.00	100.00
Character of the coke	Light spongy.	Spongy.	Light spongy.
Color of the ash	Light chocolate.	Light brownish.	Light lilac-grey.
Percentage of sulphur	1.289	1.895	1.915

These are all remarkably pure and good coals. Their small ash per centage corresponds nearly with their low specific gravity. Their proportion of sulphur is also moderate. Their large yield of volatile combustible matters, and their spongy coke, may make them profitably available for use in the gas-works. Doubtless they will be found very good for the smelting and manufacture of iron.

GRAYSON COUNTY.

COAL.

No. 1787—"*Coal, from the South or Allen bank, near the Falls of Rough Creek. Two feet thick. Collected by P. N. Moore.*"

A pure-looking coal, breaking easily, with a shining pitch-like appearance, and an irregular, so-called, bird's-eye fracture. Has very little fibrous coal and no apparent pyrites, except some fine granular.

COMPOSITION, AIR-DRIED.

Specific gravity	1.343		
Hygroscopic moisture	6.50	Total volatile matters	36.54
Volatile combustible matters	30.04		
Coke (quite dense)	63.46	Carbon in the coke	55.54
		Light lilac-grey ash	7.92
	100.00		100.00
Per centage of sulphur	1.972		

FERRUGINOUS AND MARLY CLAYS OF GRAYSON COUNTY.

No. 1788—"*Ferruginous Clay. Nodular. Below the upper limestone. Hat Branch of Bear Creek. Three and a half to four feet thick.*"

Of a handsome chocolate-brown color. Not adhering much to the tongue. Powder of a handsome grey-chocolate color.

No. 1789—"*Nodular Ferruginous Clay. Canolaway Creek.*"

Resembles the preceding.

No. 1790—"*Marly Shale, found below the limestone. Hat Branch of Bear Creek. Four feet thick. Collected by John R. Procter.*"

Breaking easily when dry. Of a greyish-olive-green color, with some parts brownish. Not adhering much to the tongue. Powder of a handsome greenish-grey color.

No. 1791—"*Marly Shale. Haycraft's Lick. Similar to preceding.*"

Of a dark olive-grey color when dry.

No. 1792—"*Red Marly Shale, same locality, &c., mixed with the preceding in the sample.*"

Of a chocolate brown color.

No. 1793—"*Brown Marly Clay. Cedar Knob Lick.*"

Of a dark reddish-brown or chocolate color when dry. Conglomeratic, with fragment of material similar to No. 1792.

COMPOSITION OF THESE GRAYSON COUNTY FERRUGINOUS AND MARLY CLAYS AND SHALES, DRIED AT 212° F.

	No. 1788.	No. 1789.	No. 1790	No. 1791	No. 1792	No. 1793
Alumina . . . . } Iron and manganese oxides }	14.451	*b*12.282 } *c*7.588 }	26.221	27.811	25.758	23.071
Lime carbonate	1.160	1.380	9.160	.880	1.580	1.180
Magnesia	1.715	1.643	6.629	.824	4.437	.497
Phosphoric acid	1.089	see *b*.	1.089	.109	.102	.089
Potash } Total, obtained by fusion;	4.240	5.049	4.944	5.554	5.145	4.093
Soda } includes insoluble silicates.	.948	1.060	1.061	.657	.347	.438
Silica and insoluble silicates .	74.360	*d*68.380	44.760	59.920	58.960	60.760
Water expelled at red heat, &c.	7.000	8.250	6.136	4.245	3.671	9.872
Total	*a*104.963	*a*105.632	100.000	100.000	100.000	100.000

(*a*) The apparent excess is due to the alkalies in the insoluble silicates, which are estimated also in the *total* alkalies given above.
(*b*) Including phosphoric acid and manganese oxide, not separately estimated.
(*c*) Iron peroxide.
(*d*) Containing of silica: 51.020; of alumina, iron and manganese oxides, and phosphoric acid, 14.330.

These ferruginous and marly shales and clays, when of a good color, may be termed mineral paints, and be very profitably used in that way; but, in consequence of their large proportions of alkalies, especially of potash, as well as of phosphoric acid, they promise to be quite valuable, applied as top dressing, for renewing old worn-out tobacco soil. As they are found in enormous quantities over a very great extent of country, the best method of making them profitably available is matter of great interest.

Chemical analyses show that, while a portion of their alkaline constituents is soluble in acids, the larger part of them is locked up in the insoluble silicates. Spread upon the soil, therefore, without admixture or preparation, their ameliorating influence would probably result more from their large proportion of the elements of clay, giving the soil more consistence, and increasing its power of absorbing atmospheric agencies, &c., than from the alkalies or phosphoric acid, &c., they contain. In short, the application of these marls to the surface might be like the plowing up of a subsoil, rich in the mineral elements of plant food, but poor in the organic compounds which help to bring them into a soluble and available state.

Exposed to the atmospheric agencies, however, the insoluble silicates undergo a gradual, slow decomposition, and their valuable ingredients are thus set free for the use of plants. The decomposing remains of vegetables accelerate this process, and hence the great propriety of using these marls together with stable manure or other organic fertilizers, or of employing a clover or other green crop, plowed in, as a means of distintegrating the silicates. Doubtless poor exhausted land, which had been top-dressed with the marl, and then sowed in clover, which, after the growth of one or two seasons, was plowed in, would be found to be greatly improved in fertility. A similar result, in some degree, might possibly be obtained, in a single season, by the use of buckwheat, plowed in at maturity.

A quicker mode of setting free the alkalies, &c., of these marls, would necessarily be more expensive. The process used in the chemical analysis, viz: that of heating, to a moderate red heat, the mixture of the finely-ground marl with a large proportion of pulverized carbonate of lime, and about an equal proportion of sal ammoniac (ammonium chloride), is quite effectual in separating all the alkalies of the insoluble silicates. But it is somewhat expensive on a large scale. In this process the mutual reaction of the carbonate of lime and sal ammoniac produces carbonate of ammonia, which evaporates and is lost, and calcium chloride, which, together with the excess of carbonate of lime present (calcined in the process partly into caustic lime), cause the decomposition of the silicates, and set free the alkalies. Calcium chloride and carbonate of lime, then, are the essential decomposing agents in this process; and as calcium chloride is present in the bittern water of all salt-works, and frequently thrown away as a waste product in other manufactories, or may be cheaply made by the application of hydrochloric acid to limestone, this process would be much more economical than that of the use of the ammonia salt. Under the head of Clay county, in the present volume, are some remarks on the proposition to use the bittern water of salt-works for this purpose—an application of this waste product, which is yet more promising, from the fact that this water contains potash and other salts, which may also be valuable on the exhausted soil.*

But, for the decomposition of the marl, not only must it be brought into a plastic state or be powdered, but the limestone or lime, with which it is to be mixed, must also be in the form of powder, so that they may be intimately mixed together and fully incorporated with the calcium chloride. With a cheap power and a good mill this might not be very expensive. In order to calcine the mixture, the plastic mass, produced by working up together the marl, lime, and solution of calcium chloride, should be made up into lumps or brick-like masses, dried to a certain extent, and then calcined at a moderate red heat, not sufficient to fuse them. The time during which they should be maintained at a red heat need not exceed a few hours.

Other modes might be available; as by the use of chlorine gas, which, if the lumps of the marl are porous, would not necessitate pulverization. This gas is to be cheaply obtained from the low-priced hydrochloric acid and oxide of manganese mixed, and if it be allowed to pass slowly from above through the marl lumps contained in a tall, tight cylindrical receptacle, would exert considerable decomposing influence upon the sil-

* It is generally believed that magnesium chloride is injurious to vegetation. As this is present in the bittern water, careful experiments to test its utility would be necessary. But the magnesium chloride would be decomposed by the lime in the process of calcination, and the free magnesia thus separated would not probably be injurious, notwithstanding the long-standing prejudice against this earth.

icates. This process would doubtless be at least as expensive as the above named.

The mere mixture of slacked lime with the powdered marl, when applied to the land, would doubtless be beneficial in accelerating its decomposition, and calcining them together at a moderate red heat might be yet more useful, especially if a little common salt be added. Indeed, merely calcining the clay alone, if the heat is not sufficient to fuse it, seems to set some of its alkaline constituents free; and hence, probably, one reason of the improvement of old soil by the English practice of paring and burning it. In numerous cases the writer has found the insoluble silicates to become more decomposable by the action of the acids after ignition.*

No. 1794—"LIMONITE IRON ORE, *containing clay iron-stone. Old Nolin Furnace property, three and a half miles north of Bee Spring. West of the road at the head of one of the forks of Decker Branch. On the road near the Brownsville and Grayson Springs road. Average sample by P. N. Moore.*"

Generally soft and porous, of a brownish-yellow color, with denser and darker colored irregular laminæ, and some nodules or portions of bluish-grey, fine granular clay iron-stone, which is somewhat oölitic, with small whitish particles.

COMPOSITION, DRIED AT 212° F.

Iron peroxide	48.913	} = 36.526 iron.
Iron carbonate	5.735	
Alumina	7.125	
Lime carbonate	9.410	
Magnesia carbonate	.144	
Phosphoric acid	.489	= .209 phosphorus.
Sulphuric acid	.199	= .080 sulphur.
Combined water and loss	8.905	
Silica and insoluble silicates	19.080	Containing 16.760 silica.
	100.000	

A good and sufficiently rich ore, with but a moderate proportion of phosphorus, likely to yield a good quality of iron, if properly smelted. It contains nearly ten per cent. of carbonate of lime, which will aid in fluxing it.

*The simultaneous use of the marl and slacked lime as a top-dressing on a clover crop, or as a preparation for a crop of clover, which is subsequently plowed under, would no doubt be quite ameliorating to the soil.

GREENUP COUNTY.

COALS.

No. 1795—"*Coal, from Turkey Lick bed, on Turkey Lick. Collected by A. R. Crandall.*"

A splint coal. Some parts seemingly quite pure, with but little fibrous coal; other portions in thin shaly layers, with granular pyrites in the fibrous coal.

No. 1796—"*Coal 3. Turkey Lick Coal. Pennsylvania Furnace. Average sample from the lower and middle parts of the coal.*"

A splint coal, separating into thin laminæ, with fibrous coal and fine granular pyrites between.

No. 1797—"*Coal, from Turkey Lick coal mines. Main entry. One hundred and eighty feet from the outcrop. Average sample taken at that spot. By A. R. Crandall.*"

A splint coal, pretty pure looking, but has some fine granular pyrites in the fibrous coal between its thin laminæ.

No. 1798—"*Turkey Lick Coal. Old entry. Hunnewell. Average sample by A R. Crandall.*"

Like the preceding, but having less of the thinly laminated portion, with fibrous coal and granular pyrites between.

No. 1799—"*Coal. Raccoon Furnace. Average sample by A. R. Crandall.*"

A splint coal, splitting into quite thin laminæ, with much light fibrous coal and some fine granular pyrites between them.

No. 1800—"*Coke, from Coal No. 3. Turkey Lick coal. Hunnewell Furnace. Collected by A. R. Crandall.*"

A bright spongy coke.

COMPOSITION OF THESE GREENUP COUNTY COALS AND COKE, AIR-DRIED.

	No. 1795.	No. 1796.	No. 1797.	No. 1798	No. 1799.	No. 1800.
Specific gravity	1.347	1.331	1.280	1.332	1.384	. . . . .
Hygroscopic moisture	4.24	4.00	4.56	4.60	4.22 }	19.20
Volatile combustible matters	34.76	37 70	36 68	34.80	30.10 }	
Coke	61 00	58.30	58.76	60.60	65.68	80.80
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	39.00	41.70	41.24	39.40	34.32	19.20
Carbon in the coke	48.70	51.60	52.40	51.00	53.68	75.10
Ash	12.30	6.70	6.36	9.60	12.00	5.70
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Dense spongy.	Light spongy.	Dense spongy.	Friable.	. . . . .
Color of the ash	Light lilac-grey.	Lilac-grey	Very light lilac-grey.	Very light lilac-grey.	Light lilac-grey.	Nearly white.
Per centage of sulphur	1.601	2.645	0.682	0 667	0.925	0.666

By comparing the sulphur per centage in No. 1796, and in the coke made from it, No. 188, it will be seen that more than three fourths of the sulphur of the coal appears to be removed in the process of coking. But the smaller ash per centage in this coke seems to indicate that a purer sample of this coal was used in its manufacture.

GREENUP COUNTY PIG IRONS.

No. 1801—"*Pig Iron. No.* 1 *Foundry iron. Hunnewell Furnace.*"

Quite a coarse-grained, light-grey iron. Somewhat hard, but yields to the file.

No. 1802—"*Pig Iron. No.* 1 *hot-blast silver-grey or glazed pig. Pennsylvania Furnace.*"

Moderately fine granular; whitish. Yields to the file and extends very little under the hammer. Quite brittle.

No. 1803—"*No.* 1 *Foundry Iron. Pennsylvania Furnace.*"

Coarser grained and darker than the preceding. Yields to the file; extends a little under the hammer.

No. 1804—"*Mill Iron. Pennsylvania Furnace.*"

Finer grained, darker, and more dull than the preceding. Extends considerably under the hammer.

No. 1805—"*No. 2 Foundry Iron. Pennsylvania Furnace.*"

Moderately fine-grained. Yields to the file; extends but little under the hammer.

No. 1806—"*No. 2 Cold-blast Iron; made from blue ore alone. Laurel Furnace. Collected by P. N. Moore.*"

A dark-grey, fine-grained iron. Extends somewhat under the hammer, but is brittle.

No. 1807—"*Mill Iron. Hot-blast. Third casting with stone-coal. Raccoon Furnace. Collected by P. N. Moore.*"

A fine granular iron. Yields to the file, and extends somewhat under the hammer.

COMPOSITION OF THESE GREENUP COUNTY PIG IRONS.

	No. 1801	No. 1802	No. 1803	No. 1804	No. 1805	No. 1806	No. 1807
Specific gravity	. . .	. . . .	. . . .	. . . .	. . . .	6.680	6.927
Iron	92.284	90.630	92.060	94.764	92.856	92.697	91.596
Graphite	2.960	2.500	2.700	2.900	3.230	2.100	2.900
Combined carbon . . .	.690	.830	.630	.780	. . . .	1.000	.250
Silicon	3.011	4.969	3.104	1.193	2.545	1.813	3.477
Slag	.880	.360	.300	.200	.360	not est.	.800
Phosphorus	.474	.741	.710	.860	.817	.454	.247
Sulphur.	not est.	.040	.033	.033	.046	.218	.237
Undetermined and loss.	. . . .	. . . .	.463	. . . .	.146	1.718	.493
Total	100.299	100.070	100.000	100.730	100.000	100.000	100.000
Total carbon	3.650	3.330	3.330	3.680	3.230	3.100	3.150

While the total quantity of carbon in these pig irons does not vary much, there is a considerable difference in the proportions of silicon and phosphorus, both of which tend to make the iron brittle in the cold. The condition of the carbon, whether it be in the state of graphite or in combination with the iron, makes a great difference in the quality of the metal, as is well known.

The cold-blast iron, No. 1806, made mostly from the "blue ore" (clay iron-stone), seems to contain nearly as much sulphur as the hot-blast iron, No. 1807, made with stone coal. The label does not state what was the character of the fuel used to smelt the former.

No. 1808—"IRON FURNACE SLAG, *from Raccoon Furnace, Greenup county. 'Mine-fall cinder, with which little iron is made, but much slag. Collected by A. R. Crandall.*"

Of a dark bottle-green color; nearly black in the mass; transparent in the thin edges. Quite fusible, without intumescence, before the blow-pipe.

SPECIFIC GRAVITY = 2.868.

COMPOSITION.

Silica	47.960	Containing of oxygen.		24.902
Alumina	18.841		8.807	
Lime	20.462		5.819	
Magnesia	1.354		.451	
Iron protoxide	8.489	= 6.062 iron	1.887	
Manganese protoxide	not est.			
Phosphoric acid	.127	= .055 phosphorus.		
Sulphuric acid	.192	= .077 sulphur.		
Potash	2.045		.347	
Soda	.405		.104	
Loss	.125		17.415	24.902
Total	100.000			

The proportion of oxygen in the *bases* to that in the *silica* is as 1 : 1.423 in this slag, and as the proportions in a good slag are about as 1 : 2, it is evident that too little lime has been used in the flux, and that consequently a large proportion of iron oxide has formed glass with the excess of silicious matter, causing a serious loss. This cinder contains quite a considerable proportion of alumina, which seems to have carried with it more than the usual quantity of phosphoric acid into the cinder. The fact that the iron furnace slag may contain this injurious ingredient, and that probably alumina, lime in sufficient quantity being present, might be more instrumental than any other material in the flux in removing it from the ore in the smelting furnace, contrary to the prevalent belief, was pointed out by the writer in volume 4th of the first series of Kentucky Geological Reports, page 44.

SOILS OF GREENUP COUNTY.

No. 1809—"*Virgin Soil. Woods. Sample taken to six inches below the surface. Top of a hill (ridge), eight feet above bed of coal. White Oak Creek, near Kenton Furnace. Collected by J. A. Monroe.*"

Dried soil of a brownish-grey color, mostly in friable lumps. Contains some fragments of ferruginous sandstone, and no quartz sand.

No. 1810—"*Subsoil to the preceding, taken eighteen inches below the surface. By J. A. Monroe.*"

Dried soil somewhat lighter colored than the preceding. Contains more ferruginous sandstone fragments, and some small hollow nodules of limonite ore. The bolting-cloth separated from the silicious residue a few minute quartzose particles.

No. 1811—"*Surface Soil to the depth of six inches, from a corn-field which has been in cultivation ten years. Valley of White Oak Creek. About ten feet above the bed of the creek. Collected by J. A. Monroe.*"

Soil of a light umber-grey color, mostly in friable lumps. The silicious residue contained a few small rounded grains of hyaline quartz.

No. 1812—"*Subsoil to the preceding, taken at eighteen inches below the surface. J. A. Monroe.*"

Subsoil of a light umber-grey color, slightly darker than the preceding. Contains fragments of brownish ferruginous sandstone.

COMPOSITION OF THESE GREENUP COUNTY SOILS, DRIED AT 212° F.

	No. 1809	No. 1810	No. 1811	No. 1812
Organic and volatile matters	5.590	5.600	4.375	3.790
Alumina and iron and manganese oxides	12.357	15.693	7.060	6.656
Lime carbonate	.045	.070	.270	.745
Magnesia	.366	.375	.083	.067
Phosphoric acid	.083	.147	.115	.109
Sulphuric acid	.003	a trace.	.027	.033
Potash	.433	.474	.098	.193
Soda	.023	.305	.068	.163
Soluble silica	.130	.095	.080	.135
Sand and insoluble silicates	79 500	76.060	86.890	87.665
Water, expelled at 388° F.	1.250	.950	1.100	.910
Loss	.220	.231	....	....
Total	100.000	100.000	100.166	100.466
Hygroscopic moisture	1.900	2.235	1.150	1.000
Potash in the insoluble silicates	2.301	2.829	1.220	0.817
Soda in the insoluble silicates	.509	.368	.520	.380
Character of the soil	Virgin woodla'd	Subsoil.	Cultivated field.	Subsoil.

As is frequently the case, there is great variety in the character of these coal-measure soils; those from the hill-top being quite rich, while the others from the valley are much less fertile: anomalous differences, evidently attributable to the original sources whence the soils were derived, or to the action of drainage waters. or other causes not known to us.

HANCOCK COUNTY.

COALS.

No. 1813—"*Cannel Coal. Cloverport Oil Company's mines, about eight miles south of Cloverport. Entry No. 12, at main breast. Base of the coal measures. Average sample by C. J. Norwood. Average thickness of the coal two and a half feet. It varies from twenty-two to thirty-six inches.*"

A dull-looking, very tough cannel coal. Has no marked appearance of pyrites.

No. 1814—"*Coal, from Hancock Coal Company's mines, below Hawesville. (Owned by the American Cannel Coal Company.) Collected by P. N. Moore.*"

Quite a pure-looking, firm, pitch-black coal. Has some little bright pyritous scales and fine granular pyrites between the laminæ.

No. 1815—"*Coal, from Milton Lawson's bank. Lead Creek, three miles from Hawesville. Average sample by P. N. Moore.*"

A splint coal, splitting into thin laminæ, with considerable fibrous coal and some granular pyrites between. Some external ferruginous stain. Has the appearance of having been weathered.

No. 1816—"*Coal, from Robt. Estes' bank. Back of Lewisport. Sample by P. N. Moore.*"

A pitch-black, rather firm coal, not all breaking into thin laminæ. Has much fibrous coal and granular and lamellar pyrites.

No. 1817—"*Coal, from James Mason's bank, between Hawesville and Lewisport. Sample by P. N. Moore.*"

Generally pitch-black and glossy—partly dull—on the cross fracture. Not generally breaking into thin laminæ. Has not much fibrous coal, but considerable appearance of granular pyrites, and some external ferruginous incrustation.

No. 1818—"*Coal, from Colbert's bank, near Lewisport. Sample by P. N. Moore.*"

A firm, pitch-black, glossy coal. Not much fibrous coal, but considerable shining pyritous scales and granular pyrites. Does not all split into thin laminæ.

No. 1819—"*Coal, from Bergenroth's bank, near old Reverdy mines. Sample by P. N. Moore.*"

A firm coal, not all breaking into thin laminæ. Has considerable fibrous coal between the laminæ, and some granular pyrites and external ferruginous stain.

No. 1820—"*Coal, from John C. Schafer's bank. Blackford Creek. Sample by P. N. Moore.*"

A pitch-black, firm, glossy coal. Considerable fibrous coal between some of the laminæ, and a few thin shining pyritous scales in the seams.

No. 1821—"*Coal, from the Breidenback bank. Lead Creek. Sample by P. N. Moore.*"

Generally glossy pitch-black, with some dull, thin laminæ, having fibrous coal between, and visible pyritous scales and granular pyrites.

No. 1822—"*Coal, from the Davidson bank, near Hawesville. Sample by P. N. Moore.*"

Appears to be a weathered specimen, having considerable ferruginous stain. Otherwise resembling the preceding.

No. 1823—"*Coal, from R. S. Lanum's bank, near Hawesville. Sample by P. N. Moore.*"

Resembles No. 1821.

COMPOSITION OF THESE HANCOCK COUNTY COALS, AIR-DRIED.

	No. 1813.	No. 1814.	No. 1815.	No. 1816.	No. 1817.	No. 1818.	No. 1819.	No. 1820.	No. 1821.	No. 1822.	No. 1823.
Specific gravity	1.213	1.357	1.353	1.323	1.289	1.401	1.336	1 308	1.292	1.268	1.292
Hygroscopic moisture	1.30	5.12	5.40	3.50	4 80	4.50	5.20	7.46	5.10	3.30	6.00
Volatile combustible matters	59.60	36.28	34.80	43.40	38.90	37.60	38.70	33 14	41.20	39.00	37.80
Coke	39.10	58.60	59.80	53.10	56.30	57.90	56.10	59.40	53.70	57.70	56.20
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	60.90	41.40	40.20	46.90	43.70	42.10	43.90	40.60	46.30	42.30	43.80
Fixed carbon in the coke	27.00	47.60	49.30	45.56	50.06	47.46	48.50	55.20	46.60	50.50	48.70
Ash	12 10	11.00	10.50	7.54	6.24	10.44	7.60	4.20	7.10	7.20	7.50
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 friable.	Dense.	Spongy.	Light spongy.	Light spongy.	Dense spongy.	Dense spongy.	Dense spongy.	Light spongy.	Light spongy.	Spongy.
Color of the ash	Light gr.-brown.	Lilac-grey	Light brownish-grey.	Purplish-chocolate.	Light brownish-grey.	Light chocolate	Light lilac-grey.	Light grey	Light lilac-grey.	Brownish-grey.	Greyish-lilac.
Per centage of sulphur	1.890	4.038	2.398	4.155	2.316	7.809	2.266	1.368	3.331	3.373	3.180

Coal No. 1813, from the Cloverport Oil Company's mines, is remarkable for the large proportion of volatile combustible matters it yields.

HARLAN COUNTY.

COALS.

No. 1824—"*Cannel Coal or Bituminous Shale, from Long Branch of Martin's Fork. Average sample of the weathered outcrop by P. N. Moore. Bed thirty-eight inches thick.*"

A dull-black, tough cannel coal. Fracture large conchoidal, somewhat in layers. Some ferruginous and earthy incrustation.

