GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

CHEMICAL REPORT

OF THE

SOILS, MARLS, CLAYS, ORES, COALS, IRON FURNACE PRODUCTS, MINERAL WATERS, &c., &c., OF KENTUCKY,

BY ROBERT PETER, M. D., &c., &c.,

CHEMIST TO THE KENTUCKY GEOLOGICAL SURVEY.

ASSISTED BY

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

THE FIRST CHEMICAL REPORT IN THE NEW SERIES AND THE FIFTH SINCE THE BEGINNING OF THE SURVEY.

PART IV. VOL. I. SECOND SERIES.

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INTRODUCTORY LETTER.

CHEMICAL LABORATORY OF THE
KENTUCKY STATE GEOLOGICAL SURVEY,
LEXINGTON, KY., April 19th, 1875.

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

DEAR SIR: I have the pleasure herewith to report the results of the chemical work performed in this laboratory, for the State Geological Survey, since September, 1873, to nearly the present date. So much could not have been effected but for the able and efficient assistance of Mr. John H. Talbutt, who has given his constant attention to this labor.

Very respectfully,

ROBERT PETER.

CHEMICAL REPORT

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By ROBERT PETER, M. D., &c., &c.

In the eighty-six *soil* analyses, which are appended, only a portion of ten counties of the State is represented, and the greater number of these soils are not to be classed amongst our most fertile. The limits of the range of variation of their several constituents is shown in the following table, viz:

	Pr. ct.	No.	County.		Pr. ct.	No.	County.
Organic and volatile matters vary from	7.985	in 1300	of Boyd	to	1.815	in 1398	of Carter.
Alumina and iron and manganese oxides vary from	15.763	in 1396	of Carter	to	2.740	in 1571	of Hardin.
Lime carbonate varies from. . .	3.890	in 1330	of Campbell	to	.045	in 1572	of Hardin.
Magnesia varies from	.520	in 1329	of Campbell	to	.034	in 1298	of Boyd.
Phosphoric acid varies from . .	.555	in 1424	of Fayette	to	.045	in 1396 in 1566	of Carter. of Hardin.
Potash varies from	.662	in 1396	of Carter	to	.062	in 1325 in 1327	of Campbell. of Campbell.
Soda varies from	.286	in 1407	of Carter	to	trace.	in 1567	of Hardin.
Sand and insoluble silicates vary from	74.840	in 1396	of Carter	to	92.455	in 1634	of Ohio.
Water expelled at 380° F. varies from	2.650	in 1558	of Hardin	to	.225	in 1572	of Hardin.
Water expelled at 212° F. varies from	5.075	in 1329	of Campbell	to	.800	in 1571	of Hardin.

The extremes may represent very rich and very poor soils; but not the general character of the soils of the counties named.

The *method* of analyses of the soils does not vary much from that described in volume III of the Kentucky Geological Reports. The principal object was, as there stated, to obtain *comparative results*, which would enable the scientific agriculturist to form an opinion as to the *chemical constitution* of our soils in their relation to husbandry; without attempting to perform the almost hopeless task of giving all the minuter constituents of each, or of presenting all those *physical conditions* which exert so great an influence on their practical fertility. To this end the several soils were treated as nearly alike as possible: air-dried together, digested for an equal time at nearly the same temperature in acid of a uniform strength, &c., &c. The specific gravity of the chlorohydric acid used being about 1.10.

The process of digestion in water, containing carbonic acid, was not employed in all, because of the press of work in the laboratory, mainly. There can be no doubt, however, that, used with proper care, this process will indicate the relative proportion of soluble plant food in the soil at the time. As this may very well vary, under different physical atmospheric conditions, it was not considered of essential value in the comparative analyses.

The well-known fact that various *physical conditions* exert a powerful influence on the productiveness of soils which have a similar chemical composition, has, in recent times, singularly perverted the minds of chemists, and consequently of agriculturists, in relation to the value of soil analyses. Because the *chemical conditions* of a soil are not the *only ones* necessary to productiveness, they have, by a perverted logic, jumped to the conclusion that these conditions are of no consequence whatever.

But if these *chemical conditions* are *indispensable* to the fertility of the soil, how much injury has been done in recent years to the scientific study of the soil and of agriculture, by the great outcry which has been raised against this kind of investigation! The comparative chemical examination of the soils of a State or country can only be made under the patronage of the government. Individual efforts are inadequate to effect it; nor could they, if adequate, so economically conduct it. The writer believes that the geological survey of any region should always include this study of the soils; yet very little has been done in this direction in all the recent State surveys, and a valuable opportunity hás been lost, which in many instances cannot recur, of studying the chemical conditions of the virgin soil of various parts of our country.

Chemists are naturally somewhat averse to soil analysis; it requires so much time and labor, so much care must be taken to secure accuracy, and there is so little variety in the work, and so small an appreciation of its value and significance amongst the people when done, that they gladly avoid it. But, in the course of time, most of them who are not too much prejudiced against the teachings of experience, arrive at the same conclusion with Prof. Aug. Voelcker, of the English Royal Agricultural College: "There was a time when I thought with many other young chemists, that soil analyses would do every thing for the farmer; three or four years of further experience and hard study rather inclined me to side with those men who consider that they are of no practical utility whatever; and now, after eighteen years of continued occupation with chemico-agricultural pursuits, and, I trust, with more matured judgment, I have come to the conclusion that there is hardly any subject so full of practical interest to the farmer as that of the chemistry of soils. The longer and more minutely soil investigations are carried on by competent men, the greater, I am convinced, will be their practical utility."—*Jour. of Roy. Agr. Soc. of Eng.*, 1865.

Even Prof. S. W. Johnson, whose somewhat harsh criticism, in 1861, of some of the former labors in this field of the writer, seemed to sound the key-note of the clamor against this kind of study in this country, has so far yielded his opposition as to give us in his valuable work, "*How Crops Feed*," 1870, the comparative analyses of several soils, and to point out the significance of their chemical composition. But he is careful to caution the reader, page 368, that although the analysis may show the amount of the mineral fertilizers in a soil, it cannot tell how much of them "is at the disposal of the present crop;" and on page 271: "These facts show how very far chemical analysis, in its present state, is from being able to say definitely what any given soil can supply to crops, *although we owe nearly all our precise knowledge of vegetable nutrition directly or indirectly to this art.*"

He might very truly have added, that we should not be able to say that a suitable *chemical* composition of a soil was not the only condition necessary to its fertility, unless we had thoroughly studied that condition. It is only by means of chemical analyses that we find out the equally indispensable nature of the physical conditions. He cannot fail to admit that it is impossible to make progress in our knowledge of the soil and its actions and conditions without a thorough study of its chemical characters.

In accordance with this outcry against this sort of investigation the difficulties of obtaining good samples for analyses has been exaggerated. In a country like that of most of this State, where there is comparatively but little quarternary or transported material constituting the soil, and especially before its character has been much altered by a dense population, there is little difficulty, with the use of necessary precautions, in obtaining representative samples of large areas similar in character and position. In many large districts in our State the soil has been formed in place by the disintegration of the rocks. In other parts, where surface action has been greater, more judgment and care must be exerted in the collection of the soils; but in no part of the State, probably, is so great local variety to be seen in the soils as frequently may be observed in the northeastern States, where the transporting action of water and of ice, in former epochs, has produced a high degree of local irregularity in the nature of the surface deposits.

In the collection of the samples of our Kentucky soils the causes of local and accidental differences of composition were, as much as possible, avoided.

Because of the very small proportion of the essential ingredients of the soil, which are carried off in crops, as compared with the whole amount of the earth, taken to the depth through which the roots of plants absorb nourishment, it has been denied that it is possible by chemical analysis to show their diminution in the old field soil, as compared with the virgin soil. Indeed it has been *logically* demonstrated to be impossible. But, it should be recollected that when, by the acid digestion, we separate these essential soluble ingredients from the greater mass of the soil, left as *sand and insoluble silicates*, which amount to from about seventy-five to ninety-two per cent. of the whole, the probabilities of error in the determination of these minuter ingredients must not be calculated into the whole weight of the soil, but into that smaller part which we have thus extracted from it.

Logic apart, the *fact* still remains, that in one hundred and forty-nine duplicate analyses, made by the writer for the Kentucky, Arkansas, and Indiana Surveys, in which the chemical composition of the virgin soil was compared, under similar conditions of treatment, with soil of a neighboring old field in the same locality, one hundred and twenty-two out of the one hundred and forty-nine showed a marked diminution of most of the essential ingredients of the soil in that of the old field as compared with the virgin soil. This certainly is not an accidental result.

In the soil analyses at present reported the results are not so striking in this relation. Partly because the samples had not, in several cases, been collected with special reference to this investigation, and partly because of greater local variations of the soil in the regions in which they were obtained.

In calculating the probable amount of exhaustion of the essential soil ingredients, it should be recollected that as much, and sometimes more, may be alienated from the soil by the solvent action of the atmospheric agents, while the surface is much exposed in the cultivation of hoed crops, than is absorbed and removed by the products. Hence the exhaustion of the soil is much more rapid under these circumstances than is generally allowed. In other words, the exhaustion of the soil when under cultivation in hoed or plowed crops, during which time a large portion of its surface is kept bare of vegetation and subjected to the leaching action of rains, is much greater than can be accounted for by the amount of the essential ingredients which are taken from it in its products.

In several instances, in the analyses of the soils described above, the "sand and insoluble silicates," left after digestion, for ten days in the acid, were analyzed by the admirable process of Professor J. Lawrence Smith, for the determination of the amount of fixed alkalies held in the form of insoluble silicates. As will be seen, in the detailed report and in the tables, the quantity of potash and soda thus held in the soil in the samples in question are, in most cases, considerable, ranging from 0.485 to 2.731 per cent. of potash to the whole soil, and 0.165 to 1.306 per cent. of soda.

It is evident that, although at *present insoluble*, and hence unavailable for plant nourishment, these alkalies are doubtless gradually released and brought into a soluble form by weathering and under the influence of the products of vegetable decay, so that they tend to prolong the fertility of the soil.

The seventeen *limestone* and *lime* analyses, of specimens from nine counties only, represent but a small part of our various lime rocks. But even these exhibit their great industrial value, including, as they do, limestones useful for the fluxing of our iron ores, as well as for purposes of construction in the form of building stone or cement, while some of them would be valuable as fertilizers on the land. The so-called lithographic stone of Barren county and of other corresponding localities may, for some purposes, with well-selected samples, replace the more costly foreign stone.*

The eighty-two *iron ores* which have been analyzed are from eleven counties, principally of the northeastern portion of the

*NOTE.—I have found it impossible to use this stone for crayon or transfer work.
N. S. SHALER.

State. Sixty-four of these are limonite ores; twenty-seven are clay ironstones or carbonate ores; and only one, to be found probably only in limited quantity in Lawrence county (see No. 1594), is of the red hematite variety.

The proportion of metallic iron, in the limonite ores examined, varies from 19.344 per cent. to 57.148 per cent. In the carbonate ores analysed the per centage of metallic iron ranges from 10.960 per cent. in what may be termed only a ferruginous limestone, up to 40.465 per cent.

Of the one hundred and ten specimens of *coal*, &c., which were examined by proximate analysis, eighty-nine were from eleven counties in Kentucky; of which five counties, viz: Boyd, Carter, Greenup, Lawrence, and Menifee, are in our northeastern coal field; and six, viz: Butler, Edmonson, Grayson, Hopkins, Muhlenburg, and Ohio counties, are in the southwestern coal field. All these coals are of the splint, dry coal, or semi-cannel coal variety; cleaving generally into thin layers, which have more or less fibrous coal between them. Although some of them make a good coke, they do not generally soften or swell much when heated or burnt, and hence, when they do not contain an unusual quantity of sulphur, they can be used, without preliminary coking, for the smelting of iron. Some of these coals, however, are quite sulphurous, and some contain a large proportion of ash,† but the better samples compare favorably with the best coals of the neighboring States.

For the purpose of this comparison seven of the best coals of the State of Ohio, two of the best of those of Illinois, and four of the celebrated "block coals" of Indiana, used there for iron smelting, &c., were submitted to similar processes of analysis with our Kentucky coals. We give the general comparative results in the following tables:

† In some cases, as the samples for analysis were taken from new and imperfect openings, it is more than probable the coals will be found to be better than is represented in the analyses given.

AVERAGE COMPOSITION OF THE COALS FROM THE NORTHEASTERN KENTUCKY COAL FIELD.

COUNTIES.	Number of samples analyzed.	Specific gravity.	Volatile combustible matters.	Fixed carbon in the coke.	Per cent. of ash.	Per cent. of sulphur.
Boyd	13	1.337	33.43	54.35	*8.46	†2.292
Carter	16	1.331	33.39	53.45	8.17	‡1.886
Greenup	14	1.375	34.50	52.20	9.37	3.165
Lawrence	6	1.326	36.27	53.85	6.86	1.285
Menifee	2	1.319	33.55	53.42	10.36	2.544
General average. .	51	1.3376	34.23	53.45	8.62	2.234

AVERAGE COMPOSITION IN THE SOUTHWESTERN COAL FIELD.

COUNTIES.	Number analyzed.	Specific gravity.	Volatile combustible matters.	Fixed carbon.	Per cent. of ash.	Per cent. of sulphur.
Butler	1	1.378	30.66	54.94	11.00	2.544
Edmonson	8	1.360	34.01	52.34	10.56	3.312
Grayson.	8	1.385	31.17	49.78	§14.38	2.083
Hopkins	2	1.385	32.95	52.55	11.20	5.019
Muhlenburg	11	1.312	36.42	53.26	6.74	2.949
Ohio.	3	1.362	34.90	53.77	8.16	3.103
General average . .	33	1.3636	33.70	52.77	10.34	3.166

* By leaving out the exceptional ash of No. 1291, the average is — 7.94.
† Without No. 1291 this average would be — 2.036.
‡ This is the average of fifteen of the coals only.
§ By leaving out the exceptional ash of No. 1454, the average would be — 12.21.

AVERAGE COMPOSITION OF THE SELECTED COALS FROM NEIGHBORING STATES.

STATES.	Number analyzed.	Specific gravity.	Volatile combustible matters.	Fixed carbon in the coke.	Per cent. of ash.	Per cent. of sulphur.
Ohio	7	1.327	34.51	55.17	6.43	1.494
Illinois.	2	1.310	31.95	59.06	5.96	1.924
Indiana	3	1.313	35.93	54.24	7.23	1.946
General average . .	12	1.317	34.13	56.12	6.54	1.768

This comparison is more or less imperfect, because the samples, which were too few in number to make it complete, were not averaged with special reference to it. Yet it measurably corroborates opinions held by geologists and others in regard to our two coal fields. For instance, it will be seen in the general averages that the coals of the southwestern field have more ash and sulphur, and a higher specific gravity, than those of the northeastern, and that the relative proportions of the combustible matters, volatile or fixed, are less in the former. The differences, however, are not very remarkable.

In each of these particulars the coals from our neighboring States of Ohio, Illinois, and Indiana, show less difference than might have been expected, in view of the fact that they had been collected from some of the most celebrated coal mines, as representing the *best coals* of those States. The following tables illustrate this:

TABLE OF THE EXTREMES OF COMPOSITION OF THE COALS.

COUNTIES.	Volatile combustible matters. From	Fixed carbon. From	Ashes. From	Sulphur. From
Boyd	29.70 to 36.70	46.86 to 57.90	5.10 to 14.74	1.285 to 5.361
Carter	27.22 to 36.26	44.64 to 58.88	3.20 to 12.10	.724 to 3.483
Greenup	31.66 to 37.70	47.00 to 56.70	5.40 to 13.00	.746 to 5.934
Lawrence	33.90 to 39.00	47.84 to 57.80	1.80 to 13.70	.736 to 3.785
Menifee	33.06 to 34.04	50.24 to 56.60	7.40 to 13.06	.997 to 4.092
Greatest extremes	27.22 to 39.00	44.64 to 58.88	1.80 to 14.74	.724 to 5.361
Butler	30.66	. . . .	11.00	2.544
Edmonson	32.00 to 39.00	45.46 to 54.26	6.94 to 14.34	1.059 to 8.685
Grayson	25.86 to 35.80	40.14 to 55.52	7.50 to 29.60	.777 to 3.565
Hopkins	30.00 to 35.90	51.10 to 54.00	6.90 to 15.50	2.759 to 7.280
Muhlenburg	30.60 to 43.08	49.80 to 58.80	3.72 to 11.80	.640 to 4.032
Ohio	33.50 to 36.20	52.20 to 55.10	7.10 to 9.00	2.837 to 3.332
Greatest extremes	25.86 to 43.08	40.14 to 58.80	3.72 to 29.60	.640 to 8.685
State of Ohio	29.68 to 36.68	54.16 to 57.06	4.20 to 8.72	.756 to 2.247
State of Illinois	31.86 to 32.04	55.64 to 59.54	5.16 to 6.76	1.376 to 2.472
State of Indiana	35.10 to 36.38	53.50 to 53.58	5.28 to 9.00	1.664 to 2.373
Greatest extremes	29.68 to 36.38	53.50 to 59.54	4.20 to 9.000	.756 to 2.472

TABLE OF THE COMPOSITION OF ELEVEN SELECTED KENTUCKY COALS FROM SEVERAL COUNTIES.

COUNTIES.	Number.	Specific gravity.	Volatile combustible matters.	Fixed carbon in coke.	Per cent. of ash.	Per cent. of sulphur.
Boyd	1286	1.308	33.30	57.60	5.80	2.480
Boyd	1289	1.320	34.50	55.40	5.10	1.285
Carter.	1346	1.288	34.36	54.60	4.40	.724
Carter.	1347	1.290	27.22	55.88	7.50	.973
Carter.	1353	1.274	34.50	58.50	3.20	2.164
Edmonson.	1418	1.336	35.14	54.26	6.94	2.706
Greenup.	1492	1.292	33.90	56.70	6.20	.746
Greenup.	1493	1.289	34.96	55.54	5.40	1.590
Hopkins.	1579	1.322	35.90	54.00	6.90	2.759
Lawrence	1589	1.281	35.30	57.80	1.80	.736
Lawrence	1593	1.284	39.00	54.76	3.74	1.066
General average . .	. . . . .	1.298	34.36	56.18	5.18	1.566

To show the great importance of collecting true and faithful *average samples* of the coal beds, for the purpose of analysis, *two picked cabinet specimens* were taken and analyzed, to-wit:

No. 1280 (*b*). *Coal No. 7, from Turkey-pen Hollow, Boyd county.*

No. 1348 (*b*). *Coal No. 7, Pritchard's coal, Mt. Savage Furnace, Carter county.*

The comparative results of the analyses are as follows—thoroughly air-dried:

	Picked sample. No. 1280 (*b*).	Ave'ge sample. No. 1280 (*a*).	Picked sample. No. 1348 (*b*).	Ave'ge sample. No. 1348 (*a*).
Specific gravity.	Not determ'd.	1.358	Not determ'd.	1.435
Hygroscopic moisture.	4.70	3.40	4.50	5.40
Volatile combustible matters . .	34.30	32.30	37.10	32.70
Coke	61.00	64.30	58.40	61.90
Total.	100.00	100.00	100.00	100.00
Total volatile matters	39.00	35.70	41.60	38.10
Carbon in the coke	59.04	55.40	56.40	52.52
Ash	1.96	8.90	2.00	9.38
Total.	100.00	100.00	100.00	100.00
Per centage of sulphur	0.983	1.230	0.571	2.356

As the value of a coal bed bears a very near relation to that of its average product, it is easily to be understood that the analysis of a *selected* sample may be of very little utility. On the other hand, the selection of a true average sample of the bed may often be a task of considerable difficulty.

The determination of the proportion of *sulphur* in coals has been much neglected in this country; and where it has been done the method generally used has been to oxidate the powdered coal in strong nitric or nitro-hydrochloric acid. This mode of analysis is not so perfect as fusion with a mixture of nitre, carbonate of soda, and salt, &c., which always, when properly managed, brings all the sulphur into the form of soluble sulphate, in whatever state it may have existed in the coal. This exhaustive mode was employed in all our estimations of this substance, and hence the quantities obtained may seem greater than are shown to exist in similar coals which have been treated with the acids.

As has now been extensively demonstrated, the sulphur in coals is rarely all combined with iron as sulphide or bi-sulphide. Some frequently exists in a free or uncombined condition, as is shown in an analysis described in the following pages. Some of it is frequently in the form of lime sulphate.

When it is recollected that vegetable matters, decomposing in a solution of sulphates of lime, magnesia, iron, &c., reduce these salts to sulphides, with the production of hydrogen sulphide in the case of the earthy salts, and when we reflect that this gaseous compound, HS, is decomposed, with the deposition of free sulphur, on contact with the air, we can easily understand how most of our coals must contain not only pyrites but free sulphur.

In the thirty-four *marls, marly shales, sands*, and *silicious concretions*, which have been analyzed, we find a general prevalence of lime, fixed alkalies, phosphoric acid, sulphuric acid, &c. Some of the marls and shales contain these in such considerable proportions as to make them locally useful for the amelioration of poor sandy land. Some of these find an application as mineral paint, for which they are adapted by their agreeable tint and other properties. Some of the more silicious could be used in the manufacture of glass, as well as for other purposes; some of post-tertiary silicious clays, or soft sandstones, might be made into bricks for scouring purposes, &c., while others, which contain but little lime, magnesia, oxide of iron or alkalies, would prove quite refractory in the fire.

But the *fire-clays* and *plastic clays* of the coal fields, of which the analyses of sixteen are appended, are especially deserving attention; and from their abundance, superior quality, and vicinity to fuel, should form the basis of extensive industries. Amongst them may be found some of the best of fire-clays, as well as some well-fitted to the manufacture of pottery ware of various kinds, including the better sorts of delf, stone china, or queensware. Skill, capital, and enterprise are all that are needed, on these somewhat neglected deposits, to make them of very great value to individuals as well as to the public. Only the want of these essentials causes us to pay a heavy tax to foreign nations for our pottery ware, when the materials for the manufacture lie measurably neglected at home. It is simply the history repeated of the importation of bricks from Holland to build houses in Albany, and the packing of English bricks, on the backs of horses, over the Alleghenies, to construct the barracks at old Fort Duquesne on the Ohio.

The nineteen samples of *pig iron* which have been analyzed are mostly of the kind known as foundry iron. On reference to the general table of their composition, it will be seen that they present considerable variety in this respect; as for example:

The per centage of	iron	ranges between	85.455 to 95.840
"	carbon	"	2.040 to 4.400
"	phosphorus	"	0.123 to 1.029
"	sulphur	"	a trace to 0.150
The specific gravity		"	6.406 to 7.782

Of the numerous *mineral waters* of our State the analyses of twenty-one are given in the present report, mostly from one locality.

BATH COUNTY.

No. 1269—Limonite Iron Ore. "*From Block-house ore bank, one and a half miles from the Old Slate Furnace, Bath county. Bed ten to twelve feet thick; on the Clinton Group. Collected by Philip N. Moore.*"

Ore generally dense and dark-colored, with some dark ochreous ore. Structure cellular and oölitic.

COMPOSITION, DRIED AT 212° F.

Iron, peroxide	76.077	= 53.254 per cent. of iron.
Alumina	2.592	
Manganese, brown oxide	.430	
Lime, carbonate	.130	
Magnesia	.281	
Sulphuric acid	.030	= 0.011 per cent. of sulphur.
Phosphoric acid	.731	= .319 per cent. of phosphorus.
Water, expelled at red heat	12.300	
Silica and insoluble silicates	8.180	= 6.160 per cent. of silica.
	100.751	

The phosphoric acid determination was made by Chancel's process, viz: by means of acid nitrate of bismuth solution, after the separation of the iron oxide, and is believed to be nearly correct. The iron ore in the Clinton Group, especially the "dye-stone ore," is usually quite phosphatic. This does not prevent it from being quite valuable for the production of iron for many purposes, although it may not be made to yield the higher grades of bar iron or steel.

BARREN COUNTY.

No. 1421—Limestone. "*Oölitic Limestone. Upper layers of upper sub-carboniferous limestone. Glasgow Junction, Barren county. Collected by Prof. N. S. Shaler.*"

A compact, nearly white, fine oölitic limestone, with a ferruginous stain on the exposed surfaces probably derived from the superincumbent soil.

No. 1422—Limestone (*compact*). "*Upper Sub-carboniferous Limestone. Glasgow Junction. Collected by N. S. Shaler.*"

A light-grey, fine granular, or compact limestone, which might be a good lithographic stone but for the presence of some imbedded fossils and minute specks of iron peroxide.

No. 1423—LIMESTONE. *Labeled "Lithographic Stone; below the building stone. Upper sub-carboniferous limestone. Glasgow Junction. Collected by Prof. N. S. Shaler."*

A light-grey, compact, or very fine granular rock, which might be a perfect lithographic stone but for the minute imbedded fossils and the small occasional specks of iron peroxide, &c., which it contains. Some layers, however, are reported measurably free from these imperfections, and found to be good enough, on actual trial, for some ordinary lithographic purposes.

COMPOSITION OF THESE BARREN COUNTY LIMESTONES, DRIED AT 212° F.

	No. 1421.	No. 1422.	No. 1423.
Specific gravity	2.678	2.721	2.689
Lime, carbonate	98.050	77.550	82.960
Magnesia, carbonate	.363	13.314	7.655
Alumina, and iron and manganese oxides	.511	2.680	2.680
Phosphoric acid	.051	.051	.115
Sulphuric acid	.260	.192	.260
Potash	.115	.154	.135
Soda	.327	.188	.156
Silica and insoluble silicates	1.060	6.060	6.160
Total	100.737	100.189	100.121
Per centage of lime	50.428	43.428	46.457
Per centage of phosphorus	.022	.022	.050
Per centage of sulphur	.104	.077	.104

No. 1421 would yield a very pure white lime.

BOYD COUNTY.

No. 1270—CLAY IRON-STONE, &c. *Labeled "Grey Limestone Ore. J. P. Jones' drift, near Ashland. Average sample selected by P. N. Moore."*

A mixed sample, with oölitic carbonate of iron, dark grains united with a whitish cement, portions of compact carbonate, and of *limonite* ore.

No. 1271—Clay Iron-stone. *Labeled "Wilson Creek Blue Block Ore. Average sample, taken from Star Furnace stock pile, by P. N. Moore."*

A fine-granular ore of various shades of dark-grey, with some slight incrustations of limonite. Not adhering to the tongue.

No. 1272—Clay Iron-stone. *Labeled "So-called Limestone Ore, from Williams' Creek. Star Furnace stock pile. Averaged by P. N. Moore."*

A granular and oölitic proto-carbonate of iron (containing much carbonate of lime). Oölitic grains nearly black, in a whitish cement.

SUMMARY OF THE COMPOSITION OF THESE BOYD COUNTY CLAY IRON-STONES, DRIED AT 212° F.

	No. 1270.	No. 1271.	No. 1272.
Iron, carbonate	32.285	66.854	19.802
Iron, peroxide	12.784	.276	21.433
Alumina (by difference)	11.968	4.260	1.193
Lime, carbonate	21.125	2.460	30.205
Magnesia, carbonate	.691	4.086	a trace.
Manganese, carbonate	.465	.572	.240
Phosphoric acid (anhydr.)	.377	.709	.257
Sulphuric acid (anhydr.)	.267	.885	.157
Silica and insoluble silicates	19.730	18.360	23.080
Water and loss	.308	1.538	3.633
Total	100.000	100.000	100.000
Per centage of iron	24.591	32.466	23.109
Per centage of phosphorus	.164	.308	.112
Per centage of sulphur	.107	.354	.063
Per centage of silica	.....	15.500	18.960

Of these ores, No. 1271 would be the best, as it is the richest; but its considerable proportions of phosphorus and sulphur will somewhat injure the toughness of the iron it yields. No. 1272 is not so objectionable in this respect. This ore as well as No. 1270, containing a large proportion of lime, although comparatively poor in iron, may yet be profitably smelted, especially in mixture with richer ores. They will obviously require less fluxing material than the other ores.

No. 1273—LIMONITE. *Labeled "Slate Ore. Head of Cane Creek, on the road to Star Furnace, Boyd county. Average sample selected by P. N. Moore."*

In irregular curved layers, varying in hardness and color from yellowish-brown to blackish-brown; frequently inclosing soft ochreous nodules.

No. 1274—LIMONITE. *Labeled "Yellow Kidney Ore, sampled from a number of places by P. N. Moore. Star Furnace property."*

Irregular curved layers of dark-colored limonite (brown hæmatite), incrusted by and inclosing soft ochreous ore.

No. 1275—LIMONITE. *Labeled "Limestone Ore;" average sample selected by P. N. Moore. Bellefont Furnace.*

Ore varying from brownish-yellow to dark brown (mostly dark brown), with some proto-carbonate of iron, ferruginous limestone, and a little calc. spar intermixed.

No. 1276—LIMONITE. *Labeled "Yellow Kidney Ore;" average sample selected by P. N. Moore. Buena Vista Furnace.*

Irregular curved layers of limonite, varying from *soft*, brownish-yellow to *dense*, dark brown ore.

No. 1277—LIMONITE, &c. *Labeled "Yellow Kidney Ore, or Kidney Ore below the No. 7 Coal." Straight Creek, Buena Vista Furnace. Average sample collected by P. N. Moore.*

Limonite layers of various depth of color, with some fine granular carbonate of iron and thin veins of calc. spar.

No. 1278—LIMONITE. *Labeled "Black Kidney Ore." Average sample, from Stock Branch Hollow, just south of Star Furnace. Collected by P. N. Moore.*

In irregular curved layers, generally of a dark purplish-brown color, with some soft ochreous nuclei and layers.

SUMMARY OF THE COMPOSITION OF THESE BOYD COUNTY LIMONITES, DRIED AT 212° F.

	No. 1273.	No. 1274.	No. 1275.	No. 1276.	No. 1277.	No. 1278.
Iron, peroxide	53.653	58.960	51.802	61.344	56.022	54.055
Iron, carbonate	. . . . .	. . . . .	10.594	. . . . .	8.821	. . . . .
Alumina (by difference)	4.324	7.284	4.523	4.236	7.194	4.919
Manganese, brown oxide	.368	.380	a trace.	a trace.	a trace.	.420
Lime, carbonate	a trace.	.430	7.480	.750	2.520	.080
Magnesia	.101	.227	.440	.208	1.271	a trace.
Phosphoric acid (anhydr.)	.313	.376	.570	.795	.526	.076
Sulphuric acid (anhydr.)	.220	.206	.089	.041	.090	.096
Combined water	10.150	10.800	8.772	11.200	10.126	10.450
Silex and insoluble silicates	30.940	21.210	15.730	21.480	13.430	30.080
Moisture and loss	. . . . .	.127	. . . . .	. . . . .	. . . . .	. . . . .
Total	100.069	100.000	100.000	100.054	100.000	100.176
Per centage of iron	37.551	41.272	41.357	42.941	43.473	37.838
Per centage of phosphorus	.137	.164	.231	.347	.229	.033
Per centage of sulphur	.086	.082	.035	.016	.036	.038
Per centage of silica	29.560	19.980	13.160	18.560	11.660	24.260

These are all good ores; Nos. 1273 and 1278 being the poorest in iron and the most silicious. The proportion of *sulphur* is small in all of them, and of phosphorus is probably not enough to injure the iron for ordinary uses. Nos. 1275 and 1277 would probably be improved for smelting by a previous roasting.

No. 1279—COAL. *Labeled "Coal No. 7, from drift one quarter mile above the store, on Furnace Branch of Straight Creek, Buena Vista Furnace. Average sample of both parts of the bed, by P. N. Moore."*

No. 1280—COAL. *Labeled "Coal No. 6, from Turkey-pen Hollow; Old Clinton Tract; Bellefont Furnace. Averaged by P. N. Moore."*

No. 1281—COAL. *Labeled "Coal No. 7, three feet thick, no parting; Chadwick Creek. Average sample, selected by A. R. Crandall."*

No. 1282—COAL. *Labeled "Coal No. 5, eighty-five feet below the yellow kidney ore, drift south side of Straight Creek, one third of a mile from Bueña Vista Furnace. Averaged by P. N. Moore."*

No. 1283—COAL. *Labeled "Keys Creek Coal, No. 6. Average sample collected by A. R. Crandall."*

No. 1284—COAL. *Labeled "Coal No. 3, from drift on Hood's Creek, one third of a mile southeast of Bellefont Furnace. Average sample collected by A. R. Crandall."*

A splint coal, exhibiting some fibrous coal and fine particles of pyrites between the layers.

No. 1285—COAL. *Labeled "Coal No. 6, from Horse Branch (or Run), near Catlettsburg, Boyd county. Average sample, collected by A. R. Crandall."*

A splint coal. Some fibrous coal between the layers, with a little ferruginous incrustation.

No. 1286—COAL. *Labeled "Coal No. 7, from the Ashland Company's mine No. 4, Coalton, Boyd county. Average sample, by P. N. Moore."*

A dark, glossy, splint coal, with some fibrous coal between the layers.

No. 1287—COAL. *Labeled "Coal No. 7, from entry No. 4; cross-entry; slate roof; Dry Branch. Average sample, by P. N. Moore."*

A jet-black pure-looking coal.

No. 1288—Coal. *Labeled "Coal No. 7, three hundred yards from the end of No. 4 entry. Trace Creek, Boyd county. Averaged by P. N. Moore."*

A pure jet-black coal. Very little fibrous coal or pyrites apparent.

No. 1289—Coal. *Labeled "Coalton Coal, No. 7. Two hundred and fifty yards from west end of No. 4 entry, &c. Averaged by P. N. Moore."*

Contains more fibrous coal and pyrites than the two preceding.

No. 1290—Coal. *Labeled "Coalton Coal, No. 7, from Mr. Bryan's Bank, Four Mile Creek, Boyd county. Collected by A. R. Crandall. Average sample."*

Jet black. Contains very little pyrites or fibrous coal.

No. 1291—Coal. *Labeled "Coal No. 11. Wm. A. Bolt's coal. East Fork of Little Sandy river, above Bolt's Fork, Boyd county. Average sample, collected by A. R. Crandall."*

A jet-black coal. But little fibrous coal or pyrites apparent.

[See Appendix, No. 1645, for analysis of another Boyd county coal.]

COMPOSITION OF THESE BOYD COUNTY COALS, DRIED AT 212° F.

	No. 1279.	No. 1280.	No. 1281.	No. 1882.	No. 1283.	No. 1284.	No. 1285.	No. 1286.	No. 1287.	No. 1288.	No. 1289.	No. 1290.	No. 1291.
Specific gravity	1.328	1.358	1.304	1.360	1.279	1.366	1.315	1.308	1.340	1.336	1.320	1.365	1.404
Hygroscopic moisture.	6.50	3.40	3.50	3.20	2.94	3.20	2.70	3.30	4.40	4.06	5.00	4.00	2.60
Volatile combus. mat'rs.	33.90	32.30	34.16	32.30	32.56	29.70	36.70	33.30	31.10	34.24	34.50	34.06	35.80
Coke	59.60	64.30	62.34	64.50	64.50	67.10	60.60	63.40	64.50	61.70	60.50	61.94	61.60
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 .	40.40	35.70	37.66	35.50	35.50	32.90	39.40	36.60	35.50	38.30	39.50	38.06	38.40
Fixed carbon in coke .	52.78	55.40	55.30	53.00	56.76	55.10	52.60	57.60	57.90	54.70	55.40	53.20	46.86
Ashes	6.82	8.90	7.10	11.50	7.74	12.00	8.00	5.80	6.60	7.00	5.10	8.74	14.74
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
Character of the coke .	Dense.	Dense.	Dense.	Dense.	Spongy.	Friable.	Spongy.	Mod.dense.	Spongy.	*Spongy.	Spongy.	Spongy.	Spongy.
Color of the ash . . .	Light lilac-grey.	Light purple-grey	Purple-grey.	Lilac-grey	Lilac-grey.	Drab-grey.	Dark lilac-grey.	Light lilac-grey.	Lilac-grey.	Lilac-grey.	Light br'wn-grey.	Dove colored.	Brownish grey.
Per centage of sulphur.	3.765	1.230	2.370	1.999	1.972	1.793	1.711	2.480	2.095	1.854	1.285	1.890	5.361

With a few exceptions these may all be considered very good coals. These few contain rather too large a proportion of ash. This will not prevent them from being very good fuel for ordinary purposes. Some of them have a notable proportion of sulphur, which may render them measurably unsuitable for the working of iron, but which will not be otherwise injurious. It may be remarked, however, that the estimation given above is of the *total amount* of sulphur in the coal, in whatever form of combination it may exist. The analyses for the determination of the sulphur having been made by deflagrating the powdered coal with a mixture of nitre, carbonate of soda, and common salt (each chemically pure, of course), and not by the usual process of oxidation with nitric acid, &c., the extraction of the sulphur is therefore more complete than usual. These are all splint coals.

The relation between the specific gravity and the proportion of ash does not seem to be a constant one, as may be seen in the following statement:

Specific gravity	1.279	Per centage of ash	7.74
"	1.304	"	7.10
"	1.308	"	5.80
"	1.315	"	8.00
"	1.320	"	5.10
"	1.328	"	6.82
"	1.336	"	7.00
"	1.340	"	6.60
"	1.358	"	8.90
"	1.364	"	11.50
"	1.365	"	8,74
"	1.366	"	12.00
"	1.404	"	14.74

In the appendix are given, for comparison, the analyses of some of the most celebrated Indiana, Ohio, and Illinois coal, which are used in the smelting of iron, &c.

No. 1292—Marly Shale. *From near the top of the ridge between Clinton Furnace and Cannonsburg, Boyd county.*

A friable indurated marly clay, of dirty-greenish and brownish colors.

COMPOSITION DRIED AT 212° F.; AS DETERMINED BY DIGESTION IN CHLOROHYDRIC ACID, &C.

Alumina, and iron and manganese oxides	12.643
Lime, carbonate	.480
Magnesia	.929
Phosphoric acid	.217
Sulphuric acid	.079
Potash	1.387
Soda	.080
Water expelled at red heat	5.830
Silica and insoluble silicates	77.560
Loss	.795
	100.000

On treating this marl, by ignition with carbonate of lime and chloride of ammonium, for the complete separation of its alkalies, according to the method proposed by Prof. J. Lawrence Smith, we obtained a total of 3.989 per cent. of *potash* and 0.639 per cent. of *soda*. So that about two thirds of the potash is in such a state of combination, in the silicates of this marly clay, as to resist the solvent action of chlorohydric acid, of specific gravity 1.1, although digested for eight or ten days in the sand-bath heat. Possibly admixture with slacked quicklime might help to set free this considerable proportion of alkali, and make it an available mineral fertilizer for exhausted light soils.

No. 1293—PIG IRON. "*Hot Blast No.* 1, *Bellefont Furnace, Boyd county. Collected by P. N. Moore.*"

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

No. 1294—PIG IRON. "*Hot Blast No.* 1, *Foundry, Buena Vista Furnace. Collected by P. N. Moore.*"

A coarse-grained grey iron. Yields to the file; extends a little under the hammer.

No. 1295—PIG IRON. "*Mill Iron No.* 1, *Ashland Furnace, Boyd county. Stone-coal Iron. Sent by Col. Douglas Putnam, jr.*"

A very fine-grained light-grey iron. Yields to the file. Brittle.

No. 1296—PIG IRON. "*Mill Iron No.* 2. *Stone-coal Iron. Ashland Furnace. Sent by Col. Douglas Putnam, jr.*

Not quite so fine-grained as the preceding. Light-grey. Yields to the file. Brittle.

No. 1297—Pig Iron. *Foundry Iron. Ashland Furnace, &c., &c. (as above). Coarser-grained than the preceding.*

Yields to the file. Brittle.

COMPOSITION OF THESE BOYD COUNTY PIG IRONS.

	No. 1293.	No. 1294.	No. 1295.	No. 1296.	No. 1297.
Specific gravity	7.132	7.127	6.410	6.503	6.406
Iron	93.208	93.712	91.420	90.899	89.731
Graphite	3.350	2.990	2.460	2.560	1.660
Combined carbon	.220	.210	.240	.160	.790
Manganese	.054	.056	.195	.236	.471
Silicon	2.389	1.908	3.709	5.121	6.308
Slag	1.160	.600	.540	.760	1.120
Aluminum	.193	.644	Not est.	Not est.	Not est.
Calcium	.144	.104	.176	.072	.152
Magnesium	.095	.095	.233	.106	.060
Potassium	.047	.063	Not est.	Not est.	Not est.
Sodium	.032	.010	Not est.	Not est.	Not est.
Phosphorus	.194	.380	.385	.394	.461
Sulphur	.005	.066	.082	.045	.015
			Loss .560		
Total	101.091	100.838	100.000	100.353	100.768
Total carbon	3.570	3.200	2.700	2.720	2.450

No. 1298—Virgin Soil. *"From woods in the valley of East Fork of Little Sandy river, taken to six inches below the surface. Farm of Vincent Calvin, near Cannonsburg, Boyd county. Collected by J. A. Monroe."*

Soil of a dirty-buff color. All passed through the coarse sieve (289 meshes to the inch).

No. 1299—Sub-soil *of the preceding, &c., &c.*

Of a buff color; lighter in tint than the preceding. All passed through the coarse sieve.

No. 1300—Virgin Soil. *"Southeastern slope of hill sixty feet above the bed of the creek. V. Calvin's farm, &c., &c. Sample taken six inches from the surface by J. A. Monroe."*

Of a dark dirty-drab grey color. The coarse sieve removed from it a considerable proportion of small fragments, many of which are angular, of ferruginous sandstone.

No. 1301—SUB-SOIL *of the preceding, taken two feet below the surface, &c., &c.*

Lighter colored than the preceding; dirty-drab grey. Sifted out more of ferruginous sandstone fragments than from the preceding.

No. 1302—OLD FIELD SOIL. "*Surface soil from a field forty-five years in cultivation, on East Fork of Little Sandy. Farm of V. Calvin, near Cannonsburg.*"

Soil of a dirty dark-buff color. All passed through the coarse sieve.

No. 1303—"SUB-SOIL *of the next preceding, taken two and a half feet from the surface, &c.*"

Of a dirty-buff color, lighter in tint than that of the surface soil. All passed through the coarse sieve.

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

	No. 1298.	No. 1299.	No. 1300.	No. 1301.	No. 1302.	No. 1303.
Organic and volatile matters	3.140	3.085	7.985	5.190	4.915	4.905
Alumina, and iron and manganese oxides	5.091	6.642	7.425	9.984	9.019	9.675
Lime, carbonate	.214	.116	.571	.392	.259	.276
Magnesia	.034	.178	.352	.251	.333	.053
Phosphoric acid	.134	.083	.208	.191	.156	.160
Sulphuric acid	trace.	. . . .	. . . .	trace.	.038	trace.
Potash	.317	.307	.435	.205	.344	.282
Soda	.076	.099	.045	.050	.027	.176
Sand and insoluble silicates	90.490	88.420	81.410	83.230	83.765	83.385
Water expelled at 380° F.	.650	.525	.915	.500	1.235	1.315
Loss	. . . .	.545	.554	.007	. . . .	. . . .
Total	100.146	100.000	100.000	100.000	100.091	100.227
Hygroscopic moisture	1.375	1.735	2.225	1.700	2.335	2.840
Potash in the insol. silicates	Not estimated.					
Soda	Not estimated.					
Character of the soil	Virgin soil. Valley.	Sub-soil.	Virgin soil. Slope of hill.	Sub-soil.	Old field.	Sub-soil.

These soils, if sufficiently drained and properly cultivated, may be made quite productive, although the silicious material is in rather large proportion in some. By comparing the composition of the virgin soil No. 1300, with that of the corresponding old field soil No. 1302, it will be seen that cropping, without the use of manures, has notably diminished the phosphoric acid, potash, and lime carbonate, while the relative proportion of the sand and silicates is increased.

[For Bourbon County Limestone, see the Appendix.]

BRACKEN COUNTY.

No. 1304—SOIL. *Labeled "Top Soil, one to eight inches from surface. Old field in grass; thin and bare in places. Sample from a fertile corner, beyond the fence where it had been out of culture for five years or more." Collected by Prof. N. S. Shaler.*

Of a dark grey-buff color. Contains no gravel or coarse sand.

No. 1305—"SUB-SOIL *of the preceding; taken fourteen to eighteen inches below the surface, just above the rock substratum. It has some faint traces of original bedding, showing that it had been formed by decomposition of rock in place. Collected by Prof. N. S. Shaler."*

Of a handsome yellowish-buff color. No gravel.

No. 1306—TOP SOIL *of the field No.* 1304; *taken in a worn place; has been longer in cultivation and is much more worn than that. Will not hold sod. Has been in cultivation over twenty years. Collected by Prof. N. S. Shaler."*

Of a yellowish-buff color, very little darker than that of the sub-soil. Contains a small quantity of small fragments of red ferruginous shale.

EXTRACTED FROM 1000 PARTS OF THESE SOILS (AIR DRIED) BY DIGESTION IN CARBONIC ACID WATER.

	No. 1304.	No. 1305.	No. 1306.
Organic and volatile matters	0.483	0.600	0.294
Alumina, and iron and manganese oxides	.013	.013	.010
Lime, carbonate	.496	.040	.080
Magnesia	.030	.023	.014
Potash	.030	.010	.020
Soda	.020	.020	.020
Soluble silica	.060	.130	.110
Phosphoric, sulphuric, and nitric acids and loss	.184	.130	.118
Total extract from 1000 parts	1.316	0.960	.666
Color of the extract	Light brown.	Light brownish grey.	Brownish grey.

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

	No. 1304.	No. 1305.	No. 1306.
Organic and volatile matters	4.140	4.775	3.335
Alumina	5.837	5.513	3.837
Iron, peroxide	7.150	6.025	3.965
Manganese, brown oxide	.225	.170	.070
Lime, carbonate	a trace.	a trace.	a trace.
Magnesia	.297	.269	.268
Phosphoric acid	.233	.424	.217
Sulphuric acid	a trace.	a trace.	a trace.
Potash	.110	.197	.135
Soda	a trace.	.174	.076
Sand and insoluble silicates	82.140	81.970	87.815
Water expelled at 380° F.	1.015	1.100	not est.
Total	101.147	100.617	99.718
Water expelled at 212° F.	2.200	3.200	2.300

These soils are all deficient in lime. Top-dressing with this material would doubtless greatly improve their productiveness. This should, however, be accompanied with the use of clover or other green fertilizing crops, to increase the proportion of *humus*, which is also deficient in the soils. The difference in the amount of soluble matters extracted by digestion in water charged with carbonic acid, as well as the relative proportions of the potash, &c., in that extracted matter, and the amount of sand and silicates, correspond with the observed relative productiveness of the soils.

No. 1307—SILICIOUS MUDSTONE (of Dr. Owen). *Rock below Soil No. 1304; averages from twenty-eight to thirty-five inches. Uniform. Some of the layers completely decomposed; all of them softened by decay. Three miles northwest of Germantown. Collected by Prof. N. S. Shaler.*

A dirty grey-buff, friable, sandy shale. Adhering to the tongue. Many fossils in the laminæ.

COMPOSITION, DRIED AT 212° F.

Silica	76.060	
Alumina, and iron and manganese oxides	14.959	(by difference).
Lime, carbonate	.500	
Magnesia, carbonate	.345	
Phosphoric acid	.486	
Potash	2.735	
Soda	1.515	
Water expelled at red heat	3.400	
	100.000	

This analysis having been made by fusion, instead of digestion in acids, &c., &c., gives the *total* contents of alkalies and phosphoric, as well that quantity which may be immediately available for plant nourishment as that which for the present is locked up in firm combination in the silicates, which can only become available in the natural course of long weathering.

BRECKINRIDGE COUNTY.

No. 1308—" RED UNDER CLAY, *from near Brandenburg. Collected by Mr. G. E. Chick.*

A somewhat adhesive ferruginous clay, of a dark brick-red color; containing some fragments of weathered chert.

COMPOSITION, DRIED AT 212° F.

Organic and volatile matters, mostly water	9.000
Alumina, and iron and manganese oxides	20.860
Lime, carbonate	1.060
Magnesia	.684
Phosphoric acid	.230
Sulphuric acid	.061
Potash (including that in the silicates)	.982
Soda (including that in the silicates)	.501
Sand and insoluble silicates	66.680
	100.058

Although this clay contains a considerable per centage of potash, nearly one per cent., it is not probable that it could be profitably used as a fertilizer, because of the fact that a very large proportion of its alkalies is in the insoluble silicates, where they would not be immediately available for plant nourishment.

It might be employed, however, to improve the condition of light sandy soils.

BUTLER COUNTY.

No. 1309—LIMONITE. *Labeled "Ore from the farm of Jas. E. Taylor, near the mouth of Little Reedy; one mile and a half from Green river. Average sample by J. R. Proctor."*

Limonite in irregular laminæ; with much softer ochreous ore.

No. 1310—LIMONITE. *Labeled "Ore above the upper coal. Stevens' coal mine, near the mouth of Bear Creek. Average sample by P. N. Moore."*

In dense, curved, dark-brown laminæ, incrusted by and inclosing softer ochreous ore.

COMPOSITION OF THESE LIMONITES, DRIED AT 212° F.

	No. 1309.	No. 1310.
Iron, peroxide	48.049	44.794
Alumina	.171	2.391
Manganese, brown oxide	.140	a trace.
Lime, carbonate	.540	.643
Magnesia	.195	.234
Phosphoric acid	.345	.535
Sulphuric acid	.473	.158
Water expelled at red heat	9.750	7.700
Silica and insoluble silicates	31.900	44.180
Alkalies, &c., and loss	.437	. . . . .
Total	100.000	100.815
Iron, per centage	33.634	31.482
Phosphorus, per centage	.150	.233
Sulphur, per centage	.189	.063
Silica, per centage	29.460	42.200

The somewhat large proportion of *phosphorus* in these two ores may make the iron obtained from them somewhat "cold-short," and the sulphur in No. 1310 is in rather too large quantity. In other respects these ores are good, and they might be profitably smelted for ordinary foundry iron.

No. 1311—CLAY IRON-STONE. *Labeled "Ore from Jno. Hudson's on Young's Ferry road. Average sample by P. N. Moore."*

A dark grey, fine-granular iron carbonate, partly converted into limonite.

No. 1312—CLAY IRON-STONE. *Labeled "Ore resting on the coal at Knob Lick, half a mile from Big Reedy Creek, near road to Young's Ferry. Average sample by P. N. Moore."*

Granular iron carbonate, somewhat oölitic, partly converted into limonite, and containing small fragments of fibrous coal.

COMPOSITION OF THESE CLAY IRON-STONES, DRIED AT 212° F.

	No. 1311.	No. 1312.
Iron, carbonate	29.914	22.583
Iron, peroxide	17.945	17.313
Alumina	3.583	.835
Lime, carbonate	12.036	6.714
Magnesia, carbonate	3.677	2.830
Manganese, carbonate	a trace.	a trace.
Phosphoric acid	.467	.972
Sulphuric acid	.381	.473
Silex and insoluble silicates	28.040	44.240
Water and loss	3.957	4.040
Total	100.000	100.000
Iron, per centage	27.041	22.969
Phosphorus, per centage	.204	.423
Sulphur, per centage	.152	.189
Silica, per centage	25.260	42.760
Specific gravity	not est.	not est.

No. 1313—COAL. *Labeled "Stevens' coal. Stevens' bank, Bear Creek, two miles from Green river, Butler county. Average sample by P. N. Moore."*

A deep-black coal, breaking into thin layers under the hammer. Fibrous coal and fine-grained pyrites between the laminæ. Contains a little shale.

COMPOSITION OF THE AIR-DRIED COAL.

	No. 1313.
Specific gravity	1.378
Hygroscopic moisture	3.40
Volatile combustible matters	30.66
Coke	65.94
Total	100.00
Total volatile matters	34.06
Fixed carbon in the coke	54.94
Ashes	11.00
Total	100.00
Character of the coke	Spongy.
Color of the ash	Brownish lilac-grey.
Per centage of sulphur	2.544

No. 1314—LIMESTONE, *from Barren river, near the mouth of Gasper Creek; sub-carboniferous. From the stock pile of Airdrie Furnace. Sampled by P. N. Moore."*

A light-grey, fossiliferous limestone.

COMPOSITION, DRIED AT 212° F.

Lime, carbonate	93.020	= [illegible].091 per cent. of lime.
Magnesia, carbonate	2.088	
Alumina, and iron and manganese oxides	.917	
Phosphoric acid	.243	= 0.106 per cent. of phosphorus.
Sulphuric acid	.604	= .242 per cent. of sulphur.
Silica and insoluble silicates	2.760	
Water and loss	.368	
	100.000	

CALDWELL COUNTY.

GALENA (lead sulphide), selected from specimens sent by S. Marble & Son, Princeton, Kentucky, from their lead mine in this county. The vein is in the sub-carboniferous limestone, described as generally five feet wide. The mine has a twenty feet drift, forty-five feet wide. The gangue of the ore is principally fluor-spar, containing more or less zinc blende.

This ore was examined principally for its proportion of silver; and by a careful analysis of the lead, obtained from it by reduction with the usual flux (of soda carbonate, potash nitrate, and sodium chloride), solution of the reduced metal in diluted nitric acid, and precipitation of the filtered solution by means of a very dilute solution of lead chloride, a very small proportion of silver was obtained, not exceeding in amount two hundred and sixty-six (266) grains to the ton (of 2,000 pounds) of the selected galena. As is well-known, pure galena contains from eighty-one to eighty-six per cent. of lead in general

This mine cannot, therefore, be profitably worked for silver; but if fluor-spar is found to be practicably valuable for the purification of iron from phosphorus, &c., this, as well as the lead, may be advantageously explored.

CAMPBELL COUNTY.

No. 1315—MARLY SHALE. *Labeled "Clay Marl, from Cincinnati Group; quarter of a mile from Newport, on the Alexandria Turnpike; upper blue clay. Collected by Prof. N. S. Shaler."* Lower Silurian.

A dark-grey, soft shale. Adhering to the tongue.

No. 1316—MARL. *Labeled "Marl, from the silicious mud-stone of Dr. Owen, ten feet from the surface. Not distinctly stratified. Gallows Gap. Collected by Prof. N. S. Shaler."*

Buff-colored; friable; fine-grained.

No. 1317—CLAY SHALE. *Labeled "Newport Reservoir; three hundred and forty feet above the Ohio river. A mixture of the clays in a set of beds, containing a few limestone layers, six feet from the surface to twelve feet." Collected by Prof. N. S. Shaler.*

A yellowish, soft shale, with some softer ferruginous clay mixed. Adhering to the tongue.

No. 1318—CLAY SHALE. *Labeled "Newport Reservoir, upper blue clay, three hundred and twenty feet above high water in the Ohio river." Collected by Prof. N. S. Shaler.*

A dark, bluish-grey soft shale. Adhering to the tongue.

No. 1319—CLAY. *Labeled "Brick Clay, about three feet above high water in the Ohio river; Newport, Kentucky." Collected by Prof. N. S. Shaler.*

A light, ferruginous, yellow silicious clay.

No. 1320—SANDY FERRUGINOUS CLAY. *Labeled "Sandy Clay, three feet from surface; Mt. Vernon road, half a mile from Alexandria Turnpike." Collected by Prof. N. S. Shaler.*

Of a light reddish-brown color.

No. 1321—FERRUGINOUS CLAY, &c. *Labeled "Ferruginous Conglomerate; side of road, one mile north of Grant's Creek. North head waters of Phillips' Creek." Collected by Prof. N. S. Shaler.*

Ferruginous clay, with nodules of impure hydrated peroxide of iron included.

No. 1322—SAND. *"Labeled "Moulding Sand, Columbia Trace, half a mile northeast of Newport Water-Works Reservoir." Collected by Prof. N. S. Shaler.*

A fine sand of a dirty-salmon color, composed mainly of minute rounded quartz grains.

No. 1323—SAND. *Labeled "Sand beneath the Brick Clay. Section on Columba corner of Harris street; Newport, Kentucky." Collected by Prof N. S. Shaler.*

A moderately fine sand, of a dirty-buff color. Examined with the glass it showed mostly rounded grains of hyaline, yellow and milky quartz, with dark graims of some ferruginous mineral.