No. 1825—"*Coal, from J. C. Howard's bank. Clover Fork of Cumberland river, one mile above Mount Pleasant. Sample by P. N. Moore from near the limited outcrop. Bed four and a half feet thick.*"

A bright, pitch-black coal (semi-bituminous), having very little fibrous coal, and no visible pyrites.

No. 1826—"*Coal, from Martin's Fork, Skidmore Creek. Taken from near the outcrop, by A. R. Crandall. Bed forty-two inches thick.*"

A much weathered sample, containing much powdered coal.

COMPOSITION OF THESE HARLAN COUNTY COALS, AIR-DRIED.

	No. 1824.	No. 1825.	No. 1826.
Specific gravity	1.510	1.289	1.356
Hygroscopic moisture	1.40	1.70	5.20
Volatile combustible matters	34.60	35.70	31.26
Coke	64.00	62.60	63.54
Total	100.00	100.00	100.00
Total volatile matters	36.00	37.40	36.46
Fixed carbon in the coke	39.40	59.60	60.08
Ash	24.60	3.00	3.46
Total	100.00	100.00	100.00
Character of the coke	Dense.	Very light spongy.	Pulveru-lent.
Color of the ash	Chocolate.	Light buff.	Light buff.
Per centage of sulphur	1.271	0.750	0.618

No. 1824 contains a very large proportion of earthy matter, and might probably be considered bituminous shale. This, however, does not prevent it from yielding even more volatile combustible matters than 1826, and nearly as much as 1825. Its specific gravity is correspondingly high. The other coals yield less than the average quantity of ash, and give a large proportion of coke, and are superior coals, especially for the manufacture of iron, &c.

HENRY COUNTY.

No. 1827—"METALLIC LEAD, *from the 'Silver and Spar Mines, three miles below Lockport, in the Lower Silurian. Collected by C. J. Norwood.*"

Brought to the laboratory to be examined for silver. On a careful analysis, by the wet way, no evidence of the presence of that metal was found, although more than fourteen grammes were examined.

No. 1828—"LIMESTONE, *Lower Silurian, from the same locality as the above. Collected by C. J. Norwood.*"

A fossiliferous, coarse granular limestone, of grey and buff colors, containing more or less calc. spar, and having small irregular cavities lined with ochreous iron oxide.

COMPOSITION, DRIED AT 212° F.

Lime carbonate	95.770
Magnesia carbonate	1.378
Alumina and iron and manganese oxides, and phosphoric acid	1.060
Sulphuric acid, alkalies, &c.	undeter'ed
Insoluble silicates	.980
Total	99.188

A good limestone, containing 53.631 per cent. of lime.

HOPKINS COUNTY.

COALS.

No. 1829—"*Coal D, from Diamond coal mine, about three quarters of a mile south of Earlington. (St. L. & S. E. R. R.) Average sample from along the entry, by C. J. Norwood.*"

A splint coal. Outer surfaces of most of the lumps somewhat soiled with dirt.

No. 1830—"*Coal D, from Saint Bernard coal mines, near Earlington. Upper drift. Bed three to four and a half feet thick. Average sample by C. J. Norwood.*"

A deep black, glossy splint coal, with but little fibrous coal between the laminæ, and no appearance of pyrites. Some thin plates of gypsum in the seams.

No. 1831—"*Coal B, from Fleming coal mine, one mile below Earlington. Bottom part two feet thick. Sample by C. J. Norwood.*"

A pitch-black, glossy coal. Some fibrous coal and fine granular pyrites between some of the laminæ, and bright pyritous and lime sulphate scales in some of the seams.

No. 1832—"*Coal B; same locality as the preceding. Top portion; four feet thick. Collected by C. J. Norwood.*"

Resembles the preceding.

No. 1833—"*Coal B, from Hecla coal mines. St. L. & S. E. R. R., near Earlington. Average sample by C. J. Norwood.*"

A pitch-black, glossy coal. But little fibrous coal between the laminæ. The sample has some thin scales of gypsum in some of the seams, and has some fragments in it of a thin pyritous shaly parting.

No. 1834—"*Coal B. Hecla mines, near Earlington. Average sample from the lower bench; about two feet four inches thick. By C. J. Norwood.*"

Resembles the preceding.

No. 1835—"*Coal B. St. Bernard coal mines, near Earlington. Lower drift. Average sample from the upper member; four feet thick. By C. J. Norwood.*" (*See also* 1830.)

Resembles No. 1830. Has some scaly incrustations of lime sulphate.

No. 1836—"*Coal D, from Hecla coal mines. Earlington. Carefully sampled by C. J. Norwood.*

A pitch-black coal. Very little fibrous coal. Some scales of lime sulphate, stained with iron oxide, in the seams, with some little shining pyrites.

COMPOSITION OF THESE HOPKINS COUNTY COALS, AIR-DRIED.

	No. 1829.	No. 1830.	No. 1831.	No. 1832.	No. 1833.	No. 1834.	No. 1835.	No. 1836.
Specific gravity	1.351	1.337	1.366	1.290	1.323	1.326	1.326	1.331
Hygroscopic moisture	5.00	4.30	3.04	2.70	3.28	3.82	3.20	2.32
Volatile combustible matters	35.26	37.64	36.90	40.74	39.32	36.38	38.30	37.68
Coke	59.74	58.06	60.06	56.56	57.40	59.80	58.50	60.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	40.26	41.94	39.94	43.44	42.60	40.20	41.50	40.00
Fixed carbon in the coke	49.24	50.56	49.06	51.64	49.54	51.10	48.50	51.00
Ash	10.50	7.50	11.00	4.92	7.86	8.70	10.00	9.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	*Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.	Lt. sp.
Color of the ash	Brownish-grey.	Dark brownish-grey.	Lilac-grey.	Light lilac-grey.	Lilac-grey.	Lilac-grey.	Lilac-grey.	Lilac-grey.
Per centage of sulphur	3.015	2.892	5.955	1.502	4.710	3.639	3.345	3.606

* Lt. sp. — Light spongy.

All of them good coals, although some few of them exceed the average per centage in ash and sulphur.

HOPKINS COUNTY SOILS.

No. 1837—"*Virgin Soil, from woods, at Harrison Station, L. & S. E. R. R., about thirty miles from Henderson. Forest growth: white and red oaks, hickories, &c. Geological formation above the sandstone. Collected by C. W. Beckham.*"

Dried soil of an umber-grey color; contains a very little ferruginous gravel. The silicious residue all passed through the bolting-cloth.

No. 1838—"*Surface soil, from a field twenty years in cultivation in corn and tobacco; adjoining the locality of the preceding soil,*" *&c., &c.*

Color of the soil like that of the preceding. It contains no gravel nor fine silicious sand.

No. 1839—"*Subsoil of the next preceding,*" *&c., &c.*

Dried subsoil of a brownish-buff color; contains no gravel nor fine silicious sand.

No. 1840—"*Virgin Soil, from woods. Farm of J. D. Morton. Morton's Gap. St. L. & S. E. R. R. Forest growth: dogwood, sweet gum, white oak, &c., &c. Substratum sandstone. Collected by C. W. Beckham.*"

No. 1841—"*Surface Soil, from an old field fifty years in cultivation; next adjoining the preceding locality. Field said to have been once exhausted and overgrown with sassafras, black jack, elm, &c. Has been cleared again, and is now in tobacco. It has been most of the time in red-top meadow. Collected by C. W. Beckham.*"

Contains no gravel or fine silicious sand.

No. 1842—"*Subsoil of the next preceding,*" *&c., &c.*

Contains no gravel or sand.

No. 1843—"*Virgin Soil, from the farm of John Wilson, near Nortonsville. St. L. & S. E. R. R. Underlying rock sandstone. Collected by C. W. Beckham.*"

Contains no gravel, but the bolting-cloth separated from the silicious residue a considerable quantity of clear quartz grains, rounded and angular.

No. 1844—"*Surface soil, from an old field fifty years in cultivation; now overgrown with blackberry, sumach, &c., &c. Same locality as preceding,*" *&c., &c.*

Contains no gravel, but a considerable proportion of fine clear quartz grains, rounded and angular.

No. 1845—"*Subsoil of the next preceding,*" *&c., &c.*

Like the preceding, contains fine quartz grains.

COMPOSITION OF THESE HOPKINS COUNTY SOILS, DRIED AT 212° F.

	No. 1837	No. 1838	No. 1839	No. 1840	No. 1841	No. 1842	No. 1843	No. 1844	No. 1845
Organic and volatile matters	3.950	3.900	3.100	5.895	4.000	3.080	7.125	3.185	3.815
Alumina and iron and manganese oxides	5.845	5.936	10.321	5.649	6.153	7.224	6.322	5.155	10.090
Lime carbonate	.125	.235	.115	.385	.245	.245	.395	.120	.145
Magnesia	.088	.137	.035	.142	.092	.095	.162	.124	.269
Phosphoric acid	.080	.099	.004	.061	.032	.061	.163	.080	.045
Potash	.193	.086	.354	.348	.300	.498	.325	.292	.518
Soda	. . . .	.145	. . . .	.103	.213	.235	.020	.186	.251
Water, expelled at 380° F.	1.375	1.150	1.050	.625	.420	.550	.875	.430	.685
Sand and insoluble silicates	88.015	88.115	84.665	86.590	89.195	88.415	85.200	91.455	85.160
Total	99.671	99.803	99.704	99.798	100.650	100.403	100.587	101.027	100.978
Hygroscopic moisture	1.750	1.600	2.600	1.580	1.225	1.335	1.775	0.730	2.160
Potash in the insoluble silicates	1.686	1.528	1.149	1.336	1.272	1.230	1.152	1.163	1.247
Soda in the insoluble silicates	.425	.371	.621	.604	.588	.621	.493	.388	.488
Character of the soil	Virgin soil.	Cultivated soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.

These soils do not appear to have been derived from the sandstone which underlies them, being richer than might be expected from such an origin, and containing no great quantity of sand. They have doubtless been formed by the disintegration of other superincumbent strata, richer in the fertilizing mineral elements, or been modified by the admixture of light drift material. The exhausting influence of culture is to be seen in each case, as shown by the generally smaller proportions of potash, phosphoric acid, organic and volatile matters, &c., and the large quantity of sand and insoluble silicates in the old field soil, as compared with the virgin soil of the next adjoining field.

These soils are not generally deficient in potash, except soil No. 1838, but their proportion of phosphoric acid is generally small, so that there is every reason to believe they would be much improved in productiveness by the use of phosphatic fertilizers, such as bone dust, superphosphate, or guano. As the tobacco culture is especially exhaustive of potash and lime, wood ashes, or some other fertilizer containing potash, might be advantageously used, together with the judicious application of lime. Both of these are best used with a clover crop, which should be plowed in after a growth of one or two years. By such a process the old exhausted fields might be greatly improved.

JACKSON COUNTY.

COALS.

No. 1846—"*Cannel Coal, from Tom Coyle's bank, seventeen miles southeast of Richmond. Represented to be twenty-one inches cannel and twenty-one inches bituminous coal. Bed about one hundred feet above the conglomerate. Sample from the weathered outcrop. By Wm. A. Gunn, Esq., Civil Engineer.*"

A rather dull-looking cannel coal. Splitting, with difficulty, into layers, with not enough fibrous coal to soil the fingers, and no apparent pyrites.

No. 1847—"*Cannel Coal, from T. J. Ballard's bank. Branch of Horse Lick, twenty-six miles from Richmond. A sub-conglomerate coal. Specimen from the outcrop. By Wm. A. Gunn, Esq.," &c.*

Resembles the preceding. Has a bird-eye structure in parts.

COMPOSITION OF THESE JACKSON COUNTY COALS, AIR-DRIED.

	No. 1846.	No. 1847.
Specific gravity	1.338	1.321
Hygroscopic moisture	2.00	2.00
Volatile combustible matters	41.00	43.66
Coke	57.00	54.34
Total	100.00	100.00
Total volatile matters	43.00	45.66
Fixed carbon in the coke	43.10	45.58
Ash	13.90	8.76
Total	100.00	100.00
Character of the coke	Spongy.	Dense.
Color of the ash	Very light buff-grey.	Grey-lavender.
Per centage of sulphur	1.049	3.384

Although No. 1846 contains more than the average proportion of earthy matters, it is yet quite valuable for fuel, especially for domestic purposes. No. 1847 is not so liable to this objection, and is a very good cannel coal.

JESSAMINE COUNTY.

MINERAL WATER.

No. 1848—"*Salt Sulphur Water, from a bored well, ninety feet deep, at Nicholasville. Brought by Mr. R. A. Downing.*"

The water was obtained at eighty feet, and stands in the well at sixty feet from the surface. Lower Silurian formation.

Specific gravity of the water = 1.023.

The water when brought to the laboratory smelt slightly of sulphuretted hydrogen, and was quite cloudy from the presence of free sulphur, derived from the decomposition of that gas. It also contained free carbonic acid gas.

The per centage of *saline matters* contained in it is 2.828, dried at 212° F. They consist of lime and magnesia sulphates, and a considerable proportion of sodium chloride, with some lime, magnesia, and iron carbonates, marked traces of lithia, iodine, and bromine, and doubtless of salts of potash and soda.

A quantitative analysis was not made at this time, but the water resembles the salt sulphur waters generally obtained by boring into the Lower Silurian limestone formation, of which several analyses are given in previous volumes, and all of which are more or less like the celebrated waters of the Blue Lick Springs.

JOHNSON COUNTY.

COALS.

No. 1849—"*Cannel Coal, twenty-seven inches thick. Lick Branch, half a mile above the mouth of White House Creek. Ten miles above Peach Orchard. Collected by A. R. Crandall.*"

Contains some bright pyrites, and is somewhat incrusted with ferruginous material. Is generally a tough cannel coal.

No. 1850—"*Rice's Coal. Head of Jenny's Creek. Thirty inches thick. Average sample by A. R. Crandall.*"

A pure-looking, glossy-black coal, with but very little fibrous coal or pyrites. Somewhat hard and not breaking into so thin laminæ as the usual splint coals. Ferruginous stains on some of the seams.

No. 1851—"*Coal, from Wheeler's bank, near Paintsville. Bed four feet six inches thick, without parting. Average sample by A. R. Crandall.*"

A pure-looking, pitch-black coal. Rather firm. Has but little fibrous coal. Some few bright pyritous scales apparent.

COMPOSITION OF THESE JOHNSON COUNTY COALS, AIR-DRIED.

	No. 1849.	No. 1850.	No. 1851.
Specific gravity	1.291	1.294	1.281
Hygroscopic moisture	2.00	3.10	2.66
Volatile combustible matters	38.20	38.60	38.04
Coke	59.80	58.30	59.30
Total	100.00	100.00	100.00
Total volatile matters	40.20	41.70	40.70
Fixed carbon in the coke	51.00	53.50	56.30
Ash	8.80	4.80	3.00
Total	100.00	100.00	100.00
Character of the coke	Dense.	Light Spongy.	Spongy.
Color of the ash	Light lilac-grey.	Light brownish-grey.	Brownish-grey.
Percentage of sulphur	0.956	1.735	1.291

Remarkably good coals, containing less than the usual proportions of sulphur and earthy matters. Being also quite firm, they might very probably be employed, without coking, in the smelting of iron in the high furnace.

KNOX COUNTY.

No. 1852—FERRUGINOUS LIMESTONE. *Labeled "Rock from Poplar Creek; farm of W. H. Hutcking. Specimen obtained from Col. John G. Eve by Prof. N. S. Shaler; together with a specimen of metal smelted from it."*

A compact, fine granular, grey rock; weathered yellowish-brown on the exterior. Fracture flat conchoidal. Some very small bright crystals of pyrites on the seams.

COMPOSITION, DRIED AT 212° F.

Iron carbonate	13.532	= 6.532 per cent. of iron.
Alumina	2.699	
Manganese carbonate	not det'd.	
Lime carbonate	42.260	
Magnesia carbonate	3.072	
Phosphoric acid	.089	
Sulphuric acid	not det'd.	
Silicious residue	31.860	
Undetermined and loss	6.488	
	100.000	

This ferruginous limestone is too poor for use in smelting, except in mixture with richer ores, to answer as flux. Possibly it might make a hydraulic cement if properly calcined.

The bright white metal which accompanied this limestone, said to have been smelted from it, and supposed to contain silver, is simply white pig metal, containing more than ninety-two per cent. of iron, nearly one per cent. of phosphorus, 0.785 per cent. of silicon, 0.104 per cent. of sulphur and carbon, &c. It is quite brittle and crystalline, somewhat in appearance like antimony. Its color is more grey than that of silver.

KNOX COUNTY SOILS.

No. 1852 (*a*)—"*Virgin Soil, from the farm of A. B. Britton, three miles north of Barbourville, at the foot of Paint Hill Knobs. Collected by C. W. Beckham. Rock substratum; sandstone.*"

Dried soil of a light-brownish-grey color; contains some rounded ferruginous concretions. The bolting-cloth removed from the silicious residue a considerable proportion of small irregular particles of partly decomposed silicates, and a few minute scales of mica.

No. 1852 (*b*)—"*Surface Soil, from a field twenty years in cultivation, from same farm and near the locality of the next preceding. Collected by C. W. Beckham.*"

Dried soil, containing some friable lumps, of a light-grey, clayey soil, mixed with a light mouse-colored powdered soil and some ferruginous sandstone and cherty fragments. The bolting-cloth separated from the silicious residue a considerable portion of particles of partly decomposed silicates (as above).

No. 1852 (*c*)—"*Virgin Soil, from the top of Paint Hill Knob, three and a half miles north of Barbourville. Forest growth almost exclusively oak, hickory, and chestnut. (Location of a Signal Station of the U. S. Coast Survey.) Substratum sandstone. Collected by C. W. Beckham.*"

Dried soil of a dark, brownish-grey color; contains small cherty and ferruginous sandy fragments. The bolting-cloth removed from the silicious residue a considerable portion of minute particles of undecomposed silicates, a few reddish rounded quartzose particles and minute scales of mica.

No. 1852 (*d*)—"*Virgin Soil, from woods, on the farm of Judge Tuggle, one and a third miles south of Barbourville, in the Cumberland River Valley. Principal forest growth: oaks, hickories, &c. Substratum sandstone. Collected by C. W. Beckham.*"

Dried soil of a light-umber-grey color. Quite a light soil—as light as wood ashes—contains no gravel. The bolting-cloth removed from the silicious residue a considerable proportion of small rounded quartzose grains.

No. 1852 (*e*)—"*Surface Soil, from an old field sixty years in cultivation; now in meadow. Same locality as the next preceding,*" *&c., &c.*

Dried soil of a lighter umber-grey than preceding; resembles it in other respects.

No. 1852 (*f*)—"*Subsoil of the next preceding,*" *&c., &c.*

Dried soil of a lighter grey-buff color; contains no gravel, &c. (as above).

COMPOSITION OF THESE KNOX COUNTY SOILS, DRIED AT 212° F.

	No. 1852 *a*	No. 1852 *b*	No. 1852 *c*	No. 1852 *d*	No. 1852 *e*.	No. 1852 *f*.
Organic and volatile matters	3.453	4.374	5.658	2.800	2.705	1.750
Alumina and iron and manganese oxides	5.456	8.781	7.825	2.835	1.904	3.644
Lime carbonate	.100	.120	.095	.045	.130	.045
Magnesia	.158	.158	.158	.016	.029	.025
Phosphoric acid	.179	.104	.185	.055	.061	.031
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.
Potash	.125	.261	.467	.112	.094	.130
Soda	.576	not est.	not est.	.021	not est.	not est.
Sand and insoluble silicates	89.115	85.165	84.765	93.790	94.530	93.215
Water expelled at 380° F.	.741	.621	.909	.525	.535	1.675
Loss	.097	.416	.....	.....	.....	.....
Total	100.000	100.000	100.062	100.199	100.048	100.515
Hygroscopic moisture	0.815	0.900	1.025	0.950	0.435	0.435
Potash in the insoluble silicates	1.648	1.648	2.320	0.399	.409	.718
Soda in the insoluble silicates	.130	.446	.546	.235	.150	.119
Character of the soil	Virgin soil.	Cultivated soil.	Virgin soil.	Virgin soil.	Old field soil.	Subsoil.

Soils *a*, *b*, and *c* contrast favorably with soils *d*, *e*, and *f*; containing less sand and insoluble silicates and more potash, phosphoric acid, organic and volatile matters, &c. A marked difference may also be observed in the proportion of alkalies contained in the insoluble silicates. The first three named soils, indeed, are peculiar in containing more silicates of the felspathic and micaceous character than common, indicating a different origin from the latter named soils, and containing a large proportion of the alkalies. The soils *d*, *e*, and *f* may be called quite poor, naturally; but they can be made productive by proper management and the use of fertilizers, if they are sufficiently drained.

LAUREL COUNTY.

SOILS.

No. 1853—"*Virgin Soil, from a farm near Jackson's Steam Mill, nine miles south of London. Forest growth principally oaks and hickories. Geological formation, carboniferous sandstone. Collected by C. W. Beckham.*"

Dried soil of a brownish umber-grey color; contains some irregular fragments of ferruginous sandstone. The bolting-cloth separated from its insoluble silicious residue quite a large proportion of small rounded white quartz grains.

No. 1854—"*Surface Soil, from an old field. Same locality as the preceding,*" *&c.*

Dried soil of a lighter and more yellowish color than the preceding; contains less of fragments of ferruginous sandstone, but fully as much of fine rounded white quartz grains.

No. 1855—"*Subsoil of the preceding,*" *&c.*

Of a still lighter and more yellowish color (brownish-grey); contains no gravel, but a large proportion of minute white quartz grains.

No. 1856—"*Virgin Soil, from woods. Farm of Jefferson Cannifax, half a mile south of London. Forest growth almost exclusively oaks, a few maples, hickories, &c. Collected by C. W. Beckham.*"

Dried soil of a brownish umber-grey color; containing clods of somewhat lighter color. Contains fragments of ferruginous sandstone or concretions in considerable quantity. Silicious residue contains some rounded white quartz grains.

No. 1857—"*Surface Soil, from an old field sixty-five years in cultivation; uninclosed. Said to be worn out. Adjoining the woods from whence the preceding sample was taken. Substratum, carboniferous sandstone. Collected by C. W. Beckham.*"

Soil lighter colored than the preceding; contains fragments of ferruginous concretions or sandstone. Silicious residue contained some rounded white quartz grains.

No. 1858—"*Subsoil of the next preceding,*" *&c.*

Dried subsoil of a brownish-buff color; contains some ferruginous sandy concretions; less than in the two preceding. The insoluble silicious residue contained but a few quartzose grains.

COMPOSITION OF THESE LAUREL COUNTY SOILS, DRIED AT 212° F.

	No. 1853	No. 1854	No. 1855	No. 1856	No. 1857	No. 1858
Organic and volatile matters. . .	6.110	3.625	2.450	5.990	3.475	3.740
Alumina and iron and mang. ox's	5.298	4.882	5.719	7.339	7.361	9.385
Lime carbonate	.110	.130	.145	.070	.120	.110
Magnesia	.011	.025	.016	.124	.053	.075
Phosphoric acid	.077	.083	.071	.096	.099	.100
Potash	.229	.312	.110	.217	.074	.447
Soda	.149	.268	.228	. . . .	. . . .	. . . .
Sand and insoluble silicates . . .	87.330	90.230	90.780	84.415	87.740	85.365
Water, expelled at 380° F. . . .	1.100	.725	.400	1.075	.675	.725
Loss	. . . .	. . . .	.081	.674	.403	.053
Total	100.414	100.280	100.000	100.000	100.000	100.000
Hygroscopic moisture.	0.865	0.550	0.575	1.535	0.800	1.425
Potash in the insoluble silicates .	.843	.661	.892	.939	.862	.975
Soda in the insoluble silicates . .	.171	.211	.214	.400	.623	.575
Character of the soil	Virgin soil.	Old field soil.	Subsoil.	Virgin soil.	Old field soil.	Subsoil.

These soils are pretty uniform in character, and, but for a paucity of phosphoric acid, which may be seen in them all, would be classed as of good average quality.

LAWRENCE COUNTY.
BLACK BAND IRON ORES.