COMPOSITION OF THESE CAMPBELL COUNTY MARLS, CLAYS, AND SANDS, DRIED AT 212° F.

	No. 1315	No. 1316	No. 1317	No. 1318	No. 1319	No. 1320	No. 1321	No. 1322	No. 1323
Silica	47.320	68.760	58.080	51.420	72.660	82.560	57.160	81.660	85.840
Alumina, and oxides of iron and manganese	28.050	12.050	31.490	29.450	20.500	12.223	33.540	12.700	3.500
Lime, carbonate	13.440	9.860	.660	6.850	a trace.	.160	.860	a trace.	7.400
Magnesia, carbonate	1.135	3.859	1.135	1.256	.832	a trace.	1.776	a trace.	.296
Potash	3.254	1.329	3.045	4.124	1.243	.675	2.698	.756	not est.
Soda	.640	.976	.986	.567	not est.	.282	.555	.637	not est.
Phosphoric acid	.345	.223	.255	.122	.192	not est.	not est.	a trace.	not est.
Sulphuric acid	Not esti	mated.							
Water expelled at red heat	4.800	2.200	4.700	4.400	4.200	4.100	3.411	4.400	2.200
Loss	.966	.743	....	1.811	.373	....	....	....	.764
Total	100.000	100.000	100.351	100.000	100.000	100.000	100.000	100.153	100.000

These marly shales, marls and clays, are not especially valuable as fertilizers, although some of them contain considerable proportions of potash and phosphoric acid. The former, however, is mostly in firm combination in the silicates, which are insoluble in acids, so that it can only be made available by long weathering, or, possibly, by the action of lime, &c.

No. 1315 appears to be the best of them. They all would be useful as top-dressing for improving light sandy soil.

The sands have no peculiar interest, although useful for many well-known purposes.

No. 1324—SOIL. *Labeled "Virgin Soil, in open woods, farm of Gen. G. B. Hodge. Flat Woods; waters of Phillips' Creek; one and a half miles southeast from Grant's Lick. Timber—white oak, hickory, small beech, and walnut." Collected by Prof. N. S. Shaler.*

Soil of a warm yellowish-drab color. It all passed through the coarse sieve (of 289 meshes to the inch), except some rootlets, a very small quantity of shot-iron ore, and a few small rounded pebbles of milky quartz.

No. 1325—SOIL. *Labeled "Old Field Soil. Field adjoining the woods whence came No. 1324. Cultivated in corn and tobacco for more than forty years. No manuring. Still brings a little corn. Sample one to seven inches from the surface." Collected by Prof. N. S. Shaler.*

Soil of a warm yellowish-drab color. All passed through the coarse sieve except a few fragments of wood, two or three small water-worn pebbles of milky quartz, and some small angular fragments of decomposing chert. It also contains some fine shot-iron ore.

No. 1326—SOIL. *Labeled "Same old field as the preceding. Plowed in 1871 to the depth of twenty inches and sub-soiled. Now (1873) in timothy grass. Seems to want lime." Collected by Prof. N. S. Shaler.*

Color, &c., much as in preceding soil.

No. 1327—SOIL. *Labeled "Sub-soil, twelve inches from the surface, same field as preceding, forty years in cultivation. Silicious mudstone beneath." Collected by Prof. N. S. Shaler.*

Soil of a yellowish-drab color; more yellowish than preceding. All of it passed through the coarse sieve, except a very small quantity of shot-iron ore.

No. 1328—SOIL. *Labeled "Spur of hill sixty feet above the position of the preceding soils. In corn for two years. Twenty bushels to the acre this year (1873); bad culture. Surface soil."*

Soil of drab color. Lighter colored than any of the preceding soils. Moist soil cakes in the bag like clay. It mostly passed through the coarse sieve, leaving only some shot-iron ore and small quartz pebbles, &c.

No. 1329—SOIL. *Labeled "Virgin Soil, border of cultivated field, newly cleared. Slope faces southwest. Land reputed rich; but in the midst of much poor land. Sells for two hundred dollars per acre. Youtsey's land, eight miles from Newport, Alexandria Turnpike." Collected by Prof. N. S. Shaler.*

A clay soil of a dark buff-grey color. Aggregated, on drying in the bag, &c., into quite hard, irregular and angular small lumps. Makes a very tenacious, sticky clay when wet.

No. 1330—SOIL. *Labeled "Sub-soil (under the preceding soil) two feet from the surface, &c." Collected by Prof. N. S. Shaler.*

A clay soil of a light grey-buff color; aggregating into pretty compact lumps on drying.

See No. 1334 for composition of the limestone underlying this land.

No. 1331—SOIL. *Labeled "A curious gravelly loam, two feet below surface, with bits of chert, from the sub-carboniferous of Upper Licking. Silicious mudstone and limestone below. Upper waters of Pond Creek, near Pond Creek Post-office, on new turnpike, about four miles southwest of Alexandria." Collected by Prof. N. S. Shaler.*

A deep yellow-buff colored sub-soil, containing nearly one sixteenth of its weight of fragments of ferruginous shaly sand rock, rounded quartzose pebbles, and shot-iron ore.

No. 1332—SOIL. *Labeled "Old field in grass. Slope of* 10° *south. Resting on river detritus. Side of run near Newport, Kentucky." Collected by Prof. N. S. Shaler.*

Soil of a dark grey-buff color. All of it passed through the coarse sieve.

No. 1333—SOIL. *Labeled "Bottom field of the next preceding, taken two feet from the surface. Detrital grit. Twenty feet above high water of Ohio river."*

Soil of a handsome orange-grey, or grey-orange-buff color. Aggregated into friable clods.

COMPOSITION OF THESE CAMPBELL COUNTY SOILS AND SUB-SOILS. DRIED AT 212° F.

	No. 1324	No. 1325	No. 1326	No. 1327	No. 1328	No. 1329	No. 1330	No. 1331	No. 1332	No. 1333
Extracted from 1,000 parts by carbonated water	2.290	1.700	1.220	0.830	1.860	2.700	5.650	0.716	1.080	1.200
COMPOSITION OF THE CARBONIC ACID WATER EXTRACT.										
Organic and volatile matters	1.060	1.030	0.580	0.530	0.720	0.690	0.490	0.316	0.396	0.815
Alumina, oxd. iron, &c.	.320	.130	.110	.040	.080	.020	.050	.010 }	.060	.030
Manganese oxide	.060	.070	.080	not est.	not est.	not est.	not est.	not est }		
Lime, carbonate	.610	.400	.260	.090	.760	1.620	4.440	.180	.430	.280
Magnesia	.080	.036	.004	.040	.010	not est.	.450	.030	.010	.040
Nitric acid	Not esti	mated.								
Phosphoric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Chlorine	Not esti	mated.								
Potash	.060	.070	.050	.010	.050	.030	.020	.020	.037	.020
Soda	.010	.050	.040	.030	.020	.040	.020	.040	.015	.020
Soluble silica	.122	.090	.055	.150	.170	.070	.180	.130	.080	.067
Loss	....	....	.021	....	.050	.230	....	....	.052	....
Total	2.322	1.876	1.220	0.890	1.860	2.700	5.650	0.726	1.080	1.272
COMPOSITION OF THESE SOILS, DRIED AT 212° F.										
Organic and volatile matters	3.650	2.555	2.540	2.435	8.965	7.615	5.960	5.160	2.775	2.135
Alumina	3.375	3.415	3.900	3.868	4.040	5.175	5.323	3.815	1.587	2.737
Iron oxide	3.125	3.038	3.274	3.972	4.787	6.750	6.890	4.300	2.980	4.465
Manganese, br. oxide	.059	.037	not est.	.427	.471	.260	.080	.390	.070	.320
Lime, carbonate	.130	.090	.125	.125	.450	.990	3.890	a trace.	a trace.	a trace.
Magnesia	.034	.496	.008	.250	.250	.520	.500	.474	.191	.300
Phosphoric acid	.145	.109	.093	.122	.093	.483	.313	.420	.256	.240
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Potash	.120	.062	.064	.062	.240	.726	.593	.443	.115	.125
Soda	.047	.132	.160	.109	.071	a trace.	.019	.045	.048	.106
Soluble silica *	.045	.090	.055	.015	.170	.070	.180	.130	.080	.067
Sand and insoluble silicates	87.545	89.335	88.395	87.560	78.963	75.590	75.415	83.775	91.655	89.040
Water expelled at 380° F.	1.160	1.110	1.020	1.040	1.500	1.850	1.017	1.250	1.035	1.010
Loss	.565	....	.366	.015	....	....	....	....	....	....
Total	100.000	100.469	100.000	100.000	100.000	100.000	100.180	100.202	100.792	100.545
Water expelled at 212° F.	1.765	1.550	1.665	2.235	2.550	5.075	4.300	4.825	1.400	2.215
Potash in insoluble silicates	not est	1.311	not est.	1.477	not est.	2.731	not est.	not est.	not est.	not est.
Soda	not est.	.700	not est.	.389	not est.	.909	not est.	not est.	not est.	not est.
Character of soil	Virgin soil.	Old field	Old field	Sub-soil.	New soil	Virgin soil.	Sub-soil.	Gravelly loam.	Old field	Old field

* It is proper to state, that this quantity does not represent the "soluble silica" which might have been extracted by boiling the "silicious residue" in solution of carbonate of soda, &c., but simply the amount which was held in the acid solution of the soil. But little importance was attached to this determination, not because its existence in the plant is considered by many modern agricultural chemists as "an accident" and "unessential," if not "useless" (see "How Crops Feed," by Prof. S. W. Johnson, page 353); but because it is to be found, ordinarily, dissolved in all waters which percolate soils. Moreover, Prof E. A. Hilgard shows that the amount of soluble silica in the silicious residue of a soil usually bears a pretty constant relation to the quantity of lime in it. Its proportion at any given time doubtless depends on the relative decomposition of the silicates of the soil at that time.

In addition to the determinations given in the preceding table of the composition of these soils, the "*sand and insoluble silicates*" were analyzed, by the method of fusion, &c., &c., with the following results, viz:

COMPOSITION OF THE SAND AND INSOLUBLE SILICATES IN THE 100 PARTS, DRIED AT 212° F.

	No. 1325.	No. 1327.	
Silica	89.560	88.660	
Alumina, &c., &c.	7.650 }		
Lime	.324 }	9.310	
Magnesia	.260 }		
Potash	1.464	1.684	= 1.311 and 1.477, severally calculated into 100 parts of the soil.
Soda	.743	.346	
Total	100.001	100.000	

An attempt was also made, with the use of the celebrated Nobel's apparatus, to submit some of these soils to silt analysis; *i. e.* to determine the relative proportions of the fine and coarser earthy material contained in them; but the results of comparative operations on the same soil were so discordant that no value whatever could be attached to them.

The writer regrets that he was not able, for want of time, &c., to apply to the silt analyses of some of these soils the improved apparatus devised by Prof. Eugene W. Hilgard, and used by him in his researches on the soils and clays of Mississippi, while he was the State Geologist, as described by him in a paper read by him at the Portland meeting of the *American Association for Advancement of Science*, August, 1873, and published in *American Journal of Science and Arts*, October and November, 1873.

The chemical analyses were conducted very much as is described in volume III of Kentucky Geological Reports, except that a larger quantity of the soil was digested in water containing carbonic acid, charged under the atmospheric pressure only, and found by analysis to contain about 0.9 of its volume of this gas. Instead of filtering the solution, a proportional quantity of it was drawn off from the residue by means of a pipette of proper construction.

The residue obtained by evaporating this solution, frequently *deflagrated* when ignited, showing the presence of *nitrates*.

This was observed, in a marked degree, with the extracts from Nos. 1324, 1325, 1326, 1327, and 1329.

The above table of the results of the analyses of these soils is interesting, as demonstrating, what has frequently been called in question by agricultural chemists in recent times, the possibility of ascertaining the agricultural capabilities of soils by chemical analysis; having due reference, of course, to the physical conditions.

For the purpose of more ready comparison of some of the results of these analyses, we copy in the following table the proportions of some of the most essential ingredients and educts of these soils:

	Extracted by carbonated water from 1,000 parts.	Extracted by acids from 100 parts.			
		Organic and volatile matters.	Lime, carbonate.	Phosphoric acid.	Potash.
No.					
1324, virgin soil	2.322	3.650	0.130	0.145	0.120
1325, old field, same locality . . .	1.876	2.550	.090	.109	.062
1326, old field, same locality . .	1.220	2.554	.125	.093	.064
1327, sub-soil, same locality . . .	.891	2.435	.125	.122	.062
1328, new field, same locality . .	1.860	8.965	.450	.093	.483
1329, virgin soil (Youtsey's), high priced; considered rich . .	2.700	7.615	.990	.483	.726

Youtsey's land will be seen, by reference to Appendix No. A. 12, to be strikingly like the California adobe soil in composition and consistence. It also resembles good blue grass soil. The others show a deficiency of lime, potash, and organic matters, or *humus*, except that of the "new field," which, like No. 1325, is apparently deficient in phosphoric acid, and which would be much more productive under better culture than it has received, and with the application of phosphate or superphosphate of lime. The use of lime, wood ashes, and of green crops, especially of clover, would be beneficial to these soils of Col. Hodges?

No. 1334—LIMESTONE. *Labeled "Blue Limestone (Cincinnati Group), just below soils Nos.* 1329 *and* 1330. *Youtsey's land, Alexandria Turnpike, eight miles from Newport, Campbell county." Collected by Prof. N. S. Shaler.*

A firm coarse-grained semi-crystalline, dark-grey limestone, full of fossils, corals and shells, with some included nodules of light olive-grey granular material.

COMPOSITION DRIED AT 212° F.

Lime, carbonate	93.200	= 52.192 per cent. of lime.
Magnesia, carbonate	2.291	
Alumina, and iron and manganese oxides	1.700	
Sulphuric acid	.535	= .214 per cent. of sulphur.
Phosphoric acid	.076	= .033 per cent. of phosphorus.
Potash	.173	
Soda	.384	
Silex and insoluble silicates	2.360	
	100.719	

A limestone not very rich in mineral fertilizers, which would yield a good lime for building purposes.

No. 1335—"MARLY SHALE, *from two miles south of Newport, Licking Three Mile Creek. Geological position, 'Cincinnati Group,' fifty feet above high water mark of the Ohio river." Collected by Prof. N. S. Shaler.*

A friable shale of a handsome light olive-grey color, containing fragments of small encrinital stems and of *orthis multicoste.*

No. 1336—"MARLY SHALE, *from Licking Three Mile Creek, two miles back of Newport (Cincinnati Group). About sixty feet above high water mark of the Ohio river. The beds are about thirty feet thick, with thin partings, and can be easily stripped. Test their value as marl." Collected by Prof. N. S. Shaler.*

Of a light olive-grey color. The laminæ are thinner than in the preceding.

COMPOSITION OF THESE MARLY SHALES, DRIED AT 212° F.

	No. 1335.	No. 1336.
Silica	54.160	57.260
Alumina	12.269	16.782
Iron peroxide, with some manganese oxide	15.550	11.500
Lime, carbonate	7.800	4.560
Magnesia	.165	.778
Phosphoric acid	.281	.008
Sulphuric acid	.659	.233
Potash	3.298	4.471
Soda	.926	1.072
Water expelled at red heat and loss	4.892	3.336
Total	100.000	100.000

These marly shales resemble in composition the marls and clays reported above.

CARTER COUNTY.

No. 1337—CLAY. *Labeled "Fire-clay; average sample from the upper bed, four feet thick, on both sides of the hill. Ridge between Grassy and Three Prong Creeks, Boone Furnace property. Whole bed eight to ten feet thick. Collected by Philip N. Moore."*

The dried clay is quite compact, scarcely to be scratched with the nail; has a soapy feel; not adhering to the tongue. Breaks into sharp angular fragments. It is of a light-grey color.

No. 1338—CLAY. *"From ridge between Grassy and Three Prong Creeks, Boone Furnace property. Lower bed. Collected by P. N. Moore."*

Compact, breaking into sharp angular fragments; hardly to be scratched with the nail; slightly adhering to the tongue; has a somewhat soapy feel. Presents, in parts, an approach to an oölitic structure. Color dark-grey, passing into dove-color.

No. 1339—CLAY. *"From same locality as preceding. Rougher part of the upper layer, &c., &c. Collected by P. N. Moore."*

A light-grey compact rock, of a harsh gritty feel; not to be scratched with the nail. Under the glass showing many rounded grains of quartzose sand. Ferruginous incrustation on the surface.

No. 1340—CLAY. "*Fire-clay under coal. Old Orchard Diggings, Boone Furnace property, Carter county. Collected by P. N. Moore.*"

A compact shaly clay, with some of the lamellar surfaces polished in various planes. Has a soapy feel, and no grit. Of a dull dove-grey color.

No. 1341—CLAY. "*Fire-clay from same bed as Nos.* 1337, 1338, *and* 1339. *A dark-colored sample from the lower part of the deposit.*" *Collected by P. N. Moore.*

Compact fine-granular; hardly scratched with the nail; adhering very slightly to the tongue. Of a dark brownish-slate color.

No. 1342—CLAY. "*Fire-clay under the twelve inch coal Geo. Osenton's land, near Grayson, Carter county. Sampled by J. A. Monroe.*"

A grey or ash-grey clay in a pulverulent condition.

No. 1343—CLAY SHALE. *Labeled "Argillaceous Shale, with some Lingulæ near the top. Railroad cut, half mile south of Station (Eastern Kentucky Railroad), Grayson, Carter county. Collected by Prof. N. S. Shaler.*"

A soft friable shale of a light buff-grey color, mottled and colored between the laminæ with ferruginous and black.

COMPOSITION OF THESE CLAYS, &c., OF CARTER COUNTY, DRIED AT 212° F.

	No. 1337.	No. 1338.	No. 1339.	No. 1340.	No. 1341.	No. 1342	No. 1343.
Silica	48.560	45.960	54.620	62.460	45.560	64.260	66.060
Alumina	37.471	38.531	32.466	27.203	43.775	24.604	23.726
Iron, oxide	a trace.	a trace.	a trace.	a trace.	a trace.	not est.	not est.
Lime	.112	.145	a trace.	a trace.	.145	.538	*.300
Magnesia	a trace.	a trace.	a trace.	a trace.	a trace.	.209	*.121
Phosphoric acid	.255	.563	.243	.147	.307	.946	.127
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	.157	not est.
Potash	.289	.250	.212	1.850	.963	.751	2.093
Soda	.283	.341	.679	.584	.728	.515	2.273
Water expelled at red heat	13.030	14.210	11.780	7.756	8.522	8.300	5.300
Total	100.000	100.000.	100.000	100.000	100.000	100.280	100.000

* Carbonates.

The composition of these clays indicate that most of them are highly "refractory" or fire-clays, and that all could be used for the manufacture of stone-ware, terra cotta, &c. Those which burn white might be used for "delf ware," or "queen's-ware," so called.

The most refractory are, probably, Nos. 1337, 1338, and 1339; the next, Nos. 1342, 1341, and 1340. The least refractory of all is the clay shale, No. 1343, which, however, notwithstanding its more than two per cent. each of potash and soda, would answer for the manufacture of stone-ware, and, most probably, of ordinary fire-brick.

It is found that a large relative proportion of silica or sand increases the refractory quality of the clay, and, according to the experiments of E. Richters* (1868), this quality is least affected by magnesia; more so by lime; still more by iron oxide; and most by potash. The influence of phosphates has not been fully determined.

For comparison, the analyses of two of the best Kaolin clays of France, of the best Stourbridge clay of England, and of a crucible clay, are here appended:

	(*a*)	(*b*)	(*c*)	(*d*)
Silica	48.68	55.30	63.40	47.50
Alumina	36.92	30.30	31.70	34.37
Iron oxide	.....	2.00	3.00	1.24
Lime	not given.	not given	not given.	.50
Magnesia	.52	.40	not est.	1.00
Phosphoric acid	not given.			
Sulphuric acid	not given.			
Potash	not est.	1:10 }	1.90	not est.
Soda	.58	2.70 }		not est.
Water expelled at red heat	13.13	8.20	not given.	1.00

(*a*) Porcelain clay of Saint Yrieiex; analyzed by Forchammer.
(*b*) Porcelain clay of China; analyzed by Ebelmann and Salvetat.
(*c*) Stourbridge fire-clay; analyzed by Prof. F. A. Abels.
(*d*) Crucible clay. Almerode, in Kurhessen.

It is evident our fire-clays do not suffer in comparison with these, and that the industrial value of these large deposits in our coal measures is very considerable.

[For other fire-clays see Greenup county, &c.]

* R. Wagner's Chemical Technology, American edition, page 294.

COALS OF CARTER COUNTY.

No. 1344—"COAL, *probably sub-conglomerate, at Old Orchard Diggings.* (*Eight inches of coal, four inches of slate, six inches of coal.*) *Boone Furnace property.*"

A dull slaty coal, having much fibrous coal between the laminæ. Exterior stained with iron oxide.

No. 1345—"COAL, *No. 7, from old entry back of Star Furnace. Upper layer twenty inches thick* (*Coalton coal*). *An average sample, collected by A. R. Crandall.*"

Breaks easily into thin irregular laminæ, with some fibrous coal between. Incrusted somewhat with iron oxide.

No. 1346—"COAL, *No. 7, from old entry back of Star Furnace. Bottom layer, two feet two inches thick. Collected by A. R. Crandall.*"

A pure-looking coal; fracture glossy and pure black, somewhat like that of asphaltum. Very little fibrous coal, pyrites, or ferruginous incrustation apparent.

No. 1347—"COAL, *No. 7, from entry back of Star Furnace. Middle layer, two feet thick. Collected by A. R. Crandall.*"

Appears to be intermediate in quality to the two preceding.

No. 1348—"COAL, *No.* 7 (*Coalton*). *Average sample from Wiley Pritchard's bank, near Mount Savage Furnace, Carter county. Collected by J. A. Monroe.*"

No. 1349—"COAL, *No. 7. Average sample of the six feet Coalton coal, from all parts of the bed. Divide between Stinson and Straight Creeks.* (*Two hundred and seventy-five feet level.*) *Mount Savage property. Averaged by P. N. Moore.*"

No. 1350—"COALTON COAL (*No. 7 coal*), *from drift on Gum branch of Straight Creek. Mount Savage Company drift, lower part of the bed. Averaged by P. N. Moore.*"

No. 1351—"COALTON COAL (*No. 7 coal*), *from drift on Gum branch of Straight Creek. Upper part of bed, Mt. Savage property. Averaged by P. N. Moore.*"

No. 1352—"*Average sample of Coalton coal* (*No.* 7), *Watson Bank, Willard, Carter county. Averaged by J. A. Monroe.*"

No. 1353—"COAL (*No.* 1) *from Graham bank, Little Fork of Little Sandy river, near Willard. Average sample by P. N. Moore.*"

[See appendix, Nos. 1646 and 1647, for the analyses of two other samples of the coal from this bank.]

No. 1354—"COALTON COAL (*No.* 7), *from main entry, west of Dry Fork, Willard. Averaged by P. N. Moore.*"

A jet-black pure-looking coal, showing iridescent colors on portions, and having very little fibrous coal or pyrites.

No. 1355—"COALTON COAL (*No.* 7) *from Old Lost Creek drift, near Willard. Averaged by P. N. Moore.*"

Of rather a rusty black color; shows but little fibrous coal or ferruginous stain.

No. 1356—"COAL (*No.* 2) *from Kibby drift, Everman's Creek, two miles from Grayson, Carter county. Average sample by J. A. Monroe.*"

No. 1357—"COAL (*No.* 1) *from Stone-coal branch of Tygert Creek, Carter county. Averaged by P. N. Moore.*"

No. 1358—"COAL (*probably No.* 2) *from a quarter of a mile north of N. Lewis' house, Barrett's Creek, Carter county. Averaged by P. N. Moore.*"

No. 1359—"COAL (*probably No.* 3) *from Carter farm, two miles east of Grayson, on Dr. Jones' land* (*not a very good average sample*). *P. N. Moore.*"

COMPOSITION OF THESE CARTER COUNTY COALS, AIR DRIED.

	No. 1344	No. 1345	No. 1346	No. 1347	No. 1348	No. 1349	No. 1350	No. 1351	No. 1352	No. 1353	No. 1354	No. 1355	No. 1356	No. 1357	No. 1358	No. 1359
Specific gravity	1.330	1.377	1.288	1.290	1.435	1.347	1.340	1.323	1.326	1.274	1.352	1.337	1.289	1.298	1.307	1.388
Hygroscopic moisture	7.00	7.70	6.60	6.40	5.40	6.90	6.40	6.06	4.40	3.80	3.20	3.70	4.10	4.60	4.20	3.00
Volatile combustible matters	36.26	28.16	34.36	27.22	32.70	33.96	31.40	32.94	33.60	34.50	35.06	35.96	34.60	33.50	33.70	36.20
Coke	56.74	64.14	59.04	66.38	61.90	59.14	62.20	61.00	62.00	61.70	61.74	60.34	61.30	61.90	62.10	60.80
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	100.00	100.00	100.00
Total volatile matters	43.26	35.86	40.96	33.62	38.10	40.86	37.80	39.00	38.00	38.30	38.26	39.66	38.700	38.10	37.90	39.20
Carbon in the coke	44.64	53.04	54.64	58.88	52.52	51.04	57.66	54.80	52.86	58.50	54.40	52.94	56.525	51.60	51.40	49.24
Ashes	12.10	*11.10	†4.40	7.50	9.38	8.10	4.54	6.20	9.14	3.20	7.34	7.40	4.775	10.30	10.70	11.56
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	100.000	100.00	100.00	100.00
Character of the coke	Pulverulent.	Very friable.	Dense porous.	Very friable.	Dense porous.	Dense porous.	Dense porous.	Dense porous.	Dense porous.	Dense porous.	Spongy.	Dense spongy.	Dense porous.	Dense porous.	Spongy.	Spongy.
Color of the ash	Nearly white.	Lilac-grey.	Light grey.	Light brown.	Lilac-grey.	Yellowish lilac-grey.	Purplish grey.	Dark purplish grey.	Brownish-grey	Brownish-grey	Lilac-grey.	Grey-brown.	Lilac-grey.	Yellowish-grey	Brownish-grey	Lilac-grey.
Per centage of sulphur	not est.	1.055	0.724	0.973	2.356	2.430	1.670	1.867	2.210	2.164	2.631	2.727	1.414	1.200	3.483	1.381

Composition of the ash of	* No. 1345	† No. 1346
Silica	5.38	2.00
Alumina and iron oxide	5.12	2.20
Lime, carbonate	0.32	a trace.
Loss	0.28	.20
Total	11.10	4.40

No. 1360—"COKE, *made from the No. 7 coal, in oven, by Mr. Bates, Willard, Carter county. Collected by A. R. Crandall.*"

A bright-looking coke somewhat dense.

COMPOSITION, AIR-DRIED.

Hygroscopic moisture	2.46
Volatile combustible matters	1.84
Coke (dry)	95.70
Total	100.00
Total volatile matters	4.30
Fixed carbon	87.34
Ashes	8.36
Total	100.00
Color of the ash	Lilac-grey.
Per centage of sulphur	2.026

The proportion of sulphur has been but slightly reduced by the coking of this coal. It is probably mostly in combination with iron, as iron proto-sulphide, and may not seriously injure this coke as fuel for the smelting and working of iron.

IRON CARBONATE ORES AND FERRUGINOUS LIMESTONE OF CARTER COUNTY.

No. 1361—FERRUGINOUS LIMESTONE. *Labeled "Limestone Ore, from Old Orchard Diggings, Boone Furnace property. Averaged by P. N. Moore."*

A dull-looking, fine-grained or compact ferruginous limestone, of a light-grey color, varied in parts by infiltrated hydrated oxide of iron. Fracture somewhat hackley. Specific gravity = 2.879.

No. 1362—CLAY IRON-STONE. *Labeled "Limestone Ore from drift at Old Orchard Diggings, head of Grassy Creek, Carter county. Undecomposed ore. Average sample from various parts of bed No. 1. Boone Furnace property. Collected by P. N. Moore."*

Irregular nodules and masses of clay iron-stone; varying in color from light-grey to blackish; mixed with some hydrated iron peroxide.

No. 1363—CLAY IRON-STONE. *Labeled "Kidneys in shale below the coal described, No. 1344, at Old Orchard Diggings, Boone Furnace property, &c. Shale, with the kidneys, four inches thick. Collected by P. N. Moore."*

Irregularly shaped nodules of fine-granular clay iron-stone superficially coated with hydrated brown iron oxide.

No. 1364—CLAY IRON-STONE. *Labeled "Limestone Ore (No. 1), Horsley bank, Boone Furnace property, &c. The undecomposed carbonate. Collected by P. N. Moore" (for a cabinet specimen).*

A fine-granular ore, varying from light-grey to purplish-grey, and incrusted in parts with limonite.

No. 1365—CLAY IRON-STONE AND LIMONITE MIXED. *Labeled "Average sample of Limestone Ore (No. 1), Horsley bank, Boone Furnace property, &c. Collected by P. N. Moore."*

A mixture of fragments of clay iron-stone and limonite ores.

No. 1366—CLAY IRON-STONE. *Labeled "Blue Limestone Ore, from west bank of Tygert Creek, about two miles from Iron Hills, Carter county. Average sample by P. N. Moore."*

Fragments of clay iron-stone nodules, invested externally with limonite layers.

No. 1367—CLAY IRON-STONE. *Labeled "Lower Block Ore, on Dry Fork of Sinking Creek, Carter county. J. M. James' land (six inches of undecomposed siderite). Average sample, by P. N. Moore."*

Compact clay iron-stone, with some little limonite.

No. 1368—CLAY IRON-STONE. *Labeled "Foxden Ore. Means and Russel land, Cumming's branch of Everman's Creek, Carter county. Averaged by P. N. Moore."*

The undecomposed carbonate covered with layers of limonite of various tints, some of which are ochreous.

No. 1369—CLAY IRON-STONE. *Labeled "Grey Limestone Ore, Mount Savage Furnace. Average sample, by J. A. Monroe."*

Grey granular and oölitic carbonate, with more or less limonite ore.

No. 1370—CLAY IRON-STONE. *Labeled "Lower Block Ore. Mr. Everman's Sammy's branch of Barrett's Creek, Carter county. Averaged by P. N. Moore."*

Mostly dark-grey, fine-granular carbonate ore, with some incrustation of limonite.

SUMMARY OF THE COMPOSITION OF THESE CARTER COUNTY CLAY-IRON-STONE ORES, &c., DRIED AT 212° F.

	No. 1361	No. 1362	No. 1363	No. 1364	No. 1365	No. 1366	No. 1367	No. 1368	No. 1369	No. 1370
Iron, carbonate	24.408	61.220	62.662	65.018	44.242	27.511	62.321	46.893	30.708	47.391
Iron, peroxide	. . . .	4.410	10.024	5.945	27.296	26.240	4.989	9.255	31.544	9.734
Alumina.	.560	2.260	1.600	1.060	1.560	9.021	7.901	5.703	1.779	4.197
Lime, carbonate	45.200	4.480	.240	2.720	6.580	2.320	12.000	12.460	2.730	5.220
Magnesia, carbonate . .	24.328	a trace.	2.838	9.038	1.046	2.838	.222	.250	.144	7.893
Manganese, carbonate .	.391	.150	3.251	2.332	.842	.270	.121	not est.	.060	.346
Phos'ic acid (anhydr.) .	.147	.313	.127	.255	.732	.499	.684	.978	.421	.121
Sulphuric acid (anhydr.)	.439	not est.	.521	1.280	4.587	.116	.206	a trace.	.491	.151
Silica and insol. silicates	2.420	21.260	13.720	10.260	11.160	25.180	10.740	23.510	25.430	20.230
KO — .135; NaO — .204	—.339	.540	. . . .	2.112	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Water and loss.	1.768	5.367	3.017	. . . .	1.955	6.005	.816	.951	6.523	4.717
Total	100.00	100.000	100.00	100.000	100.000*	100.000	100.000	100.000	100.000	100.000
Per centage of iron. . .	10.960	32 578	37.285	35.549	40.465	31.598	33.348	29.116	36.627	29.685
Per ct. of phosphorus .	0.064	0.136	0.055	.111	.321	.208	.298	.427	.184	.052
Per centage of sulphur .	0.203	. . . .	.208	.533	1.855	.046	.082	. . . .	.196	.060
Per centage of silica . .	. . . .	. . . .	. . . .	. . . .	. . . .	23.80	8.980	20.860	10.560	19.760

* This sample had in it visible fragments of pyrites, and hence the above may not be an exact determination of the average sulphur of this ore.

No. 1361 would be unobjectionable as flux for richer ores, were it not for its considerable proportion of sulphur. It would make good lime for agricultural uses; which would make a strong cement with sand for all building purposes, where its color would not be objectionable.

The Horsley bank ores Nos. 1364 and 1365, although rich enough in iron, also contain quite large proportions of sulphur, exceeding in this respect all these ores; many of which may be considered quite good of their kind, as may be seen on examination of this table.

LIMONITE IRON ORES OF CARTER COUNTY.

No. 1371—LIMONITE. *Labeled "Limestone Ore from Horsley bank, Boone Furnace property. (A cabinet specimen.) Collected by P. N. Moore."*

In irregular curved laminæ of various tints, from dark brown to red and light yellow; with some soft ochreous ore.

No. 1372—LIMONITE. *Labeled "Average sample of Lambert Main Block Ore, Potato Knob Hill. From the stock pile, Iron Hills Furnace, Carter county. Collected by J. A. Monroe."*

Ore varying from dense dark chocolate-brown, irregular laminæ and grains, to brownish-yellow soft ochreous.

No. 1373—LIMONITE. *Labeled "Potato Knob Iron Ore. Average sample. Iron Hills Furnace, &c."*

In nodules varying from one to six inches in diameter. Exterior of hard dark-brown limonite; interior nodules soft and porous, of yellowish and reddish-brown colors.

No. 1374—LIMONITE. *Labeled "Main Block Ore, Stewart bank. Divide between Barrett's and Everman's Creeks, three miles west of Grayson, Carter county. Average sample."*

The irregular laminæ and concretions varying in color from dark chocolate-brown or purplish to greyish-yellow.

No. 1375—LIMONITE. *"From Royster Hill Lambert bed. Iron Hills Furnace. The ochre from the lower part of the bed."*

Porous and showing a small oölitic structure. Color brownish and greyish-yellow.

No. 1376—LIMONITE. *Labeled "German Ore. Smith Hill. Taken from an imperfectly shown bed, possibly not fully representing the whole bed, except that the ore seems very uniform. None of the blue ore, or kidneys above the main bed, included in this sample. Iron Hills, Carter county. Collected by P. N. Moore."*

Ore generally porous or ochrey, of a yellowish-brown color mottled with light-grey. Some few laminæ of hard limonite.

No. 1377—LIMONITE. *Labeled "Crown Ore. Smith Hill. Iron Hills, &c. Average sample, from upper part of the bed only, by P. N. Moore."*

Composed of irregular laminæ of dense dark-brown limonite, with cavities and included soft ochreous ore.

No. 1378—LIMONITE. *Labeled "Lower Block Ore. Perry's branch of Tygert Creek, west of Olive Hill. Land of Tygert Valley Iron Company. Average sample by P. N. Moore."*

Fragments of dense limonite laminæ mixed with some small clay iron-stone nodules.

No. 1379—LIMONITE. *Labeled "Average sample of Lower Block Ore, from road on west side of Garvin's Hill, west of Olive Hill. Land of Tygert Valley Iron Company."*

Fragments of limonite laminæ and clay iron-stone nodules.

No. 1380—LIMONITE. *Labeled "Block Ore from Garvin's Hill, west of Olive Hill. Land of Tygert Valley Iron Company. Average sample."*

No. 1381—LIMONITE. *Labeled "Main Block Ore; Old Mount Tom Ore, Carter county. Averaged by J. A. Monroe."*

A very dense ore, in curved irregular laminæ of deep bluish and brownish colors, with some dark-brown softer ore between.

No. 1382—LIMONITE, *&c. "Main Block Ore with associated overlying Kidney Ore, from Kibby Diggings. Divide between Lost and Tygert Creeks. Carter county. Averaged by J. A. Monroe."*

Small nodules of fine-granular grey carbonate ore, surrounded by curved irregular laminæ of dense limonite, frequently separated by soft ochreous ore.

No. 1383—LIMONITE. *"Rough Ore, one hundred feet above the Foxden Ore (see clay iron-stones), on Means and Russel's land, Cumming's branch of Everman's Creek. Averaged by J. A. Monroe."*

In irregular hard thin laminæ of dark-brown to brownish-yellow colors; with some soft ochreous ore.

No. 1384—LIMONITE. "*Red Limestone Ore from Graham bank. Average sample from the stock pile, by P. N. Moore.*"

In curved, irregular, hard laminæ; varying in color from yellowish and reddish-brown to deep brown and almost black, with soft, lighter colored ochreous ore incrusting and included.

No. 1385—LIMONITE. "*Yellow Kidney Ore, Mount Savage Furnace, Carter county. Average sample, by P. N. Moore.*"

In irregular curved laminæ, involving nuclei of softer ore. Color varying from deep brown and red to yellowish.

No. 1386—LIMONITE. "*Main Block Ore, Stinson Creek. Mount Savage Furnace. Average sample, by J. A. Monroe.*"

Curved irregular laminæ of dense limonite; generally dark colored, including light-grey nodules of porous carbonate of iron ore.

No. 1387—LIMONITE. "*Ore seventy-three feet above the sub-carboniferous limestone. On Clark's branch of Tygert's Creek, two miles from Iron Hills Furnace. Average sample, by P. N. Moore.*"

Varying from dense, dark-colored limonite laminæ to soft ochreous ore.

As will be seen, on examination of the following table of their composition, these limonite ores of Carter county are generally good, and may be profitably worked with proper management in the smelting; although some of them contain too much sulphur and phosphorus to make very tough iron.

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

	No. 1371	No. 1372	No. 1373	No. 1374	No 1375	No. 1376	No. 1377	No. 1378	No. 1379	No. 1380	No. 1381	No. 1382	No. 1383	No. 1384	No. 1385	No. 1386	No. 1387
Iron, peroxide	81.640	52.460	65.657	57.090	38.285	57.557	52.736	40.139	56.670	59.950	71.502	61.316	51.623	71.680	66.200	59.347	52.238
Iron, carbonate	....	....	....	....	....	....	....	5.731	8.538	....	....	19.435	....	....	....	9.599	....
Alumina	3.160	7.504	4.921	4.203	5.455	2.727	3.531	8.030	4.405	5.230	8.557	3.537	1.671	4.135	3.907	1.957	4.512
Manganese, brown oxide	a trace.	a trace.	a trace.	a trace.	.120	a trace.	.320	*.422	.180	....	a trace.	a trace.	a trace.	.090	.030	.030	.130
Lime carbonate	.180	a trace.	a trace.	a trace.	.460	a trace.	a trace.	.380	a trace.	4.580	a trace.	a trace.	a trace.	.380	.430	830	.650
Magnesia	.919	.155	.040	.086	.065	.065	.065	*.254	*.883	.343	.054	.212	.483	.050	.345	2.027	.641
Phosphoric acid	.060	1.224	.893	.370	1.000	1.746	.800	.038	.337	.842	.466	.166	.081	.084	.130	.153	1.695
Sulphuric acid	not est.	.268	.694	.391	.071	.185	.171	.177	.130	.845	.800	1.009	.408	.270	.182	.302	.230
Combined water	11.280	12.360	10.740	11.100	9.500	11.700	10.700	7.609	9.377	11.860	9.500	3.545	9.230	10.800	11.730	5.945	10.650
Silex and insoluble silicates	2.600	25.360	17.780 }	26.760	44.760	26.180	31.840 }	37.220	19.480	16.860	9.030 }	10.780	36.830	12.650	16.530 }	19.810	30.580
Moisture and loss	.161	.669	... }		.284	....	... }		....	...	.091 }		....	....	.633 }		
Total	100.000	100.000	100.635	100.000	100.000	100.760	100.103	100.000	100.000	100.510	100.000	100.000	100.326	100.159	100.000	100.000	100.119
Per cent. of iron	57.148	36.722	45.959	39.963	26.799	40.290	36.815	29.816	44.736	41.965	50.051	48.385	36.136	50.176	46.340	45.347	36.566
Per cent. of phosphorus	.026	.534	.391	.161	.436	.762	.344	.013	.147	.367	.203	.072	.035	.036	.057	.066	.740
Per cent. of sulphur	....	.107	.241	.156	.030	.074	.068	.071	.060	.335	.320	.403	.163	.108	.072	.120	.091
Per cent. of silica	not est.	23.980	15.960	22.256	40.960	not est.	27.360	....	....	16.860	7.640	9.960	....	11.560	13.860	15.060	24.260

* Carbonates.

LIMESTONES OF CARTER COUNTY.

No. 1388—"LIMESTONE *used as a flux at Boone Furnace when in operation. Collected by P. N. Moore.*"

A hard, compact, light buff-grey limestone. Fracture somewhat conchoidal.

No. 1389—"LIMESTONE (*sub-carboniferous*) *to be used as flux by the Iron Hills Furnace. Averaged by P. N. Moore.*"

A compact or fine granular limestone, of a light-grey color.

No. 1390—"LIMESTONE *used as flux at Mount Savage Furnace. Average sample, by J. A. Monroe.*"

A compact limestone of a dark-grey color, mixed with fragments of ferruginous sandstone and chert.

COMPOSITION OF THESE LIMESTONES, DRIED AT 212° F.

	No. 1388.	No. 1389.	No. 1390.
Specific gravity	2.624	2.700	not est.
Lime carbonate	97.720	95.150	75.750
Magnesia, carbonate	not est.	.245	.575
Alumina, and iron and manganese oxides	.300	1.390	6.403
Phosphoric acid (anhydrous)	.083	.130	.057
Sulphuric acid (anhydrous)	not est.	a trace.	.775
Potash	.115	not est.	not est.
Soda	.167	not est.	not est.
Silica and insoluble silicates	1.560	3.060	14.700
Soluble silica	.120	not est.	*1.740
Total	100.065	99.975	100.000
Per centage of lime	54.723	53.284	42.420
Per centage of phosphorus	.036	.056	.032
Per centage of sulphur	not est.	a trace.	.310

* Water and loss.

Nos. 1388 and 1389 are very pure limestones, and very suitable for use as flux in the iron furnace; but No. 1390 is quite objectionable, because of its considerable proportion of *sulphur*, and its nearly fifteen per centage of silicious matters.

PIG IRONS OF CARTER COUNTY.

No. 1391—PIG IRON. "*Foundry No.* 2, *made at Boone Furnace, Carter county, in* 1870."

A brilliant grey iron; moderately coarse-grained. Yields to the file; but breaks readily under the hammer.

No. 1392—PIG IRON. "*Foundry Iron No.* 1, *made at Boone Furnace in* 1870."

Darker colored, somewhat finer-grained, and softer than the preceding; flattening somewhat under the hammer.

No. 1393—PIG IRON. "*Hot Blast, No.* 1 *Foundry* ("*sow*"), *Iron Hills Furnace, Carter county. Collected by P. N. Moore.*"

Rather coarse-grained; with brilliant grains. Yields to the file, but is somewhat hard. Flattens but little under the hammer.

No. 1394—PIG IRON. "*Hot Blast, No.* 1 *Foundry, Mount Savage Furnace. Collected by P. N. Moore.*"

A brilliant coarse-grained iron. Hard, but yields to the file. Extends but little under the hammer.

	No. 1391.	No. 1392.	No. 1393.	No. 1394.
Specific gravity	6.423	6.905	7.021	6.889
Iron	90.958	93.212	92.387	91.502
Graphite	2.164	2.940	3.340	2.670
Combined carbon	.116	.060	.760	.030
Manganese	.115	.083	.056	.123
Silicon	2.682	1.634	2.240	4.470
Slag	4.180	2.460	.620	1.160
Aluminum	.479	.330	.120	.128
Calcium	not est.	not est.	.120	.144
Magnesium	. . . .	. . . .	.056	.112
Potassium	. . . .	. . . .	.080	.076
Sodium	. . . .	. . . .	. . . .	.023
Phosphorus	.304	.486	.836	.203
Sulphur	not est.	.079	.057	.041
Total	100.998	101.284	100.672	100.680
Total carbon	2.280	3.000	4.100	2.700

SOILS OF CARTER COUNTY.

No. 1395—SOIL. *"From the farm of Jas. W. Scott, near Lower Tygert bridge, near Olive Hill, Carter county. Top soil in oak woods, sixty feet above the bed of the creek. Limestone slope southward. Drainage between the slope and the sandstone capping the hills. Sample to depth of six inches. Collected by Prof. N. S. Shaler."*

Virgin soil. Soil of a greyish orange-buff color, with streaks and mottlings of dark-grey. Compacted into clods in the bag. The coarse sieve (289 meshes to inch) removed about six per cent. of ferruginous and decomposing cherty fragments.

No. 1396—SOIL. *Labeled "Sub-soil of the preceding, one foot below the surface, &c."*

This sub-soil is of an orange-red, or bright red ochre color. Compacted into clods in the bag.

The coarse sieve removed from it a very small quantity of small fragments of weathered chert, &c.

No. 1397—"SOIL *from the farm of Jas. W. Scott (locality as above). Old field, in pasture for eighteen, and cultivated for five years. Slope from height of limestone bench and sandstone beyond. Northern exposure, thirty feet above Tygert Creek. Collected by N. S. Shaler."*

Soil of a dirty-grey buff color. Sifted out about five per cent. of cherty and ferruginous small fragments, with the coarse sieve.

No. 1398—"SUB-SOIL *of the next preceding, one foot below the surface, &c."*

Sub-soil colored like next preceding; slightly more reddish. Sifted out, with the coarse sieve, about twenty-three per cent of small fragments, more or less rounded, of ferruginous sandstone, iron ore, and weathered chert.

No. 1399—"TOP SOIL. *Woods near Iron Hill, Carter county. From eastward slope, ravine to southward. Limestone above, twenty-five feet thick. Conglomerate still above. Oak and beech woods, about one hundred feet above Tygert Creek. Collected by J. A. Monroe.*"

Soil of a grey-buff color. Sifted out, with the coarse sieve, about sixteen per cent. of shaly ferruginous sandstone fragments.

No. 1400—"SUB-SOIL *of the next preceding, taken eighteen inches below the surface, &c., &c.*"

Sub-soil of a lighter color than the surface soil and more adhesive. Contains fragments of sandstone.

No. 1401—"TOP SOIL, *for six inches below the surface, from an old field on Riggs' farm at Iron Hills. From the slope of hill toward Tygert Creek. Limestone one hundred feet or more above, and sandstone above that. Woodland a few rods off to top of the hill. This field has been cultivated in corn for many years." Collected by J. A. Monroe.*

Soil of a grey-buff color. Sifted out of it, with the coarse sieve, about twenty per cent of fragments of ferruginous sandstone, &c.

No. 1402—"SUB-SOIL *of the next preceding, taken eighteen inches from the surface, &c., &c.*"

Of a handsome yellowish-buff color. Compacted into friable lumps in the bag. Sifted out, with the coarse sieve, about ten per cent. of fragments of ferruginous sandstone and iron ore.

No. 1403—"SURFACE SOIL, *from woodland on farm of William Abbott, five miles west of Olive Hill, Carter county. One hundred and fifteen feet above the west branch of Tygert's Creek. Slope northwest. Limestone on top of the hill. Collected by A. R. Crandall.*"

Soil of a grey-buff color. The coarse sieve removed a considerable quantity of small ferruginous and cherty fragments.

No. 1404—"SUB-SOIL *of the next preceding. One foot from the surface, &c., &c. Collected by A. R. Crandall.*"

Of a buff color. Contains angular fragments of ferruginous sandstone.

No. 1405—"OLD FIELD SOIL. *Farm of William Abbott, west branch of Tygert's Creek, &c. Field fifty-five feet above the bed of the creek; on bench of Waverly sandstone. Tops of the hills capped with limestone. Surface soil; has been cultivated sixty years; was once an orchard.*" *Collected by A. R. Crandall.*

Soil of a light grey-buff color; aggregated into friable clods in the bag. The coarse sieve removed from it less than two per cent. of small silicious sandstone, cherty, and ferruginous fragments.

No. 1406—"SUB-SOIL *of the next preceding; one foot below the surface, &c.*" *Collected by A. R. Crandall.*

Sub-soil of a lighter and more clear buff color than the surface soil; contains less than two per cent. of small cherty and ferruginous gravel.

No. 1407—SOIL *from an old field on Widow Garvin's farm, four miles west of Olive Hill. Ten feet above the bed of Tygert's Creek. On Waverly sandstone; with limestone and coarse sandstone near the tops of the hills. Surface soil. Collected by A. R. Crandall.*"

Soil of a grey-buff color, contains about four per cent. of small rounded ferruginous sandstone and cherty fragments.

No. 1408—"SUB-SOIL *of the next preceding, one foot to eighteen inches below the surface. Collected by A. R. Crandall.*"

Sub-soil of a lighter color than the preceding surface soil; in friable clods.

Sifted out, with coarse sieve, about eight per cent. of ferruginous, cherty, and sandstone fragments.

No. 1409—SOIL. *Labeled "Sub-soil of bottom land, two feet from the surface; twenty-five feet above Little Sandy river, Grayson, Carter county. The surface soil was not collected on account of accidents affecting its composition." Collected by Prof. N. S. Shaler.*

Sub-soil of a light buff-grey color; nearly white; in friable lumps. Seems to be mainly composed of fine grains of sand.

COMPOSITION, DRIED AT 212° F.

Volatile and combustible matters, expelled at red heat	2.500	
Alumina, and iron and manganese oxides	11.500	
Lime carbonate	.560	= .313 per cent. of lime.
Magnesia	.121	
Phosphoric acid	.223	
Sulphuric acid	not est.	
Potash (total obtained by fusion)	.366	
Soda (total obtained by fusion)	.587	
Silica (separated by fusion)	84.000	
Loss	.143	
	100.000	

This sub-soil having been analyzed by fusion with the mixed alkaline carbonates, and not by digestion in chlorohydric acid, as the other soils of this county were treated, could not be tabulated with them.

The proportions of potash and soda given above appear large, as compared with those found in similar sandy soils by digestion in acids; but these represent the *total amount* of these alkalies, contained not only in the soluble portion of the soil, but also in the insoluble silicates; the process of J. Lawrence Smith for the separation of the alkalies from silicates, viz: fusion with a mixture of lime carbonate and ammonium chloride, having been employed in the above analysis.

COMPOSITION OF THESE CARTER COUNTY SOILS AND SUB-SOILS, DRIED AT 212° F.

Extracted from 1000 parts of the air-dried soil, by digestion in water containing carbonic acid in solution.

	No. 1395.	No. 1396.	No. 1397.	No. 1398.	No. 1399.	No. 1400.	No. 1401.	No. 1402.	No. 1405.	No. 1406.	No. 1407.
Organic and volatile matters	0.500	0.420	0.500	0.370	lost.	0.350	1.120	0.320	0.700	0.340	0.800
Alumina, oxide of iron, and phosphoric acid	.030	.010	.010	.010	lost.	.020	lost.	.020	lost.	.020	.070
Brown oxide of manganese	.050	.010	.080	.030	lost.	.030	lost.	.020	lost.	.020	.290
Lime carbonate	.710	.130	.660	.330	lost.	.300	lost.	.060	lost.	.040	.720
Magnesia	.040	.010	.050	.020	lost.	.020	lost.	.030	lost.	.020	.100
Phosphoric acid	not est.	not est.	not est.	not est.	lost.	not est.	lost.	not est.	lost.	not est.	not est.
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	lost.	a trace.	lost.	a trace.	lost.	a trace.	a trace.
Chorine	a trace.	a trace.	a trace.	a trace.	lost.	a trace.	lost.	a trace.	a trace.	a trace.	a trace.
Nitric acid	not est.	not est.	not est.	not est.	lost.	not est.	lost.	not est.	lost.	not est.	not est.
Potash	.060	.060	.090	.050	lost.	.040	lost.	.040	lost.	.050	.050
Soda	.050	.030	.030	.040	lost.	.010	lost.	a trace.	lost.	.020	.020
Soluble silica	.070	.080	.110	.050	lost.	.030	lost.	.020	.030	.030	.020
Loss	.090	....	.130	.120	lost.	.020	lost.	.060	lost.	....	....
Total extract, dried at 212° F.	1.600	0.770	1.660	1.020	....	0.820	2.870	0.570	1.180	0.540	2.070
Color of extract	Dark brown.	Brownish white.	Dark umber.	Brownish grey.	....	Yellowish-white	Umber (dark).	Yellowish-white	Brownish white.	Brownish white.	Dark umber.

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

	No. 1395.	No. 1396.	No. 1397.	No. 1398.	No. 1399.	No. 1400.	No. 1401.	No. 1402.	No. 1403.	No. 1404.	No. 1405.	No. 1406.	No. 1407.	No. 1408.
Organic and vol. matters	3.110	4.800	2.250	1.815	4.165	2.200	3.925	2.315	4.685	2.625	2.860	2.000	3.740	2.200
Alumina, Iron peroxide, Manganese, brown oxide	7.405	17.360	4.777	6.409	7.595	8.406	6.637	8.375	4.013	5.410	4.540	5.890	6.115	5.600
Lime carbonate	.420	.270	.880	.680	.320	.155	.180	.095	.109	.109	.145	.080	.245	.220
Magnesia	.272	.124	.057	.155	.088	.142	.051	.153	.050	.061	.035	.056	.115	.178
Phosphoric acid	.060	.045	.093	.076	.160	.109	.118	.115	.147	.163	.125	.163	.076	.086
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.	not est.	not est.	.060	.046	not est.	not est.	not est.	not est.
Potash	.293	.662	.213	.255	.275	.385	.279	.273	.153	.371	.111	.204	.279	.366
Soda	.148	.149	.132	.151	.186	.169	.163	.076	.032	.046	.157	.131	.288	.048
Soluble silica	.170	.095	not est.	.145	.245	.160	.145	.145	not est.	not est.	.220	.080	.220	.190
Sand and insol'ble silicates	87.630	74.840	91.690	90.515	85.465	87.340	88.140	87.740	89.515	89.940	91.240	91.575	89.390	91.215
Water expelled at 380° F.	.885	1.400	.600	.480	1.160	.625	.900	.555	.990	.770	.690	.450	.828	.450
Loss	.....	.255	.....	.....	.341	.309	.....	.158	.246	.459	.....	.....	.....	.....
Total	100.393	100.000	100.692	100.681	100.000	100.000	100.538	100.000	100.000	100.000	100.123	100.569	101.294	100.483
Moisture lost at 212° F.	2.020	2.354	1.125	1.270	1.945	1.400	1.475	1.405	1.380	1.270	1.215	1.275	1.350	1.035
Potash in insol'ble silicates	.584	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.
Soda in insoluble silicates	.165	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.
Character of soil	Virgin soil	Sub-soil.	Old field.	Sub-soil.	Virgin soil	Sub-soil.	Old field.	Sub-soil.	Virgin soil	Sub-soil.	Old field.	Sub-soil.	Old field.	Sub-soil.

Although these Carter county soils cannot be classed with the naturally very rich soils, there is no apparent reason, in view of their composition, why they may not be made quite profitably productive, under proper culture and by the observance of the golden rule of agriculture viz: to restore to the soil in manures, &c., the essential ingredients which are removed from it in the crops. These soils are measurably deficient in *humus* or organic matters, and contain rather more than the normal proportion of sand and silicates. These defects may be remedied in some localities, where the sub-soil contains more clay, &c. (as is the case with No. 1396), by gradually bringing up the sub-soil, in the annual plowings, with the simultaneous use of clover and other green crops. It appears also from the analyses, that while lime and potash seem to be in sufficient abundance, phosphoric acid is rather deficient in most of these soils. The use of bone-dust, or other phosphatic fertilizers, would doubtless be beneficial.