No. 1858—"*Black Band Ore, from near Louisa; sent by Col. John Rice. Bed said to be thirty-one inches thick, of which twelve to sixteen inches are black-band, the rest bituminous shale.*"

A dull greyish-black, fine granular ore; some little bright-yellow pyrites apparent.

No. 1858 (*a*)—"*Black Band Ore, from same locality as preceding. (Gavat farm, on the west fork of Big Sandy river. A four to six feet bed of coal just below it.) Brought by Mr. John R. Procter.*"

No. 1858 (*b*)—"*Average sample of the Black Band Iron Ore, on Louisa Fork of Big Sandy river, six miles south of Louisa. Collected by A. R. Crandall.*"

Thickness of the layer about two feet, of which only about eight to twelve inches are of Black Band Ore. Latterly it has been reported as sixteen inches, at the bottom of the black shale which constitutes most of the bed.

These several samples were examined as to their proportions of iron, phosphorus, sulphur, &c., with the following results:

	No. 1858.	No. 1858 *a*.	No. 1858 *b*.
Specific gravity	3.151	not det'd.	not det'd.
Iron	33.264	33.923	25.746
Phosphorus	not det'd.	not det'd.	.553
Sulphur	.483	not det'd.	.354
Lime	not det'd.	not det'd.	.924
Magnesia	not det'd.	not det'd.	.150
Bituminous matters	not det'd.	not det'd.	13.700
Silica	7.460	not det'd.	6.360
Alumina	not det'd.	not det'd.	17.920

The iron is mostly in the form of carbonate in the ore, as are also the lime and magnesia, and the phosphorus and sulphur in that of phosphoric and sulphuric acids. The proportions of these two latter ingredients are somewhat large, but yet not so great as to prevent this ore from being made profitably available for foundry iron, &c., if it is to be obtained in sufficient abundance and as rich in iron as the samples 1858 and 1858 (*a*).

LAWRENCE COUNTY COALS.

No. 1859—"*Peach Orchard Coal. (Coal No. 3.) Miller's Branch opening. Collected by A. R. Crandall.*"

A pitch-black coal, breaking in thin laminæ, with some fibrous coal and fine granular pyrites between. Some external ferruginous stain.

No. 1860—"*Peach Orchard Coal. (Coal No. 3.) Same locality. Sample somewhat weathered. Collected by A. R. Crandall.*"

No. 1861—"*Cannel Coal. Little Laurel Creek. Collected by A. R. Crandall.*"

Shows very little pyrites.

COMPOSITION OF THESE LAWRENCE COUNTY COALS, AIR-DRIED.

	No. 1859.	No. 1860.	No. 1861.
Specific gravity	1.317	not est.	1.245
Hygroscopic moisture	3.26	3.24	1.84
Volatile combustible matters	34.22	36.56	48.16
Coke	62.52	60.20	50.00
Total	100.00	100.00	100.00
Total volatile matters	37.48	39.80	50.00
Fixed carbon in the coke	55.36	54.96	44.74
Ash	7.16	5.24	5.26
Total	100.00	100.00	100.00
Character of the coke	Dense.	Dense.	Dense.
Color of the ash	Light brownish-grey.	Light lilac-grey.	Buff.
Per centage of sulphur	0.901	1.189	1.076

The Peach Orchard coal has a high reputation where it is brought into market, and many samples show a much smaller proportion of ash than is given above. An analysis reported by the late Dr. Owen (volume I, old series, Kentucky Geological Reports, page 69) gives only the small ash per centage of 2.85. The proportion of sulphur is also quite small. This coal is a semi-cannel or splint coal, and might very probably be employed with advantage in the smelting of iron, without coking. It is an admirable fuel for domestic purposes.

LAWRENCE COUNTY LIMONITE IRON ORES.

No. 1862—"*Limestone Ore; portions of three samples, from different localities, mixed. On upper Blaine Creek. Collected by A R. Crandall.*"

No. 1863—"*Red Kidney Ore, from near the mouth of Cherokee Creek, about fifty feet above the limestone ore. Collected by A. R. Crandall.*"

COMPOSITION OF THESE LIMONITE ORES, DRIED AT 212° F.

	No. 1862.	No. 1863.
Iron peroxide	67.515	55.693
Alumina	1.280	1.151
Manganese oxide	not est.	not est.
Lime carbonate	a trace.	a trace.
Magnesia	a trace.	a trace.
Phosphoric acid	.135	.284
Sulphuric acid	.423	.302
Combined water	10.150	10.510
Silicious residue	20.480	31.280
Loss	.017	.780
Total	100.000	100.000
Per centage of iron	47.250	39.105
Per centage of phosphorus	.059	.124
Per centage of sulphur	.175	.111
Per centage of silica	16.960	25.660

These are quite good iron ores, rich enough in iron, and containing less than the usual proportion of phosphorus.

No. 1864—"BITUMINOUS SILICIOUS PETRIFACTION. *Irish Creek. Probably associated with Coal No. 2. Collected by A. R. Crandall.*"

Presenting the appearance of fibrous coal which has been infiltrated with silica.

COMPOSITION, AIR-DRIED.

Silica and silicates	80.66
Carbonaceous matter	13.40
Alumina and iron oxide, &c.	1.80
Lime carbonate	.26
Water and loss	3.88
Total	100.00

LEE COUNTY.

COALS.

No. 1865—"*Coal, from Daniel Scott's bank, three quarters of a mile above Proctor. Bed thirty-six inches thick. Sample by A. R. Crandall.*"

A pitch-black splint coal, having but little fibrous coal. Some fine granular pyrites between the thin laminæ.

No. 1866—"*Coal, from the same locality as the last, from another entry. Bed forty-one inches thick. Sample by A. R. Crandall.*"

Resembles the preceding.

No. 1867—"*Pryse's Coal. Lower Stufflebean Creek. Three quarters of a mile west of Beattyville. Average sample from two places, two hundred and two hundred and eighty-six yards from the mouth of the entry. By A. R. Crandall. Thickness of bed thirty-six to forty inches.*"

A pure-looking, pitch-black, glossy splint coal, with very little fibrous coal and fine granular pyrites between the laminæ.

No. 1868—"*Coal, from Phillips' bank, on Mirey Branch. Probable average thickness of the bed forty inches. Average sample from the stock pile, by A. R. Crandall.*"

Resembles the preceding; contains some small scales of bright pyrites.

No. 1869—"*Coal, from R. B. Jameson's bank, two miles below Beattyville, on Mike's Branch. Average sample by A. R. Crandall.*"

A splint coal. Has some fibrous coal and granular pyrites.

COMPOSITION OF THESE LEE COUNTY COALS, AIR-DRIED.

	No. 1865.	No. 1866.	No. 1867.	No. 1868.	No. 1869.
Specific gravity	1.331	1.334	1.307	1.307	1.330
Hygroscopic moisture	2.30	2.10	4.00	3.10	3.40
Volatile combustible matters	38.10	38.10	35.50	36.64	32.70
Coke	59.60	59.80	60.50	60.26	63.90
Total	100.00	100.00	100.00	100.00	100.00
Total volatile matters	40.40	40.20	39.50	39.74	36.10
Fixed carbon in the coke	51.64	51.54	55.50	56.96	57.60
Ash	7.96	8.26	5.00	3.30	6.30
Total	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Spongy.	Light spongy.	Dense spongy.	Spongy.
Color of the ash	Lilac-grey.	Lilac-grey.	Light lilac-grey.	Light buff-grey.	Light lilac-grey.
Per centage of sulphur	2.356	3.991	1.041	1.030	1.368

These coals resemble, in their general properties, those of Lawrence county, reported on above; and although some of these contain a little more sulphur than those, the remarks appended to the latter are equally applicable to these.

LEWIS COUNTY.

SOILS.

No. 1870—"*Soil, from the Ohio bottom, border of creek; ten feet from its surface, about three and a half miles above Quincy. Collected by N. S. Shaler.*"

Dried soil mostly in friable lumps, of a light brownish-grey color; contains no gravel. Silicious residue contains quartzose sand, which will not pass through fine bolting-cloth.

No. 1871—"*Subsoil of the preceding; taken one to three feet below the surface,*" *&c., &c.*

Dried subsoil in friable lumps, somewhat lighter colored than the surface soil; of a light yellowish-grey color.

No. 1872—"*Old Field Soil, cultivated for over fifty years; never overflowed. Back of the Ohio bottom, on Scaffold (or "Scuffle") Creek, three and a half miles above Quincy, and above locality of the two preceding. Produces forty bushels of corn to the acre on an average. Collected by N. S. Shaler.*"

Dried soil of a light-grey color, slightly less yellowish than the next preceding, and slightly darker.

COMPOSITION OF THESE LEWIS COUNTY SOILS, DRIED AT 212° F.

	No. 1870.	No. 1871.	No. 1872.
Organic and volatile matters	3.325	2.665	4.425
Alumina and iron and manganese oxides	10.965	8.995	9.545
Lime carbonate	.125	a trace.	.180
Magnesia	.266	.092	.208
Phosphoric acid	.125	.125	.205
Sulphuric acid	a trace.	.015	.050
Potash	.501	.387	.462
Soda	.116	.128	.134
Soluble silica	.095	.095	.085
Sand and insoluble silicates	83.465	86.365	83.100
Water expelled at 380° F.	1.025	.685	1.725
Loss	.....	.448	.....
Total	100.008	100.000	100.119
Hygroscopic moisture	3.000	2.225	2.335
Potash in the insoluble silicates	1.843	1.233	1.138
Soda in the insoluble silicates	1.036	.868	.954
Character of the soil	Surface soil.	Subsoil.	Old field soil.

These soils, evidently composed of fine detritus deposited by the water of the river, contain more than the average quantity of potash in a state of combination soluble in acids, and hence immediately available for plant growth. The proportions of organic and volatile matters, of phosphoric acid and lime, as well as of the alkalies in the insoluble silicates, are not more than the average. No. 1871 subsoil is especially deficient in lime. Yet they may well be characterized as fertile soils, more especially No. 1872.

LINCOLN COUNTY.

No. 1873—"CLAY, *from the head waters of Green river, on the land of Mr. Thos. W. Varnon. Bed two to four feet from the surface, and said to be forty-two to forty-five feet thick; resting on black shale, which is fifty feet thick. Salt water is found by boring at the depth of eighty-four feet, and some little petroleum in the sandstone. Sent by Senator Varnon.*"

Clay imperfectly laminated, of a dark olive-grey color. Fuses before the blow-pipe. Burns of a grey-buff color.

COMPOSITION, DRIED AT 212° F.

Silica	61.580
Alumina	23.946
Iron protoxide	5.814
Lime	.201
Magnesia	.850
Potash	1.542
Soda	.362
Water and loss	5.705
Phosphoric acid	not det'd.
Total	100.000

The considerable proportions of the iron oxide, lime, potash, and soda prevent this clay from being refractory in the fire. But while it is therefore unfit for the manufacture of fire-bricks, it will yet answer well for ordinary pottery, terra cotta work, or tiles.

CRAB ORCHARD SALTS (SO-CALLED).

The saline matters obtained by the evaporation of the saline waters of Crab Orchard and vicinity, Lincoln county.

No. 1874—"*Crab Orchard Springs Salts; put up by the Crab Orchard Salts Company. Said to be obtained from the waters of various springs mixed. Evaporated at the Springs, and warranted genuine, as sold in sealed bottles by J. B. Wilder & Co., Louisville.*"

A granular salt, colored light-buff with iron peroxide. Dried for about a month, in the water-bath it lost 33.715 per cent. of its weight by the evaporation of water; mainly water of crystallization.

No. 1875—"*Crab Orchard Salts; furnished by Messrs. Arthur Peter & Co., Louisville, from their stock; obtained by Dr. Luney Egbert, druggist, of Crab Orchard. Said also to be derived from various springs.*"

This also is in granular lumps, and presents various shades of buff color, from the presence of iron peroxide.

COMPOSITION OF THESE SAMPLES OF CRAB ORCHARD SALTS, DRIED AT 212° F.

	No. 1874.	No. 1875.
Magnesia sulphate	54.842	60.627
Soda sulphate	13.566	8.260
Potash sulphate	2.707	2.814
Lime sulphate	2.149	1.795
Lithia sulphate	.038	.028
Sodium chloride	2.954	1.874
Lime carbonate	.032	.018
Magnesia carbonate	.089	.036
Iron peroxide	.078	.028
Silica	.124	.118
Water of crystallization and loss	23.421	24.402
Total	100.000	100.000

These salts have quite an extensive medicinal use in some localities. The proportions of lithium salt shown in the above analyses is not so great as is generally claimed for these salts.

MADISON COUNTY.

CLAYS.

No. 1876 (*a*)—"*Potter's Clay (quality No.* 1). *Upper Silurian. Waco, nine miles east of Richmond. Collected by A. R. Crandall.*"

A light-grey soft clay, with some ochreous stains and infiltration.

No. 1876 (*b*)—"*Potter's Clay (quality No.* 2). *Same locality,*" *&c., &c.*

Of a bluish-grey color.

COMPOSITION OF THESE CLAYS, DRIED AT 212° F.

	No. 1876 *a*.	No. 1876 *b*.
Silica	59.976	56.960
Alumina, iron and manganese oxides, and phosphoric acid	27.640	28.740
Lime carbonate	.280	.200
Magnesia	.606	.752
Potash	3.931	2.502
Soda	.547	.315
Combined water and loss	7.020	10.531
Total	100.000	100.000

Neither of these would answer for fire-clay, because of their large proportions of alkalies, lime, magnesia, iron oxide, &c. The iron was not separately determined, and hence the reason why the one is better than the other for the use of the potter was not clearly ascertained. Possibly the smaller proportion of silica and larger amount of alumina, iron oxide, &c., have something to do with it. These are good clays for ordinary stone-ware, &c.

MADISON COUNTY COALS.

No. 1877—"*Coal, from Cox's coal bank. Top of Big Hill. Bed forty inches thick. A sub-conglomerate coal. Average sample by A. R. Crandall.*"

A deep-black splint coal, splitting into very thin laminæ, with much fibrous coal and some little pyrites, some of which is in a small shot form.

No. 1878—"*Coal, from M. Moran's mine. Top of Big Hill, on the road. Bed said to be thirty-six to forty-four inches thick. A sub-conglomerate coal. Sample (more sulphurous than usual) brought by Mr. Wm. A. Gunn, Civil Engineer, &c.*"

A pretty pure-looking splint coal, with very little fibrous coal, but considerable fine granular pyrites between the laminæ.

COMPOSITION OF THESE MADISON COUNTY COALS.

	No. 1877.	No. 1878.
Specific gravity	1.281	1.282
Hygroscopic moisture	2.66	1.90
Volatile combustible matters	33.68	45.76
Coke	63.66	52.34
Total	100.00	100.00
Total volatile matters	36.34	47.66
Fixed carbon in the coke	56.16	44.86
Ash	7.50	7.48
Total	100.00	100.00
Character of the coke	Dense spongy.	Dense.
Color of the ash	Nearly white.	Nearly white.
Per centage of sulphur	0.824	2.888

These two samples, from the same bed evidently, present remarkable differences; No. 1878 giving off much more volatile combustible matters, and leaving less carbon in the coke than the other, approaching more nearly to the character of a cannel coal than that. The relative proportions of sulphur are also very different; all illustrating the great variations in composition which may appear between a selected hand specimen and an average sample of the whole bed. The coke obtained from No. 1877 is somewhat dense and fine cellular.

MAGOFFIN COUNTY.

COALS.

No. 1878 (*a*)—"*Salyersville Coal. Lower part; fourteen inches thick. Half cannel. Collected by A. R. Crandall.*"

A sample partly cannel and partly bright bituminous or splint coal. No apparent fibrous coal or pyrites.

No. 1879—"*Salyersville Coal. Upper part; eighteen inches thick. Collected by A. R. Crandall.*"

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

No. 1880—"*Coal, from Amos Davis' bank, on Licking river. Bed forty-four inches thick, with a five-inch parting. Sample by A. R. Crandall.*"

A firm, pitch-black splint coal, with some fibrous coal and fine granular pyrites between its thin laminæ.

No. 1881—"*Coal, from Stacye coal bank, near the mouth of Johnson's Creek. Bed four feet thick, without parting. Average sample from near the outcrop. By A. R. Crandall.*"

A somewhat mixed sample. Mostly bright, pitch-black coal, with some little dull, and seemingly cannel coal.

No. 1882—"*Colvin's Cannel Coal. Bed three feet thick. Average sample from the main outcrop. By A. R. Crandall.*"

Rather a dull-looking cannel coal. Portions showing a somewhat fibrous structure; other portions splitting into thin laminæ. Has very little fibrous coal and no apparent pyrites. Surfaces soiled somewhat with dirt.

COMPOSITION OF THESE MAGOFFIN COUNTY COALS, AIR-DRIED.

	No. 1878 *a*.	No. 1879.	No. 1880.	No. 1881.	No. 1882.
Specific gravity	1.275	1.292	1.309	1.270	1.235
Hygroscopic moisture	1.80	2.70	4.34	3.70	2.30
Volatile combustible matters	45.60	38.04	37.36	36.64	51.90
Coke	52.60	59.26	58.30	59.66	45.80
Total	100.00	100.00	100.00	100.00	100.00
Total volatile matters	47.40	40.74	41.70	40.34	54.20
Fixed carbon in the coke	43.40	51.62	53.14	54.68	37.56
Ash	9.20	7.64	5.16	4.98	8.24
Total	100.00	100.00	100.00	100.00	100.00
Character of the coke	Dense spongy.	Light spongy.	Spongy.	Light spongy.	Very dense.
Color of the ash	Buff-grey.	Very light bro'h-grey.	Light purplish-grey.	Light buff-grey.	Brownish-grey.
Per centage of sulphur	0.688	1.470	1.357	0.944	1.415

All of these coals are good, and most of them very good, containing but a moderate or small proportion of ash, and less than the usual quantity of sulphur. The cannel coals, although leaving more ash than the others, would doubtless produce fully as much heat, in equal weights of the coals, because of their larger proportions of hydrocarbons: it being a well-established fact that *hydrogen* will give out three times as much heat as *carbon*, when they are burned in equal weights.

MARTIN COUNTY.

COALS.

No. 1883—"*Coal No. 1, from Warfield. Mouth of Collins' Creek. Entry near the salt-works. Average sample from upper four and a half feet bed. By A. R. Crandall.*"

A jet-black, pure-looking coal, breaking into thin laminæ, with some fibrous coal and fine granular pyrites between.

No. 1884—"*Coal. Warfield. Opening in the face of the hill on Tug Fork, three hundred feet above low water. Sample by A. R. Crandall.*"

Aspect of the coal a little more dull than that of the preceding.

No. 1885—"*Warfield Splint Coal. Three hundred and one feet above the main Warfield coal. Bed three feet thick, with two thin clay partings. Sample by A. R. Crandall.*"

Has fibrous coal between the laminæ, but little appearance of pyrites. Some little ferruginous stain on the seams.

No. 1886—"*Eight Feet Coal. Head of Laurel Fork of Nat's Creek. Sample from an old opening. By A. R. Crandall.*"

Rather a dull-looking coal. Has but little fibrous coal and no apparent pyrites between the laminæ. Some little ferruginous stain.

No. 1887—"*Coal No. 1. Warfield. Sample from two rooms. By A. R. Crandall.*"

Generally a glossy, pitch-black splint coal. Has very little fibrous coal, generally, between the laminæ. Some thin scales of brassy pyrites in some of the seams, and occasional layers of fibrous coal with granular pyrites

COMPOSITION OF THESE MARTIN COUNTY COALS, AIR-DRIED.

	No. 1883.	No. 1884.	No. 1885.	No. 1886.	No. 1887.
Specific gravity	1.351	1.358	1.358	1.367	1.302
Hygroscopic moisture	2.16	2.50	2.24	3.50	2.00
Volatile combustible matters	33.60	33.70	33.06	31.94	35.12
Coke	64.24	63.80	64.70	64.56	62.88
Total	100.00	100.00	100.00	100.00	100.00
Total volatile matters	35.76	36.20	35.30	35.44	37.12
Fixed carbon in the coke	55.06	52.62	52.70	52.06	54.82
Ash	9.18	11.18	12.00	12.50	8.06
Total	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Light spongy.	Dense.	Dense.	Dense.
Color of the ash	Brownish-grey.	Light lilac-grey.	Very light lilac-grey.	Very light lilac-grey.	Lilac-grey.
Per centage of sulphur	2.563	0.754	0.604	0.873	0.983

These Martin county coals generally contain rather more than the average amount of earthy matters, but less than the usual quantity of sulphur. Their rather large proportion of ash, however, does not materially detract from their value for use in manufacturing processes, or for fuel.

M'LEAN COUNTY.

No. 1888—"BITUMINOUS SHALE (*so-called cannel coal*), *from near Wrightsburg. Collected by C. J. Norwood.*"

A somewhat tough, dull-looking bituminous shale. Some ferruginous stain on the exposed surfaces.

No. 1889—"COAL, *from near Wrightsburg. Average sample by C. J. Norwood.*"

A jet-black, splint coal, with very little friable fibrous coal and granular pyrites between some of the thin laminæ.

COMPOSITION, AIR-DRIED.

	No. 1888.	No. 1889.
Specific gravity	not det'd.	1.241
Hygroscopic moisture	1.60	3.30
Volatile combustible matters	36.40	36.00
Coke	62.00	60.70
Total	100 00	100.00
Total volatile matters	38.00	39.30
Carbon in the coke	31.36	57.88
Ash	30.64	2.82
Total	100.00	100.00
Character of the coke	Friable.	Light spongy.
Color of the ash	Brownish lilac-grey.	Buff-grey.
Per centage of sulphur	not est.	1.024

The coal No. 1889 is remarkably pure and good. The bituminous shale or impure cannel coal might, in many cases, be profitably used as fuel, notwithstanding its large ash per centage.

MORGAN COUNTY.

COALS.

No. 1890—"*Pierat's Cannel Coal. Collected by A. R. Crandall.*"

A tough, somewhat dull-looking coal, breaking with difficulty into thin laminæ. Has a satiny lustre on its cross fracture. Contains no apparent pyrites or fibrous coal. The sample is mixed with a little attached brittle, glossy, splint coal.

No. 1891—"*Cannel Coal, from Maynhier's bank. Elk Fork of Licking river. Layer of cannel coal two feet two inches thick. Collected by A. R. Crandall.*"

A dull-black, clean-looking coal. Fracture somewhat fibrous across the laminæ. No fibrous coal or apparent pyrites.

No. 1892—"*Six-foot Coal. Near West Liberty. Collected by A. R. Crandall.*"

A soft splint coal, breaking into thin laminæ, with fibrous coal between, but no apparent pyrites.

COMPOSITION OF THESE MORGAN COUNTY COALS, AIR-DRIED.

	No. 1890.	No. 1891.	No. 1892.
Specific gravity	1.230	1.331	1.353
Hygroscopic moisture	2.06	2.30	4.26
Volatile combustible matters	49.64	41.60	35.24
Coke	48.30	56.10	60.50
Total	100.00	100.00	100.00
Total volatile matters	51.70	43.90	39.50
Fixed carbon in the coke	43.20	44.70	50.10
Ash	5.10	11.40	10.40
Total	100.00	100.00	100.00
Character of the coke	Spongy.	Very dense spongy.	Dense spongy.
Color of the ash	Light buff-grey.	Grey-buff.	Nearly white.
Per centage of sulphur	0.955	1.271	1.011

Cannel coal No. 1890 is remarkably pure and good; the others contain more than the average quantity of earthy matters, yet are profitable coals.

MEADE COUNTY.

No. 1893—"SALT WATER, *fresh from the well. Glen Font Salt-works. Collected by C. J. Norwood.*"

The water deposits a reddish sediment in the bottle, and gives an alkaline reaction after a time.

SPECIFIC GRAVITY OF THE WATER = 1.065.

COMPOSITION OF THE WATER IN 1000. PARTS.

Iron and manganese oxides, alumina and phosphoric acid,	0.055	Contained in the sediment deposited on boiling.
Lime carbonate	.654	
Magnesia carbonate	.018	
Silica	.005	
Sodium chloride	74.750	
Potassium chloride	.250	
Calcium chloride	9.050	
Magnesium chloride	2.080	
Barium chloride	.036	
Strontium chloride	.026	
Lithium chloride	.284	
Bromides and iodides	not est.	
Soluble silica	not est.	
	87.208	

This brine, like that of the Goose Creek Salt-works, in Clay county (which see), contains notable quantities of barium and strontium chlorides; and as the former salt is considered injurious to the animal economy, it is well to get rid of it in the manufacture of the salt. This is easily to be done, as described under the head of the Goose Creek Salt-works.