The influence of cropping on the composition of the soil may be measurably observed by comparing the analyses of the virgin soils and the old field soils, as given above. In all the proportion of organic matters is found to be reduced, and that of the sand and silicates increased, in the old field, as compared with the virgin soil; and in most of them a reduction in quantity may be seen in the potash and phosphoric acid of the old field; showing the exhausting influence of cropping without the use of manures.

EDMONSON COUNTY.

No. 1410—LIMONITE. *Labeled "From Bythe Meredith farm. Collected by Prof. N. S. Shaler (Nolin)."*

Composed partly of elliptical hollow concretions of dense dark reddish-brown laminæ, with some softer ochreous ore.

No. 1411—LIMONITE. *Labeled "Proctor Ore Bank, Sycamore Creek. Collected by Prof. N. S. Shaler and J. R. Proctor."*

Principally in dark brown dense laminæ, forming an irregular stalactitic, hollow columnar structure with septæ (or irregularly large cancellated), incrusted with some softer yellowish and brownish ochreous ore.

No. 1412—LIMONITE. *Labeled "Frederick's Bank, Beaver Dam Creek. Two hundred feet above the limestone. Collected by Prof. N. S. Shaler. (Five feet ore. Uniform.")*

Generally of a yellowish-brown color, porous and cellular; but with some dark hard laminæ, small whitish oölitic concretions some of which are hollow, and brownish and yellowish ochreous material. Contains some fossil shells, &c.

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

	No. 1410.	No. 1411.	No. 1412.
Iron, peroxide	55.028	76.284	52.926
Alumina	1.006	2.361	4.792
Manganese, brown oxide	.040	.030	.210
Lime carbonate	a trace.	.180	.180
Magnesia	.108	.068	.425
Phosphoric acid	.312	1.055	.355
Sulphuric acid	.133	.151	.143
Water expelled at red heat	8.300	12.000	10.400
Silex and insoluble silicates	35.180	7.951	30.580
Total	100.107	100.080	100.011
Iron, per centage	35.519	53.399	37.048
Phosphorus, per centage	.135	.460	.154
Sulphur, per centage	.053	.059	.057
Silica, per centage	33.700	7.660	29.160

These are good iron ores. No. 1411 is more than usually rich in iron, but it contains more phosphorus than is desirable.

[See Appendix for other iron ores of this county.]

No. 1413—COAL. *"From Tar Lick, Davis Creek, Edmonson county. Five and a half feet thick. Collected by Prof. N. S. Shaler."*

A glossy splint coal, breaking into thin irregular laminæ, with tar (petroleum) and fibrous coal—the remains of reedy leaves—and more or less fine-granular pyrites between them.

No. 1414—COAL. "*Found on Mill branch. Level of main Nolin coal. Collected by Prof. N. S. Shaler.*"

Splint coal. Separates under the hammer into thin irregular laminæ, with fibrous coal, containing fine-granular pyrites between.

No. 1415—COAL. "*Found on the surface. Has been longer exposed and more weathered than the preceding. Mill branch. Collected by Prof. N. S. Shaler.*"

No. 1416—COAL. "*From Knob Lick, Dismal Creek. Geological level of main Nolin coal. Collected by Prof. N. S. Shaler.*"

A weathered specimen of splint coal, incrusted with ochreous iron oxide on the surface. Separating into thin irregular laminæ, with fibrous coal between.

No. 1417—COAL "*At Gross', one hundred and eighty feet above Bear Creek. Collected by Prof. N. S. Shaler and J. R. Proctor.*"

A splint coal, breaking into thin irregular laminæ, with fibrous coal and much fine-granular pyrites between.

No. 1418—COAL. "*Shoal branch, Nolin coal. Collected by Prof. N. S. Shaler and J. R. Proctor.*"

Splint coal, breaking into thin laminæ, with fibrous coal and but little pyrites between them.

No. 1419—COAL. "*Tar Lick Coal, branch of Davis. (Main Nolin coal.) Collected by J. R. Proctor. Five and a half feet thick.*"

A deep-black coal, with soft bituminous matter between the thin laminæ, and but little fibrous coal or pyrites.

No. 1420—Coal. "*From Mill branch of Bear Creek. Average sample, by P. N. Moore.*"

Much of it breaks into thin laminæ, with but little fibrous coal, and some fine-granular pyrites between.

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

	No. 1413	No. 1414	No. 1415	No. 1416	No. 1417	No. 1418	No. 1419	No. 1420
Specific gravity	1.282	1.350	1.367	1.345	1.429	1.336	1.335	1.437
Hygroscopic moisture	2.30	3.60	3.20	2.60	1.20	3.66	4.06	4.06
Volatile combustible matters	32.10	33.00	33.80	33.80	39.00	35.14	33.24	32.00
Coke	65.60	63.40	63.00	63.60	59.80	61.20	62.70	63.94
Total	100.00	100.00	100-00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	35.40	36.60	37.00	36.40	40.20	38.80	37.30	36.06
Fixed carbon in the coke	56.30	54.40	52.60	53.14	45.46	54.26	51.70	50.84
Ashes	9.30	9.00	10.40	10.46	14.34	6.94	11.00	13.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Cellular.	Spongy.	Moderately dense.	Spongy.	Dense.	Light cellular.	Spongy.	Light spongy.
Color of the ash	Light lilac-grey	Lilac-grey.	Lilac-grey.	Light-grey.	Dark greyish-purple.	Lilac-grey.	Light lilac-grey.	Grey-lilac.
Per centage of sulphur	1.059	2.101	2.923	2.425	8.685	2.706	1.670	4.938
Per centage of phosphoric acid	not est.	not est.	not est.	not est.	0.178	not est.	not est.	not est.

These Edmonson county coals answer very well for the ordinary purposes of fuel, and those which do not contain an inordinate quantity of sulphur will doubtless answer well for the working of iron. No. 1417, however, contains more than eight per cent. of this ingredient, and more than fourteen per cent. of ashes, containing a notable proportion of phosphoric acid. Yet even this impure coal contains more than eighty-four per cent. of combustible matters, including part of the sulphur (some of which, however, remains in the ashes combined with iron), and may answer for ordinary fuel.

[For other Edmonson county ores, see Appendix.]

Cast Iron from Baker Furnace. Some fragments from this old furnace, which had been exposed to the weather for twenty years, were collected by Prof. Shaler, for examination of its general quality.

It is a fine-grained, light-grey iron, which is more tenacious and extends more under the hammer than most samples of best pig iron. Possibly it has been improved in this respect by its long weathering in thin pieces. The analysis of a piece of the pig iron from this furnace will be found in the Appendix.

[For Nos. 1421, 1422, and 1423, see Barren county.]

FAYETTE COUNTY.

No. 1424—"SURFACE SOIL *to depth of one foot, of a field which has not been very long in cultivation, principally in hemp, of which it no longer produces very good crops. Blue-grass land, seven miles from Lexington on the Newtown Turnpike. Sub-stratum, Lower Silurian blue limestone. Land of E. M. Coleman." Why is it not very good hemp land?*

Soil of a light greyish-brown color. It all passed through the coarse sieve, of 289 meshes to inch, except a small proportion of shot-iron ore and irregular fragments of chert.

No. 1425—"SOIL *to the depth of four inches from an old field fifty years or more in cultivation almost without intermission, without manure of any kind, principally in hemp and corn, with occasionally small grain. Farm of R. Peter, formerly of the late Col. S. Meredith, on the Newtown road, six and a half miles from Lexington; blue-grass land. Sub-stratum, blue limestone of the Lower Silurian formation."*

Soil of a warm grey-brown color; containing only a few small angular fragments of weathered and porous chert.

This field was selected by my son, Benj. D. Peter, for some experimental agricultural operations, which he has reported to Prof. Shaler.

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

	No. 1424.	No. 1425.
Organic and volatile matters	6.340	6.575
Alumina, and iron and manganese oxides	8.890	8.200
Lime carbonate	.745	.440
Magnesia	.366	.221
Phosphoric acid	.550	.316
Sulphuric acid	.065	.036
Potash	.169	.247
Soda	.057	.263
Sand and insoluble silicates	81.467	83.340
Water and loss	1.556	.362
Total	100.000	100.000
Potash in the insoluble silicates	0.905	1.256
Soda in the insoluble silicates	.844	.101

The apparent paucity of potash in No. 1424 may account for its failure to produce good hemp crops.

As compared with the original virgin soil of the same locality, these soils contain much less *organic matters* (*humus*), and a smaller amount of *potash*, than that. These essential materials are especially influential in hemp production, as the presence of these and of lime seems to be necessary to a *vigorous* growth of this plant; the only kind of growth considered profitable by our farmers.

The current belief amongst our hemp-growers is, or has been, that this crop does not rapidly exhaust the soil, provided the hemp is spread for rotting on the field which produced it.

The rotting process does undoubtedly restore to the soil, in an available condition for plant nourishment, a considerable proportion of the fertilizing principles which had been withdrawn from it in the crop; but in the operation of braking the hemp, the hemp herds and rough tow being generally burnt on the spots where the process is performed, the alkaline and earthy ingredients of these become irregularly deposited, and much of the soluble fertilizing mineral matter of the ashes is liable to be washed down into the sub-soil, to become for the time unavailable; while a large quantity of vegetable matter, which ought to be employed in returning to the soil the *humus*, which has been destroyed during the growth of the crop, is converted into atmospheric gases by burning.

The adoption of some plan by which our hemp-raisers may restore the organic matter of the hemp herds, &c., to the soil, in the form of *humus*, would tend to retard the exhaustion of the hemp land. But there exists a prejudice among them that hemp herds are injurious to the land, which is probably not based upon fact.

The *insoluble silicates* left after thorough digestion of these soils in warm chlorohydric acid assisted by a little nitric acid, was found upon analysis by fusion, to contain quite a large proportion of alkalies. In both cases these silicates contained *about five times as much potash* as was dissolved out from the soils by the acids. This quantity of the alkalies, in combination in the *insoluble silicates*, so-called, is not *immediately available* for plant nourishment, but yet serves to prolong the fertility of the soil; for these silicates, although not easily decomposable by acids, are gradually decomposed by the atmospheric agencies, and especially under the influence of alkaline substances.

Hence the application of lime, for instance, to soil of this kind, which has been measurably exhausted of its immediately available alkalies, may, by partial decomposition of these silicates, bring more of these alkalies into a soluble condition, and thus temporarily increase its fertility.

These insoluble silicates, left after the acid digestion, when examined with the lens, exhibit small grains, which look like partly decomposed feldspathic mineral, sometimes of different tints, mixed with minute rounded or angular grains of hyaline and milky quartz, &c.

These facts, especially that of the existence of so much potash and soda in these insoluble silicates of the soil, throw some light on the origin of soils; as they tend also to aid us in scientific agriculture.

No. 1426—QUICKLIME, *obtained by the calcination of limestone of some of the fossiliferous layers of the blue limestone of the Lower Silurian formation. Cliff on Elkhorn Creek, northeast boundary of the above named farm. Also some milky calcareous spar, from a four to six feet wide vein at the same locality, which was mixed and calcined with the limestone.*

This lime, not perfectly calcined, was used on the experimental field above mentioned.

Its *composition* was found to be as follows:

Lime	68.804
Magnesia	.241
Alumina, and iron and manganese oxides	4.565
Phosphoric acid	.415
Sulphuric acid	.446
Carbonic acid	11.450
Potash	1.330
Soda	.099
Silex and insoluble silicates	6.130
Water and loss	6.520
Total	100.000

This lime was not submitted to analysis until after it had been exposed to the air for a few days.

It will be seen from this analysis, that lime from these fossiliferous layers of our limestone may prove a valuable fertilizer, on fields which have been impoverished by too much cropping. For, not only will it, by its decomposing action on the insoluble silicates, render a new quantity of alkalies available for plant food, but its own considerable proportions of phosphoric and sulphuric* acids, and of potash and soda, will greatly aid in the amelioration.

No. 1426—CALCAREOUS SPAR (*above mentioned*) *from the vein, nearly vertical, in the blue limestone on North Elkhorn Creek, land lately belonging to R. J. Breckinridge's estate (Bradalbane).*

Analyzed by my son, Alfred M. Peter, as was also the quicklime.

*The considerable proportion of sulphuric acid given in the preceding analysis is probably partly derived from iron sulphide sometimes diffused in this limestone.

COMPOSITION, DRIED AT 212° F.

Lime carbonate	96.610	= 54.101 per cent. of lime.
Magnesia, carbonate	.401	
Alumina, and iron and manganese oxides	1.740	
Phosphoric acid	.057	
Sulphuric acid	not est.	
Potash	.443	
Soda	.275	
Silica and insoluble silicates	.360	
Loss	.114	
	100.000	

This nearly opaque, milky calc. spar is much stained superficially with iron oxide, &c. The analysis shows a much smaller amount of phosphoric acid than is contained in the limestone layers; but the proportion of alkalies, if no error is made, is quite considerable.

WATERS OF FAYETTE COUNTY.

As is well known, the spring and well waters of this blue limestone region are what are denominated "hard waters," containing a considerable quantity of dissolved carbonates of lime and magnesia, &c.

As a type of these limestone waters, that of a remarkable spring, the "Big Spring," on the writer's farm, about six and a half miles from Lexington, on the Newtown Turnpike, was selected for chemical analysis.

This "Big Spring" is a perennial stream of considerable force, boiling up in the bottom of a sink-hole, which is some fifty to sixty feet deep, and flowing through underground channels and caverns a considerable distance, to be discharged into the North Elkhorn Creek.

The water was taken after the long dry season of our late summer and autumn, and was remarkably clear; as it always is except after heavy rains. The temperature of it was noted during one of our late protracted cold spells; and when the temperature of the atmosphere was at zero and only ten degrees above, it maintained that of fifty-three or fifty-four; very little below the mean of the temperature of this region.

The analyses of this water and of the waters of the bored wells given below, were made by my youngest son Alfred

Meredith Peter, under my inspection, as a chemical exercise, and were very carefully and faithfully performed.

The results show that the hard waters of our springs and wells might not only be fertilizers, when used for irrigating growing crops, but that, as was first noted by the celebrated Boussingault, they may supply to growing animals necessary earthy salts which may be deficient in their food. That, especially, they may supply lime to animals fed on Indian corn, which food is found to be somewhat deficient in this ingredient.

COMPOSITION OF THE BIG SPRING WATER IN 1000 PARTS.

No. 1427.	Held in solution by free carbonic acid.
Lime, carbonate	0.2027
Magnesia, carbonate	.0227
Iron, carbonate	.0027
Manganese, carbonate	.0003
Alumina	.0012
Phosphoric acid	.0001
Silica	.0011
Total of sediment formed on boiling	0.2308
	Contained in the boiled water.
Lime, sulphate	0.0208
Potassium, chloride	.0012
Sodium, chloride	.0018
Magnesium, chloride	.0027
Silica	.0074
Organic matters	.0086
Lithia	a trace.
Total saline matters	0.2733

The total saline matters amount to about sixteen grains to the wine gallon of water. They are doubtless derived from the soil and the limestone rock.

As was stated in the previous volumes of Kentucky Geological Reports, the water obtained in this region by boring into the limestone substratum is always more or less salt, and is frequently accompanied with gas (carburetted hydrogen), the flow of which, however, is not very durable. During the late very dry season a number of borings were made in this neighborhood (near Lexington), with the same results; the water smelling strongly of petroleum, and sometimes of sulphuretted hydrogen, being always more or less brackish, and there being generally a temporary emission of gas.

The waters of three of these bored wells were analyzed by my son (A. M. Peter), with the following results, viz:

No. 1428—"WATER *from a bored well of Mr. Sutton's, about ninety-eight feet deep, on the Leestown road, near the Scott county line.*"

A weak sulphur water.

No. 1429—"WATER *from a bored well of Mr. Edward P. Gains, about one hundred feet deep, on the Georgetown Turnpike, about nine miles northwest of Lexington, near Donerail.*"

The water rose about thirty feet in the well. Specific gravity = 1.035.

No. 1430—"WATER *from a bored well, about ninety-six feet deep, on the farm of Mr. Price McGrath, two and a half miles from Lexington, on the Newtowu Turnpike.*"

The water rose to within about twenty-eight feet of surface. Gas was evolved in considerable quantities during the boring.

COMPOSITION OF THESE WELL WATERS.

Held in solution by free carbonic acid.

	No. 1428.	No. 1429.	No. 1430.
Lime, carbonate	0.1008	0.0104	0.1711
Magnesia, carbonate	.0882	.0018	.0053
Iron, carbonate	.0042	.0008	.0062
Manganese, carbonate	. . . . .	. . . . .	.0005
Phosphoric acid	a trace.	. . . . .	.0002
Silica	.0078	.0038	.0017
Total sediment on boiling	0.2010	0.0168	0.1850

In solution in the boiled water.

	No. 1428.	No. 1429.	No. 1430.
Lime, sulphate	. . . . .	0.6263	0.0309
Magnesia, sulphate	0.0541	. . . . .	. . . . .
Potash, sulphate	.0355	. . . . .	. . . . .
Soda, sulphate	.0600	. . . . .	. . . . .
Soda, carbonate	.1448	. . . . .	. . . . .
Calcium, chloride	. . . . .	3.0246	.5794
Magnesium, chloride	. . . . .	2.9881	.7837
Sodium, chloride	1.9409	34.4313	10.1040
Potassium, chloride	. . . . .	.1883	.1120
Magnesium, bromide	. . . . .	.0157	a trace.
Magnesium, iodide	. . . . .	.0096	a trace.
Lithium, chloride	a trace.	.0181	a trace.
Total saline matters	2.4363	41.3188	11.8750

The water from Mr. Sutton's well smells strongly of hydrosulphuric acid; which was not estimated, because this could only be done correctly at the well. All these waters contain, in addition, a little *organic matter*, and a little *silica* in the boiled water.

The amount of saline matters in Mr. Gains' well water is remarkable, being about five ounces and a half to the wine gallon. The saline matters in quantity and in kinds resemble those of the oceans; and doubtless had their origin in the ancient sea under which our rock strata were deposited.

Another well bored by Mr. Wm. Adams, on his farm next adjoining that of Mr. McGrath, gave water at the depth of about seventy-eight feet; which rose fifty feet in the bore. Much gas was blown out during this boring also.

The water of this well contained 0.54 of saline matter in the thousand of the water; which, tested qualitatively, was found to contain sulphuric, carbonic, and phosphoric acids, chlorine, lime, magnesia, potash, iron oxide, and a trace of lithium. It doubtless resembles that of Mr. McGrath, but is weaker. It, like that, smells strongly of petroleum.

Mr. Jno. Keiser bored to the depth of about two hundred and sixty feet, on an elevated ridge on his farm, about six miles from Lexington, on the Newtown Turnpike, and obtained only a very small quantity of brackish water, which gradually rose to within sixty feet of the surface. Some of the borings, taken at various depths, were preserved for examination. They indicate the usual layers of limestone, with thin marly shales and occasional silicious beds, of the formation in this region.

FRANKLIN COUNTY.

No. 1431—"GREEN MARLY SHALE *from below the Arsenal at Frankfort. Bed about eight inches thick (Upper Cambrian Group). Collected by Prof. N. S. Shaler.*"

A friable shale of a greyish-green color.

No. 1432—"MARLY SHALE. *Same locality as the preceding, but lying above that. Collected by N. S. Shaler.*"

Quite friable. Of dull olive and brownish colors.

No. 1433—"MARLY SHALE. *Used as a paint at Frankfort, &c. Sent by Mr. James L. Sneed for analysis.*"

Of an olive-grey color, with some brownish-yellow mixed.

No. 1434—"MARLY SHALE. *From Armstrong farm, Bridgeport. Geological position Cincinnati Group, just below the silicious mudstone. In same position as the marl near Newport. Collected by Prof. N. S. Shaler." Used for paint. Said to be good for polishing iron, &c.*"

Of a handsome light olive-grey color.

COMPOSITION OF THE FIRST TWO OF THESE MARLY SHALES, DRIED AT 212° F.

	No. 1431.	No. 1432.
Alumina, and iron and manganese oxides	10.415	15.395
Lime, carbonate	1.440	*.875
Magnesia	.800	2.298
Phosphoric acid	.435	.460
Sulphuric acid	.738	.570
Potash	3.488	3.565
Soda	.042	.318
Water expelled at red heat	5.350	6.400
Silex and insoluble silicates	77.380	70.060
Total	100.088	99.941
Per centage of potash in the silicates	4.991	3.565
Per centage of soda in the silicates	.654	.430

* Lime.

These marly shales are remarkable for their large per centage of potash; which probably may make them valuable for application to exhausted land of a light and sandy nature. A previous moderate calcination with lime intimately mixed, might, if practicable, make them more available in this respect by setting free more or less of the potash locked up in the insoluble silicates. It will be seen that No. 1431 contains in all, as much as 8.479 per cent. of potash, and No. 1432 a total amount of 7.130 per cent.

These, and similar marly shales, have been used as pigments; for which purpose they are quite appropriate, if of an agreeable tint, as they will not decompose the oil with which they are mixed, are not readily altered by atmospheric agencies under such conditions, and contain nothing of a poisonous nature. Their use for scouring or polishing depends on the very fine silicious sand contained in them.

COMPOSITION OF THE LATTER TWO OF THESE FRANKLIN COUNTY MARLY SHALES, DRIED AT 212° F.

	No. 1433.	No. 1434.
Silica	50.360	52.060
Alumina	16.816	18.831
Iron and manganese oxides	6.997	9.200
Lime	8.736	3.666
Magnesia	.936	1.210
Phosphoric acid	.217	.319
Sulphuric acid	2.280	.920
Potash (total)	3.623	5.402
Soda (total)	1.731	.720
Carbonic acid / Water and loss	8.304	7.672
Total	100.000	100.000
Per centage of phosphorus	.095	0.139
Per centage of sulphur	.912	.368

Although the sulphur and iron in these marls are calculated in these analyses as sulphuric acid and iron oxide, severally, a portion of each, not determined, is combined as iron sulphide. These two analyses are tabulated separately from the first two of similar marls of this county, because in these latter analyses the method of *complete* decomposition by fusion was employed, while the first two were analyzed by digestion of the marls in acids, and the subsequent fusion of the insoluble silicious residue for the determination of the total amount of the alkalies. The remarks appended to the first two apply equally to these.

No. 1435—"WATER *from a bored or driven well, near the Kentucky river. Water stands about thirty-four feet from the surface of the ground, which is twelve to fourteen feet above low water level in that river. The height of the well water is affected by that of the river. Used in the steam boiler of the Frankfort Cotton Mill Company.*"

The sample of the water, together with some of the white powdery sediment and hard scale of the boiler, were sent to the laboratory by Mr. Milton McGrew, President of the company.

Nothing had been added to the water in the boiler, and the sediment and scale had been taken out of the boiler after running with this water for two weeks.

COMPOSITION OF THE WELL WATER IN 1000 PARTS.

Held in solution in the water by the free carbonic acid deposited on boiling.	
Free carbonic acid	not est.
Lime carbonate	0.2493
Magnesia, carbonate	.0032
Silica	.0005
Sediment on boiling	0.2530
Contained in the boiled water.	
Lime sulphate	0.1100
Calcium chloride	.0254
Magnesium chloride	.0174
Sodium chloride	.0460
Potassium chloride	.0142
Soda carbonate	.0413
Nitric and phosphoric acids	a trace.
Silica	.0006
	0.2549

Total saline contents of the water, 0.5079 to the thousand parts. The fresh water gives a slight alkaline reaction with reddened litmus; the soda, stated as carbonate above, is doubtless present in it as bi-carbonate.

On examination of the *white powdery boiler sediment*, it was found to be mainly lime carbonate, with about five per cent. of magnesia carbonate, two to three of lime sulphate, more than one per cent. of alumina and iron oxide, with a trace of phosphoric acid, a little silica, and traces of the alkalies.

The hard *boiler scale*, on the contrary, was found to be mainly lime sulphate, with small proportions of lime and magnesia carbonates, and traces of silica, phosphoric acid, &c.

It is evident that the hard scale, which is the most injurious to the boiler, may be prevented by the addition to the water of enough carbonate of soda, say in the form of cheap soda ash, to decompose the lime sulphate. This would probably cause the sediment to be wholly powder.

No. 1436—SULPHUR MINERAL WATER *from a bored well, ninety-six feet deep, at Fleetwood Farm of Col. J. W. Hunt Reynolds, near Frankfort.*

The water stands at about twenty-five feet from the bottom.

COMPOSITION OF THIS WATER.

	In 1000 parts.	In a wine gallon (231 cubic inches).
Free hydrosulphuric acid gas	0.0343 parts.	1.9981 grains.
Free carbonic acid gas	.2772 "	16.1730 "
Held in solution by the free carbonic acid.		
Lime carbonate	.1397 parts.	8.1350 grains.
Magnesia carbonate	.1029 "	6.0030 "
Iron and manganese carbonates	marked traces.	marked traces.
Total sediment on boiling	0.2426	14.1380
Potash sulphate	.2535 parts.	14.7800 grains.
Sodium sulphide	.1057 "	6.1670 "
Sodium chloride	1.0152 "	59.2140 "
Potassium chloride	.0798 "	4.6580 "
Calcium chloride	.0713 "	4.1620 "
Magnesium chloride	.0228 "	1.3330 "
Silica	.0343 "	2.0000 "
Organic matters	a trace.	a trace.
Bromine, iodine, and lithium	marked traces.	marked traces.
Total	1.8250 parts.	106.4420 grains.

A very good saline sulphur water, which may be useful in cutaneous and parasitic diseases, granular sore eyes, some forms of neuralgia and rheumatism, &c., &c., when employed externally or internally under the advice and direction of a physician.

This water was analyzed by the writer, for Col. Reynolds, before the reörganization of the Geological Survey; but it has been reëxamined recently in this laboratory, and, in addition to the ingredients reported to him, notable quantities, not quantitatively estimated, of iodine and lithium, were observed in it. The water acquires a yellowish tint on standing in bottles; doubtless owing to the formation of sulphuretted sulphide of sodium by the decomposing influence of the atmospheric oxygen on the hydrosulphuric acid.

FULTON COUNTY.

No. 1437—SOIL. *Labeled "Sub-soil of an old tobacco field. The soil proper has been washed away. Field about one hundred and fifty feet above the Mississippi river, four miles east of Hickman. Collected by Prof. N. S. Shaler."*

This sub-soil is of a brownish dark-buff, or light yellowish-brown color.

COMPOSITION, DRIED AT 212° F.

Organic and volatile matters	2.250
Alumina, and iron and manganese oxides	6.005
Lime carbonate	.230
Magnesia	.414
Phosphoric acid	.172
Sulphuric acid	not est.
Potash	.159
Soda	.072
Sand and insoluble silicates	90.490
Water expelled at 380° F.	.650
Total	100.442
Hygroscopic moisture, per cent.	2.250
Potash in the insoluble silicates, per cent.	1.479
Soda in the insoluble silicates, per cent.	1.306

It will be seen that in this sub-soil, which contains a very large proportion of fine sand and insoluble silicates, and which only gave up 0.159 per cent. of its potash after long digestion, with heat, in chlorohydric acid, there is yet a reserve supply of that alkali of more than nine times that quantity, locked up in the insoluble silicates. This potash, although not immediately available for the use of plants, will doubtless be gradually brought into an available condition, under the slow but certain action of the atmospheric agencies and under that of *humus*, &c.

No. 1438—MINERAL WATER. "*Chalybeate water, sent by Mr. B. R. Walker, from Nick Combs' Spring, four miles southwest of Hickman, Fulton county.*"

This chalybeate water contains free carbonic acid and 0.302 of *saline matters* in the one thousand of water. This consists of iron, manganese, lime and magnesia carbonates, with some lime and magnesia sulphates, &c. The quantity sent was too small for a thorough analysis.

It is probably a valuable chalybeate water.

No. 1439—"INDURATED SILICIOUS CLAY. *From the bluffs, one hundred feet above low water mark, Hickman, Fulton county. Tertiary formation. Collected by Prof. N. S. Shaler.*"

Of a light-grey color, with ferruginous infiltrations. Breaks readily, with an irregular fracture. Adheres slightly to the tongue. Is somewhat plastic when powdered and rubbed up with water. When calcined, is of a light buff color.

No. 1440—"SILICIOUS CONCRETION *or soft sandstone from the Bluff at Hickman, fifty feet above low water. Tertiary. Collected by Prof. N. S. Shaler.*"

A whitish, porous, and friable silicious rock or concretion; adheres to the tongue. Only slightly plastic when powdered and rubbed up with water. Burns of a light buff color.

No. 1441 — "SILICIOUS CONCRETION *or soft sandstone, from Chickasaw Bluff, eight miles south of Hickman. Tertiary. Bed ten feet thick. Collected by Prof. N. S. Shaler.*"

A light-grey or dove-colored soft and porous silicious rock, adhering to the tongue. Scarcely at all plastic when powdered and rubbed up with water.

No. 1442—"SOFT SANDSTONE. *Chickasaw Bluff, near the base, eight miles south of Hickman.*"

A dull light-yellowish-grey porous soft sandstone; adheres strongly to the tongue. Composed of minute rounded quartzose grains, with a whitish cement.

COMPOSITION OF THESE FULTON COUNTY SOFT SANDSTONES AND SILICIOUS DEPOSITS, DRIED AT 212° F.

	No. 1439.	No. 1440.	No. 1441.	No. 1442.
Silica	74.960	81.060	89.160	94.060
Alumina, and iron and manganese oxides	18.350	13.609	7.809	3.129
Lime carbonate	.560	.560	.380	.380
Magnesia	.309	.139	.086	.173
Phosphoric acid	.051	.051	.051	.051
Sulphuric acid	.501	.844	.707	.981
Potash	.230	.231	.115	.230
Soda	.124	.021	.080	.124
Water expelled at red heat	5.800	3.600	2.400	1.600
Total	100.885	100.115	100.788	100.728

These silicious deposits do not contain enough mineral fertilizing ingredients to make them valuable for application to the soil, nor enough alumina to constitute good plastic clay. Yet they may be made useful in tempering clay which contains too much alumina, or for the formation of common glass and for scouring purposes. Some of them are plastic enough to enable them to be moulded, and the silicious material is fine enough, in some, to permit them to be used as "Bath Brick" for household scouring. Common brick could probably be made out of No. 1439.

Some of these layers, in which the proportions of alkalies, lime, magnesia, and iron oxide are small, may perhaps be manufactured into a kind of fire-brick.

Part of the sulphur which appears in the above summary of analyses as sulphuric acid, is doubtless in combination with some of the iron in the sandstone, in the form of iron sulphide;

the oxidation of which may account for a portion of the excess in the total.

No. 1443—"CLAY *from the foot of Grand Chain, Illinois. Post Tertiary. Collected by Prof. N. S. Shaler.*"

Of a light-grey-dove color, with brownish incrustations. Fracture large conchoidal-hackly; quite porous; adheres strongly to the tongue; grinds easily into a tough plastic mass with water. Calcines of an orange-buff color; but fuses before the blow-pipe. *Specific gravity*, in its porous state = 1.764. Contains minute glimmering scales of mica.

COMPOSITION, DRIED AT 212° F.		
Silica	70.660	
Alumina, and iron and manganese oxides	20.309	
Lime carbonate	.960	
Magnesia	.307	
Sulphuric acid	1.188	= .475 per cent. of sulphur.
Phosphoric acid	.051	
Potash	.819	
Soda	.487	
Water expelled at red heat, and loss	5.219	
	100.000	

This clay, which was collected for comparison with the Fulton county tertiary deposits, would prove of no especial value as a fertilizer, except on very sandy soils to improve their consistence. It would probably answer for common pottery or bricks; but is too fusible for fire-brick. It compares pretty well with No. 1439.

GRAYSON COUNTY.

No. 1444—CLAY IRON-STONE "*From three miles south of Litchfield. A six inch layer, on the land of Jno. H. Higden, in the carboniferous limestone. On the old Brownsville road. Collected by Prof. N. S. Shaler.*"

Fine granular, or compact. Dark grey.

COMPOSITION DRIED AT 212° F.

Iron, carbonate	60.466	} = 33.630 per cent. of iron.
Iron, peroxide	6.536	
Alumina	7.179	
Lime carbonate	4.050	
Magnesia, carbonate	6.378	
Manganese, carbonate	a trace.	
Phosphoric acid	.102	= 0.035 per cent. of phosphorus.
Sulphuric acid	.054	= .022 per cent. of sulphur.
Silica and insoluble silicates	14.450	= 11.900 per cent. of silica.
Water and loss	.785	
	100.000	

Quite a good ore of its kind.

No. 1445—LIMONITE IRON ORE. *"From north side of Grindstone branch of Rock Creek. Hill below Owen Whittrie's. Grayson county. Collected by P. N. Moore."*

A porous and cellular limonite, varying in color from dark brown and steel black to reddish-brown and ochreous.

COMPOSITION, DRIED AT 212° F.

Iron, peroxide	27.192	= 19.344 per cent. of iron.
Alumina	4.299	
Manganese, brown oxide	a trace.	
Lime carbonate	.410	
Magnesia	.317	
Phosphoric acid	.249	= 0.109 per cent. of phosphorus.
Sulphuric acid	.103	= .041 per cent. of sulphur.
Water expelled at red heat	5.600	
Silica and insoluble silicates	61.730	= 25.500 per cent. of silica.
Moisture and loss	.100	
	100.000	

This ore is too poor in iron and too silicious to be of much value.

[See Appendix for other Grayson county iron ores.]

No. 1446—MARLY SHALE. *"From Sunset Lick, a mile and a half west of Litchfield. Geological position the carboniferous formation. Collected by Prof. N. S. Shaler."*

A friable marly shale of a greyish and brownish-olive color. This marl, when analyzed by digestion in acids, &c., gave the following results, dried at 212° F., viz:

Alumina, and iron and manganese oxides	19.133
Lime	.269
Magnesia	.353
Phosphoric acid	.267
Sulphuric acid	.027
Potash	2.910
Soda	.052
Water expelled at red heat	6.230
Silica and insoluble silicates	71.580
Total	100.821

The *silica and insoluble silicates*, when *sintered* with lime carbonate and ammonium chloride, &c., &c., yielded 1.205 per cent of *potash*, and 0.55 per cent. of *soda*, in addition to that given above as extracted by digestion in acids. So that the *total* amount of potash in the marl appears to be 4.115 per cent. and that of soda 0.602 per cent.

Some of the same marly shale, from this locality, subsequently collected by Mr. P. N. Moore, was analyzed by fusion with the mixed alkaline carbonates; *sintering* with lime carbonate and ammonium chloride, &c., &c., and gave the following results, viz:

Alumina	14.130
Iron and manganese oxides	13.480
Lime	.538
Magnesia	1.158
Phosphoric acid	.280
Sulphuric acid	.204
Potash	4.625
Soda	.783
Water, &c., expelled at red heat	6.000
Silica	60.060
Total	101.258

The apparent excess in the total may be partly due to oxidation of combined iron and sulphur in the marl, and probably, also, to an over-estimation of the water.

Its considerable proportion of *potash* might make it useful as a fertilizer on impoverished land, were this alkali all in *an available* condition. But the analyses show that a great portion of it is in firm combination, in the silicates insoluble in acids; only to be released, and made available for plant growth, by the slow process of weathering, under the influence of atmospheric agencies, *humus*, &c. Whether lime could be profitably employed to decompose these silicates and set free the alkalies, is yet to be tried.

The remarks given under the head of marly shales of Campbell and Franklin counties, as to their use as "mineral paint," &c., apply to this marly shale also.

No. 1447—"SOFT SANDSTONE; *a micaceous, uncemented sand rock, from Horse Branch, on the Elizabethtown and Paducah Railroad. Border of Grayson and Ohio counties. Very friable. Can be shoveled like sand. Collected by Prof. N. S. Shaler. Geological position carboniferous.*"

Of a light drab, or grey-buff color, consisting of small quartz grains, mostly rounded, some spangles of mica, some few grains of blackish and greenish ferruginous mineral, and a fine powder, somewhat ferruginous, which can easily be washed out from the quartz sand, &c., by water. Water disintegrates the lumps.

This soft sand rock, *dried at* 212°, gave the following results, on analysis by acid digestion, &c.:

Sand and insoluble silicates	87.700
Alumina, colored with iron oxide	7.040
Lime (estimated as carbonate)	.100
Magnesia	.245
Phosphoric acid	.370
Sulphuric acid	.049
Potash	.975
Soda	.401
Water, &c., expelled at red heat	3.000
Loss	.120
Total	100.000

This would undoubtedly answer well for the manufacture of common glass. Its considerable proportion of potash, nearly one per cent. extracted by acids, has probably been mainly derived from the mica which it contains, while the phosphoric acid, also considerable for a sand, has doubtless been mostly extracted from the dark greenish mineral. This sand would prove a useful addition to heavy clay soil. No doubt analysis by fusion would show that it contains a much larger proportion of potash than digestion in acids demonstrates.

No. 1448—COAL. *Labeled "Tar Lick Coal, Dismal Creek, Grayson county. Average sample, by P. N. Moore.*"

Mostly in thin laminæ, with some bituminous matter, fibrous coal, and fine-granular pyrites between them. Generally of a deep-black color, with occasional ferruginous stains.

No. 1449—COAL. "*Gravelly Lick, Miller's Fork of Bear Creek. Average sample, by P. N. Moore.*"

Splitting into thin laminæ, with a little fibrous coal and fine-granular pyrites between.

No. 1450—COAL. "*Near the School-house, on Brushy branch of Calloway Creek, W. B. McGrew's. Collected by P. N. Moore.*"

Much weathered.

No. 1451—COAL (*impure*) "*Copperas bank, branch of Hunting Fork of Rock Creek, above the conglomerate. Collected by P. N. Moore.*"

Mostly in thin laminæ, some of which are shaly. Some ferruginous incrustation.

No. 1452—COAL. "*L. Higdon's, Pearson's branch of Rock Creek. Below the conglomerate. About fifteen feet above the limestone. Collected by P. N. Moore.*"

A jet-black coal; generally breaking into thin laminæ, some of which are somewhat shaly. Not much fibrous coal or granular pyrites apparent. Some ferruginous incrustation.

No. 1453—COAL (*impure*) "*From Gum Spring Fork of Cane Camp Creek, Nolin Furnace property. Sample from above the slate parting only. Collected by P. N. Moore.*"

A much weathered coal, in thin laminæ, much tarnished with ferruginous and aluminous incrustations.

No. 1454—COAL (*impure*) "*From same locality as preceding. Sample from below the slate parting only. Collected by P. N. Moore.*"

In thin laminæ, some shaly; weathered dull and stained with ferruginous and clayey incrustation.

COMPOSITION OF THESE GRAYSON COUNTY COALS, AIR-DRIED.

	No. 1448.	No. 1449.	No. 1450.	No. 1451.	No. 1452.	No. 1453.	No. 1454.
Specific gravity	1.305	1.395	1.346	1.378	1.364	1.446	1.512
Hygroscopic moisture . .	4.70	4.14	6.26	3.50	3.60	6.50	4.40
Vol. combustible matters .	31.40	30.52	32.44	33.40	35.80	29.10	25.86
Coke	63.90	65.34	61.30	63.10	60.60	64.40	69.74
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters . .	36.10	34.66	38.70	36.90	39.40	35.60	30.26
Carbon in the coke . . .	52.20	50.08	53.80	47.50	49.40	49.60	40.14
Ashes	11.70	15.26	7.50	15.60	11.20	14.80	29.60
Total	100.00	100.00	100.00	100 00	100.00	100.00	100.00
Character of the coke . .	Spongy.	Dense spongy.	Light friable.	Light spongy.	Light spongy.	Friable.	Friable.
Color of the ash	Light brownish grey.	Brownish grey.	Greyish-salmon.	Lilac-grey.	Lig't chocolate	Light brownish	Nearly white.
Per centage of sulphur. .	1.945	3.565	1.476	2.041	3.158	0.818	0.777

No. 1455—"COAL, *remarkable for being found in the sub-carboniferous limestone; about seventy-five to a hundred and twenty feet below the Chester Group. Collected by C. J. Norwood.*"

A much weathered specimen; splitting easily into thin laminæ, with very little fibrous coal or pyrites between. Some little ferruginous stain.

COMPOSITION—SPECIFIC GRAVITY = 1.338.

Hygroscopic moisture	4.24
Volatile combustible matters	30.82
Coke (light friable)	64.94
Total	100.000
Total volatile matters	35.06
Carbon in the coke	55.52
Ashes (brownish salmon-grey)	9.42
Total	100.00
Per centage of sulphur	2.892

Interesting only because of its unusual position.

GRAYSON SPRINGS MINERAL WATERS.

These waters were mostly collected and tested qualitatively, at the springs, by Mr. Jno. H. Talbutt; who spent several days in this work and in the evaporation of a quantity of some of the principal ones, for the purpose of determining the more rare ingredients. The quantitative analyses were performed at our chemical laboratory in Lexington.

No. 1456—"SULPHUR WATER *from the Centre Spring, a natural spring, the most popular of the Grayson Springs.*"

Inclosed in a "gum" three feet deep and one and a half feet in diameter. Flows in a perennial stream, of about half an inch diameter. Gas bubbles up frequently, in moderate intermittent bursts. The water is of nearly a constant temperature of 61° F.; clear, depositing in its channel a dark-grey slimy sediment; and on the gum an incrustation varying in color from blackish and brownish to greenish and pinkish.

The spring is about two hundred yards southeast from the hotel. Has a reputation as diuretic, aperient, &c., &c. Reaction of the recent water is neutral with litmus paper, but when it has been partly evaporated it is slightly alkaline.

No. 1457—SULPHUR WATER *from the Moreman Spring.*

A natural spring, inclosed in a sycamore "gum" (twenty-two inches deep by eleven in diameter). Stream constant the year round, through a three-quarter inch hole. Bubbles of gas rise intermittently. Sediment in the channel of overflow, whitish; that at the bottom of the gum greenish-black, and slimy. Temperature of the water 66° to 67° F., nearly constant.

Considered one of the best of the waters for cutaneous diseases. Acts pretty constantly as aperient. Reaction of the recent water, neutral.

No. 1458—SULPHUR WATER *of the McAtee* Sulphur Spring.*

A natural spring (said to have two sources, one warm the other cold), located at the base of the hill, farthest of all from the house, nearest to the creek; near the bath-house. Included in a wooden box, fourteen by twenty-two inches, and twenty inches deep. The flow is about sufficient to fill a half inch pipe. There is a slight intermittent evolution of gas. Temperature, said to be invariable, at 60° F. The sediment in the box is dark green, with much pinkish; slimy. The incrustation on the box, greenish of various tints and shades. This water is not quite so strong as that of the "Center Spring."

No. 1459—SULPHUR WATER *of the "Stump Spring."*

A natural spring, included in a sycamore "gum," twelve inches in diameter and twenty deep. The flow is about a quarter to half inch in diameter. There is a slight evolution of gas in bubbles. Temperature of the water 64° F., said to be invariable. The sediment in the gum is blackish and slimy. The incrustation very slight, and nearly black. The taste of the water is sweetish-brackish. Reaction with litmus papers, *neutral.*

No. 1460—SULPHUR WATER *of the "Jar Spring."*

A natural spring, nearest to the house (near the Stump and Big Gum Springs), included in a gum twelve inches in diameter

*Called by Dr. Owen "Macatine." Volume 1, Kentucky Geological Reports, page 270.

and twenty-six deep. Flow of water from quarter to half an inch in diameter. Slight evolution of gas in bubbles, smelling strongly of sulphuretted hydrogen, as do all the others. Temperature of the water 63° F., said to be constant. Taste sweetish. Reaction, *neutral*. The sediment is dark-colored; slimy. The incrustation on the gum whitish, with greenish and purplish tints.

No. 1461—SULPHUR WATER *from the "Eye Spring."*

A natural spring, included in a "gum" ten to eleven inches in diameter and twenty deep. The flow of water is about a quarter of an inch in diameter. Temperature of the water, 66° F., said to be invariable. (The temperature of the atmosphere, at the time of observation, was 86° F.) Very little evolution of gas bubbles. The sediment in the gum is dark, and slimy. The incrustation on the gum dark green, yellowish, and purplish, and dirty-whitish. Taste brackish. Reaction, *neutral*.

No. 1462—SULPHUR WATER *from the "White Sulphur Spring," near the "Big Gum," and between it and the Moreman Spring, to the left of the walk.*

Flow about quarter to half an inch in diameter. A slight intermittent evolution of gas bubbles. Temperature 62° F., said to be invariable. Incrustation whitish. Sediment greenish near the gum. Tastes and smells stronger of sulphuretted hydrogen than any of the other springs. Reaction, *neutral*. Water not at present used.

No. 1463—SULPHUR WATER *from the "Hymenial Spring."*

A feeble spring, situated about ten feet from the "Center Spring." Temperature of the water 65° F., said to be invariable. Sediment greenish-black, with pinkish portions, and slimy. Incrustation on the "gum" dark-green and dirty-white. Reaction, *neutral*.

No. 1464—SULPHUR WATER *from the "Rock Spring."*

The original spring of the group. Situated at the base of the hill. Flows out from the rock in a constant stream, which might fill an inch pipe. Temperature 58° F., said to be invariable. A whitish scum on the water in the channel of out-flow; no gas bubbles evolved. Sediment bluish-blackish. Reaction, *neutral.* Not very strong in sulphuretted hydrogen.

No. 1465 — SULPHUR WATER *from an Artesian Well, one thousand feet deep, and six inches in diameter, completed in* 1865.

Bored for "oil" on Hunting Fork, a tributary of Rock Creek, near Mr. H. Haynes', six miles from Grayson Springs, on the property of the Boston Kentucky Central Rock Oil Company, H. W. Fuller, President. At first the water spouted twenty feet above the surface of the ground, from the two-inch tube. The tube is now out, and the hole has been widened for six feet down and cased with an eight-inch square wooden box. The water now flows out in a six-inch stream. Temperature 61.5° F. Gas is evolved constantly in large bubbles. The incrustation on the boxing, &c., is blackish, and is to be seen in the channel of the stream for half a mile down. The water is clear and colorless, and gives an *alkaline reaction.* A salt water stream is said to enter the well about one hundred and fifty feet below the surface.

COMPOSITION OF THESE SULPHUR WATERS OF GRAYSON COUNTY IN 1000 PARTS.

Name of spring	Centre.	More-man.	McAtee.	Stump.	Jar.	Eye.	White Sulphur.	Hyme-nial.	Rock.	Artesian
	No. 1456	No. 1457	No. 1458	No. 1459	No. 1460	No. 1461	No. 1462	No. 1463	No 1464	No. 1465
Specific gravity of water	1.0022	1.0011	1.0015	1.0016	not est.	not est.	not est.	not est.	not est.	not est.
Free carbonic acid gas .	0.1950	0.1234	0.1500	0.1650	0.2020	not est.	not est.	not est.	not est.	not est.
Free sulphuretted hydrogen gas	.0200	.0248	.0203	.0410	.0265	0.0239	0.0270	not est.	not est.	0.0380
Lime carbonate	0.1736	0.1952	0.1806	0.2002	0.1632	0.1872	0.1832	0.1525	0.1660	0.1360
Magnesia carbonate . .	a trace.	.0512	.0002	a trace.	.0345	.0042	.0018	not est.	.0118	.0228
Iron, and manganese carbonates and phosphates	.0027	.0048	.0078	.0066	.0072	.0096	.0096	. . . .	.0072	.01[illegible]6
Silica	.0022	.0094	.0028	.0008	.0032	.0036	.0104	. . . .	.0022	.0260
Organic matters and loss	not est.	not est.	.0022	.0268	.0271	.0096	.0090	. . . .	.0304	.0038
Total sedi'nt on boiling	0.1785	0.2606	0.1914	0.0342	0.2352	0.2132	0.2140	not est.	0.2176	0.1992
Lime sulphate	1.1649	0.4541	0.4528	0.6291	0.5078	0.6683	0.6505	0.9001	0.5946	1.3044
Magnesia sulphate . . .	.5774	.3768	.4616	.6093	.5781	.7542	.6522	.8835	.4704	.8778
Potash sulphate	. . . .	. . . .	.0024	.0023	.0045	.0017	. . . .	.0085	.0011	not est.
Soda sulphate	. . . .	. . . .	.0126	.0374	. . . .	.0147	. . . .	. . . .	.0288	not est.
Iron, manganese and alumina sulphates and phosphates	.0034	.0007	.0192	not est.	traces.	traces.	traces.	traces.	traces.	traces.
Sodium sulphide	.0521	.0409	not est.	not est.	.0207	.0100	.0257	.0220	.0059	.0254
Soda combined with organic acids	.0044	.0066	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Potash " "	.0009	.0038	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sodium chloride . .	. . . .	. . . .	.0200	.0053	.0760	.1059	.01[illegible]	.0226	.0084	.2960
Magnesium chloride . .	0.1898	.0145	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Silica	.0034	.0029	.0060	.0022	.0008	.0058	.0[illegible]8	.0032	.0048	.0056
Organic matters and loss	not est.	not est.	not est.	.0200	.2029	.0222	.1777	not est.	.1484	not est.
Total saline matters .	2.0748	1.1609	1.3252	1.5740	1.6260	1.7960	1.7470	1.9974	1.4800	2.7084
Lithium, iodine and bromine	traces.	traces.	traces.	traces.	not est.	not est.	not est.	not est.	not est.	not est.
Temperature of spring, F.	61°	66°, 67°	60°	64°	6[illegible]	66°	[illegible]2	[illegible]5°	5[illegible]	61°, 65°

The small quantities of lithium compound, indicated in the above table, were detected by means of the spectroscope, after proper treatment of the saline residuum obtained by the evaporation of from ten to twenty litres of the water. The bromine and iodine traces could only be observed by the appropriate tests after a similar evaporation.

The *organic matters* recorded in the table are composed of *apocrenic* and *crenic* acids and the singular substance called *Barégine*, from the fact that it was first observed in the sulphur water of the celebrated Barège Springs of the Pyrenees.

This *Barégine* is found in solution in many of the sulphur waters of the world; more especially in the thermal waters.

On evaporation of such waters they assume a yellowish tint and leave a yellowish-brown residue, which, on calcination, gives out ammoniacal fumes and the odor of burnt horn; leaving a very large proportion of ash, mainly silicious. This organic matter, approaching to the nature of the albuminoid or gelatinous principles, is what is called Barègine.

By exposure of these waters to the air this dissolved nitrogenous matter undergoes a change; becomes less soluble and forms a sediment, or deposit, in the spring and its channel, of a slimy nature, which is called *glairine*, and which is usually combined with other precipitated materials from the water, such as iron and manganese sulphides, lime and magnesia carbonates, free sulphur, &c., &c., and probably changes, by gradual decomposition, into *crenic* and *apocrenic acids*, &c.

Glairine, with crenic and apocrenic acids, and other substances mentioned above, were abundantly found in the unctuous slimy sediment of these Grayson sulphur springs. Generally more of the latter than of the crenic.

This sediment was collected by Mr. Talbutt from the bottom of the water in the "gum" usually, from the following springs, viz: "Centre," "Moreman," "McAtee," "Stump," and "Hymenial," and brought to the laboratory for examination, in close bottles, with some of the water of the spring included.

On examination, some weeks afterward, the supernatant water was found to be glairy in all except that from the *Stump* Spring. In those from the Centre and Moreman springs the water over the sediment was of a dirty-olive green color, of a sulphurous and putrescent odor, *glairy*, and as thick as ordinary white of egg. When this was poured off and the sediment agitated with more distilled water, this also became glairy and colored, on standing; and the same result was obtained in a second and third operation of the kind; the quantity of the dissolved organic matter appearing gradually to be diminished. The "Centre" sediment gave the most of this glairy material; that of the "Moreman," "McAtee," and "Hymenial" gave less, and that of the "Stump," although it colored the water slightly, did not make it glairy or communicate to it the semi-putrescent, sulphurous odor, so marked with the others.

The glairy colored solution, poured off from the sediment, was evaporated and analyzed. The dark brownish solid residuum, obtained by evaporation, presented the usual properties of *glairine*. It burnt with a burnt-horn, ammoniacal odor, leaving a large quantity, more than forty per cent., of whitish *ash*. This ash was largely *silicious*, but contained also *alumina*, *iron* and *manganese oxides*, *lime*, *magnesia*, and *phosphoric* and *sulphuric acids*. The glairley soluble matter also contained apocrenic acid.

The dark colored original sediments, which had thus been washed with water to remove some of the glairine, &c., were found to contain much *apocrenic* and *crenic* acids, especially the former, with alumina, iron and manganese oxides, lime, magnesia, phosphoric and sulphuric acids, sulphur, &c. Becoming somewhat charred when calcined and giving off the odor of burnt animal and vegetable matters. That from the "Centre" Spring giving more of the odor of burnt animal matter. Those of the others giving mostly the odor of burnt vegetable matter.

Doubtless the other sulphur waters of this locality also contain these remarkable organic ingredients, or most of them. What influence they have in therapeutic applications of these waters has not been determined. It is probable, however, that this decomposable organic material, from whatever unknown source derived, may, by reaction upon the dissolved earthy sulphates of the water, produce some of the sulphydric acid which it contains.

It may be interesting to append the chemical composition of *glairine* of three different varieties, as determined by J. Bouis. ("*Comptes Rendus,*" *XLI, page* 116.)

	Carbon.	Hydrogen.	Nitrogen.	Ashes.
Glairine, pulpy, grey	48.69	7.70	8.10	30.22
Glairine, fibrous, red	44.06	6.69	5.57	35.00
Glairine, pulpy, green	45.20	6.95	5.60	40.07

No. 1466—CHALYBEATE WATER, *from the chalybeate well at Grayson Springs.*

Well ten feet deep; walled up with rock, three feet square. Water about four feet deep in well. It is said that three streams of chalybeate and one of fresh water flow into it. A very slight occasional evolution of gas. Temperature of the water, 71° F. The water is raised with a wooden pump. The sediment or deposit, where the water flows from the pump and trough, is ferruginous, brownish-red. Reaction, *neutral.*

No. 1467—CHALYBEATE WATER, *from a well near Grayson Springs; sent by Mr. Van Meter, proprietor of the springs, for examination.*

This, like the preceding, deposited a flocculent light-brown ferruginous sediment in the containing bottle.

No. 1468—CHALYBEATE WATER, *from "Indian Spring," a natural source, near Jones' Mill; head of Sunfish Creek, five miles from Paducah and Louisville Railroad. Sent for examination by Mr. H. Haynes.*

This also deposited a brownish ferruginous sediment in the bottle.

COMPOSITION OF THESE CHALYBEATE WATERS, IN 1000 PARTS OF THE WATER.

	No. 1466.	No. 1467.	No. 1468.
Free carbonic acid	0.207	not est.	not est.
Lime carbonate	0.1251	0.2580	0.0076
Magnesia carbonate	a trace.	.0020	a trace.
Iron and manganese carbonates and phosphates, with traces of alumina	.0118	.0800	.0133
Silica	.0022	.0180	.0028
Total, held in solution by carbonic acid	0.1391	0.3580	0.0237
Lime sulphate	0.0110	2.328	0.0692
Magnesia sulphate	a trace.	.741	a trace.
Potash sulphate	a trace.	.063	a trace.
Soda sulphate	a trace.	1.130	a trace.
Sodium chloride	.0081	.1510	.0423
Potassium chloride	.0076	. . . .	.0038
Silica	not est.	.0150	.0086
Total saline contents	0.1658	4.786	0.1476

From these analyses, which can only be considered approximative, it appears that the water from the well near Grayson Springs is the strongest and the most aperient. The small quantity of the water sent, and the alterations which always take place in waters of this kind, under the influence of the atmosphere, prevent these examinations from being entirely conclusive.