One thousand parts of the water evaporated to dryness left a little more than one hundred parts of saline matters, dried at 212° F. The difference between that amount and the sum of the solid ingredients given in the analysis is doubtless owing to moisture, the undetermined ingredients, and unavoidable loss.

No. 1894—"THE BITTERN WATER, *from the Glen Font Salt-works.*"

The water has a slightly brownish color.

Specific gravity = 1.270.

This water, analyzed by my son, Alfred M. Peter, gave the following results:

COMPOSITION IN 100. PARTS.

Sodium chloride	3.206
Potassium chloride	.553
Calcium chloride	12.043
Magnesium chloride	13.314
Lithium chloride	.658
Barium chloride	.096
Strontium chloride	.147
Copper chloride	.008
Iodine	.002
Bromine	.382
Total	30.409

The trace of copper is doubtless due to the copper pipes, &c., in contact with the water. The proportion of lithium chloride is considerable. Whether there is enough bromine in it for profitable extraction depends on commercial and other circumstances.

Remarks on other probable useful applications of the bittern waters of salt-works will be found under the head of Goose Creek Salt-works, Clay county; also under the head of Grayson county marls.

With these samples there came a specimen of the "*salt water from the first settler*," which also had a brownish tint, and deposited a brownish sediment in the bottle.

Its *specific gravity* was 1.205, and it contained nearly twenty-six per cent. of dry saline matters.

Also "*water from the Grainer*," which had crystals of salt at the bottom. *Specific gravity* = 1.210.

It gave a little more than twenty-four per cent. of dried saline matters on evaporation, and was found to contain iodine equal to 0.009 per cent. of potassium iodide.

No. 1895—"SALT, *manufactured from the Glen Font brine. Collected by C. J. Norwood.*"

A moderately coarse-grained salt. Slightly damp with bittern water. Of a very light pinkish tint in the mass, from the presence of a little of the red sediment.

COMPOSITION, DRIED AT 212° F.

Sodium chloride (common salt) with traces of potassium and lithium chlorides	97.317
Calcium chloride	1.235
Magnesium chloride	1.415
Barium and strontium chlorides	traces only.
Insoluble residue (remains of red sediment)	.033
Total	100.000

This may be considered quite a pure salt as compared with the usual products of our salt-wells. The *traces* of barium salt are too small to be injurious; nor is the residue of red sediment injurious. The deliquescent salts, calcium, and magnesium chlorides, keep the salt always moist; they are said also to injure its antiseptic properties somewhat. These are easily removed by the addition of a little carbonate of soda—soda ash will do—which will precipitate lime and magnesia carbonates, and leave an equivalent of sodium chloride in solution. Thus purified, in the last operation before graining, the resulting salt would be perfectly dry and white and pure.

In addition to the above-described samples, the following were also received and examined from these salt-works, viz:

(*a*)—"*The hard red crust formed around the steam-pipe, where the heat is not great.*" (*A rather indefinite description.*)

This crust, of a handsome orange-red color in the interior and brown on the exterior, having a radiated fibrous structure, dissolved in chlorohydric acid with effervescence; and was found to consist mainly of lime, iron, and magnesia carbonates, &c.

(*b*)—"*The sediment formed inside the copper pipes conveying steam into the salt water.*"

A greenish-white, fibrous crust (colored thus slight by the action of the water on the copper), mainly made up of hexagonal prisms of lime carbonate. *An artificially formed* aragonite.

Testing showed no evidence of strontium in it, and only a trace of magnesium. The crystals, under the microscope, appear beautifully transparent and colorless. The crust has the external form of the interior of the pipe, and is somewhat impregnated with the soluble salts of the water.

(*c*)—"*The sediment from the bottom of the settler.*"

A yellowish-brown mud, containing saline matters. When these were washed out the insoluble residue was found to consist mainly of lime carbonate and a little magnesia carbonate, colored with iron oxide.

These samples were all collected by C. J. Norwood.

MENIFEE COUNTY.

COALS.

No. 1896 (*a*)—"*Coal, from Price and Fitch's bank. Top of the mountain. Bed thirty-four inches thick. Sample from the coal yard of Richardson and Bosworth, Lexington.*"

A bright splint coal, breaking with difficulty across the laminæ; easily in their direction. Some reedy fibrous coal and bright thin pyritous plates between them.

No. 1896 (*b*)—"*Coal, from Adams' bank, near Frenchburg. Old Slate Branch. Average Sample collected by A. R. Crandall.*" *In the Sub-carboniferous limestone.*

A very pure-looking coal; glossy, pitch-black. Has very little fibrous coal or pyrites.

No. 1896 (*c*)—"*Coal. Old State Road Branch. Sample from the stock pile. By A. R. Crandall.*"

A very pure-looking, glossy, deep pitch-black coal. Very little fibrous coal or pyrites apparent.

No. 1896 (*d*)—"*Coal, from Steele's bank. Mouth of Brushy Fork of Beaver Creek. Collected by A. R. Crandall.*"

A pitch-black splint coal; not so glossy or black as 1896(*b*). Has some fine pyrites and fibrous coal between the laminæ.

COMPOSITION OF THESE MENIFEE COUNTY COALS, AIR-DRIED.

	No. 1896 *a*.	No. 1896 *b*.	No. 1896 *c*.	No. 1896 *d*.
Specific gravity	1.300	1.300	1.318	1.301
Hygroscopic moisture	5.00	5.00	2.70	3.80
Volatile combustible matters	39.06	32.40	38.22	38.60
Coke	55.94	62.60	59.08	57.60
Total	100.00	100.00	100.00	100.00
Total volatile matters	44.06	37.40	40.92	42.40
Fixed carbon in the coke	53.18	58.40	54.82	52.00
Ash	2.76	4.20	4.26	5.60
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Dense.	Spongy.	Light spongy.
Color of the ash	Brownish-lilac-grey.	Light yellowish-grey.	Lilac-grey.	Brownish-lilac-grey.
Per centage of sulphur	1.199	0.614	1.615	2.095

These are all remarkably good coals, containing less than the average of earthy matters, as well as of sulphur.

No. 1897—"LIMONITE IRON ORE. *Branch of Beaver Creek. Menifee county. Average sample by P. N. Moore.*"

COMPOSITION, DRIED AT 212° F.

Iron peroxide	54.750	= 38.750 per cent. of iron.
Alumina	14.517	
Manganese oxide	not est.	
Lime carbonate	a trace.	
Magnesia	.047	
Phosphoric acid	.697	= .304 phosphorus.
Sulphuric acid	a trace.	
Combined water	8.600	
Silicious residue	20.830	Containing 19.300 silica.
Loss	.559	
	100.000	

This is quite a good iron ore, with an average proportion of phosphoric acid, which will not injure it for all ordinary iron production. Its considerable proportion of alumina may help to carry off much of this injurious ingredient in the furnace slag or cinder.

MUHLENBURG COUNTY.

COALS.

No. 1898—"*Coal B, from the Louisville and Stroud City mines. Owensboro Junction. 'Gas coal;' sixteen inches thick; at the top of the bed. Collected by C. J. Norwood.*"

A bright jet-black coal, with very little fibrous coal or pyrites apparent.

No. 1899—"*Coal B, from the same mine. Bed three to four feet thick. Owensboro Junction. Sample by C. J. Norwood.*"

A pitch-black, glossy coal. Has some fibrous coal and fine granular pyrites between some of the laminæ, and thin, bright pyritous and gypseous scales in some of the seams.

No. 1900—"*Coal B, from the Memphis Coal Company's mine, four miles south of Owensboro Junction, E., O. & N. R. R. From stock pile; probably from the top of the bed. Has been weathered for eighteen months, and is not a fair sample. Collected by C. J. Norwood.*"

A pitch-black coal, with but little fibrous coal or pyrites apparent.

No. 1901—"*Coal B. Bed four feet four inches to four feet eight inches thick. Saint Louis mines. Owensboro Junction. Sample by C. J. Norwood.*"

A pitch-black coal. Has some fibrous coal, and a few shining pyritous scales.

No. 1902—"*Coal B. Same mine as the next preceding. The gas coal;' sixteen inches thick. Collected by C. J. Norwood.*"

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

No. 1903—"*Coal B. Rothrock's coal mine, a mile and a half north of Owensboro Junction. Upper bench; three feet nine inches thick. Average sample by C. J. Norwood.*"

Generally a pitch-black, glossy coal, with but little fibrous coal, &c., but the sample contained portions of an inch thick pyritous layer, weighing about nine per cent. of the whole, which was separated from the coal analyzed and examined separately (see 1903 *a*).

COMPOSITION OF THESE MUHLENBURG COUNTY COALS, AIR-DRIED.

	No. 1898	No. 1899	No. 1900	No. 1901	No. 1902	No. 1903
Specific gravity	1.280	1.309	1.313	1.235	1.307	1.332
Hygroscopic moisture	4.60	3.36	5.40	5.40	4.60	3.80
Volatile combustible matters	42.60	37.90	35.90	34.20	37.60	36.20
Coke	52.80	58.74	58.70	60.40	57.80	60.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	47.20	41.26	41.30	39.60	42.20	40.00
Fixed carbon in the coke	50.06	52.74	53.60	54.20	52.64	51.80
Ash	2.74	6.00	5.10	6.20	5.16	8.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Light spongy.	Light spongy.	Light spongy.	Light spongy.	Light spongy.
Color of the ash	Light grey.	Light lilac-grey.	Light lilac-grey.	Bright lilac-grey.	Dark brownish-grey.	Lilac-grey.
Per centage of sulphur	1.601	2.686	2.219	3.136	2.372	3.194

No. 1903 (*a*)—The *pyritous shale*, separated from the general sample as above stated, left on incineration 65.90 per cent. of its weight of red-brown ash. It contained 27.64 per cent. of its weight of sulphur. If it had been left in the sample it would have increased the *ash* per centage of the whole to 13.394 per cent., and the *sulphur* per centage of the whole to 5.410 per cent. It was probably only accidentally present in the sample. This pyritous layer would certainly be rejected in preparing the coal for the market.

MUHLENBURG COUNTY SOILS.

No. 1903 (*a*)—"*Virgin Soil, from the farm of A. Stroud, twenty-seven miles from Owensboro. Collected by C. W. Beckham.*"

A clay soil, generally in lumps, breaking of a light bluish-grey color, with ferruginous infiltrations. Contains a small proportion of fine iron gravel. The bolting-cloth removed from the silicious residue a small quantity of small rounded grains of reddish and hyaline quartz.

No. 1903 (*b*)—"*Subsoil of the preceding*," *&c.*

Dried soil somewhat lighter colored than the preceding; contains rather more of rounded ferruginous concretions. The silicious residue contained some fine rounded quartzose grains.

No. 1903 (*c*)—"*Surface Soil, from a field about thirty years in cultivation; in grass all the time except for the last four years, when it was in corn and small grain. Underlying rock; sandy shale. Collected by C. W. Beckham.*"

Dried soil of a light, buff-grey color; contains some few ferruginous sandy concretions. The bolting-cloth separated from the silicious residue a considerable proportion of small rounded, clear and reddish quartz and silicate grains.

COMPOSITION OF THESE MUHLENBURG COUNTY SOILS, DRIED AT 212° F.

	No. 1903 *a*.	No. 1903 *b*.	No. 1903 *c*.
Organic and volatile matters	3.325	1.052	1.242
Alumina and iron and manganese oxides	4.137	3.548	3.749
Lime carbonate	.345	.006	.145
Magnesia	.176	.167	.122
Phosphoric acid	.198	.102	.121
Sulphuric acid	a trace.	a trace.	a trace.
Potash	.145	.167	.255
Soda	not est.	not est.	.477
Sand and insoluble silicates	90.215	94.340	93.140
Water, expelled at 380° F.	1.222	1.050	1.242
Total	99.763	100.432	100.493
Hygroscopic moisture	1.800	0.775	0.965
Potash in the insoluble silicates	1.339	1.091	1.113
Soda in the insoluble silicates	.716	.564	.474
Character of the soil	Virgin soil.	Old field soil.	Subsoil.

Soils of good average quality.

OHIO COUNTY.

COALS.

No. 1904—"*Coal D, from McHenry coal mine. McHenry Station. This sample does not include the 'sulphur band.' Collected by C. J. Norwood.*"

Quite a handsome, pitch-black, glossy coal. Has some fibrous coal between some of the laminæ, with granular pyrites, and some thin pyritous scales in the seams.

No. 1905—"*Coal D. Same locality as the preceding. This sample includes the 'sulphur band.' Collected by C. J. Norwood.*"

No. 1906—"*Coal D, from Render mine. Hamilton Station. Sample from the nut coal pile. Collected by C. J. Norwood.*"

A pure-looking, glossy-black coal; somewhat soft. Has very little fibrous coal, and no apparent pyrites. Some thin incrustation of gypsum in the seams.

No. 1907—"*Coal D, from same locality as next preceding. Sample from the slack pile. By C. J. Norwood.*"

No. 1908—"*Coal, from Charles Wesley Stephens'. On Rough Creek, above Hartford. Collected by C. J. Norwood.*"

A bright, pitch-black coal, breaking easily into irregular layers. Fracture often in natural joints, showing a coarse, irregular fibrous structure on surfaces. Contains but little fibrous coal. Some pieces show some thin scales of bright pyrites and gypsum.

No. 1909—"*Coal, from G. B. Hocker's coal bank. On Rough Creek, about four and a half miles above Hartford. Collected by C. J. Norwood.*"

Resembles the preceding; has fewer irregular seams, more fibrous coal, and fewer pyritous scales. Exterior with ferruginous stain.

No. 1910—"*Coal, from same locality as the next preceding,*" *&c., &c.*

Resembles the preceding, but is brighter and has less pyrites, &c. A very pure-looking coal. Some exterior ferruginous incrustation.

No. 1911—"*Coal, from Marion Sandifer's coal bank. Big Muddy Creek, one mile southwest from Elm Creek. Sampled from near the outcrop. May not be a fair sample of the bed. Collected by C. J. Norwood.*"

A dull-looking splint coal, with but little fibrous coal between the laminæ. Apparently weathered. Somewhat soiled with dirt, which will increase the apparent ash per centage. Sample also contains some bituminous shale, which will exert the same influence in the analysis. Not much apparent pyrites.

No. 1912—"*Coal, from L. M. Patterson's mine. Point Pleasant. Collected by C. J. Norwood.*"

A splint coal of irregular appearance. Portions are pitch-like; others are quite shaly. (Excluded from the sample a lump which seemed to be a portion of a pyritous parting.)

No. 1913—"*Coal D, from Williams' coal bank. On Ben's Lick. Point Pleasant road. Collected by C. J. Norwood.*"

Resembles the preceding; not much of it pitch-like on the cross fracture. Shows some scales of bright pyrites and some of gypsum. Not much fibrous coal present.

No. 1914—"*Bituminous Shale (so-called cannel coal). H. D. Bennett's coal bank; three miles north of Hartford. A lower coal? Collected by C. J. Norwood.*"

A dull, brownish-black, tough bituminous shale; in thin adherent laminæ, the cross-fracture of which is jet-like. Some exterior earthy stain.

No. 1915—"*Coal, from Berry and Walker's land. Head waters of North Fork of Muddy Creek, four miles east of Hartford, near Ben Hines' coal bank. At the old opening, first above the bank at Stanton Baltzel's. Probably not a fair average sample. Collected by C. J. Norwood.*" (*See No.* 1922.)

Much ferruginous and earthy incrustation on the exterior. Fracture bright, pitch-like. Very little appearance of fibrous coal, but some of pyrites. It seems to be a pure coal, with less lamination than ordinary splint coal.

No. 1916—"*Coal, from Bill Hines' coal bank, four miles east from Hartford. Sample from above the clay parting. By C. J. Norwood.*"

A bright, generally pitch-like coal, with some little fibrous coal, but with little appearace of pyrites between the laminæ. Not so much laminated as ordinary splint coal. Some ferruginous stains in the seams.

No. 1917—"*Coal, from the same bank. Sample from below the clay parting. By C. J. Norwood.*"

Resembles the next preceding; but more of it cleaves into thin laminæ, with fibrous coal between.

No. 1918—"*Coal E. On Rough Creek; mouth of Brush Creek; three miles below Hartford. Collected by C. J. Norwood.*"

A splint coal, mostly splitting into very thin laminæ, with reedy or dull-looking fibrous coal between. Very little appearance of pyrites. Some of the thin laminæ are pitch-like on the cross-fracture. Ferruginous and earthy stain on the exterior surfaces.

No. 1919—"*L. D. Taylor's Coal. Collected by C. J. Norwood.*"

A firm splint coal, splitting into pretty thin laminæ, with fibrous coal and some fine granular pyrites between. Some little bright pyritous scales in the seams.

No. 1920—"*Coal D, from Brown's coal bank, three miles south 40° west from Hartford. Taken from an entry where pyrites were abundant. By C. J. Norwood.*"

Some portions pitch-like; others dull. Generally separating into thin laminæ, with fibrous coal between. Bright pyritous scales and some scales of gypsum in the seams.

No. 1921—"*William Warden's Coal; near the roadside, about half a mile northwest from Centretown. From a heap, and consequently may not be an average sample. Coal covered. C. J. Norwood.*"

A rather firm coal. Some portions pitch-like. Some fibrous coal and granular pyrites between the laminæ.

No. 1922—"*Coal, from Berry and Walker's land. Hines' tract; in a ravine draining into North Fork of Muddy Creek. Sample from the lower two feet. An outcrop sample. By C. J. Norwood.*"

A splint coal, mostly splitting into thin laminæ; generally dull, with some pitch-like layers. Much fibrous coal-dust in the sample.

No. 1923—"*Coal, from A. Woodward's coal bank, on Barrett's Creek. Bed twenty-four to thirty inches thick. A low coal. By C. J. Norwood.*"

Sample evidently from an outcrop, considerably soiled with ferruginous dirt. Coal easily broken and split into quite thin laminæ, some of which present tarnished irised colors. Contains much fibrous coal and bright pyrites.

No. 1924—"*Coal, from Gaines' bank, near Fordsville. Bed four feet thick. Average sample by C. J. Norwood.*"

A firm splint coal, some of it pitch-like on the cross-fracture. Not much fibrous coal, but considerable fine granular pyrites. Some external ferruginous stain.

No. 1925—"*Coal, from H. Dooring's mine. About four miles east from Point Pleasant. Lower member four feet five inches thick. Collected by C. J. Norwood.*

A bright, pitch-black, firm coal, handsomely iridescent on some of the seams. Has very little fibrous coal and some fine granular pyrites between the laminæ.

No. 1926—"*Coal, from Henry Thompson's coal bank. One and three quarters of a mile from Elm Lick. A lower coal (H?). Sample from below the parting, three feet five inches thick. The whole bed, including the parting, four feet ten inches. Collected by C. J. Norwood.*"

A pitch-black coal, in very thin laminæ, with much fibrous coal of a reedy appearance. No apparent pyrites.

No. 1927—"*Coal, from Morton's coal bank, two miles northwest from Centretown. Bed from eight to nine feet thick, with a thin clay parting. Sample from the lower member four feet four inches to four feet seven inches thick. By C. J. Norwood.*"

A pitch-black, pure-looking coal. Iridescent on some of the seams. Not easily breaking into thin laminæ, with very little fibrous coal. Some pyritous and gypsum scales in the seams.

No. 1928—"*Coal, from Martin's coal bank, near Elm Lick. Coal H? From the lower member; not a fair sample, as it is from a new opening just begun. C. J. Norwood.*"

In quite thin laminæ, with fibrous coal and some granular pyrites between. Seems to have been much weathered. Is much stained with ferruginous clayey matter.

No. 1929—"*Coal, from Henry Davis' mine, about four miles east from Point Pleasant. Sample from the upper member three feet nine inches thick. By C. J. Norwood.*"

A pure-looking, pitch-black, firm coal. Not all easily breaking into thin laminæ. Has some fibrous coal and granular pyrites.

COMPOSITION OF THESE OHIO COUNTY COALS, AIR-DRIED.

	No. 1904.	No. 1905.	No. 1906.	No. 1907.	No 1908.	No. 1909.	No. 1910.	No. 1911.	No. 1912.	No. 1913.	No. 1914.	No 1915.	No. 1916.
Specific gravity	1.318	1.331	1.310	1.336	1.295	1.297	1.251	1.382	1.386	1.345	1.593	1.273	1.305
Hygroscopic moisture	3.80	2.70	4.40	4.10	5.00	5.90	5.54	5.10	4.80	3.50	2.20	5.30	6.54
Volatile combustible matters	36.66	35.24	38.20	34.36	36.74	33.80	35.66	30.70	33.70	36.30	27.80	45.70	37.92
Coke	59.54	62.06	57.40	61.54	58.26	60.30	58.80	64.20	61.50	60.20	70.00	49.00	55.54
Total	100.00	100.00	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	40.46	37.94	42.60	38.46	41.74	39.70	41.20	35.80	38.50	39.80	30.00	51.00	44.46
Fixed carbon in the coke	52.00	53.62	49.94	51.24	55.66	56.90	56.20	54.24	52.26	50.92	35.28	45.00	51.54
Ash	7.54	8.44	7.46	10.30	2.60	3.40	2.60	9.96	9.24	9.28	34.72	4.00	4.00
Total	100.00	100.00	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.	Light spongy.	Light spongy.	Light spongy.	Light spongy.	Light spongy.	Light spongy.	Spongy.	Spongy	Light spongy.	Pulverulent.	Dense spongy.	Light spongy.
Color of the ash	Light lilac-grey.	Lilac-grey	Light lilac-grey.	Lilac-grey	Light brown.	Buff.	Light buff	Light brownish lilac-grey.	Brownish lilac-grey.	Brownish lilac-grey	Dark brownish lilac-grey.	Lilac-grey	Light yellowish-brown
Per centage of sulphur	1.944	3.785	2.246	3.263	1.605	1.038	0.983	2.164	3.364	3.524	5.694	2.150	1.917

COMPOSITION OF THESE OHIO COUNTY COALS, AIR-DRIED—(Continued)

	No. 1917.	No. 1918.	No. 1919.	No. 1920.	No. 1921.	No. 1922.	No. 1923.	No. 1924.	No. 1925.	No. 1926.	No. 1927.	No. 1928.	No. 1929.
Specific gravity	1.295	1.384	1.340	1.356	1.357	1.380	1.413	1.310	1.310	1.282	1.348	1.321	1.411
Hygroscopic moisture	4.80	4.80	6.80	4.80	6.66	6.00	2.70	6.10	5.54	3.96	3.94	3.70	3.20
Volatile combustible matters	41.00	35.80	32.40	35.60	33.64	34.30	39.30	37.50	35.66	40.50	37.86	36.64	37.06
Coke	54.20	59.40	60.80	59.60	59.70	59.70	58.00	56.40	58.80	55.54	58.20	59.66	59.74
Total	100.00	100.00	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	45.80	40.60	39.20	40.40	40.30	40.30	42.00	43.60	41.20	44.46	41.80	40.34	40.26
Fixed carbon in the coke	49.14	45.20	52.50	49.66	51.56	50.36	45.90	50.46	48.88	52.38	50.48	55.30	47.24
Ash	5.06	14.20	8.30	9.94	8.14	9.34	12.10	5.94	9.92	3.16	7.72	4.36	12.50
Total	100.00	100.00	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	Light spongy.	Spongy.	Spongy.	Spongy.	Light spongy.	Spongy.	Spongy.	Spongy.	Much inflated.	Much inflated.	Light spongy	Dense.	Dense.
Color of the ash	Dark lilac-grey.	Light lilac-grey.	Very light lilac-grey.	Light lilac-grey.	Light grey.	Grey-brown.	Greyish purplish-brown.	Light grey.	Dark lilac-grey.	Lilac-grey.	Lilac-grey.	Light purplish-brown.	Dark lilac-grey
Per centage of sulphur	2.356	3.015	2.109	3.180	2.768	4.307	7.959	3.002	4.199	1.407	3.128	1.241	6.809

These Ohio county coals are generally good, and some of them are very good; the ash and sulphur per centages of some of them, it will be seen, exceed the average; but none, except the one characterized as bituminous shale, is very seriously injured for all ordinary applications: even this might be utilized as fuel in its own vicinity.

The general correspondence between the specific gravity and ash per centage is still further exhibited in these analyses.

OHIO COUNTY LIMONITE IRON ORES.

No. 1930—"*Limonite Ore, from Alfred Ashby's land, on the waters of Walton Creek. Seems to be slightly magnetic? Collected by C. J. Norwood. Coal measures.*"

A porous, cellular, somewhat friable ore; generally of a deep-brown color, with blotches and thin laminæ of light ochreous and irregular portions of denser, fine granular, or specular ore, of a steel-blue color, which is slightly magnetic and gives a red streak.

No. 1931—"*Limonite, from Dooring's iron bank. Coal measures. Sampled for analysis by C. J. Norwood.*"

Composed of irregular laminæ; generally of a dark-brown color, with lighter, ochreous ore mixed and incrusting. Somewhat friable. Powder of a handsome bright yellow-ochre color.

No. 1932 — "*Limonite, from same locality as preceding,*" *&c. &c.*

Resembles the preceding. Probably a little more dense.

No. 1933—"*Ochreous Limonite, from Mrs. Kate Inglehart's place, eight miles southwest of Hartford. Coal measures. Collected by C. J. Norwood.*"

A fine granular, friable ochre, of a handsome brownish-yellow color.

COMPOSITION OF THESE OHIO COUNTY LIMONITE IRON ORES, DRIED AT 212° F.

	No. 1930.	No. 1931.	No. 1932.	No. 1933.
Iron peroxide	75.845	55.357	56.972	18.676
Alumina	.837	9.656	1.148	2.481
Manganese oxide	not est	not est.	not est.	not est.
Lime carbonate	a trace.	a trace.	a trace.	a trace.
Magnesia	.176	.248	.176	.338
Phosphoric acid	.648	.287	.280	.073
Sulphuric acid	not est.	not est.	not est.	not est.
Combined water	9.273	8.860	8.920	6.152
Silicious residue	13.830	26.550	32.504	72.280
Total	100.609	100.958	100.000	100.000
Iron per centage	53.091	38.750	39.880	13.073
Phosphorus per centage	.283	.125	.177	.032
Sulphur per centage	not est.	not est.	not est.	not est.
Silica per centage	9.960	23.420	24.460	69.100

No. 1930 is a good iron ore, containing not more than the average proportion of phosphorus, which may be partly removed, in smelting, in combination with its large proportion of alumina, if sufficient lime be employed as the flux. Nos. 1931 and 1932, although containing much less iron, may be made available in mixture with other richer ores. But No. 1933 is too poor for iron production, and could only be employed as a pigment, or in mixture with very rich ores, to furnish silicious matter to aid in fluxing them.

OWEN COUNTY.

No. 1934—"GALENA, *from a vein about twenty-three inches thick, on Twin Creek. Sent by Thos. J. Jenkins, Esq., New Liberty.*"

A digging has been made more than eighty feet deep, and the vein gradually widens as it descends. The specimen sent was obtained about five feet below the surface. *Lower Silurian formation.*

The galena has some little zinc blende mixed with it, and has a gangue of baryta sulphate and calcareous spar (lime carbonate). It contains, of course, the usual per centage of lead, being a definite chemical compound of lead and sulphur; and, if found in sufficient quantities in the vein, for the cheap production of lead, would be valuable; but in this region, where galena is very frequently found, mixed in large or small (but generally small) proportion with the baryta sulphate, which forms numerous veins in our "blue limestone," the prevalent idea is that there is a large quantity of silver in this shining ore. Indeed, companies have been formed, and much capital sunk in the opening and working of so-called silver mines in the baryta veins of our Lower Silurian limestone; with the usual result, that even the lead obtained and the spar sold would not repay the cost of the labor, while silver is not found.

The specimen above described was examined carefully for the presence of silver, in the wet way, with the result that no ponderable quantity of that metal could be separated from it. This has been the usual result of the analyses of the galenas of this region. They all appear to be remarkably poor in silver. The only practical question in relation to these metallic veins seems, therefore, to be, whether they can be profitably worked for the lead alone. The baryta sulphate, which is quite abundant in these veins, has not yet found a profitable application in any quantity.

No. 1935—"BARYTA SULPHATE; *massive.* (*Ponderous spar.*) *From the same locality as the above. Hunter's Mill. Twin Creek. Collected by C. J. Norwood.*"

This spar was analyzed by my son, Alfred M. Peter, mainly for the purpose of determining the proportion of strontium contained in it, with the following result:

COMPOSITION, DRIED AT 212° F.

Baryta sulphate	80.31
Strontia sulphate	17.05
Lime sulphate	.34
Iron peroxide	.15
Silica	.29
Loss, &c., &c.	1.86
Total	100.00

The proportion of strontia sulphate is larger than was supposed. The presence of strontium in this spar corresponds with its existence in association with barium in some of the saline waters of our State, as shown under the head of Clay and Meade counties in the present report.

OWSLEY COUNTY.

COALS.

No. 1936—"*Coal, from the mines of Steffee & Samuel. South Fork of Kentucky river, four miles above Boonesville, on the east bank of the river. Sample sent by Mr. J. T. Steffee, and analyzed at the request of the Governor. Bed three feet thick.*"

A good-looking splint coal. Iridescent on some of its surfaces; containing some bright pyritous scales, and showing marked reedy impressions on some of the laminæ.

No. 1937—"*Cannel Coal, owned by Steffee & Samuel. South Fork of Kentucky river,*" &c., &c. (*as above*).

A handsome cannel coal. Very tough. Jet-black and glossy on its cross fracture. Has no apparent pyrites.

COMPOSITION OF THESE OWSLEY COUNTY COALS, AIR-DRIED.

	No. 1936.	No. 1937.
Specific gravity	1.294	1.161
Hygroscopic moisture	2.10	0.50
Volatile combustible matters	35.24	59.70
Coke	62.66	39.80
Total	100.00	100.00
Total volatile matters	37.34	60.20
Fixed carbon in the coke	58.66	32.34
Ash	4.00	7.46
Total	100.00	100.00
Character of the coke	Spongy.	Dense.
Color of the ash	Light lilac-grey.	Light brown.
Per centage of sulphur	1.424	not det'd.

These coals are both remarkably good and pure of their kinds. The cannel coal exceeds the celebrated Haddock's cannel coal in volatile matters fully ten per cent., and equals the Breckinridge coal of Hancock county in its volatile combustible matters (see No. 1813, Cloverport Oil Company's coal), than which it has a smaller ash per centage. It greatly resembles this celebrated coal, but is purer. Should our petroleum wells run low, coals of this character will be again profitably available for the production of so-called coal oil, lubricating oils, and other paraffins, with the lighter hydrocarbons, now derived almost exclusively from the mineral oil. A greater economy in the manufacture of these from the cannel coal, and the profitable use of the gas and coke, which are simultaneously produced, may favor the competition of the coal distillates with those from the petroleum.

PERRY COUNTY.

COALS.

No. 1938—"*Coal, from Josiah Cobb's bank, near Hazard. Average sample taken from the upper part of the bed, the lower part not being uncovered. By P. N. Moore.*"

A pure, pitch-black splint coal, having very little fibrous coal between the laminæ, but with ferruginous stain and appearance of pyrites in parts.

No. 1939—"*Coal, from Campbell's bank. Mace's Creek. Sampled from near the outcrop; hence probably will give more ash than the coal further in. Collected by P. N. Moore.*"

A splint coal, very much weathered and soiled with dirt; hence the ash per centage is probably greater than that of the bed. The sample has much powdered (fibrous) coal in it; probably more than belongs to it.

No. 1940—"*Coal, from R. C. Combs' bank; below Hazard, on the North Fork of Kentucky river. Collected by P. N. Moore.*"

A pure-looking, pitch-black splint coal. Has some ferruginous stain on some of its seams, but very little fibrous coal or apparent pyrites.

No. 1941—"*Coal, from Logan's drift. Brashear Salt-works. Collected by P. N. Moore.*"

Resembles the preceding, but has no ferruginous stain.

No. 1942—"*Coal, from David Grigsby's bank. Lot's Creek. Bituminous coal, above the cannel coal. Collected by P. N. Moore.*"

Coal, breaking into thin laminæ, with but little fibrous coal or granular pyrites between them. Exterior of the lumps dull and much stained with ferruginous and clayey matters, as though they had been weathered, which probably may somewhat increase the ash per centage.

No. 1943—"*Coal, from the same bed as the next preceding. Lower part of the bed. The cannel coal. Collected by P. N. Moore.*"

Mostly tough, compact cannel coal, with a satiny lustre on its cross-fractured surfaces. Some pieces more readily separate into thin laminæ. The exterior surfaces are soiled with ferruginous and clayey matters, which will probably make the apparent ash per centage greater than that of the clean coal of the beds.

COMPOSITION OF THESE PERRY COUNTY COALS, AIR-DRIED.

	No. 1938	No. 1939	No. 1940	No. 1941	No. 1942	No. 1943.
Specific gravity	1.289	1.370	1.303	1.288	1.274	1.290
Hygroscopic moisture	2.10	3.70	2.06	1.60	1.80	1.20
Volatile combustible matters	36.20	30.64	36.74	36.10	40.90	40.86
Coke	61.70	65.66	61.20	62.30	57.30	57.94
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	38.30	34.34	38.80	37.70	42.70	42.06
Fixed carbon in the coke	58.20	57.02	56.30	56.40	53.70	48.44
Ash	3.50	8.64	4.90	5.90	3.60	9.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Pulverulent.	Spongy.	Light spongy.	Light spongy.	Dense.
Color of the ash	Buff-grey.	Grey-buff.	Brownish-grey.	Light grey.	Brown-grey.	Light grey.
Per centage of sulphur	0.836	0.654	1.436	0.836	1.339	0.634

These Perry county coals are remarkably good, containing much less than the average quantity of sulphur, and leaving, generally, but a small amount of ash. With the exception of the cannel, they are semi-bituminous or splint coals, of the same character as the celebrated Block coal of Indiana. The coals of the eastern coal field of Kentucky, as yet measurably unknown and undeveloped, promise to be more valuable in the future than any in the State.

PULASKI COUNTY.

COALS.

No. 1944—"*Coal, from the Cumberland coal banks; mine owned by W. S. Brown and Wm. Owens; two miles south from the Cumberland river; nine miles from Rockcastle Springs; eighteen miles from Somerset. Sub-conglomerate coal. Bed forty inches thick, without a parting. Average sample taken fifty feet from the mouth of the mine. By John H. Talbutt.*"

A pure-looking coal; somewhat tough, with but little fibrous coal and some fine granular pyrites between the laminæ.

No. 1945—"*Coal, from Doolin coal bank; owned by Allen Jones; one mile from Cumberland river; ten miles from Rockcastle Springs. A sub-conglomerate coal. Average sample taken from the head of the drift, seventy-five feet from the mouth. By John H. Talbutt. Bed fifty-one inches thick, containing a good deal of pyrites in some places.*"

A pitch-black splint coal, with but little fibrous coal between the laminæ, but much pyrites.

COMPOSITION OF THESE PULASKI COUNTY COALS, AIR-DRIED.

	No. 1944.	No. 1945.
Specific gravity	1.357	1.357
Hygroscopic moisture	2.40	2.00
Volatile combustible matters	36.76	35.30
Coke	60.84	62.70
Total	100.00	100.00
Total volatile matters	39.16	37.30
Fixed carbon in the coke	50.24	52.94
Ash	10.60	9.76
Total	100.00	100.00
Character of the coke	Spongy.	Light spongy.
Color of the ash	Brownish-lilac-grey.	Dark lilac-grey.
Per centage of sulphur	2.494	3.565

These two samples resemble each other considerably. They are good and profitable coals, although their ash and sulphur per centages somewhat exceed the average.

No. 1946—"CHALYBEATE WATER, *from Rockcastle Springs. From a natural spring on the north side of Rockcastle river, near its margin, and below high-water level. Water said to* *come from a bed of shale; is confined in a box about eighteen inches in diameter, from which it flows in a half-inch stream. Brown-ochreous, ferruginous incrustation on the box. Sample collected by John H. Talbutt."*

COMPOSITION OF THIS CHALYBEATE WATER IN 1000. PARTS.

Iron carbonate	0.0145		Held in solution by carbonic acid.
Lime carbonate	.0438		
Magnesia carbonate	.0148	= .0731	
Lime sulphate	.0029		
Magnesia sulphate	.0036		
Soda sulphate	.0531		
Sodium chloride	.0026		
Silica	.0128		
	0.1481		

The water contained 0.0930 per thousand, by weight, of free carbonic acid.

Although containing but a very small proportion of saline matters or of iron, this water may be not the less available in the treatment of many diseases. Indeed, some of the most celebrated mineral waters of the world are nearly pure water. The undoubted curative or restorative effects of such waters depend, not only on their depurative influence, when regularly taken in proper quantity, and the alterative influence of minute proportions of iron compounds or other ingredients present in them, but also on the exercise, change of scene, relaxation of mind, and regular diet and regimen, which are generally to be found at the watering-place. (See Whitley county for other chalybeate springs of this neighborhood.)

ROCKCASTLE COUNTY.

COALS.

No. 1947—"*Coal, from Myzner's and Myers' bank. Livingston. An inter-conglomerate coal. Average sample by A. R. Crandall; taken one hundred and fifty yards in entry No. 1. Average thickness of the bed twenty-eight inches.*"

A pure-looking, glossy-black splint coal. But little fibrous coal between the laminæ, and no apparent pyrites.

No. 1948—"*Coal, from same mine. Entry No. 2. Average Sample collected by A. R. Crandall.*"

Much like the preceding in appearance.

No. 1849—"*Coal, from Grisham's coal mine, near Livingston. First above the conglomerate. Upper 'brashy coal' bed; average thickness two feet. Average sample by C. J. Norwood.*"

A splint coal. Fibrous coal and much granular pyrites between its thin laminæ.

No. 1950—"*Coal, from same mine. From the lower nine inches of the two feet bed. Local name, 'Block coal.' By C. J. Norwood.*"

A deep-black, glossy coal, iridescent in parts. But little fibrous coal or pyrites apparent.

COMPOSITION OF THESE ROCKCASTLE COALS, AIR-DRIED.

	No. 1947.	No. 1948.	No. 1949.	No. 1950.
Specific gravity	1.318	1.357	1.327	1.374
Hygroscopic moisture	2.00	2.20	2.20	2.10
Volatile combustible matters	36.66	36.50	35.86	39.50
Coke	61.34	61.30	61.94	58.40
Total	100.00	100.00	100.00	100.00
Total volatile matters	38.66	38.70	38.06	41.60
Fixed carbon in the coke	51.94	51.70	54.94	49.86
Ash	9.40	9.60	7.00	8.54
Total	100.00	100.00	100.00	100.00
Character of the coke	Light spongy.	Light spongy.	Spongy.	Spongy.
Color of the ash	Lilac-grey.	Dark lilac-grey.	Light chocolate.	Purplish-grey.
Per centage of sulphur	2.205	4.802	4.302	2.933

These coals greatly resemble, in general composition, those from near the Cumberland river, described under the head of Pulaski county.

No. 1951—"CLAY, *from Pine Hill coal mines. Rockcastle county. Collected by John H. Talbutt.*"

A light-grey plastic clay, mottled with ferruginous.

This was only examined for its proportion of alkalies. It was found to contain of potash = 3.083 per cent. of the dried clay (at 212°); soda = 0.524 per cent.

It therefore would not probably prove to be a very refractory clay.

No. 1952—"METALLIC IRON. *Brought by Mr. Jones, of Lexington.*"

Said to be from Holley farm, on the dividing ridge between Goose creek and Rockcastle river, head waters of Rockcastle river, near the line of Laurel county. It is similar to a specimen brought to the writer from near Manchester, Clay county, in 1854, by the late Daniel White. Said by both these individuals to be abundant on the surface. It is similar in appearance to some specimens obtained by Mr. C. J. Norwood and others from near Manchester, Clay county, and said to be abundant there.

It presents the appearance of medium fine-grained "mill iron;" is dark-colored; yields to the file, but is quite brittle, extending very little under the hammer. The surface of Mr. Jones' specimen was polished and treated with nitric acid; but while this produced a fine-radiated, Damascus-like appearance, no Widmanstattian figures were produced.

The pieces obtained all seem to be portions of a slab, about one and a half inches thick, the exterior surfaces of which have a coating about one sixteenth of an inch thick of oxide, which looks as though it had either been caused by heat or by a long exposure to the atmosphere.

It was found, on examination, to contain of carbon, about two to three per cent.; silicon, about one per cent.; a doubtful trace of copper, but no nickel.

The per centage of iron was not ascertained, nor was the analysis carried further.

The fact that so many pieces of this iron have been brought to the laboratory, and that so many persons bear testimony to its abundance on the surface in the region in question, is interesting. Is it a meteoric iron? If not, how came it to be scattered over the ground at such a distance from iron furnaces? Persons in the part of the country where it is found might perhaps throw light on the subject.

WEBSTER COUNTY.

MINERAL WATERS.

No. 1953—"*Water, from the 'Sulphur Spring.' Sebree Springs. Collected by C. J. Norwood.*"

The water, when brought to the laboratory, had deposited a slight black sediment in the bottle, containing some iron sulphide, and had lost its sulphuretted hydrogen. It still contained free carbonic acid gas, the amount of which was not estimated. It gave a slight alkaline reaction. (Analyzed by my son, Alfred M. Peter.)

COMPOSITION IN 1000. PARTS OF THE WATER.

Iron and manganese oxides	0.0007	Held in solution in the recent water by free carbonic acid.
Lime carbonate	.2178	
Magnesia carbonate	.0499	
Lime sulphate	.0617	
Magnesia sulphate	.0570	
Potash sulphate	.0042	
Soda sulphate	.1433	
Sodium chloride	.2760	
Silica	.0176	
Organic matters and loss	.0076	
Total saline matters	0.8358	Dried at 212° F.

Unquestionably a very good saline sulphur water, containing traces of iron and manganese. Part, if not all of the organic matters, may have been derived from the cork.

No. 1954—"*Water, from the 'Chalybeate Spring.' Sebree Springs, &c., &c. Collected by C. J. Norwood. This spring is frequented by people from Henderson and Evansville, &c., and has considerable local reputation.*"

Most of the iron had been deposited in the bottle as a brownish sediment; but this was re-dissolved, analyzed, and calculated into the whole amount in the following report of the analysis. This analysis was also made by Alfred M. Peter.

COMPOSITION IN 1000. PARTS.

Iron carbonate	0.0297	Held in solution by carbonic acid.
Manganese carbonate	trace.	
Lime carbonate	.0247	
Magnesia carbonate	.0179	
Lime sulphate	.0218	
Potash sulphate	.0042	
Soda sulphate	.0205	
Sodium chloride	.0026	
Silica	.0010	
Organic matters and loss	.0066	
Total saline matters	0.1290	Dried at 212° F.

The proportion of free carbonic acid in the water was not determined, as doubtless much of it had escaped in transportation. There can be no doubt that it may be made available in the treatment of many maladies, under proper medical advice.

WEBSTER COUNTY SOILS.

No. 1955—"*Virgin Soil. Woods pasture. Farm of Mr. Bowland, near Madisonville. Forest growth: elm, black walnut, red and white oak, &c., &c. Underlying rock; sandstone. Collected by C. W. Beckham.*"

Dried soil of a brownish-buff color; contains no gravel. The silicious residue contained a few small rounded grains of clear quartz.

No. 1956—"*Surface Soil, from a field twelve to fifteen years in cultivation in corn and tobacco; from same farm and near the same locality as the above. Collected by C. W. Beckham.*"

Dried soil of a dark brownish-buff color; contains no gravel. Silicious residue contains a few small rounded quartz grains.

No. 1957—"*Subsoil of the next preceding,*" *&c., &c.*

Dried soil of a buff color; contains no gravel. Silicious residue like the preceding.

COMPOSITION OF THESE WEBSTER COUNTY SOILS, DRIED AT 212° F.

	No. 1955	No. 1956	No. 1957
Organic and volatile matters	4.010	2.975	3.575
Alumina and iron and manganese oxides	4.064	3.997	7.289
Lime carbonate	.145	.220	.145
Magnesia	.178	.160	.124
Phosphoric acid	.071	.118	.061
Sulphuric acid	not est.	not est.	not est.
Potash	.288	.104	.135
Soda	.055	.152	.415
Sand and insoluble silicates	91.350	91.490	88.015
Water, expelled at 380° F.	.400	.225	.500
Loss	....	.559	....
Total	100.561	100.000	100.259
Hygroscopic moisture	1.500	1.375	2.105
Potash in the insoluble silicates	1.461	1.534	1.619
Soda in the insoluble silicates	.759	.698	.912
Character of the soil	Virgin soil.	Cultivated soil.	Subsoil.

These soils are good for sandstone soils, and can be made quite productive by proper management and the judicious use of manures, of which phosphatic fertilizers are indicated. They promise a considerable durability in the considerable proportions of alkalies contained in their insoluble silicates.

WHITLEY COUNTY.

MINERAL WATERS.

No. 1958—"*Chalybeate Water. L. Renfro's. Cumberland Falls. Spring about one hundred yards below the falls, on the north side of the river. From just above the Lower Conglomerate. The sandstone from which it flows is near the level of high water in the river. The water is contained in a small rock basin. It forms an ochreous deposit, and contains some flocculent matter. There are other similar sources in the neighborhood. Collected by John H. Talbutt.*"

No. 1959—"*Chalybeate Water. L. Renfro's. Cumberland Falls. Spring on the south side of the river, just under the falls of Eagle Creek, and about three hundred yards below the falls; above high water. This water deposits an ochreous* *sediment also. It issues from the Conglomerate rock in a wooden spile. Collected by J. H. Talbutt."*

COMPOSITION OF THESE CHALYBEATE WATERS, IN 1000. PARTS OF THE WATER.

	No. 1958.	No. 1959.	
Iron and manganese carbonates . .	0.0082	0.0072	Held in solution in the water by carbonic acid.
Lime carbonate	.0476	.0405	
Magnesia carbonate	.0327	.0266	
Silica	.0007	not det'd.	
Lime sulphate.	.0141	.0049	
Magnesia sulphate	.0060	.0060	
Iron and alumina sulphates	.0038	.0053	
Potassium chloride.	not est.	not est.	
Sodium chloride	not est.	.0031	
Silica	.0297	.0176	
Undetermined and loss	.0432	.0088	
Total dry saline contents	0.1860	0.1200	In 1000. parts of the water.

The amount of free carbonic acid in these chalybeate waters was not determined. The judicious use of these waters could no doubt be made quite beneficial in the treatment of many maladies.

No. 1960—"*Bituminous Shale, or impure Coal; from Louis Renfro's land; Cumberland Falls. Bed fifteen inches thick; one hundred and sixty yards below the falls, and one hundred and eighty feet above the river, and about the same distance from it. In massive sandstone; forty feet thick, immediately above. Inter-conglomerate. Collected by John H. Talbutt."*

This shale, air-dried, gave off 2.84 per cent. of *hygroscopic moisture* at 212° F., and 27.16 per cent. of *volatile combustible matters*, leaving 70.00 per cent. of *dense coke*, which contained 26.60 per cent. of *ash*. The *fixed carbon* thus amounted to 43.40 per cent. Its per centage of sulphur was found to be 2.562; so that it may be made available for fuel, &c., in its vicinity, notwithstanding its large proportion of earthy matter.

WHITLEY COUNTY SOILS.

No. 1961—"*Soil; uncultivated; from the bluff opposite Rock-castle Springs. On the Conglomerate. Collected by John H. Talbutt."*

Dried soil of a light umber-grey color. Contains a few small fragments of ferruginous sandstone. The bolting-cloth separated from its silicious residue about one fourth of its bulk of fine, rounded, colorless quartz grains.

No. 1962—"*Virgin Soil; from the top of King's Mountain. Eight hundred feet above the valley. (U. S. Coast Survey Station.) Collected by C. W. Beckham.*"

Dried soil of a brownish-grey color; contains about twenty to thirty per cent. of small shaly ferruginous sandstone fragments. The bolting-cloth separated from its silicious residue a large proportion of fine, rounded grains of hyaline quartz, and greyish, partly decomposed silicates, and a few mica scales.

COMPOSITION OF THESE WHITLEY COUNTY SOILS, DRIED AT 212° F.