No. 1469—SOIL. "*Sample to the depth of eight inches from an old field, fifty years in cultivation, which has been lying uncultivated for the last fifteen years. Collected by C. Schenk.*"

Situated twenty-five hundred feet west of the twenty-first mile-post on the Louisville and Paducah Railroad; west of Big Clifty. Locality, six hundred and seventy feet to the right of that road and four feet above the level of the rail. Underlying rock, *sandstone*. *Timber* of the locality, mostly black oak, with some white and red oak; with a few poplars on the creeks. *Undergrowth* sumach, dogwood; much sassafras and persimmon. *Rotation of crops*: 1. Tobacco; 2. Corn; 1. Oats; sometimes with clover. No manure. *Yield:* of corn and oats, of each ten bushels to the acre. Soil of a yellowish light-umber color.

No. 1470—SOIL. "*Sub-soil of the preceding, taken at a depth of from eight to forty inches. Collected by C. Schenk.*"

Sub-soil of a dull-light-brick color.

No. 1471—"VIRGIN SOIL. *Sample to depth of six inches. Collected by C. Schenk.*"

From a point two hundred feet east of the twenty-second mile-post, on above named railroad; two hundred and fifty feet to the right of the road, and four feet above the level of the rail. Underlying rock, *sandstone*. Has been two years in cultivation. Usual yield of this locality, according to report of the farmers, of corn and oats, each ten to twenty bushels, and of wheat five to ten bushels. It yields tobacco only when manured. Timber same as in preceding.

Soil of a greyish-brown or light umber color. The coarse sieve (two hundred and eighty-nine meshes to inch) removed from it a few rounded ferruginous particles only.

No. 1472—"SUB-SOIL *of the next preceding; taken to the depth of from six to thirty-six inches. Collected by C. Schenk.*"

Sub-soil of a light greyish-buff color. Contains a few small rounded ferruginous particles.

No. 1473—"VIRGIN SOIL, *three years in cultivation. Collected by C. Schenk.*"

Sample to the depth of seven inches, from a locality one thousand feet west of the twenty-sixth mile-post, on the Louisville and Paducah Railroad, and three hundred and sixty feet to the left of that road, at the level of the rail. Drainage slope = 1:150. Substratum, *limestone.* Timber, red, black, and white oak, with sugar-tree and poplar. Timber full of holes, except the poplar. Undergrowth, dogwood, sassafras, persimmon. Sometimes one hundred cords of wood to the acre.

Rotation of crops: two years in corn; yield, twenty-five bushels to the acre; one year in oats; same yield. New land here yields fifteen to thirty bushels of corn, twenty to thirty of oats, and eight hundred to a thousand pounds of tobacco, per acre.

Soil of an umber color; darker than the preceding virgin soil. It contains a few rounded ferruginous particles.

No. 1474—"SUB-SOIL *of the next preceding, taken at the depth of from seven to thirty-six inches. Collected by C. Schenk.*"

Sub-soil of a light grey-buff color. Contains a few small rounded ferruginous particles.

No. 1475—SOIL. "*Sample to the depth of five and a half inches, of an old field, forty years in cultivation. Collected by C. Schenk.*"

Near the Grayson Spring Station, Louisville and Paducah Railroad, four hundred and fifty feet to the right of that road, at a point five hundred and thirty feet east of the twenty-six mile-post. Fifteen feet above the level of the rail. Drainage slope = 1:30. Substratum, *limestone.* Rotation of crops: two years in corn, one in oats and clover (sometimes tobacco first). Field has been in grass for the last three years. Yield: corn, twelve to twenty bushels; wheat, eight; and oats, fifteen per acre.

Dried soil of a brownish-grey color. Sifted out very few small rounded ferruginous particles.

No. 1476—"SUB-SOIL *of the next preceding, taken from five and a half to thirty-six inches below the surface. Collected by C. Schenk.*"

Sub-soil of a grey-buff color. Contains but few rounded ferruginous particles.

NOTE.—For the rest of this serial collection of soils, &c., made by Mr. Schenk, on and near the line of the Elizabethtown and Paducah Railroad, see Hardin and Ohio counties.

COMPOSITION OF THESE GRAYSON COUNTY SOILS, &c., DRIED AT 212° F.

	No. 1469	No. 1470	No. 1471	No. 1472	No. 1473	No. 1474	No. 1475	No. 1476
Organic and volatile matters	3.850	3.375	4.850	3.200	4.950	3.350	4.500	3.275
Alumina, and iron and manganese oxides	7.215	10.990	5.515	7.497	6.195	6.647	4.172	6.022
Lime carbonate	.345	.195	.145	.045	.340	.020	.220	.145
Magnesia	.240	.159	.140	.140	.176	.104	.167	.125
Phosphoric acid	.076	.166	.125	.093	.175	.093	.118	.093
Sulphuric acid	Not esti	mated.						
Potash	.243	.308	.112	.105	.327	.105	.120	.405
Soda	.125	.104	.051	.044	.023	.070	.045	. . . .
Sand and insoluble silicates	80.850	84.490	88.790	87.565	86.780	88.965	90.640	89.580
Water expelled at 380° F.	925	.425	1.325	.875	1.075	1.100	1.100	.350
Loss	.131	. . . .	. . . .	.436	.009	. . . .	. . . .	.005
Total	100.000	100.212	101.053	100.000	100.000	100.454	101.082	100.000
Moisture expelled at 212° F.	2.025	2.925	2.125	2.700	1.950	1.650	1.775	3.500
Potash in the insoluble silicates	1.0395	. . . .	1.602	. . . .	. . . .	. . . .	. . . .	.828
Soda in the insoluble silicates	0.479	. . . .	.377	. . . .	. . . .	. . . .	. . . .	.624
Character of the soil	Old field soil.	Sub-soil	Virgin soil.	Sub-soil	Virgin soil.	Sub-soil	Old field soil.	Sub-soil

Although these Grayson county soils cannot be classed amongst the naturally very rich soils, because they are rather too sandy; yet, if they are well drained, they may be made quite profitable with proper management and by the judicious use of fertilizers. There is no reason, except unskillful culture, why they are not at present more productive than is represented above. Their near vicinity to good markets should introduce a more scientific husbandry.

GREENUP COUNTY.

No. 1477—CLAY. *Labeled "Fire-clay, Louder's land, near Kenton Furnace. Collected by P. N. Moore."*

A compact, fine-grained, non-plastic clay-stone of a light-grey color; hardly adhering to the tongue; breaking readily into sharp angular fragments; fracture somewhat conchoidal. This, when reduced to powder, easily works up with water into a plastic mass, which is the case with the other samples of this kind described below.

No. 1478—"FIRE-CLAY, *two feet above the limestone ore; head of Powder-mill hollow, two miles from Kenton Furnace. Collected by P. N. Moore."*

An olive-grey shaly clay, breaking easily into layers, but not so easily across them; adhering to the tongue.

No. 1479—"CLAY, *fourth above the limestone and limestone ore, on Pea Ridge. Thickness two to two and a half feet. Weathering white. Collected by J. A. Monroe."*

A whitish clay, in soft friable lumps; colored with oxide of iron in the crevices.

No. 1480—"CLAY; *thin bed, resting on limestone ore of Pea Ridge, near Hunnewell."*

A soft friable plastic clay; colored olive-green and brownish and yellowish-grey.

No. 1481—"CLAY. *Two and a half feet bed; second above limestone ore. Pea Ridge. Collected by J. A. Monroe."*

Olive-brownish-grey. Harsh to the feel. Breaks in angular fragments.

No. 1482—"CLAY, *fourteen inches thick. Third bed above the limestone ore at Pea Ridge. Collected by J. A. Monroe.*"

A brownish-grey compact clay, breaking into irregular layers, which are polished on their surfaces; adheres slightly to the tongue.

No. 1483—CLAY. "*Fire-clay. Thomas' bank. Average sample of upper layer; five feet above the cherty limestone. Head waters of Wing's branch of Shultz Creek. Collected by P. N. Moore.*"

A compact clay-stone of a light-grey color (yellowish and bluish); even fracture; soapy feel; not scratched by the nail; scarcely adhering to the tongue.

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

	No. 1477	No. 1478	No. 1479	No. 1480	No. 1481	No. 1482	No. 1483
Silica	49.680	62.920	66.560	47.060	67.700	55.560	47.560
Alumina	35.281	20.735	22.679	36.620	22.092	31.027	40.661
Iron oxide, &c.	a trace.	3.820	a trace.	a trace.	a trace.	a trace.	a trace.
Lime	.213	.213	.157	.615	.101	.325	.280
Magnesia	.136	2.281	.605	.389	.285	.403	.497
Phosphoric acid	.626	.371	.563	.626	.498	.358	.249
Sulphuric acid	not est.	not est.	not est.	not est.	not est.	not est.	a trace.
Potash	.193	2.601	1.946	1.156	1.156	1.167	.308
Soda	.211	.659	.690	.234	.268	.560	.409
Water expelled at red heat, and loss	13.660	6.400	6.800	13.300	7.900	10.600	10,036
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000

On submitting these clays to the action of the blow-pipe, No. 1480 was found to be most softened by the heat, while Nos. 1477, 1481, and 1483 were most refractory; the others occupied an intermediate position. They all burnt nearly white, but No. 1478 burnt of a light-buff color, and No. 1479, No. 1480, and No. 1483 acquired a very light pink tint on being calcined. They are undoubtedly all very good clays, and the more silica they contain, within certain limits, and the smaller their proportions of potash, soda, oxide of iron, lime, magnesia, and phosphoric acid, the better they withstand the melting influence of fire.

[See Carter county for other clays of this kind.]

No. 1484—"COAL, *No. 1, used at Kenton Furnace. Average sample.*"

A brittle coal, breaking into irregular layers; fractured surface dark, glossy, asphaltum-like. Impressions of reedy leaves on the laminæ, and some fine-grained pyrites.

No. 1485—"COAL, *average sample, from J. Thompson's bank, near Kenton Furnace. Bed sixteen inches thick. Collected by J. A. Monroe.*"

A brittle coal, breaking into thin irregular layers, which have much pulverulent mineral charcoal between them.

No. 1486—COAL, *No.* 3. "*Average sample of the main coal of Raccoon Furnace. Below the shale parting.*"

A dark colored coal, breaking easily into thin layers. Separated by much fibrous coal, with some fine-grained pyrites diffused in it.

No. 1487—COAL, *No.* 3. "*Average sample of the upper part of the coal used at Raccoon Furnace. Mine one and a third miles east of southeast of the furnace. The upper twenty inches of the thirty-six inch bed. Collected by P. N. Moore.*"

Much like the preceding.

No. 1488—COAL. "*Main coal, No.* 3; *lower part below the shale parting. Buffalo Furnace. Averaged by P. N. Moore.*"

No. 1489—"MAIN COAL, *No.* 3; *above the shale parting. Buffalo Furnace. Averaged by P. N. Moore.*"

No. 1490—COAL. "*Alcorn Creek coal; probably sub-conglomerate. Raccoon Furnace. Averaged by P. N. Moore.*"

No. 1491—COAL, *No.* 1. "*Hanna bank coal. Average of the upper portion of the bed, from the stock pile, by P. N. Moore.*"

No. 1492—"*Hanna bank coal, &c. Averaged from the lower part of the bed, from the stock pile, by P. N. Moore. Coals identified by Mr. Witherow.*"

No. 1493—"COAL, *probably No. 3; thirty feet below the Kidney ore, Laurel Furnace. Average from coal shed, by P. N. Moore.*"

No. 1494—COAL, *No. 6; from the hill back of Amanda Furnace. Average sample from all parts of the bed, by A. R. Crandall.*"

A bright, jet-black, splint coal, with but little fibrous coal between the layers. Some slight ferruginous external stain.

No. 1495—COAL, *No. 6; from branch above the shops, Hunnewell Furnace. Averaged from the upper part of the bed only, by A. R. Crandall.*"

Splint coal. Has but little fibrous coal between the laminæ. Slight external ferruginous stain.

No. 1496—COAL, *No. 3.* "*From drift near Pennsylvania Furnace. Averaged by P. N. Moore.*"

A glossy jet-black coal, with fibrous coal and very little appearance of pyrites between the thin laminæ.

No. 1497—COAL, *No. 6.* "*From a new opening one mile above the shops at Hunnewell Furnace. (Old Greenup Furnace.) Average sample.*"

A glossy pitch-black splint coal; shows but little fibrous coal or pyrites.

[See Appendix for other Greenup county coals.]

COMPOSITION OF THESE GREENUP COUNTY COALS, AIR DRIED.

	No. 1484	No. 1485	No. 1486	No. 1487	No. 1488	No. 1489	No. 1490	No. 1491	No. 1492	No. 1493	No. 1494	No. 1495	No. 1496	No. 1497
Specific gravity	1.316	1.345	1.250	1.420	1.374	1.389	1.374	1.389	1.292	1.289	1.335	1.365	1.300	1.355
Hygroscopic moisture	4.82	4.96	4.80	4.28	3.20	2.90	3.30	4.00	3.20	4.10	4.04	4.30	3.20	3.80
Volatile combustible matters	32.90	32.98	34.64	36.52	36.26	33.76	31.90	31.66	33.90	34.96	33.62	35.60	36.60	37.70
Coke	62.28	62.06	60.56	59.20	60.54	63.34	64.80	64.34	62.90	60.94	62.34	60.10	60.20	58.50
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	100.00
Total volatile matters	37.72	37.94	39.44	40.80	39.46	36.66	35.20	35.66	37.10	39.06	37.66	39.90	39.80	41.50
Carbon in the coke	55.18	55.46	52.58	47.00	47.54	51.34	52.20	53.44	56.70	55.54	53.34	50.24	53.14	47.20
Ash	7.10	6.60	7.98	12.20	13.00	12.00	12.60	10.90	6.20	5.40	9.00	9.86	7.06	11.30
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	100.00
Character of the coke	Friable.	Light spongy.	Dense.	Dense.	Spongy.	Dense.	Friable.	Spongy.	Spongy.	Spongy.	Dense.	Spongy.	Dense spongy.	Spongy.
Color of the ash	Chocolate.	Lilac-grey.	Lilac-grey.	Lilac-grey.	Dark lilac-grey.	Dark lilac-grey.	Lilac-grey.	Dark lilac-grey.	Lilac-grey.	Dark brick.	Light lilac-grey.	Grey-purple.	Lilac-grey.	Dark-brown purple.
Per centage of sulphur	1.409	4.774	1.331	5.934	3.647	4.911	2.507	4.633	0.746	1.590	1.318	5.263	2.264	4.213

These comparative analyses show how much the coal of a given bed may vary in its different layers in the proportion of sulphur, ashes, &c. These Greenup county coals are generally very good coals, well suited to the working of iron. Some of them, however, are rather too sulphurous for this purpose.

A certain correspondence, not perfect, is to be observed in these coals, between their *specific gravity* and proportion of *ash*, as is shown below:

Specific gravity.	Per centage of ash.	Specific gravity.	Per centage of ash.
1.250	7.98	1.355	11.03
1.289	5.40	1.365	9.86
1.292	6.20	1.374	12.60
1.300	7.06	1.374	13.00
1.316	7.10	1.389	10.90
1.335	9.00	1.389	12.00
1.345	6.60	1.420	12.20

No. 1498—LIMESTONE. "*Average sample of the ferruginous limestone from Pea Ridge. Collected by J. A. Monroe.*"

A compact, or fine-granular, brownish-grey limestone. Non-fossiliferous. Varying in tint.

No. 1499—LIMESTONE. "*Sub-carboniferous; used as flux at the Raccoon Furnace. From the head of Old Town Creek.*"

A compact or fine-granular limestone, varying in color from light reddish-grey to darker greenish-grey. Contains chert.

No. 1500—LIMESTONE. "*Sub-carboniferous. Average sample of the limestone used as flux at Kenton Furnace. Collected by J. A. Monroe.*"

A compact or fine-granular limestone, of a light-grey color.

No. 1501—LIMESTONE. "*Ferruginous. Buffalo Creek, Boone Furnace.*"

A compact or fine-granular limestone; grey-buff, varying in tint.

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

	No. 1498.	No. 1499.	No. 1500.	No. 1501.
Specific gravity	.....	2.680	2.700	2.770
Lime carbonate	88.140	88.150	92.050	60.750
Magnesia carbonate	.797	.385	.220	25.656
Iron carbonate	.....	.....	.....	3.420
Alumina }	.....	....	.....	4.167
Iron peroxide }	3.760	.152	1.490	.....
Manganese oxide }				
Phosphoric acid	.178	.051	.128	.013
Sulphuric acid	.044	not est.	.199	.315
Potash	.269	not est.	not est.	not deter'd.
Soda	.240	not est.	not est.	not deter'd.
Silica and insoluble silicates	5.960	9.560	4.460	5.680
Loss	.612	1.702	1.453	.....
Total	100.00	100.00	100.000	100.001
Per centage of lime	49.358	49.359	51.548	34.020
Per centage of phosphorus	.077	0.022	.056	.005
Per centage of sulphur	.017	not est.	.079	.126

These limestones are quite pure enough and quite good for use as flux in the iron furnace. No. 1501 is a magnesian limestone. The proportions of phosphorus and sulphur are low in all of them. Nos. 1499 and 1500 would yield a very pure white lime on calcination.

No. 1502—CLAY IRON-STONE. *Labeled "Lower block ore, near the level of the limestone ore. Alcorn Creek, Raccoon Furnace."*

A fine-granular, dark-grey ore; adhering slightly to the tongue.

No. 1503—CLAY IRON-STONE. *Labeled "Blue kidney ore, locally replacing the main block ore; from drift one mile southeast from Laurel Furnace."*

A fine-granular ore, of a grey color more or less deep; with very thin incrustation of limonite ore. Some portions adhere to the tongue.

No. 1504 — CLAY IRON-STONE. *Labeled "Main block ore, Amanda Furnace. Averaged by P. N. Moore."*

A dark-grey granular proto-carbonate ore, with some dense irregular laminæ of limonite ore.

No. 1505—CLAY IRON-STONE. *Labeled "Conglomerate ore, on Darby branch of Clay Lick, Buffalo Furnace. Average sample."*

Principally grey granular proto-carbonate ore, with some limonite.

No. 1506—CLAY IRON-STONE. *Labeled "Lower block ore," Womack's bank ore, Old Town Creek. Sample from ore weathered six months. Collected by P. N. Moore.*

Mostly dense, dark-grey, fine-granular clay iron-stone, with some coarser grained and softer, with a little limonite.

No. 1507—CLAY IRON-STONE. *Labeled "Grey ore, or main block ore, Baker bank drift, Laurel Furnace. Averaged by P. N. Moore, from the stock pile. Identified by Mr. G. Coxe."*

Mostly proto-carbonate ore, containing many encrinital fossils, with some little limonite.

No. 1508—CLAY IRON-STONE. *Labeled "Grey ore from under the hearth rock sandstone, near Raccoon Furnace. Collected by P. N. Moore."*

Mainly brownish-grey fine-granular carbonate, with a whitish cement. Contains some little bituminous matter. Incrusted somewhat with reddish-brown limonite ore.

COMPOSITION OF THESE GREENUP COUNTY CLAY IRON-STONES, DRIED AT 212° F.

	No. 1502	No. 1503	No. 1504	No. 1505	No. 1506	No. 1507	No. 1508
Specific gravity	3.280	3.297	. . . .	. . . .	3.263	. . . .	. . . .
Iron carbonate	54.773	78.722	33.321	30.516	44.678	55.258	64.624
Iron peroxide	8.648	.204	21.270	14.271	6.500	13.468	4.044
Alumina	7.800	2.746	4.991	6.197	4.178	.670	4.414
Lime carbonate. . . .	3.780	2.250	.980	16.980	2.230	4.880	1.340
Magnesia carbonate . . .	3.088	.380	.439	.591	1.903	4.528	.836
Manganese carbonate . .	1.204	.421	a trace.	a trace.	a trace.	.660	not est.
Phosphoric acid	.447	.505	.434	.614	.204	.368	.217
Sulphuric acid	.298	1.160	1.208	2.330	.250	1.043	.563
Silica and insol. silicates .	20.250	11.340	31.730	28.980	36.880	15.660	20.310
Water, bituminous matters, and loss	. . . .	2.272	5.627	. . . .	3.177	4.065	3.650
Total	100.288	100.000	100.000	100.429	100.000	100.000	100.000
Per centage of iron . . .	29.851	38.146	30.975	22.270	26.073	36.103	33.627
Per centage of phosphorus	.195	.221	.189	.267	.089	.200	.095
Per centage of sulphur .	.105	.524	.483	.905	.104	.416	.225
Per centage of silica . .	18.560	9.700	29.520	27.360	34.360	13.360	14.440

Some of the carbonate ores, which contain a larger proportion of iron peroxide, will be found described with the limonite ores. Phosphorus is in rather large proportion in Nos. 1502, 1503, 1504, and 1507, and sulphur exceeds in 1503, 1504, and 1505. Possibly some of this latter may be driven off in the process of roasting the ore. No. 1505, which contains the smallest proportion of iron, having nearly seventeen per cent. of carbonate of lime, may yet be profitably smelted, especially mixed with richer ores.

No. 1509—LIMONITE "*Limestone ore, Samuel Wamock's land, Tygert Creek. Bed one foot thick. Collected by A. R. Crandall. Not an average sample.*"

Generally of a dark reddish-brown, varying to blackish and yellowish colors. In irregular laminæ. Adhering to the tongue.

No. 1510—LIMONITE. *Labeled "Average sample of lower Block ore, from branch of Tygert Creek."*

Varying in color, hardness, &c., from dark-brown, hard, irregular laminæ, to yellowish-red and brownish ochreous. Powder of a brownish-yellow color.

No. 1511 — LIMONITE (*with some proto-carbonate ore*); *labeled "Limestone ore, Hood's branch of Tygert's Creek. Average sample. Used at Raccoon Furnace."*

In irregular laminæ of various tints of yellowish and reddish brown, with some portions of clay iron-stone.

No. 1512—LIMONITE, &c. *"Average sample. Poynter bank. Raccoon Furnace."*

Dark brownish-red fragments, mixed some of clay iron-stone.

No. 1513—LIMONITE. *"Average sample of Two Lick 'Limestone ore,' Kenton Furnace. Averaged by P. N. Moore, from the stock pile."*

Generally of a dark-brown color, with incrustations of soft ochreous ore.

No. 1514—LIMONITE. *Labeled "Lower block ore," from Louder bank. Averaged by P. N. Moore.*

In irregular dark-brown laminæ, with softer ochreous and grey material intermixed and incrusting.

No. 1515—LIMONITE. *"Average sample of Coon Fork Limestone ore; taken from the unburnt kiln at Kenton Furnace by P. N. Moore, and identified by Mr. Folson."*

A dense, chocolate-red ore, scarcely adhering to the tongue. Contains some iron proto-carbonate.

No. 1516—LIMONITE. *Labeled "Shover drift Limestone ore. Average sample, by P. N. Moore, Kenton Furnace."*

A dense, chocolate-red colored ore, with but little ochreous material.

No. 1517—LIMONITE. *Labeled "Limestone ore. Powder Mill Hollow, Kenton Furnace."*

In irregular masses and laminæ of a chocolate-brown color, with soft ochreous ore between.

No. 1518—LIMONITE. *"Average sample of lower Block ore, from James Thompson's bank, Kenton Furnace. Collected by P. N. Moore."*

Laminæ of dense limonite, with softer ochreous material between, and some clay iron-stone in the interior.

No. 1519—LIMONITE. *Labeled "Lower Block ore. Average sample from Allen bank, Kenton Furnace. Collected by P. N. Moore."*

Irregular laminæ of hard dark brown limonite, with much brownish-yellow softer mineral between, and some whitish, clay-like substance, in the crevices.

No. 1520—LIMONITE, &c. *"Main Block ore, locally changed to a very calcareous ore, Buffalo Furnace. Averaged by P. N. Moore."*

Ore partly of yellowish-grey iron proto-carbonate of a crystalline-granular structure, not adhering to the tongue; in parts changed into dark reddish-brown limonite, which adheres to the tongue. Contains some small scales of mica and a few green specks (which may contain iron phosphide).

No. 1521—LIMONITE. *Labeled "Main Block ore, Little Morton bank, Laurel Furnace. Averaged by J. A. Monroe."*

In irregular curved laminæ of various thicknesses, differing in color, from dark clove-brown, almost black, to reddish and yellowish-brown; with nodules and incrustations of softer ochreous ore.

No. 1522—LIMONITE, &c. "*Average sample of Kidney ore, above the main Block ore. From the Buffalo Furnace stock pile. Collected by P. N. Moore.*"

Dense dark and light-brown limonite, with a little ochreous ore; mixed with compact or fine-granular grey clay iron-stone.

No. 1523—LIMONITE. "*Main Block ore, Brushy Knob bank, Laurel Furnace. Average sample, from the stock pile, by P. N. Moore.*" (*Determine only iron and silica.*)

Varying from hard dark-brown laminæ to brownish-yellow ochreous ore.

No. 1524—LIMONITE. "*Kidney ore, Osenton bank, Laurel Furnace. Averaged by P. N. Moore. Identified by Mr. G. Cox.*" (*Determine only the iron and silica.*)

Curved irregular laminæ of dense dark colored limonite ore, inclosing nodules of compact clay iron-stone.

No. 1525—LIMONITE. "*Rough ore, Darby branch of Clay Lick Creek. The upper of two lower block ores, Buffalo Furnace. Average sample, by P. N. Moore.*" (*Determine only the iron and silica.*)

Yellowish-brown limonite, mixed with grey iron proto-carbonate ore. Both showing an oölitic structure.

No. 1526—LIMONITE. "*Kidney block ore, or main Block ore. McAlister Point, Buffalo Furnace. Averaged by P. N. Moore.*"

Mostly in dark, purplish-brown, irregular, curved laminæ. (One small nucleus of partly decomposed clay iron-stone noticed.)

No. 1527—LIMONITE. "*Rough block ore; below the main Block ore, at Raccoon Furnace. Averaged by P. N. Moore.*"

Mostly in irregular, curved laminæ, with some softer ochreous ore included.

No. 1528—LIMONITE. *"Lower Block ore, on J. Downie's land, Old Town Creek. Averaged by P. N. Moore."*

Mostly porous, ochreous ore, with some dense limonite laminæ included.

No. 1529—LIMONITE. *"Limestone ore; called slate ore. Ridge between Cane Creek and Wilson Creek, Hunnewell Furnace. Average sample, by P. N. Moore."*

Mostly moderately dense, irregular laminæ, of a handsome brownish-purple color, with some ochreous ore.

No. 1530—LIMONITE. *Labeled "Lime kidney ore, Brush Creek, Pennsylvania Furnace. Average sample, by P. N. Moore."*

Principally in irregular curved laminæ, of a dark color; somewhat oölitic; inclosing, and incrusted with, some little undecomposed clay iron-stone.

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

	No. 1509	No. 1510	No. 1511	No. 1512	No. 1513	No. 1514	No. 1515	No. 1516	No. 1517	No. 1518	No. 1519	No. 1520
Iron, peroxide	80.040	41.556	60.576	54.703	67.859	54.530	46.984	72.957	49.770	50.006	41.390	23.396
Iron, carbonate	....	....	15.623	17.758	....	....	7.890	....	....	....	....	14.972
Alumina	2.680	8.604	2.860	2.300	1.160	2.120	5.580	1.660	6.315	8.317	6.777	4.077
Manganese, brown oxide	not est.	....	....	.440	.980	1.380	‡.572	.640	.640	a trace.	.180	‡.421
Lime carbonate	a trace.	.180	a trace.	.340	.120	.040	21.240	.380	.380	.380	a trace.	33.775
Magnesia	.425	not est.	.619	.499	1.275	1.823	2.904	.083	.115	.201	.065	‡.968
Phosphoric acid	.115	.882	.632	.128	.143	.908	.371	.500	.166	.767	.579	.537
Sulphuric acid	.264	.851	not est.	.680	not est.	.336	not est.	.178	a trace.	.356	.154	.157
Alkalies	*.584	....	....	....	....	....	....	....	....	....	....	....
Combined water	10.000	10.100	†7.040	†7.194	†12.923	10.900	†6.599	9.340	9.020	11.760	9.700	†5.457
Silex and insoluble silicates	6.560	38.160	12.650	15.958	15.560	28.360	7.860	15.160	33.200	28.820	40.380	16.240
Moisture and loss	....	....	....	....	....	....	....	....	.394	....	.775	....
Total	100.668	100.233	100.100	100.000	100.000	100.397	100.000	100.898	100.000	100.607	100.000	100.000
Per centage of iron	56.280	29.089	49.945	46.865	47.501	38.171	39.025	51.070	34.839	35.004	28.973	23.597
Per centage of phosphorus	.050	.358	.276	.055	.062	.428	.131	.218	.072	.339	.252	.224
Per centage of sulphur	.107	.340	not est.	.272	not est.	.134	not est.	.071	a trace.	.142	.061	.070
Per centage of silica	not est.	not est.	not est.	12.960	11.560	not est.	not est.	not est.	32.960	not est.	not est.	13.530

* Potash — 0.346; soda — 0.238. † And loss. ‡ Carbonates.