	No. 1961.	No. 1962.
Organic and volatile matters	3.075	4.265
Alumina and iron and manganese oxides	3.429	2.695
Lime carbonate	.115	.110
Magnesia	.080	.084
Phosphoric acid	.061	.140
Sulphuric acid	.008	not est.
Potash	.194	.052
Soda	.164	not est.
Sand and insoluble silicates	91.105	91.465
Water, expelled at 380° F.	1.500	.782
Total	99.731	99.593
Hygroscopic moisture	1.200	0.950
Potash in the insoluble silicates	.692	0.989
Soda in the insoluble silicates	.120	.291
Character of the soil	Virgin soil.	Virgin soil.

Better soils than might have been expected from their location.

WOLFE COUNTY.

COALS.

No. 1963—"*Coal, from C. M. Hanks' bank. Compton. Bed twenty-eight inches thick; without parting. Sample by A. R. Crandall.*"

A pure-looking, pitch-black coal. Has but little fibrous coal. Some shining pyritous scales in the seams.

No. 1964—"*Cannel Coal, or Bituminous Shale. James F. Ely's. Gilmore Creek. Sample by P. N. Moore.*" Hand specimen.

A dull-looking cannel coal, breaking with difficulty. No appearance of fibrous coal or pyrites. Small glimmering micaceous scales abundant in it.

No. 1965—"*Cannel Coal. John W. Fauhner's. Stillwater Creek. Collected by P. N. Moore.*" Not an average sample.

A dull-black, pure-looking coal, with a large conchoidal fracture.

No. 1966—"*Coal, from Hobb's bank, on Benjamin Baker's land; four and a half miles from Compton. Collected by P. N. Moore.*"

A pure-looking splint coal. A little fibrous coal and fine granular pyrites between some of its laminæ. One piece contained some particles of light reddish-brown *resin*.

COMPOSITION OF THESE WOLFE COUNTY COALS, AIR-DRIED.

	No. 1963.	No. 1964.	No. 1965.	No. 1966.
Specific gravity	1.336	1.434	1.383	1.294
Hygroscopic moisture	3.74	1.30	1.16	3.50
Volatile combustible matters	35.52	41.40	44.58	35.20
Coke	60.74	57.30	54.26	61.30
Total	100.00	100.00	100.00	100.00
Total volatile matters	39.26	42.70	45.74	38.70
Fixed carbon in the coke	52.64	28.20	32.76	56.70
Ash	8.10	29.10	21.50	4.60
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Pulverulent.	Pulverulent.	Spongy.
Color of the ash	Lilac-grey.	Nearly white.	Light lilac-grey.	Lilac-grey.
Per centage of sulphur	2.466	0.846	0.530	1.189

The so-called cannel coals contain so much earthy matter that they might (one or both) be properly called bituminous shales. They are remarkable, however, for the large proportion of volatile combustible matters they yield; and hence may be made available, if the petroleum production fails, in the manufacture of the coal oil and other hydrocarbons, &c., which are now so extensively used. They will make quite good fuel, notwithstanding their large ashy residue. Coal No. 1966 is exceptionally pure and good, and No. 1963 is also quite a good coal.

TABLE I. SOILS, SUBSOILS, &c., DRIED AT 212° F.

Number in Report.	County.	Organic and volatile matters.	Alumina and iron and manganese oxides.	Lime carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and insoluble silicates.	Water expelled at 380° F.	Water expelled at 212° F.	Potash in the insoluble silicates.	Soda in the insoluble silicates.	Remarks.
1677	Bell	4.700	4.817	0.190	0.338	0.093	not est.	0.164	0.115	89.390	0.600	1.825	2.568	0.389	J. Turner's; val. of Big Yel. Cr.; vir. s.
1678	Bell	5.575	4.015	.190	.067	.220	not est.	.160	.217	88.875	.775	2.550	.735	.018	J. Turner's; old field soil.
1679	Bell	2.600	1.710	.115	.045	.125	not est.	.056	.006	93.940	.900	1.350	.851	.082	J. Turner's; subsoil.
1680	Bell	5.725	4.339	.065	.050	.096	not est.	.068	.035	89.390	.650	1.800	.568	.119	J. Turner's; virgin soil (foot-hills).
1681	Bell	2.750	4.137	.065	.042	.073	not est.	.106	.032	92.090	.885	.875	.713	.137	J. Turner's; subsoil
1682	Bell	5.050	3.557	.265	.131	.093	not est.	.212	. . . .	90.215	.750	1.875	.347	.107	Cultivated field soil.
1683	Bell	1.800	2.474	.115	.060	.061	not est.	.086	.014	95.115	.750	.850	.501	.216	Cultivated subsoil.
1684	Bell	11.565	4.615	.145	.098	.125	not est.	.139	.074	84.040	.035	3.700	.583	.090	Virgin soil; top of Brison Mt.
1685	Bell	5.750	4.662	.145	.079	.108	not est.	.131	.039	88.540	.900	2.275	.717	.150	Subsoil; top of Brison Mt.
1686	Bell	4.050	4.197	.095	.068	.093	not est.	.128	not est.	90.440	.750	1.475	1.387	.213	Virgin soil; Yellow Creek Valley.
1687	Bell	5.925	8.846	.280	.052	.124	not est.	.139	.085	83.140	1.100	2.450	2.507	.344	Old field; Big Creek Valley.
1688	Bell	4.850	8.120	.095	.088	.093	not est.	.191	.117	86.040	.750	1.875	2.275	.251	Old field; subsoil.
1689	Bell	5.525	7.339	.095	.088	.001	not est.	.143	.063	85.140	1.200	2.275	2.362	.273	Old field; Big Yellow Creek Valley.
1690	Bell	4.725	7.013	.095	.088	.077	not est.	.243	. . . .	87.125	1.000	1.900	2.351	. . . .	Old field; subsoil Big. Yel. Cr. Valley.
1691	Bell	3.500	2.913	.290	.070	.093	.007	.158	.050	92.090	1.100	1.150	.490	.169	Old field; foot of Cumberland range.
1692	Bell	2.450	2.815	.275	.044	.125	.003	.203	.013	92.040	1.050	1.175	.674	.186	Old field; subsoil, f't of Cumb'd range.
1693	Bell	4.125	5.990	.225	.080	.125	.007	.109	.177	87.590	1.450	1.500	1.831	.501	Cultivated field; foot-hills.
1694	Bell	4.025	6.997	.225	.081	.093	.007	.368	. . . .	86.815	1.250	1.515	1.904	.348	Cultivated field; subsoil, foot-hills.
1695	Bell	7.175	9.626	.265	.155	.189	.007	.429	.190	80.040	2.075	2.500	2.519	.303	Old field; Big Yellow Creek Valley.
1696	Bell	5.675	12.816	.115	.322	.294	.013	.443	. . . .	78.240	2.025	2.525	2.640	.464	Old field; subsoil, Big Yel. Cr. Valley.
1723	Christian . . .	4.200	4.810	.065	.155	.125	not est.	.135	. . . .	89.940	.475	1.725	.925	.434	Virgin woodland soil (sandstone).
1724	Christian . . .	4.360	6.467	.125	.151	.008	not est.	.176	.261	88.710	.500	1.740	.980	.479	Cultivated soil (for 15 years).
1725	Christian . . .	3.133	9.310	.120	.139	.150	not est.	.083	.116	86.290	.375	1.900	1.131	.561	Subsoil of preceding.
1726	Christian . . .	3.300	3.922	.095	.115	.038	not est.	.121	.172	91.850	.250	.925	1.462	.569	Virgin soil.
1727	Christian . . .	4.330	6.402	.220	.100	.108	not est.	.247	.153	87.925	.325	1.500	1.457	.875	Old field soil.
1728	Christian . . .	4.065	12.155	.160	.164	.080	not est.	.637	.084	81.890	.450	2.800	1.367	1.044	Subsoil.
1729	Christian . . .	5.165	5.540	.270	.178	.070	not est.	.385	. . . .	88.615	.595	1.710	1.669	.478	Virgin soil (compact limestone).
1730	Christian . . .	4.065	4.618	.270	.124	.042	not est.	.256	. . . .	88.915	.445	1.590	1.642	.605	Old field soil.
1731	Christian . . .	3.600	11.193	.295	.142	.093	not est.	.457	. . . .	83.645	.400	3.000	1.516	.662	Subsoil.
1732	Christian . . .	2.625	4.036	.130	.097	.124	not est.	.121	.125	92.625	.450	1.050	1.421	.575	Virgin soil (sandstone).
1733	Christian .	2.925	5.992	.170	.153	.093	not est.	.125	. . . .	89.755	.550	1.365	1.166	.420	Old field soil (sandstone).
1734	Christian .	2.775	9.052	.070	.156	.108	not est.	.174	. . . .	86.575	.600	2.165	1.368	.461	Subsoil (sandstone).
1735	Christian . . .	4.675	4.127	.190	.107	.108	not est.	.260	. . . .	89.765	.725	1.600	1.304	.545	Virgin soil (limestone).
1736	Christian . . .	3.115	5.884	.270	.151	.086	not est.	.210	. . . .	89.815	.550	1.400	1.263	.345	Old field soil (limestone).
1737	Christain . . .	3.500	12.727	.295	.232	.108	not est.	.707	. . . .	81.890	.750	3.135	. . . .	. . .	Subsoil (limestone).
1750	Daviess	5.475	6.174	.120	.016	.141	not est.	.134	.301	86.605	.975	1.775	.855	.581	Virgin soil; hill top.
1751	Daviess	3.150	7.065	.245	.034	.125	not est.	.053	. . . .	88.390	.925	1.515	1.122	.709	Old field; hill top.
1752	Daviess	2.715	10.654	.095	.021	.061	not est.	.244	. . . .	85.415	.910	1.565	1.380	.680	Subsoil; hill top.
1753	Daviess	5.875	5.349	.220	.044	.086	not est.	.407	. . . .	86.590	1.450	1.700	.975	.403	Virgin soil; upland.
1754	Daviess	2.550	5.502	.085	.133	.083	not est.	.265	. . . .	90.890	.600	.875	1.396	.729	Old field; upland.
1755	Daviess	3.175	12.958	.075	.080	.102	not est.	.475	.075	81.300	1.175	3.500	1.457	.639	Subsoil; upland.

1779	Fayette	4.676	9.570	0.230	0.140	0.444	not est.	0.287	not est.	82.860	1.824	2.165	1.274	0.211	Woodland pasture (blue grass) soil.
1780	Fayette	3.085	10.445*	.220	.140	.540	not est.	.343	.192	83.260	1.234	1.965	1.314	.583	Subsoil to same.
1781	Fayette	7.800	12.286	1.145	.394	.364	not est.	.735	.084	76.690	1.300	2.975	.718	.200	Virgin open pasture; blue grass soil.
1782	Fayette	4.410	14.427	.545	.340	.358	not est.	.402	.301	77.440	.925	3.135	.910	.212	Subsoil to same.
1783	Fayette	4.400	19.921	.130	.376	.364	not est.	.755	. . . .	72.540	1.200	3.525	.044	.167	Under clay of same.
1809	Greenup. . . .	5.590	12.357	.045	.366	.083	.003	.433	.023	79.500	1.250	1.900	2.301	.509	Vir soil; woods; hill top; Wh. Oak Cr.
1810	Greenup. . . .	5.600	15.693	.070	.375	.147	trace.	.474	.305	76.060	.950	2.235	2.829	.368	Subsoil to same.
1811	Greenup. . . .	4.375	7.060	.870	.083	.115	.027	.098	.068	86.890	1.100	1.150	1.220	.520	Cultivated field; Valley Wh. Oak Cr.
1812	Greenup. . . .	3.790	6.656	.745	.067	.109	.033	.193	.163	87.665	.910	1.000	.817	.380	Subsoil to same.
1837	Hopkins . . .	3.950	5.845	.125	.088	.080	not est.	.193	. . . .	88.015	1.375	1.750	1.686	.425	Virgin soil; woods; sandstone.
1838	Hopkins . . .	3.900	5.936	.235	.137	.099	not est.	.086	.145	88.115	1.150	1.600	1.528	.371	Cultivated field; sandstone.
1839	Hopkins . . .	3.100	10.321	.115	.035	.064	not est.	.354	. . . .	84.665	1.050	2.600	1.149	.621	Subsoil of same.
1840	Hopkins . . .	5.895	5.649	.383	.142	.061	not est.	.348	.103	86.590	.623	1.580	1.336	.604	Vir. soil; w'ds; Morton's Gap; sandst'e.
1841	Hopkins . . .	4.000	6.153	.245	.092	.032	not est.	.300	.213	89.195	.420	1.225	1.272	.588	Old fi'd soil; Morton's Gap, sandstone.
1842	Hopkins . . .	3.080	7.224	.245	.095	.061	not est.	.498	.235	88.415	.550	1.335	1.236	.621	Subsoil of same.
1843	Hopkins . . .	7.125	6.322	.305	.162	.163	not est.	.325	.020	85.2[illegible]	.875	1.775	1.152	.403	Vir. soil, near Nortonsville; sandstone.
1844	Hopkins . . .	3.185	5.155	.120	.124	.080	not est.	.292	.186	91.455	.430	.730	1.163	.388	Old field, near Nortonsville; sandstone.
1845	Hopkins . . .	3.815	10.090	.145	.269	.045	not est.	.518	.251	85.160	.685	2.160	1.247	.488	Subsoil of same.
1852a	Knox	3.453	5.456	.100	.158	.179	not est.	.125	.576	89.115	.741	.815	1.648	.130	Vir. soil; foot of Pt. Hill K'bs; s'dst'e.
1852b	Knox	4.374	8.781	.120	.158	.104	not est.	.261	not est.	85.165	.621	.900	1.648	.446	Old fi'd soil; f't of Pt. Hill K'bs; s'dst'e.
1852c	Knox	5.658	7.825	.095	.158	.185	not est.	.467	not est.	84.765	.909	1.025	2.320	.546	Vir. soil; top of Paint Hill Knobs.
1852d	Knox	2.800	2.835	.045	.016	.055	not est.	.112	.021	93.790	.525	.950	.399	.235	Virgin soil; Cumberland R. Valley.
1852e	Knox	2.765	1.904	.130	.029	.061	not est.	.094	not est.	94.510	.535	.435	.409	.150	Old fi'd soil, same locality as next above.
1852f	Knox	1.750	3.644	.045	.025	.031	not est.	.130	not est.	93.215	1.675	.435	.718	.119	Subsoil of same.
1853	Laurel	6.110	5.298	.110	.011	.077	not est.	.229	.149	87.330	1.100	.865	.843	.171	Virgin soil (sandstone).
1854	Laurel	3.625	4.882	.130	.025	.083	not est.	.312	.268	90.230	.725	.550	.661	.211	Old field soil, same locality.
1855	Laurel	2.450	5.719	.145	.016	.071	not est.	.110	.228	90.780	.400	.575	.892	.214	Subsoil of the next above.
1856	Laurel	5.990	7.339	.070	.124	.096	not est.	.217	. . . .	84.415	1.075	1.535	.939	.400	Virgin soil near London (sandstone).
1857	Laurel	3.475	7.361	.120	.053	.099	not est.	.074	. . . .	87.740	.675	.800	.862	.623	Old field soil (same locality).
1858	Laurel	3.740	9.385	.110	.075	.100	not est.	.447	. . . .	85.365	.725	1.425	.975	.575	Subsoil of next preceding.
1870	Lewis	3.325	10.965	.125	.266	.125	trace.	.501	.116	83.465	1.025	3.[illegible]	1.843	1.036	From Ohio Bottom.
1871	Lewis	2.665	8.995	trace.	.092	.125	.015	.387	.128	86.365	.685	2.225	1.233	.808	Subsoil of same.
1872	Lewis	4.425	9.545	.180	.208	.205	.050	.462	.134	83.100	1.725	2.335	1.138	.954	Old field soil; back of Ohio Bottom.
1903a	Muhlenburg . .	3.325	4.137	.345	.176	.189	trace.	.145	not est.	90.215	1.222	1.800	1.339	.716	Virgin soil (A. Stroud's farm).
1903b	Muhlenburg . .	1.052	3.548	.006	.167	.102	trace.	.167	not est.	94.340	1.050	.775	1.091	.564	Subsoil of same (A. Stroud's farm).
1903c	Muhlenburg . .	1.242	3.749	.145	.122	.121	trace.	.255	.477	93.140	1.242	.965	1.113	.474	Old field soil of same (sandy shale).
1955	Webster. . . .	4.010	4.064	.145	.178	.071	not est.	.288	.055	91.350	.400	1.500	1.461	.759	Vir. soil; woods pasture near Madis'v'e.
1956	Webster. . . .	2.975	3.997	.220	.160	.118	not est.	.104	.152	91.490	.225	1.375	1.534	.693	Cultivated field (same locality).
1957	Webster. . . .	3.575	7.289	.145	.124	.061	not est.	.135	.415	88.015	.500	2.105	1.619	.912	Subsoil of same.
1961	Whitley	3.075	3.429	.115	.080	.061	.008	.194	.164	91.165	1.500	1.200	.692	.120	Virgin soil (on bluff); conglomerate.
1962	Whitley	4.265	2.695	.110	.084	.140	not est.	.052	. . . .	91.465	.782	.950	.989	.291	Virgin soil; top of King's Mountain.

* Containing: of alumina 6.093, iron peroxide 4.330, and manganese oxide 0.021 per cent.

TABLE II. COALS, AIR-DRIED.

Number in Report.	County.	Specific gravity.	Hygroscopic moisture.	Volatile combustible matters.	Coke.	Total volatile matters.	Fixed carbon in the coke.	Ash.	Character of the coke.	Color of the ash.	Per centage of sulphur.	Remarks.
1667	Bell	1.276	1.90	37.50	60.60	39.40	57.90	2.70	Light spongy	Light-brown	1.519	Abram Lock's coal, Straight Creek.
1668	Bell	1.262	1.00	43.60	55.40	44.60	47.80	7.60	Dense spongy	Buff-grey	.590	Cannel coal; Col. Eves', Stony Creek.
1669	Bell	1.346	1.80	35.50	62.70	37.30	52.20	10.50	Light spongy	Very light grey	.956	Hignite coal; Branch of Yellow Creek, upper bed.
1670	Bell	1.290	2.04	36.64	61.32	38.68	58.02	3.30	Light spongy	Light lilac-grey	.736	Hignite coal; Branch of Yellow Creek, middle bed.
1671	Bell	1.277	2.96	35.28	61.76	38.24	59.40	2.36	Light spongy	Brownish-grey	.420	Hignite coal; Branch of Yellow Creek, lower bed.
1672	Bell	1.360	1.02	37.76	61.22	38.78	48.22	13.00	Light spongy	Lilac-grey	1.670	From Little Clear Creek.
1673	Bell	1.325	1.76	38.90	59.34	40.66	52.54	6.80	Light spongy	Lilac-grey	2.027	From Little Clear Creek.
1674	Bell	1.344	1.26	33.96	64.78	35.22	55.42	9.36	Light spongy	Light lilac-grey	2.672	From Fork Ridge, Stony Creek.
1675	Bell	1.282	1.36	35.80	62.84	37.16	59.54	3.30	Light spongy	Buff-grey	.975	Jas. Barnett's, Clear Fork.
1676	Bell	not est	1.50	37.94	60.50	39.44	58.40	2.16	Light spongy	Brownish-buff	1.038	Jas. Barnett's, Clear Fork, market sample.
1702	Breathitt	1.405	3.30	31.44	65.26	34.74	49.76	12.50	Dense friable	Pinkish-grey	.991	Roberts' bank, Troublesome Creek, bituminous part.
1703	Breathitt	1.280	3.40	43.40	53.20	46.80	46.96	6.24	Friable	Light buff-grey	.630	Roberts' bank, Troublesome Creek, cannel part.
1704	Breathitt	1.290	2.20	39.20	58.60	41.40	51.14	7.46	Spongy	Lilac-grey	2.525	Roberts' bank, Troublesome Creek, middle part.
1705	Breathitt	1.265	1.30	47.00	51.70	48.30	44.40	7.30	Dense	Brownish-grey	1.574	Haddock's cannel coal, Troublesome Creek.
1706	Breathitt	1.360	1.60	43.20	55.20	44.80	33.80	21.40	Pulverulent	Light-buff	2.549	Johnson's cannel coal, Frozen Creek.
1707	Breathitt	1.180	1.20	58.80	40.00	60.00	35.30	4.70	Dense	Light grey-buff	not est	Johnson's cannel coal, Frozen Creek.
1708	Breathitt	1.300	2.50	41.10	56.40	43.60	49.22	7.18	Light spongy	Dark lilac	.818	Johnson's cannel coal, Frozen Creek.
1709	Breathitt	1.328	2.10	43.10	54.80	45.20	43.36	11.44	Spongy	Light grey	4.609	Cannel coal; A. Little's, Quicksand Creek.
1710	Breathitt	1.398	2.78	35.52	61.70	38.30	44.94	16.76	Dense spongy	Light lilac-grey	1.423	Jackson Wells' coal, Troublesome Creek.
1711	Breathitt	1.280	.94	52.38	46.68	53.32	35.54	11.14	Dense	Light lilac-grey	1.423	Cannel coal, George's Creek.
1712	Breathitt	1.290	4.90	35.30	59.80	40.20	55.50	4.30	Spongy	Light grey	3.153	Simon Holland's coal.
1713	Breathitt	1.290	2.76	36.68	60.56	39.44	56.50	4.03	Light spongy	Light yellowish-grey	.865	Wolf Creek bank coal.
1714	Breathitt	1.297	3.56	33.56	62.88	37.12	58.38	4.50	Light spongy	Light lilac-grey	1.381	Wm. Spencer's coal, North Fork of Kentucky River.
1719	Christian	1.307	4.60	31.94	63.46	36.54	54.36	9.10	Dense	Light lilac-grey	1.469	Coal I, Coalton banks.
1720	Christian	1.332	5.10	32.50	62.40	37.60	55.70	6.70	Very dense	Light lilac-grey	1.277	Coal L, two miles south of Petersburg.
1721	Christian	1.398	3.70	32.50	63.74	36.26	50.04	13.70	Light spongy	Greyish-brown	3.716	Coal J, at Petersburg Station, St. L. & S. E. R. R.
1742	Clinton	1.349	1.50	37.74	60.70	39.30	50.20	10.50	Light spongy	Light lilac-grey	2.911	Conglomerate main coal, Cumberland mines.
1757	Daviess	1.323	6.2	36.20	57.60	42.40	50.90	6.70	Light spongy	Lilac-grey	1.519	Coal 2, Montgomery's mine.
1758	Daviess	1.340	4.10	38.50	57.40	42.60	51.00	6.40	Spongy	Lilac-grey	1.538	Coal D, Dutch mine.
1759	Daviess	1.318	5.80	35.06	59.14	40.86	50.40	8.74	Light spongy	Light lilac-grey	3.985	Coal D, Ion Harbor mines.
1760	Daviess	1.337	5.12	34.72	60.16	39.84	51.44	8.72	Light spongy	Light lilac-grey	3.513	Coal D, Dean's mine.
1761	Daviess	1.285	6.20	41.90	51.90	48.10	47.40	4.50	Light spongy	Grey-lilac	3.743	Coal from Duncan's bank, near Knottsville.
1784	Floyd	1.279	3.20	38.80	58.00	42.00	55.04	2.96	Light spongy	Light chocolate	2.310	Coal from Snipe's bank, Abbott's Creek.
1785	Floyd	1.274	2.50	40.80	56.70	43.30	53.40	3.24	Light spongy	Light grey	1.895	Coal from Harris' bank, Muddy Creek.
1786	Floyd	1.307	2.50	38.56	58.94	41.06	53.44	5.50	Spongy	Light lilac-grey	1.915	Coal from Hatcher's bank, Abbott's Creek.
1787	Grayson	1.343	6.50	30.04	63.46	36.54	55.54	7.92	Quite dense	Light lilac-grey	1.972	Coal from South or Allen bank, Falls of Rough Creek.
1795	Greenup	1.347	4.24	34.76	61.00	39.00	48.70	12.30	Spongy	Light lilac-grey	1.601	Turkey Lick coal.
1796	Greenup	1.331	4.00	37.70	58.30	41.70	51.60	6.70	Dense spongy	Lilac-grey	2.645	Coal 3, Turkey Lick, Pennsylvania Furnace.
1797	Greenup	1.280	4.56	36.68	58.76	41.24	52.40	6.36	Light spongy	Very light lilac-grey	.682	Turkey Lick coal mines, main entry
1798	Greenup	1.332	4.60	34.80	60.60	39.40	51.00	9.60	Dense spongy	Very light lilac-grey	.667	Turkey Lick coal, old entry.

1799	Greenup. . . .	1.384	4.22	30.10	65.68	34.32	53.68	12.00	Friable	Light lilac-grey . . .	.925	Raccoon Furnace coal.
1800	Greenup. . . .	not est	19.20		80.80	19.2	75.10	5.70	. . . .	Nearly white	.666	Coke from Coal 3; Turkey Lick coal, Hunnewell Furn.
1813	Hancock . . .	1.213	1.30	59.60	39.10	60.90	27.00	12.10	Dense; friable. . .	Light grey-brown . .	1.890	Cannel coal; Cloverport Oil Company coal, entry No. 18.
1814	Hancock . . .	1.357	5.12	36.20	58.60	41.40	47.60	11.00	Dense.	Lilac-grey	4.038	Hancock Coal Company mines.
1815	Hancock . . .	1.353	5.40	34.80	59.80	40.20	49.30	10.50	Spongy	Light brownish-grey.	2.398	Milton Lawson's bank, Lead Creek.
1816	Hancock . . .	1.323	3.50	43.40	53.10	46.90	45.56	7.54	Light spongy . . .	Purplish chocolate . .	4.155	Robert Estes' bank, back of Lewisport.
1817	Hancock . . .	1.289	4.80	38.90	56.30	43.70	50.06	6.24	Light spongy . . .	Light brownish-grey.	2.316	Jas. Mason's bank, between Hawesville and Lewisport.
1818	Hancock . . .	1.401	4.50	37.60	57.90	42.10	47.46	10.44	Dense spongy . . .	Light chocolate . . .	7.809	Colbert's bank, near Lewisport.
1819	Hancock . . .	1.336	5.20	38.70	56.10	43.90	48.50	7.60	Dense spongy . . .	Light lilac-grey . . .	2.266	Bergenroth's bank, near Old Reverdy mines.
1820	Hancock . . .	1.308	7.46	33.14	59.40	40.60	55.20	4.20	Dense spongy . . .	Light grey.	1.368	John C. Schafer's bank, Blackford Creek.
1821	Hancock . . .	1.292	5.10	41.20	53.70	46.30	46.60	7.10	Light spongy . . .	Light lilac-grey . . .	3.331	Breidenbach's bank, Lead Creek.
1822	Hancock . . .	1.268	3.30	39.00	57.70	42.30	50.50	7.20	Light spongy . .	Brownish-grey	3.373	Davidson bank, near Hawesville.
1823	Hancock . . .	1.292	6.00	37.80	56.20	43.80	48.70	7.50	Spongy	Greyish-lilac.	3.180	R. S. Lanum's bank, near Hawesville.
1824	Harlan	1.510	1.40	34.60	64.00	36.00	39.40	24.60	Dense.	Chocolate	1.271	Cannel coal or bituminous shale, Martin's Fork.
1825	Harlan	1.289	1.70	35.70	62.60	37.40	59.60	3.00	Very light spongy .	Light-buff	.750	J. C. Howard's bank, Clover Fork, Cumberland river.
1826	Harlan	1.356	5.20	31.26	63.54	36.46	60.08	3.46	Pulverulent	Light-buff	.618	Martin's Fork, Skidmore Creek.
1829	Hopkins . . .	1.351	5.00	35.26	59.74	40.26	40.24	10.50	Light spongy . . .	Brownish-grey	3.015	Coal D, Diamond coal mines.
1830	Hopkins . . .	1.337	4.30	37.64	58.06	41.94	50.56	7.50	Light spongy . . .	Dark brownish-grey .	2.802	Coal D, St. Bernard coal mines.
1831	Hopkins . . .	1.366	3.04	36.90	60.06	39.94	49.06	11.00	Light spongy . . .	Lilac-grey	5.955	Coal B, Fleming coal mine, bottom portion.
1832	Hopkins . . .	1.290	2.70	40.74	56.56	43.44	51.64	4.92	Light spongy . . .	Light lilac-grey . . .	1.502	Coal B, Fleming coal mine, top portion.
1833	Hopkins . . .	1.323	3.28	39.32	57.40	42.60	49.54	7.86	Light spongy . . .	Lilac grey	4.710	Coal B, Hecla coal mines, average sample.
1834	Hopkins . . .	1.326	3.82	36.38	59.80	40.20	51.50	8.70	Light spongy . . .	Lilac grey	3.639	Coal B, Hecla coal mines, lower bench.
1835	Hopkins . . .	1.326	3.20	38.30	58.50	41.50	48.50	10.00	Light spongy . . .	Lilac grey	3.345	Coal B, St. Bernard coal mines, lower drift.
1836	Hopkins . . .	1.331	2.32	37.68	60.00	40.00	51.00	9.00	Light spongy . . .	Lilac-grey	3.606	Coal D, Hecla coal mines, average sample.
1846	Jackson	1.338	2.00	41.00	57.00	43.00	43.10	13.90	Spongy	Very light buff-grey .	1.049	Cannel coal, Tom Coyle's bank, 100 feet above Congl'te.
1847	Jackson	1.321	2.00	43.60	54.34	45.66	45.58	8.76	Dense.	Grey-lavender	3.384	Cannel coal, T. J. Ballard's bank, Horse Lick.
1849	Johnson	1.291	2.00	38.70	59.80	40.20	51.00	8.80	Dense.	Light lilac grey . . .	.956	Cannel coal, Lick Branch, White House Creek.
1850	Johnson . . .	1.294	3.10	38.60	58.30	41.70	53.50	4.80	Light spongy . .	Light brownish-grey	1.752	Rice's coal, head of Jenny's Creek.
1851	Johnson	1.280	2.00	[illegible]	59.30	40.70	[illegible]	3.00	Spongy	Light-grey	1.291	Coal from Wheeler's bank, near Paintsville.
1859	Lawrence . . .	1.317	3.26	34.22	62.52	37.48	55.36	7.16	Dense.	Light brownish-grey .	0.901	Coal 3; Peach Orchard, Miller's Branch opening.
1860	Lawrence . . .	n. d.	3.24	36.56	60.20	39.80	54.56	5.24	Dense.	Light lilac-grey . . .	1.189	Coal 3; Peach Or'd, Miller's Br'h opening (weathered).
1861	Lawrence . . .	1.245	1.84	48.10	50.0	50.00	14.74	5.76	Dense.	[illegible]	1.076	Cannel coal, Little Laurel Creek.
1865	Lee	1.331	2.30	38.10	59.6	[illegible]	[illegible]	7.96	Light spongy . . .	Lilac-grey	2.356	From Dan'l Scott's bank, near Proctor.
1866	Lee	1.334	2.10	38.10	59.80	40.20	51.54	8.26	Spongy	Lilac-grey	3.991	Same locality as above, another entry.
1867	Lee	1.307	4.00	35.50	60.50	39.50	55.50	5.00	Light spongy . . .	Light lilac-grey . . .	1.041	Pryse's coal, Lower Stufflebean Creek.
1868	Lee	1.307	3.10	36.04	60.26	39.74	56.96	3.30	Dense spongy . . .	Light buff grey. . . .	1.030	From Phillip's bank, Mirey Creek.
1869	Lee	1.330	3.40	32.70	63.90	36.10	57.60	6.30	Spongy	Light lilac grey . . .	1.368	From R. B. Jameson's bank, Mike's Branch.
1877	Madison . . .	1.281	2.00	33.08	63.66	36.34	56.10	7.50	Dense spongy . . .	Nearly white.	.824	Cox's coal bank, top of Big Hill.
1878	Madison . . .	1.282	1.90	45.76	52.34	47.66	44.86	7.48	Dense.	Nearly white	2.888	Moran's mine, top of Big Hill.
1878a	Magoffin . . .	1.275	1.80	45.60	52.60	47.40	43.40	9.20	Dense spongy . . .	Buff-grey	.688	Salyersville coal (half cannel), lower portion.
1879	Magoffin . . .	1.292	2.70	38.04	59.26	40.74	51.62	7.04	Light spongy . . .	Very light br'nish-grey	1.470	Salyersville coal (half cannel), upper portion.
1880	Magoffin . .	1.309	4.34	37.30	58.30	41.70	53.14	5.16	Spongy	Light purplish-grey .	1.357	Amos Davis' coal, on Licking river.
1881	Magoffin . . .	1.271	3.70	36.64	59.66	40.34	54.68	4.98	Light spongy . . .	Light buff-grey . . .	.944	Sacye Bank coal, near Mouth of Johnson's Creek.
1882	Magoffin . . .	1.235	2.30	51.90	45.80	54.20	37.56	8.24	Very dense . . .	Brownish grey . . .	1.415	Colvin's cannel coal.
1883	Martin	1.351	2.16	33.60	64.24	35.76	55.06	9.18	Light spongy . . .	Brownish-grey	2.563	Coal 1; Mouth of Collins' Creek; Warfield.
1884	Martin . . .	1.358	2.50	33.70	63.80	36.20	52.02	11.18	Light spongy . . .	Light lilac-grey . .	.754	Coal; Warfield; Tug Fork.
1885	Martin	1.358	2.24	33.06	64.70	35.30	52.70	12.00	Dense.	Very light lilac-grey .	.604	Warfield splint coal, above main coal.
1886	Martin	1.367	3.50	31.94	64.56	35.44	52.06	12.50	Dense.	Very light lilac-grey .	.873	Eight-feet coal, head of Laurel Fork of Nat's Creek.
1887	Martin	1.302	2.00	35.12	62.88	37.12	54.82	8.06	Dense.	Lilac-grey	.983	Coal 1; Warfield.
1888	McLean. . . .	not est	1.60	36.40	62.00	38.00	31.36	30.64	Friable	Brownish lilac-grey .	not est	Bituminous shale, near Wrightsburg.
1889	McLean. . . .	1.241	3.30	36.00	60.70	39.30	57.88	2.82	Light spongy . . .	Buff-grey	1.024	Coal, near Wrightsburg.
1890	Morgan . . .	1.231	2.06	49.64	48.30	51.70	43.20	5.10	Spongy	Light buff-grey. . . .	.955	Pierat's cannel coal.
1891	Morgan	1.331	2.30	41.60	56.10	43.90	44.70	11.46	Very dense spongy.	Grey-buff	1.271	Cannel coal; Maynhier's bank, Elk Fork, Licking river.

TABLE II. COALS, AIR-DRIED—(Continued).

Number in Report.	County.	Specific gravity.	Hygroscopic moisture.	Volatile combustible matters.	Coke.	Total volatile matters.	Fixed carbon in the coke.	Ash.	Character of the coke.	Color of the ash.	Per centage of sulphur.	Remarks
1892	Morgan	1.353	4.26	35.24	35.24	39.50	50.10	10.40	Dense spongy . . .	Nearly white	1.011	Six-foot coal, near West Liberty.
1896a	Menifee	1.300	5.00	39.06	55.94	44.06	53.18	2.76	Spongy	Brownish lilac-grey .	1.199	Price and Fitch's bank, top of the mountain.
1896b	Menifee	1.300	5.00	32.40	62.60	37.40	58.40	4.20	Dense	Light yellowish grey .	.614	Adams' bank, Old Slate Branch, near Frenchburg.
1896c	Menifee	1.318	2.70	38.22	59.08	40.92	54.80	4.26	Spongy	Lilac-grey	1.615	Old State Road Branch.
1898	Muhlenburg . .	1.280	4.60	42.60	52.80	42.70	50.06	2.74	Spongy	Light-grey	1.601	Coal B, Louisville and Stroud City mines (top of bed).
1899	Muhlenburg . .	1.309	3.36	37.90	58.74	41.26	52.74	6.00	Light spongy . . .	Light lilac-grey . . .	2.686	Coal B, Memphis Coal Company's mine.
1900	Muhlenburg . .	1.313	5.40	35.90	58.70	41.30	53.60	5.10	Light spongy . . .	Light lilac-grey . . .	2.219	Coal B, Louisville and Stroud City mine.
1901	Muhlenburg . .	1.235	5.40	34.20	60.40	39.60	54.20	6.20	Light spongy . . .	Bright lilac-grey . . .	3.136	Coal B, St. Louis mines, Owensboro Junction.
1902	Muhlenburg . .	1.307	4.60	37.60	57.80	42.20	52.64	5.16	Light spongy . . .	Dark brownish-grey .	2.372	Coal B, St. Louis mines. "Gas coal."
1903	Muhlenburg . .	1.332	3.80	36.20	60.00	40.00	51.80	8.20	Light spongy . . .	Lilac-grey	3.194	Coal B, Rothrock's mine (upper bench).
1904	Ohio	1.318	3.80	36.66	59.54	40.46	52.00	7.54	Spongy	Light lilac-grey . . .	1.944	Coal D, McHenry coal mine (without sulphur band).
1905	Ohio	1.331	2.70	35.24	62.06	37.94	53.62	8.44	Light spongy . . .	Lilac-grey	3.785	Coal D, McHenry coal mine (with sulphur band).
1906	Ohio	1.310	4.40	38.20	57.40	42.60	49.94	7.46	Light spongy . . .	Light lilac-grey . . .	2.246	Coal D, Render mine. From nut coal pile.
1907	Ohio	1.336	4.10	34.36	61.54	38.46	51.24	10.30	Light spongy . . .	Lilac-grey	3.263	Coal D, Render mine. From the slack pile.
1908	Ohio	1.295	5.00	36.74	58.26	41.74	55.66	2.60	Light spongy . . .	Light-brown	1.605	From Ch. W. Stephens' bank, Rough Creek.
1909	Ohio	1.297	5.90	33.80	60.30	39.70	56.90	3.40	Light spongy . . .	Buff	1.038	From G. B. Hocker's bank, Rough Creek.
1910	Ohio	1.251	5.54	35.66	58.80	41.20	56.20	2.60	Light spongy . . .	Light-buff	.983	From same locality as last.
1911	Ohio	1.382	5.10	30.70	64.20	35.80	54.24	9.96	Spongy	Light br'ish lilac-grey	2.164	From Marion Sandifer's bank, Big Muddy Creek.
1912	Ohio	1.386	4.80	33.70	61.50	38.50	52.26	9.24	Spongy	Brownish lilac-grey .	3.364	From L. M. Patterson's mine, Point Pleasant.
1913	Ohio	1.345	3.50	36.30	60.20	39.80	50.92	9.28	Light spongy . . .	Brownish lilac-grey .	3.524	Coal D, Williams' coal bank, Ben's Lick.
1914	Ohio	1.593	2.20	27.80	70.00	30.00	35.28	34.72	Pulverulent	Dark br'ish lilac-grey	5.694	Cannel coal or bituminous shale; H. D. Bennett's.
1915	Ohio	1.273	5.30	45.70	49.00	51.00	45.00	4.00	Dense spongy . . .	Lilac grey	2.150	Coal; Berry & Walker's land, Muddy Creek.
1916	Ohio	1.305	6.54	37.92	55.54	44.46	51.54	4.00	Light spongy . . .	Light yellowish-brown	1.917	Coal; Ben. Hines' coal bank (above the clay parting).
1917	Ohio	1.295	4.80	41.00	54.20	45.80	49.14	5.06	Light spongy . . .	Dark lilac-grey . . .	2.356	Coal; Ben. Hines' coal bank (below the clay parting).
1918	Ohio	1.384	4.80	35.80	59.40	40.60	45.20	14.20	Spongy	Light lilac-grey . . .	3.015	Coal E, on Rough Creek, Mouth of Brush Creek.
1919	Ohio	1.340	6.80	32.40	60.80	39.20	52.50	8.30	Spongy	Very light lilac-grey .	2.109	L. D. Taylor's coal.
1920	Ohio	1.356	4.80	35.60	59.60	40.40	49.66	9.94	Spongy	Light lilac grey . . .	3.180	Coal D, Brown's coal bank.
1921	Ohio	1.357	6.66	33.64	59.70	40.30	51.56	8.14	Light spongy . . .	Lilac-grey	2.768	Wm. Warden's coal, near Centretown.
1922	Ohio	1.380	6.00	34.30	59.70	40.30	50.36	9.34	Spongy	Grey-brown	4.307	From Berry & Walker's land, Hines' tract.
1923	Ohio	1.413	2.70	39.30	58.00	40.20	45.90	12.10	Spongy	Grey purplish-brown.	7.959	From A. Woodward's bank, on Barrett's Creek.
1924	Ohio	1.310	6.10	37.50	56.40	43.60	50.46	5.94	Spongy	Light-grey	3.002	From Gaines' bank, near Fordsville.
1925	Ohio	1.310	5.54	35.66	58.80	41.20	48.88	9.92	Much inflated . . .	Dark lilac-grey . . .	4.199	From H. Dooring's mine.
1926	Ohio	1.282	3.96	40.50	55.54	44.46	52.38	3.16	Much inflated . . .	Lilac-grey	1.407	From Henry Thompson's bank (a lower coal).
1927	Ohio	1.348	3.94	37.86	58.20	41.80	50.48	7.72	Light spongy . . .	Lilac-grey	3.128	From Norton's coal bank.
1928	Ohio	1.321	3.70	36.64	59.66	40.34	55.30	4.36	Dense	Light purplish-brown.	1.241	From Martin's bank, near Eden Lick.
1929	Ohio	1.401	3.20	37.06	59.74	40.26	47.24	12.50	Dense	Dark lilac-grey . . .	6.809	From Henry Davis' mine (upper portion).
1936	Owsley	1.294	2.10	35.24	62.66	37.34	58.66	4.00	Spongy	Light lilac-grey . . .	1.424	From Steffee & Samuel's mine, South Fork of Ky. river.
1937	Owsley	1.161	.50	59.70	39.80	60.20	32.34	7.46	Dense	Light-brown	not est	Cannel coal; Steffee & Samuel's mine, S. Fk. Ky. river.
1938	Perry	1.289	2.10	36.20	61.70	38.30	58.20	3.50	Light spongy . . .	Buff-grey	.836	Coal from Josiah Cobb's bank, near Hazard (upper part).
1939	Perry	1.370	3.70	30.64	65.66	34.34	57.02	8.64	Pulverulent	Grey-buff	.654	Coal from Campbell's bank, Mace's Creek.
1940	Perry	1.303	2.06	36.74	61.20	38.80	56.30	4.90	Spongy	Brownish-grey . . .	1.436	Coal from R. C. Comb's bank, below Hazard.

1941	Perry	1.288	1.60	36.10	62.30	37.70	56.40	5.90	Light spongy . . .	Light-grey	.836	Coal from Logan's drift, Brashear's salt-works.
1942	Perry	1.274	1.80	40.90	57.30	42.70	53.70	3.60	Light spongy . . .	Brown-grey	1.339	Coal from David Grigsby's bank, Lot's Creek.
1943	Perry	1.290	1.20	40.86	57.94	42.06	48.44	9.50	Dense	Light-grey	.634	Coal from D. Grigsby's bank, lower part. Cannel coal.
1944	Pulaski	1.357	2.40	36.76	60.84	39.16	50.24	10.60	Spongy	Brownish lilac grey .	2.494	Coal from Cumberland coal banks (Sub-congl'rate coal).
1945	Pulaski	1.357	2.00	35.30	62.70	37.30	52.94	9.76	Light spongy . . .	Dark lilac-grey . . .	3.565	Coal from Doolin's bank (a Sub-conglomerate coal).
1947	Rockcastle . .	1.318	2.00	36.66	61.34	38.66	51.94	9.40	Light spongy . . .	Dark lilac-grey . . .	2.205	Coal from Myzner & Myers' bank, Livingston (Entry 1).
1948	Rockcastle . .	1.357	2.20	36.50	61.30	38.70	51.70	9.60	Light spongy . . .	Dark lilac-grey . . .	4.802	Coal from Myzner & Myers' bank, Livingston (Entry 2).
1949	Rockcastle	1.327	2.20	35.86	61.94	38.06	54.94	7.00	Spongy	Light-chocolate . . .	4.302	Coal from Grisham's coal mine (the brashy coal).
1950	Rockcastle . .	1.374	2.10	39.50	58.40	41.60	49.86	8.54	Spongy	Purplish-grey	2.933	Coal from Grisham's coal mine (lower nine inches).
1960	Whitley . . .	n. d.	2.84	27.10	70.00	30.00	43.40	26.60	Dense	Purplish-grey	2.562	Cannel coal or bituminous shale; Cumberland Falls.
1963	Wolfe	1.336	3.74	35.52	60.74	39.26	52.64	8.10	Spongy	Lilac-grey	2.466	Coal from C. M. Hanks' bank, Compton.
1964	Wolfe	1.434	1.30	41.40	57.30	42.70	28.20	29.10	Pulverulent	Nearly white	.846	Cannel coal or bituminous shale; J. F. Ely's, Gilmore Cr.
1965	Wolfe	1.383	1.16	44.58	54.26	45.74	32.70	21.50	Pulverulent	Light lilac-grey . . .	.530	Cannel coal? J. W. Faukner's, Stillwater Creek.
1966	Wolfe	1.294	3.50	35.20	61.30	38.70	56.70	4.60	Spongy	Lilac-grey	1.189	Coal from Hobb's bank, near Compton.

TABLE III. IRON ORES (LIMONITES), DRIED AT 212° F.

Number in Report.	County.	Iron peroxide.	Iron carbonate.	Manganese br'n oxide.	Alumina.	Lime carbonate.	Magnesia.	Phos'oric acid.	Sulphuric acid.	Comb'ed water.	Silica and silicates.	Moisture & loss.	Per centage of iron.	Per centage of phosphorus.	Per centage of sulphur.	Per centage of silica.	Remarks.
1652	Bath	70.060	. . .	not est	4.540	0.040	0.021	1.620	0.031	12.300	11.530	. . .	49.042	0.707	0.012	11.530	Slate Furnace ore, "Howard's Hill."
1653	Bath	69.728	. . .	not est	8.642	.170	.045	1.154	.134	12.650	7.930	. . .	48.809	.504	.053	7.760	Slate Furnace ore (upper part of bed).
1654	Bath	47.321	. . .	not est	5.418	.690	.079	.161	.376	12.050	33.330	.575	33.125	.070	.159	27.600	Chalybeate Springs, Pilot Knob.
1655	Bath	39.068	11.479	not est	8.346	18.710	6.159	.868	.185	7.835	7.350	. . .	30.734	.379	.074	7.560	Near Owingsville (18 to 20 feet thick).
1656	Bath	59.621	. . .	not est	12.370	.500	.144	.709	trace.	10.400	15.830	.426	41.735	.309	trace.	13.960	Old coaling bank, Clear Creek.
1657	Bath	66.329	. . .	not est	12.532	trace.	.173	.709	trace.	9.580	9.720	.957	46.440	.309	trace	9.060	Richardson's bank, Clear Creek.
1658	Bath	65.310	. . .	not est	11.947	.730	.140	.825	trace.	11.000	9.580	.468	44.570	.360	trace.	9.580	Pergam bank, Clear Creek.
1762	Edmonson . .	40.798	. . .	1.293		trace	trace.	1.019	.360	7.250	50.030	. . .	28.559	.445	.207	46.760	Still-house Branch of Bear Creek.
1763	Edmonson . .	47.724	. . .	2.501		trace	trace	.697	.315	8.250	41.145	. . .	33.407	.304	.125	39.560	Dismal Creek.
1764	Edmonson . .	49.906	. . .	3.330		trace.	trace.	.694	.395	9.320	36.780	. . .	39.407	.303	.158	33.460	Sycamore Branch of Bear Creek.
1765	Edmonson . .	32.820	. . .	2.356		trace.	trace.	.984	.285	8.330	55.180	.045	22.974	.430	.114	48.960	Mill Branch of Bear Creek.
1766	Edmonson . .	77.871	. . .	not est	1.444	trace.	.070	.505	trace	11.050	8.660	.040	54.510	.221	trace	8.660	Cave Branch of Gulf Creek.
1770	Estill	74.127	. . .	not est	3.542	.390	.461	.601	not est	11.270	9.580	.029	51.889	.262	not est	7.860	From Lustre drift.
1771	Estill	65.535	. . .	not est	2.798	.450	1.073	.537	not est	9.800	20.480	. . .	45.874	.234	not est	18.260	Logan Ridge limestone ore.
1772	Estill	75.598	. . .	not est	1.971	.540	.258	.601	not est	11.730	8.910	.392	52.918	.262	not est	7.260	Tubbs' bank ore.
1773	Estill	65.591	. . .	not est	5.762	trace.	.248	.447	trace.	11.000	16.230	.722	45.914	.195	not est	14.160	Horse Ridge ore banks.
1794	Grayson . . .	48.913	5.735	not est	7.125	9.410	.144	.489	.199	8.905	19.080	. . .	36.526	.209	.080	16.760	Old Nolin Furnace ore.
1862	Lawrence . . .	67.515	. . .	not est	1.280	trace.	trace.	.135	.423	10.150	20.480	.017	47.250	.059	.175	16.960	Limestone ore, Upper Blane Creek.
1863	Lawrence . . .	55.693	. . .	not est	1.151	trace.	trace.	.284	.302	10.510	31.280	.780	39.105	.124	.111	25.660	Red kidney ore, Cherokee Creek.
1897	Menifee	54.750	. . .	not est	14.515	trace.	.047	.697	trace.	8.600	20.830	.559	38.750	.304	trace.	19.500	From Branch of Beaver Creek.
1930	Ohio	61.179	. . .	not est	15.503	trace.	.176	.648	not est	9.273	13.830	. . .	48.825	.283	not est	9.960	Alfred Ashby's, Walton Creek.
1931	Ohio	44.594	. . .	not est	20.419	trace.	.248	.287	not est	8.860	26.550	. . .	31.216	.125	not est	23.420	Dooring's iron bank.
1932	Ohio	44.916	. . .	not est	13.204	trace.	.176	.280	not est	8.920	32.504	. . .	31.241	.177	not est	24.460	Same locality.
1933	Ohio	15.044	. . .	not est	6.113	trace.	.338	.073	not est	6.152	72.280	. . .	10.531	.032	not est	69.100	Ochreous limonite.

TABLE III (A). IRON ORES (CLINTON OR DYESTONE ORES), DRIED AT 212° F.

Number in Report.	State.	Iron peroxide.	Iron carbonate.	Manganese brown oxide.	Alumina.	Lime carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Combined water.	Silica and silicates.	Moisture and loss.	Per centage of iron:	Per centage of phosphorus.	Per centage of sulphur.	Per centage of silica.	Remarks.
A	Tennessee . . .	77.380	. .	3.941		0.420	trace	0.319	trace.	2.500	15.960	not est	54.166	0.140	trace	15.760	Cumberland Gap; Poor Valley Ridge, upper bed.
B	Tennessee . . .	73.935	. . .	5.776		4.510	.260	.319	trace.	3.850	11.730	not est	51.754	.140	trace.	11.730	Cumberland Gap; Poor Valley Ridge, upper bed.
C	Tennessee . . .	47.965	. . .	2.130		1.230	.194	.575	trace	4.000	43.690	not est	33.575	.251	trace.	42.760	Cumberland Gap; Poor Valley Ridge, middle bed.
D	Tennessee . . .	80.820	. . .	not est		not est	not est	not est	not est	not est	not est	not est	56.574	not est	trace.	11.260	Cumberland Gap; from Old Clinton Furnace.
E	Pennsylvania .	38.48	*4.37	not est	9.56	†1.06	trace	1.48	.05	4.500	37.99	not est	30.34	.210	.05	37.99	Dysart's mine, middle bed.

* Iron protoxide. † Lime.

TABLE IV. IRON ORES (CLAY IRON-STONES), DRIED AT 212° F.

Number in Report.	County.	Specific gravity.	Iron carbonate.	Iron peroxide.	Alumina.	Lime carbonate.	Magnesia carbonate.	Manganese carbonate.	Phosphoric acid.	Sulphuric acid.	Silica and silicates.	Water and loss.	Per cent. of iron.	Per cent. of phosphorus.	Per cent. of sulphur.	Per cent. of silica.	Remarks.
1769	Estill	not est	76.491	4.049	2.014	5.400	0.514	not est	0.409	0.267	9.330	. . .	39.758	0.178	0.107	7.660	Tubbs' bank, near Estill Furnace.
1858	Lawrence . . .	1.351	. . .	. . .	not est	. . .	. . .	. . .	. . .	. . .	. . .	. . .	33.264	not est	.483	7.460	From near Louisa. Black Band ore.
1858a	Lawrence . . .	not est	. . .	. . .	not est	. . .	. . .	. . .	. . .	. . .	. . .	. . .	33.923	not est	.354	not est	From near Louisa. Black Band ore.
1858b	Lawrence . . .	not est	. . .	. . .	17.92	*.924	†.150	. . .	. . .	. .	. . .	. . .	25.746	.553	. . .	6.36	Louisa Fork Big Sandy river. Black Band ore.‡

* Per cent. of lime. † Per cent. of magnesia. ‡ Per cent. of bituminous matters, 13.700: these not estimated in 1858 and 1858a.

TABLE V. PIG IRONS.

Number in Report.	County.	Specific gravity.	Iron.	Graphite.	Combined carbon.	Manganese.	Silicon.	Slag.	Aluminum.	Calcium	Phosphorus.	Sulphur.	Total carbon.	Remarks.
1659	Bath	7.007	92.631	3.840	0.710	not det.	1.520	0.100	not det.	0.090	0.363	0.278	4.550	Cold blast No. 1 charcoal; Bath Furnace.
1660	Bath	7.667	92.056	3.640	.310	not det.	1.760	.100	not det.	.116	1.080	.218	3.950	Old Slate Furnace
1661	Bath	7.142	93.1[illegible]6	3.860	.590	not det.	.914	.160	not det.	not det.	.527	.011	4.45	Cold blast No. 1 charcoal car wheel; Cot. Fur.
1662	Bath	7.017	91.924	3.440	1.060	not det.	1.319	.260	not det.	not det.	.220	.107	4.50	Cold blast No. 2 charcoal; Bath Furnace.
1663	Bath	7.092	93.472	3.100	1.510	not det	.652	.160	not det.	not det.	.290	.121	4.610	Cold blast No. 3 charcoal; Bath Furnace.
1664	Bath	7.168	93.004	2.700	1.410	not det.	1.007	.260	not det.	not det.	.120	.172	4.110	Cold blast No. 4 charcoal; Bath Furnace.
1700	Boyd	6.921	92.962	2.100	1.310	not det.	2.545	.220	not det.	not det.	.568	.114	3.410	Hot blast mill iron; Bellefonte Furnace
1701	Boyd	6.163	89.902	2.900	.070	not det.	5.082	.280	not det	not det.	.417	.114	2.970	Hot blast silver-grey; Bellefonte Furnace.
1716	Carter	6.930	93.[illegible]63	3.950	.770	not det.	1.799	.160	not det.	not det.	.680	.081	4.720	Hot blast mill iron; Mt Savage Furnace.
1717	Carter	7.042	91.584	2.600	1.070	not det.	3.058	.620	not det.	not det.	.609	.152	3.670	Hot blast foundry No. 2; Mt. Savage Furnace.
1718	Carter	7.435	89.087	2.300	.500	not det	5.575	.660	not det.	not det	.609	.136	2.800	Hot blast silver-grey; Mt Savage Furnace.
1774	Estill	7.108	93.728	3.520	780	.389	1.202	.360	.264	not det	.290	.080	4.300	Cold blast No. 3 charcoal; Red River Furnace.
1775	Estill	not est.	93.963	2.000	2.550	.181	.363	.320	.648	not det.	.338	104	4.550	Cold blast No. 5 charcoal; Red River Furnace.
1776	Estill	7.220	94.174	3.340	1.110	not det.	.447	.360	not det.	not det.	.402	.182	4.450	Cold blast No 1 charcoal car wh'l iron; R. R. F.
1777	Estill	7.272	94.582	3.500	1.200	not det.	.900	.300	not det.	not det.	.444	.066	4.700	Cold blast No. 1 charcoal car wh'l iron; Estill F.
1801	Greenup	not det	92.284	2.960	.090	not det.	3.011	.880	not det.	not det.	.474	not est	3.050	No. 1 foundry iron; Hunnewell Furnace.
1802	Greenup	not det	90.630	2.500	.830	not det.	4.969	.300	not det.	not det.	.741	.040	3.330	No. 1 hot blast silver-grey; Pennsylvania Fur.
1803	Greenup . . .	not det.	92.060	2.700	.630	not det.	3.104	.300	not det.	not det.	.710	.033	3.330	No. 1 foundry iron; Pennsylvania Furnace.
1804	Greenup	not det.	94.764	2.900	.780	not det.	1.193	.200	not det.	not det.	.860	.033	3.680	Mill iron; Pennsylvania Furnace.
1805	Greenup	not det.	92.856	3.230	. . . .	not det.	2.545	.300	not det.	not det.	.817	.046	3.230	No. 2 foundry iron; Pennsylvania Furnace.
1806	Greenup	6.680	92.697	2.100	1.000	not det	1.813	not est.	not det.	not det.	.454	.218	3.100	No. 2 cold blast iron, from blue ore; Laurel F.
1807	Greenup	6.927	91.596	2.900	.250	not det.	3.417	.800	not det.	not det.	.247	.237	3.150	Hot blast mill iron, stone coal; Raccoon Fur.
F	Tennessee . . .	not est	92.828	3.260	.840	.153	1.668	.480	.766	.112	.145	.068	4.100	From Clinton ore; Old Clinton Furnace.

TABLE VI. CLAYS, DRIED AT 212° F.

Number in Report.	County.	Silica and silicates.	Silica.	Alumina.	Iron oxide.	Lime.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Water expelled at red heat.	Remarks.
1697	Boone	. . . .	48.360	33.060		3.057	0.367	not est.	not est.	4.664	1.706	8.786	Clay from near Burlington.
1767	Edmonson. . .	. . . .	80.160	11.600		.760*	.560	not est.	not est	3.854	.583	2.483	Clay from Sowder's farm.
1768a	Edmonson. . .	. . . .	77.660	16.800		.480*	not est.	not est.	not est.	1.002	.484	4.340	Clay from Sowder's farm (the upper part).
1768b	Edmonson. . .	. . . .	74.460	20.440		.640*	not est.	not est.	not est.	not est.	not est.	4.460	Clay from Sowder's farm (the second part).
1768c	Edmonson. . .	. . . .	71.560	22.860		.680*	not est.	not est.	not est.	not est.	not est.	4.900	Clay from Sowder's farm (the third part).
1768d	Edmonson. . .	. . . .	67.560	22.540		.980*	.671	.025	. . . .	2.470	.058	5.690	Clay from Sowder's farm (the lowest part).
1873	Lincoln	. . . .	61.580	23.946	5.814	.201	.850	not est.	not est.	1.542	.362	5.705	Clay from head waters of Green river.
1876a	Madison. . . .	. . . .	59.976	27.640		.280*	.606	not est.	not est	3.931	.547	7.020	Potter's clay (Upper Silurian); Waco.
1876b	Madison. . .	. . . .	56.960	28.740		.200*	.752	not est.	not est.	2.501	.315	10.531	Potter's clay (Upper Silurian); Waco.

* Carbonate.

TABLE VII. MARLY SHALES; MARLS AND SILICIOUS CONCRETIONS, DRIED AT 212° F.

Number in Report	County.	Silica and silicates.	Silica.	Alumina.	Iron oxide.	Lime carbonate.	Lime.	Magnesia carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Total potash.	Total soda.	Water, &c.	Remarks.
1665	Barren	8.860	. . . .	5.800		66.160	. . .	14.083	. . .	not est	not est	. . .	5.097	. . .	From Proctor's Cave
1741	Clinton	. . . .	70.800	18.840		. . . .	0.594	. . . .	4.358	not est	not est	4.240	.794	. . .	From Cumberland City Mines.
1788	Grayson. . . .	74.360	. . . .	14.451		1.60	. . .	. . . .	1.715	1.089	not est	4.240	.948	7.000	Nodular ferruginous clay, Bear Creek.
1789	Grayson. . . .	68.380	. . . .	12.451	7.588	1.380	. . .	. . . .	1.643	not est	not est	5.049	1.060	8.250	Nodular ferruginous, Canolaway Creek.
1790	Grayson. . . .	44.760	. . . .	26.221		9.160	. . .	6.629		1.089	not est	4.944	1.061	6.136	Marly shale below limestone; Hot Branch, **Bear Creek.**
1791	Grayson. . . .	59.920	. . . .	27.811		.880	. . .	. . . .	.824	.109	not est	5.554	.657	4.245	Marly shale, Haycraft's Lick.
1792	Grayson. . . .	58.961	. . . .	25.758		1.580	. . .	. . . .	4.437	.102	not est	5.145	.347	3.671	Red marly shale, Haycraft's Lick.
1793	Grayson. . . .	60.760	. . . .	23.071		1.180	. . .	. . . .	.497	.089	not est	4.093	.438	9.872	brown marly shale, Cedar Knob Lick.
1864	Lawrence . . .	80.660	. . .	1.800		.260	. . .	. . . .	. . .	not est	not est	not est	not est	3.88	Carbonaceous matters 13.40. **Petrifaction.**

APPENDIX.

THE CLINTON IRON ORE. DYESTONE ORE OF TENNESSEE. FOSSIL ORE.

In consequence of the great abundance of this valuable ore in the mountainous region of Tennessee, very near to the Kentucky line, and in view of the proximity of Kentucky coal beds to these ore beds, the members of the Geological Survey collected some characteristic average samples from them, which have been analyzed, with the following results:

A. "*Clinton Ore; upper bed, in Poor Valley Ridge. Cumberland Gap, Tennessee. Average sample from a number of exposures of the beds. By P. N. Moore. Clinton Group.*"

A soft ore, easily breaking into irregular laminæ or scales; filled with small disc-formed concretions or fossil casts. Powder of a blood-red color.

B. "*Clinton Ore; upper bed. Foot of Poor Valley Ridge, on a branch down from the Virginia Road. Cumberland Gap, Tennessee. Collected by P. N. Moore.*"

Very much like the preceding.

C. *Clinton Ore. Middle bed of the ore; twenty-six inches thick. Cumberland Gap, &c. Collected by P. N. Moore.*"

Harder and more compact than the preceding; containing but few fossil-like concretions or casts. Externally of a brownish-ochreous appearance. Powder of a light reddish-brown color.

D. "*Dyestone Ore, from near Cumberland Gap, Tennessee. From old Clinton Furnace. Clinton Group.*"

For comparison with the above, the analysis of a similar ore from Pennsylvania, analyzed by Professor Persifer Fraser, of the University of Pennsylvania, is appended.

E. *"Hard Fossil Ore, or Clinton Ore. Middle bench of Drysart's mine. Pennsylvania."*

COMPOSITION OF THESE CLINTON ORES, DRIED AT 212° F.

	A.	B.	C.	D.	E.
Specific gravity	3.942	3.914	3.190	. . . .	. . . .
Iron peroxide	77.380	73.935	47.965	80.820	38.48
Iron protoxide	. . . .	. . .	. . . .	. . . .	4.37
Alumina } Manganese oxide	3.941	5.776	2.130	. . . .	9.56 not est.
Lime carbonate	.420	4.510	1.230	. . . .	*1.06
Magnesia	a trace.	.266	.194	. . . .	a trace.
Phosphoric acid	.319	.319	.575	. . . .	1.48
Sulphuric acid	a trace.	a trace.	a trace.	. . . .	†.05
Combined water	2.500	3.850	4.000	. . . .	4.500 ‡2.54
Silica and insoluble silicates	15.960	11.730	43.690	. . . .	37.99
Total	100.520	100.386	99.784	. . . .	100.00
Per centage of iron	54.166	51.754	33.575	56.574	30.34
Per centage of phosphorus	.140	.140	.251	. . . .	.21
Per centage of sulphur	a trace.	a trace.	a trace.	. . . .	.05
Per centage of silica	15.760	11.730	42.760	11.260	37.99

* Lime. † Sulphur. ‡ Alkalies.

Professor J. P. Lesley, Chief of the Pennsylvania Geological Survey, states that the iron produced from this ore is always "cold-short," but that it is valuable to work with richer and less fusible ores. This is the character of this ore in other localities, and it appears to have a wide range, extending even into Wisconsin. But the samples examined in this laboratory do not yield as much phosphoric acid as the usual average of this ingredient; and from experiments which have been made in smelting this Tennessee ore, it is believed that a good tough iron can be made from it.

F. *A sample of the Pig Iron made at the furnace at the Cumberland Gap, from the Clinton Ore, was obtained by Mr. P. N. Moore, and analyzed.*

The iron is fine-grained mill iron? It yields with difficulty to the file, but extends under the hammer a little more than is usual with pig iron.

COMPOSITION OF THIS CLINTON PIG IRON.

Iron	92.828	
Graphite	3.260	Total carbon = 4.100.
Combined carbon	.840	
Manganese	.153	
Silicon	1.668	
Slag	.480	
Aluminum	.766	
Calcium	.112	
Magnesium	.270	
Phosphorus	.145	
Sulphur	.068	
	100.590	

It will be seen that this iron will compare favorably with the best quality of pig metal.

G. "*Coal from Winter's Gap, near Knoxville, Tennessee.*"

In a valley about ten miles from the Cincinnati Southern Railroad. The bed is said to be seven feet thick, and three acres of it have been mined out without leaving a pillar. Said to be the best pit coal in Tennessee. The sample was presented by Gen. Winder at the Centennial Exhibition. It is quite a pure-looking, firm, pitch-black, glossy coal; not breaking into thin laminæ; having no apparent fibrous coal, and very little granular pyrites.

COMPOSITION, AIR-DRIED.

Specific gravity	1.256		
Hygroscopic moisture	1.64	Total volatile matters	38.40
Volatile combustible matters	36.76		
Spongy coke	61.60	Fixed carbon in the coke	59.90
		Carrot-colored ash	1.70
	100.00		100.00
The per centage of sulphur is	1.450		

This is a coal of remarkable purity, leaving a smaller proportion of ash than any coal examined during the Geological Survey of Kentucky. Of course it cannot be considered an *average* sample of the bed, yet it is evidence of its superior quality. The proximity of this bed of coal to the Cincinnati Railroad makes it matter of interest to our citizens.

GERMAN GLASS POT FIRE-CLAY, AS COMPARED WITH SAMPLES OF KENTUCKY CLAY.

On a recent visit to the great International Centennial Exhibition at Philadelphia, the attention of the writer was attracted by an exhibit of this fire-clay, supposed to be one of the most refractory known, and imported for the construction of crucibles to withstand a very high heat, but particularly for our glass manufacturers, who seem to agree that no other known clay will so completely withstand the great heat of their furnaces, and the fluxing influence of the melted glass, as this. It is consequently almost universally used by them as the material for the construction of the glass pots or large crucibles, in which the glass is made and melted.

The exhibit of this clay at the Centennial Exhibition was made by J. Goebel & Co., importers of German clay, and manufacturers of crucibles, &c., Maiden Lane, New York. It showed the clay in its natural and prepared conditions; and accompanying the specimens was a report of the chemical analysis of the material, said to have been made in Germany, a copy of which is appended.

With a view to study this valuable clay, in comparison with some Kentucky samples from our coal measures, the writer secured a sample from what appeared to be a washed and prepared specimen on exhibition, which had been moulded into a cubical block, and which he has analyzed.

H. *The Clay is of a light grey color; adheres strongly to the tongue; and exhibits a large irregularly conchoidal fracture. Before the blow-pipe it fused only on the extremity of the small pointed fragment, into a white slag.*

I. *Another specimen of this German Glass Pot Clay was obtained at the Co-operative Window Glass Works, at the foot of Coal Hill, opposite Pittsburg (near the inclined railroad). The pot-maker, who furnished the sample from a partly used barrel of the material, stated that it was in the condition in which it was imported from Germany.*

This had not been re-worked or washed. It resembles the preceding, but is a little more friable, and slightly lighter colored. Its powder, however, is somewhat darker than the powder of that. Before the blow-pipe it acted like that.

J. *Copy of the analysis of this clay made in Germany, as exhibited by J. Goebel & Co.*

For comparison with these, I append a copy of the analysis of some clay from Carter county, Kentucky (see volume I, Kentucky Geological Reports, new series, page 179, lower paging), labeled—

"No. 1337—*Fire-clay; average sample from the upper bed, four feet thick, on both sides of the hill. Ridge between Grassy and Three Prong Creek. Boone Furnace property. Whole bed eight to ten feet thick. Collected by P. N. Moore.*"

This clay, forming a heavy stratum, is in a compact state—so hard as scarcely to be scratched with the nail; breaking into angular fragments. It is of a light-grey color, and becomes plastic when reduced to powder.

COMPOSITION OF THESE FIRE-CLAYS, DRIED AT 212° F. (Except J, which seems to have been more thoroughly dried).

	H.	I.	J.	No. 1337.
Silica	*70.860	†73.660	70.60	48.560
Alumina	20.900	19.460	23.60	37.471
Iron oxide (calculated as peroxide)	1.560	1.560	. . . . .	a trace.
Iron sulphide	. . . . .	. .	1.10	. . . . .
Lime	.347	.168	.36	.112
Magnesia	.220	.209	.45	a trace.
Phosphoric acid	not est.	not est.	not est.	.255
Sulphuric acid	not est.	not est.	not est.	not est.
Potash	.578	.520	not est.	.289
Soda	.112	.046	not est.	.283
Water expelled at red heat	6.800	6.200	‡3.89	12.030
Total	101.377	101.823	100.00	99.000

* Including about four per cent. of fine sand.
† Including about three and a half per cent of fine sand.
‡ Organic matters and loss.

The iron peroxide obtained in the analyses of H and I was doubtless derived from iron sulphide in the clay. The apparent excess is probably due mainly to fixed alkalies in the precipitated alumina, which may be estimated correspondingly too high.

The large proportion of silica in the German clay (a part of which is in the state of fine sand) is notable in comparison with the Carter county clay; and this large proportion of silica or sand increases the refractory quality of the clay. But pure fine sand or pulverized quartz could quite cheaply be added to our clay, which, in other respects, seems to be at least equal in quality as a fire-clay to the German article, containing even less of those ingredients which increase the fusibility of clay, viz: iron oxide, lime, potash, soda, and magnesia. How the phosphoric acid acts in this relation is said not to have been fully determined by experiment; but it undoubtedly increases the fusibility. As will be seen, the proportion of this ingredient was not ascertained in the German clay, although it is no doubt present in notable quantity.

There can be little doubt that some of our native fire-clays can be made quite refractory by a judicious process of preparation or purification, including, perhaps, washing with water, or water containing chlorohydric acid, which is very cheap, the addition of pulverized quartz, &c.

In this relation we may notice a beautiful hydrated silicate of alumina—the Indiana kaolin, or what is denominated *Indianaite* by Prof. E. T. Cox, of the Indiana Geological Survey—a large and handsome sample of which was exhibited at the Centennial. This remarkable clay-like mineral, which was discovered first in Illinois, and called Golconda clay, was found in Lawrence county, Indiana, in 1875, forming a six feet bed, just under the coal measures conglomerate, and over a bed of brown hematite iron ore. Where it has not been impregnated with iron oxide it is a pure hydrated silicate of alumina, of the composition of halloysite, passing in its greenish portions into alophane.

This so-called porcelain clay soon attracted the attention of potters, and is now in great demand for the manufacture of the finer qualities of pottery ware. The writer believes, however, from the brief examination he has given it, that it deserves a more exalted application, being, when pure and free from infiltrated iron oxide and lime, more refractory before the blow-pipe than any clay he has examined. It is therefore believed that it might find a more suitable application in the manufacture of the most refractory crucibles, and that, when mixed with pure fine sand or pulverized quartz, it might very well answer for glass pots.

The general composition of the white variety, as reported by Prof. Cox (Geological Report of Indiana, 1874, page 18), is as follows:

Silica	45.90
Alumina	40.34
Lime	trace.
Water	13.26

A specimen of this mineral, obtained by the writer from that exhibited at the Centennial (beautifully translucent; nearly white, with a slight greenish tint), when examined for fixed alkalies, gave 0.198 per cent. of *potash*, and 0.204 of *soda*, when dried at 212 F. It was not examined for alkaline earths or phosphoric acid.

This mineral, which may be made so useful in the arts, may doubtless be discovered in Kentucky in a similar geological position with that in Indiana.