COMPOSITION OF THESE GREENUP COUNTY LIMONITES, DRIED AT 212° F.—Continued.

	No. 1521.	No. 1522.	No. 1523.	No. 1524.	No. 1525.	No. 1526.	No. 1527.	No. 1528.	No. 1529.	No. 1530.
Iron, peroxide	68.928	56.279	56.84	67.984	42.560	64.577	36.985	44.876	57.551	60.206
Iron, carbonate	. . . . .	11.392	not deter'd.	not deter'd.	not deter'd.	. . . . .	. . . . .	. . . . .	. . . . .	not est.
Alumina	2.768	4.709	not deter'd.	not deter'd.	not deter'd.	not est.	5.508	4.083	6.017	1.044
Manganese, brown oxide	.290	a trace.	not deter'd.	not deter'd.	not deter'd.	1.360	.040	.260	.130	a trace.
Lime, carbonate	.680	.180	not deter'd.	not deter'd.	not deter'd.	.440	.520	.990	.150	.285
Magnesia	.641	.476	not deter'd.	not deter'd.	not deter'd.	.820	.533	.357	.758	.381
Phosphoric acid	.249	.601	not deter'd.	not deter'd.	not deter'd.	.172	.367	.166	.057	.161
Sulphuric acid	.748	.260	not deter'd.	not deter'd.	not deter'd.	.151	.116	.123	.105	.852
Combined water	11.100	*9.173	not deter'd.	not deter'd.	not deter'd.	*11.250	8.330	9.850	10.300	9.500
Silex and insoluble silicates	15.240	16.930	not deter'd.	not deter'd.	not deter'd.	21.230	46.760	39.080	25.450	25.930
Moisture, carb. acid, and loss	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	.841	.215	. . . . .	1.641
Total	100.644	100.000	. . . . .	. . . . .	. . . . .	100.000	100.000	100.000	100.518	100.000
Per centage of iron	48.249	44.896	39.788	47.589	29.792	45.204	25.889	31.413	40.285	42.144
Per centage of phosphorus	.098	.262	not deter'd.	not deter'd.	not deter'd.	.075	.160	.061	.025	.070
Per centage of sulphur	.299	.104	not deter'd.	not deter'd.	not deter'd.	.070	.046	.049	.042	.341
Per centage of silica	13.600	15.260	24.060	12.900	40.160	18.600	44.460	35.960	18.860	20.860

* And loss.

Although some of these ores contain too much phosphorus to make tough iron, they are generally good and profitable. The intelligent reader can estimate their relative value by this table.

[See Appendix for other Greenup county ores, &c.]

No. 1531—PIG IRON. "*Hot blast, No. 1 Foundry. Probably made in 1872 or 1873, Buffalo Furnace. Collected by P. N. Moore.*"

Quite a coarse-grained, brilliant, grey iron. Yields to the file; flattens a little under the hammer.

No. 1532—PIG IRON. "*Cold blast, No. 1 Foundry, Buffalo Furnace. Collected by P. N. Moore.*"

A moderately fine-grained, dark-grey iron, which yields easily to the file.

No. 1533—PIG IRON. "*Silver-grey hot blast iron. Made when working very hot, so that it is very cold-short. Buffalo Furnace. Collected by P. N. Moore.*"

A mottled, nearly white, silvery iron. Soft enough to yield to the file, but quite brittle. Scarcely flattening at all under the hammer.

No. 1534—PIG IRON. "*No. 1 Foundry, hot blast iron, Kenton Furnace. Collected by P. N. Moore.*"

A moderately coarse-grained, grey iron. Hard, but yields to the file. Extends considerably under the hammer.

No. 1535—PIG IRON. "*Hot blast, No. 1 Foundry iron; made at the fifth casting after thirty-six hours stoppage, on full burthen. The third casting gave grey iron. Collected by P. N. Moore.*"

A moderately coarse-grained, grey iron.

No. 1536—PIG IRON. "*No. 2, Foundry iron; from Hunnewell (formerly Greenup) Furnace. Collected by P. N. Moore.*"

A moderately coarse-grained, grey iron; very hard, but yields to the file. Extends considerably under the hammer.

COMPOSITION OF THESE GREENUP COUNTY PIG IRONS.

	No. 1531.	No. 1532.	No. 1533.	No. 1534.	No. 1535.	No. 1536.
Specific gravity . . .	6.825	6.944	6.872	6.897	7.117	7.041
Iron	91.656	94.739	88.106	92.724	91.668	92.368
Graphite	2.790	3.620	1.950	3.320	2.950	3.690
Combined carbon . .	a trace.	.780	.570	.660	. . . . .	. . . . .
Manganese	.084	.056	.014	.612	.332	.020
Silicon	4.106	.877	7.317	2.090	3.817	2.515
Slag	.600	.120	.900	.300	1.200	1.130
Aluminum	.399	.060	.165	.442	.128	.582
Calcium	.168	.104	.128	.184	.075	.048
Magnesium	.095	.082	.125	.190	.122	a trace.
Potassium	.086	.048	.048	.104	not est.	.056
Sodium	.016	.041	.002	.004	not est.	a trace.
Phosphorus	.695	.609	.768	.622	.334	.684
Sulphur	.150	.037	.019	.046	.041	.026
Total	100.845	101.173	100.112	101.298	100.667	101.119
Total carbon	2.790	4.400	2.520	3.980	2.950	3.690

[See Appendix for other pig irons of this county.]

No. 1537—SOIL. "*Surface soil, from near the top of Pea Ridge; two hundred and fifty feet above the railroad at Hunnewell, one and a half miles southwest of hill to east. 'Coaled land.' Has a second growth of oak, with a few maples, hickories, pines, &c. Above the limestone of Pea Ridge. Collected by J. A. Monroe.*"

Soil of a dark yellowish-grey color. The coarse sieve (289 meshes to inch) removed from it some fragments of ferruginous sandstone.

No. 1538—SOIL. *Labeled "Sub-soil of the preceding, to eighteen inches below the surface, &c.*"

Of a brownish-buff color; containing nearly half its weight of irregular fragments of ferruginous sandstone, with ferruginous concretions.

No. 1539—SOIL. *Labeled "Under clay to the two preceding, taken to three feet below the surface.*"

Clay of a brownish-buff color, with lighter colored portions intermixed. Contains a considerable proportion of fragments of ferruginous sandstone and ferruginous concretions, but not quite so much as the preceding.

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

	No. 1537.	No. 1538.	No. 1539.
Organic and volatile matters	5.050	4.030	5.105
Alumina, Iron peroxide, Manganese, brown oxide	6.831	9.595	9.223
Lime carbonate	a trace.	.123	.091
Magnesia	.116	.223	.034
Phosphoric acid	.089	.115	.192
Sulphuric acid	.058	.017	.019
Potash	.217	.231	.312
Soda	.055	.097	.120
Soluble silica	Not estimated.		
Sand and insoluble silicates	86.505	84.565	84.695
Water expelled at 380° F.	1.000	.685	.615
Loss	.079	.319	. . . . .
Total	100.000	100.000	100.406
Moisture expelled at 212° F.	1.650	1.775	2.150
Potash in insoluble silicates	Not estimated.		
Soda in insoluble silicates	Not estimated.		
Character of soil	Coaled land Surface soil	Sub-soil.	Under clay.

These soils are of medium good quality; they would be benefited by top-dressing with lime, and, if well drained, could be made quite productive by judicious management, the use of green crops, and other fertilizers. The surface soil is not as rich in the mineral fertilizers as the sub-soil and under clay.

HARDIN COUNTY.

No. 1540—SOIL. "*Forty-five years in cultivation. Taken to the depth of eight inches. Collected by C. S. Schenk.*"

Farm of H. B. Helm; three thousand two hundred and fifty feet west from Elizabethtown, and sixteen hundred feet to the right of the Elizabethtown and Paducah Railroad (facing Paducah), twenty feet above the rail. Slope 1:25. On limestone substratum. Timber: elm, sycamore, shell-bark hickory, hazelnut, sumach, sassafras, dogwood, &c. Rotation of crops: lately, two years in corn; one in oats, with three in clover, followed by two in wheat. Yield: of corn, thirty bushels; wheat, fifteen to twenty; of oats, twenty-five bushels to the acre. The land has been kept in good order and has had some straw manure.

Soil of a dark drab color. The coarse sieve (two hundred and eighty-nine meshes to inch) sifted out a little shot-iron ore and small fragments of ferruginous sandstone.

No. 1541—"SUB-SOIL *of the preceding; one thousand feet to the right of the railroad, and three thousand four hundred feet from Elizabethtown, on the Elizabethtown and Paducah Railroad Twenty feet above the rail. Taken to the depth of from eight to twelve inches. Collected by C. S. Schenk.*"

Of a lighter color than the preceding; greyish-buff. Contains some fragments of chert and small quartzose and ferruginous concretions.

No. 1542—"UNDER CLAY *to the two preceding, taken at a depth of from twelve to thirty-six inches. Collected by C. S. Schenk.*"

Of a lighter color than the preceding, and more yellowish. Contains some small fragments of weathered chert and ferruginous sandstone, and small concretions of oxides of iron and manganese.

No. 1543—"VIRGIN SOIL, *taken to the depth of eight inches. Farm of J. B. Bryan. Collected by C. S. Schenk.*"

Four thousand eight hundred feet west from Elizabethtown, on the Elizabethtown and Paducah Railroad, and twenty-eight hundred feet from the railroad. Thirty feet above the rail. Substratum, *limestone.* Timber: post oak, black and red oak, hickory, hazel, sumach, sassafras, and dogwood. The soil in this neighborhood, cultivated carelessly, yields thirty-five bushels of corn to the acre.

Soil of a dark drab color. Contains a notable quantity of fragments of weathered chert and some of a fossil cyathophyllum.

No. 1544—"SUB-SOIL *of the preceding, from the depth of from eight to thirty-four inches. The limestone rock is thirty-six inches below the surface. Collected by C. S. Schenk.*"

Color lighter than that of preceding; of brownish-buff. Contains fragments of chert, more or less weathered, and of fossils.

No. 1545—"SOIL *of an old field, over forty years in cultivation without manure. Collected by C. S. Schenk.*"

Seven thousand two hundred and sixty feet west of Elizabethtown, on the Elizabethtown and Paducah Railroad, one thousand one hundred and forty-three feet to the left of that road, and ten feet above the level of the rail. Slope = 1:70. Sample to the depth of eight inches. Timber: same as the preceding. Rotation of crops: wheat, oats, clover, &c. Yields, when well managed, thirty bushels of corn, fifteen to sixteen of wheat, and twenty of oats, to the acre.

Soil of a dark drab color. Contains only a few small fragments (chips) of flint.

No. 1546—"SUB-SOIL *of the preceding, taken from eight to thirty-four inches from the surface. Collected by C. S. Schenk.*"

Sub-soil of a lighter and more yellowish color than the preceding; brownish-buff.

No. 1547—VIRGIN SOIL, *taken to the depth of eight inches. Collected by C. S. Schenk.*"

Field seven thousand two hundred and sixty feet west from Elizabethtown, eight hundred and thirty-seven feet to the left of Elizabethtown and Paducah Railroad, and ten feet above the level of the rail. Slope = 1:65. Has been cultivated one year in corn, producing forty bushels to the acre; has been resting five years. Had no manure. Substratum limestone, at the depth of ten feet.

Soil of a dark drab color; contains no gravel, and very few small fragments of weathered chert and decayed vegetable roots.

No. 1548—"SUB-SOIL *of the preceding, taken at the depth of from ten to thirty-four inches. Collected by* C. S. *Schenk.*"

Sub-soil of a handsome brownish-salmon color.

No. 1549—"NEW SOIL, *to the depth of eight inches, farm of Daniel Klingelsmith's heirs. Collected by C. S. Schenk.*"

Eleven thousand three hundred and fifty feet west of Elizabethtown, on the Elizabethtown and Paducah Railroad, and two hundred and fifty feet to the north. Three feet above the level of the rail. Slope = 1:45. Substratum, limestone. Has been in cultivation five years. Rotation of crops: two years in corn; then one each in wheat, oats, and corn. Rented out land. No manure. Yields, of corn, thirty bushels; of wheat, twenty; and of oats, twenty-five bushels to the acre.

Soil of a brownish, dark-grey color. Contains no gravel.

No. 1550—"SUB-SOIL *to the preceding, taken at the depth of from eight to thirty-six inches from the surface. Collected by C. S. Schenk.*"

Sub-soil of a greyish-buff color. Contains some fragments of weathered chert.

No. 1551—"SOIL, *taken to the depth of eight inches, from an old field long in cultivation; rented out, and supposed to be worn out. Collected by C. S. Schenk.*"

Land of heirs of Daniel Klingelsmith, thirteen thousand eight hundred and eighty feet west from Elizabethtown, on Elizabethtown and Paducah Railroad; fifty feet to the right, on a level with the rail. Slope = 1:15. Rotation of crops: corn, wheat, oats, clover. Yields, of corn, seventeen bushels; of wheat, twelve; of oats, fifteen to sixteen bushels to the acre. No manure.

Soil of a brownish drab color. Contains some few small fragments of much weathered chert.

No. 1552—"SUB-SOIL *to the preceding, taken at from eight to thirty-nine inches from the surface. Collected by C. S. Schenk.*"

Color much like that of the preceding soil. No gravel or chert fragments sifted out.

No. 1553—"VIRGIN SOIL. *Woodland. Farm of Hayden English, sixty feet west of the four mile-post, on the Elizabethtown and Paducah Railroad; four feet above the level of the rail. Collected by C. S. Schenk.*"

Sample taken to the depth of twelve inches. Slope = 1:15. Timber: scrub oak, black oak, and black jack, generally of small size. Undergrowth: small sumach, sassafras, &c. Yield of such land is, of corn, eleven bushels; of wheat, six; of oats, eleven bushels to the acre.

Dry soil of a grey-buff color.

No. 1554—"SUB-SOIL *of the preceding, taken from twelve to twenty-six inches below the surface." Collected by C. S. Schenk.*"

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

No. 1555—"NEW SOIL, *five years in cultivation, from farm of J. English. Collected by C. S. Schenk.*"

Sample taken to depth of eight inches, at a point two hundred and seventy feet west of the six mile-post, on the Elizabethtown and Paducah Railroad; twenty-one hundred feet to the left of the railroad, and at a level of ten feet above the rail. Slope = 1:75. Timber: black, white, red, and post oak, hickory, chestnut, &c. Rotation of crops: two years in corn, one each in oats, wheat, and corn. No manure. Yield of corn, thirty; of wheat, twelve; and of oats, twenty bushels to the acre.

Dried soil of a drab color.

No. 1556—"SUB-SOIL *of the preceding, taken at a depth of from eight to thirty-six inches. Collected by C. S. Schenk.*"

Dry sub-soil of a grey-buff color; lighter and more yellowish than preceding.

No. 1557—"SOIL *from an old field, forty-five years in cultivation. Snider's farm. Collected by C. S. Schenk.*"

Sample taken to the depth of eight inches, at a point thirteen hundred feet west of the six mile-post, on the Elizabethtown and Paducah Railroad, and twelve hundred and seventy feet to the left, at a level of ten feet above the rail. Slope 1:35. Section of the hole where the soil was taken: soil, eight inches; yellow clay, twenty-two inches; red clay, six inches. (The red clay land is considered best in this part of the State.) Roots penetrate to depth of eight feet, where the rock is found. Rotation of crops: corn, wheat, oats. Has been four years in pasture, and the last two years in grass. Yield: corn, twenty-two; oats, fifteen to sixteen; wheat, eight; potatoes, fifty-five; rye, ten bushels, and tobacco, eight hundred pounds to the acre.

Dried soil of a drab color.

No. 1558—"SUB-SOIL *of the preceding, taken at a depth of from eight to thirty-six inches. Collected by C. S. Schenk.*"

Dried sub-soil of a brownish-orange color.

No. 1559—"SOIL *of an old field, forty years or more in cultivation." Collected by C. S. Schenk.*"

Sample taken to the depth of six inches, at a point two hundred and fifty feet west of the nine mile-post (Long Grove Station). Three hundred and fifty feet to the right of the Elizabethtown and Paducah Railroad, at a level of twelve feet above the rail. Slope = 1:19. Timber, much like that in preceding soils of this county. Rotation of crops, for the last nine years: four in corn, one in wheat, with three in clover and one in wheat. No manure. Yield: corn, twenty-two; wheat, eight; oats, fifteen bushels to the acre.

Dried soil of a yellowish umber-grey color.

No. 1560—"SUB-SOIL *of the preceding, taken at from six to thirty-six inches from the surface. Collected by C. S. Schenk.*"

Dried sub-soil of a dark grey-buff color.

No. 1561—"SOIL *of an old field, farm of E. Hansborough. Collected by C. S. Schenk.*"

Sample taken to the depth of five inches, at a point one thousand three hundred and twenty-seven feet west of the three mile-post; eight and a quarter miles from Elizabethtown, on the Elizabethtown and Paducah Railroad; one thousand three hundred and fifty feet to the left of that road, and level with the rail. Slope = 1:24. Timber much like that on the preceding soils. Substratum limestone, at depth of forty-five inches. Rotation of crops: corn, wheat, oats, clover. No manure. Yield: corn, thirty; wheat, eighteen; oats, thirty; potatoes, forty bushels; tobacco, eight hundred to one thousand two hundred pounds to the acre. One of the best farms in this locality. Land kept in good order.

Dried soil darker than the next preceding, of a brownish-umber dark grey color.

No. 1562—SUB-SOIL *of the preceding. Sample taken from five to forty-five inches below the surface. Collected by C. S. Schenk.*"

Dried sub-soil of a light brick-red color. Somewhat adhesive.

No. 1563—"SOIL *of an old field, forty years in cultivation, without manure. Collected by C. S. Schenk.*"

Sample taken to the depth of ten inches, at a point two hundred feet to the right of the seven mile-post, Elizabethtown and Paducah Railroad; level five feet above the rail. Substratum limestone. Slope = 1:50. Rotation of crops: corn, wheat, oats, clover. Land kept in good order. Yield of corn, twenty-five; of wheat, twelve; of oats, twenty bushels to the acre.

Dried soil of a yellowish-umber color.

No. 1564—"SUB-SOIL *of the preceding, taken at a depth of from ten to thirty-eight inches. Collected by C. S. Schenk.*"

Dried sub-soil of a light yellowish-brick color. Somewhat adhesive.

No. 1565—"VIRGIN SOIL, *Woodland, on Hanson Duncan's farm. Collected by C. S. Schenk.*"

Sample taken to ten inches in depth, at a point seven hundred and sixty feet east of his house; about eighty feet below the Elizabethtown and Paducah Railroad at East View. Rock substratum—limestone.

Dried soil of a yellowish light-umber color.

No. 1566—"SUB-SOIL *of the preceding, taken at a depth of from ten to forty-six inches. Collected by C. S. Schenk.*"

Dried sub-soil of a light yellowish-brick color.

No. 1567—SOIL *from an old field, twenty-four years in cultivation. Collected by C. S. Schenk.*"

Sample taken to the depth of eight inches, at a point twelve hundred feet, north 50° east from Hanson Duncan's house; one hundred and seventeen feet below the railroad at East View Station. Slope = 1:26. Substratum limestone. Rotation of crops: 1. corn, 1. rye, 3. clover, 1. wheat. No manure. Yield: corn, thirty-five; wheat, seventeen; rye, six to seven bushels to the acre.

Dried soil of a yellowish light-umber color.

No. 1568—"SUB-SOIL *of the preceding, taken at a depth of from eight to forty inches. Collected by C. S. Schenk.*"

Dried sub-soil of a light yellowish-brick color.

No. 1569—"VIRGIN SOIL, *one year in cultivation, from sand land on Hanson Duncan's farm, near East View. Collected by C. S. Schenk.*"

Sample taken to the depth of four inches, at a point four hundred and twenty feet west of his house. Height level with the roof of his house. Slope = 1:7. Substratum limestone. Timber about the same as described above. Land not much cultivated; considered too poor except for peaches, apples, &c.; but tobacco yields six hundred pounds to the acre.

Dried soil of a yellowish umber-grey; lighter colored than the preceding sample.

No. 1570—SUB-SOIL *of the preceding, taken at a depth of from four to thirty-six inches. Collected by C. S. Schenk."*

Sub-soil of a light yellowish-brick color.

No. 1571—SOIL *from an old field, sixteen years in cultivation, on Hanson Duncan's farm, near East View. Collected by C. S. Schenk."*

Sample taken to depth of six inches, at a point seven hundred and fifty feet, north 20° east from his house. Height, six feet above his house. Slope = 1:7. Substratum sandstone. In some years it has yielded eleven bushels of corn to the acre. Is now in orchard. Produces good peaches.

Dried soil of a yellowish light umber-grey color.

No. 1572—SUB-SOIL *of the preceding, taken at a depth of from six to thirty-four inches. Collected by C. S. Schenk."*

Sub-soil of a light brick-color, varying in intensity. Contains many angular fragments of soft, friable, ferruginous sandstone.

NOTE.—For a continuation of this serial collection of soils, made on or near the line of the Elizabethtown and Paducah Railroad, by Mr. C. S. Schenk, see Grayson and Ohio counties.

COMPOSITION OF THESE HARDIN COUNTY SOILS, &c., DRIED AT 212° F.

	No. 1540.	No. 1541.	No. 1542.	No. 1543.	No. 1544.	No. 1545.	No. 1546.	No. 1547.	No. 1548.	No. 1549.	No. 1550.	No. 1551.	No. 1552.
Organic and vol. matters	3.675	2.600	2.650	2.950	2.500	3.100	2.025	3.300	3.035	4.150	2.750	3.535	3.150
Alumina, and iron and manganese oxides. .	5.790	8.617	10.775	5.786	9.705	6.905	9.190	7.705	11.624	6.865	8.870	8.784	11.900
Lime carbonate .	.160	.195	.110	.195	.145	.245	.195	.295	.110	.495	.245	.230	.175
Magnesia	.250	.431	.158	.375	.240	.258	.140	.339	.267	.501	.284	.152	.321
Phosphoric acid . . .	.160	.123	.115	.119	.125	.204	.125	.156	.216	.108	.134	.156	.108
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Potash (ext'ed by acid)	.154	.188	.265	.404	.462	.308	.327	.193	.256	.209	.399	.159	.150
Soda (extracted by acid)	.109	.002	.030	.030	.035	.033	.037	.027	.160	.079	.054	.026	.140
Sand and insol. silicates	88.590	86.975	84.740	89.555	85.925	87.465	86.840	86.815	83.925	86.590	86.640	86.215	83.315
Water expel'd at 380° F.	1.235	.925	.750	.900	.850	1.100	.725	1.050	.600	1.250	.850	.800	.700
Loss	. . . .	. . . .	.407	.186	.013	382	396	.120	. . . .	. . . .	. . . .	. . . .	.041
Total	100.123	100.056	100.000	100.000	100.000	100.000	100.000	100.000	100.193	100.247	100.226	100.057	100,000
Hygroscopic moisture .	1.510	1.575	2.140	1.125	1.650	1.325	1.700	1.500	1.800	1.650	1.875	1.650	2.200
Potash in insol. silicates	0.803	not est.	not est.	0.617	0.798	0.977	not est.	not est.	not est.	not est.	not est.	0.864	not est.
Soda in insol. silicates.	.467	not est.	not est.	0.188	0.406	0.280	not est.	not est.	not est.	not est.	not est.	.444	not est.
Character of soil . . .	Old field soil.	Sub-soil.	Under clay.	Virgin soil.	Sub-soil.	Old field.	Sub-soil.	Virgin soil.	Sub-soil.	New soil.	Sub-soil.	Old field.	Sub-soil.

COMPOSITION OF THESE HARDIN COUNTY SOILS, &c., DRIED AT 212° F.—(Continued.)

	No. 1553	No. 1554	No. 1555	No. 1556	No. 1557	No. 1558	No. 1559	No. 1560	No. 1561	No. 1562	No. 1563	No. 1564
Organic and volatile matters	1.950	1.990	2.185	2.135	2.100	2.935	2.625	2.525	3.215	3.785	3.080	2.785
Alumina, and iron and manganese oxides	5.926	8.344	5.692	9.476	6.359	12.798	7.388	10.445	6.790	15.763	6.564	10.763
Lime carbonate	.130	.080	.270	.220	.220	.220	.190	.120	.370	.620	.445	.495
Magnesia	.167	.204	.213	.208	.050	.194	.095	.362	.189	.095	.213	.282
Phosphoric acid	.076	.093	.070	.134	.093	.124	.124	.120	.172	.124	.123	.124
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Potash (extracted by acid)	.163	.298	.250	.313	.223	.342	.221	.339	.202	.421	.293	.212
Soda (extracted by acid)	.005	.120	.037	.045	.023	.033	.026	.260	.049	.101	.050	.219
Sand and insoluble silicates	90.465	88.115	89.965	86.240	89.790	82.165	88.090	85.140	87.765	77.375	87.975	84.290
Water expelled at 380° F.	.935	.775	1.425	.900	.950	.975	1.150	.950	1.400	1.515	1.235	1.135
Loss	.183	. . . .	. . . .	.329	.192	.214	.091	. . . .	. . . .	.201	022	. . . .
Total	100.000	100.019	100.107	100.000	100.000	100.000	100.000	100.261	100.152	100.000	100.000	100.305
Hygroscopic moisture	1.585	2.200	1.400	2.400	1.485	2.650	1.385	2.450	1.600	3.860	1.300.	1.375
Potash in the insoluble silicates	1.140	not est.	not est.	not est.	0.560	not est.	0.675	not est.	1.148	.974	not est.	not est.
Soda in the insoluble silicates	.641	not est.	not est.	not est.	.373	not est.	.339	not est.	.731	.420	not est.	not est.
Character of the soil	Virgin soil.	Sub-soil.	New soil.	Sub-soil.	Old field.	Sub-soil.	Old field.	Sub-soil.	Old field.	Sub-soil.	Old field.	Sub-soil.

COMPOSITION OF THESE HARDIN COUNTY SOILS, &c., DRIED AT 212° F.—(Continued.)

	No. 1565.	No. 1566.	No. 1567.	No. 1568.	No. 1569.	No. 1570.	No. 1571.	No. 1572.
Organic and volatile matters	3.215	4.400	3.050	2.575	2.600	2.225	2.165	2.575
Alumina, and iron and manganese oxides	5.365	6.395	5.550	5.828	4.465	7.015	2.740	6.900
Lime carbonate	.445	.270	.305	.236	.170	.080	.180	.045
Magnesia	.168	.205	.240	.078	.176	.104	.087	.068
Phosphoric acid	.172	.045	.102	.112	.147	.134	.067	.102
Sulphuric acid	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.	a trace.
Potash (extracted by acid)	.188	.202	.173	.183	.212	.202	.135	.183
Soda (extracted by acid)	.041	.050	a trace.	.053	.055	.076	.072	.045
Sand and insoluble silicates	87.940	88.425	89.290	90.470	91.790	89.855	94.290	89.940
Water expelled at 380° F.	1.525	.650	1.100	.475	.775	.450	.550	.225
Loss	.841	.....	190	.....	.....	.....	.....	.....
Total	100.000	100.742	100.000	100.010	100.390	100.141	100.286	100.083
Hygroscopic moisture	1.890	1.800	1.690	2.360	1.225	1.900	0.800	2.075
Potash in the insoluble silicates	1.550	not est.	not est.	not est.	1.332	.....	0.869	0.485
Soda in the insoluble silicates	.350	not est.	not est.	not est.	.444	.....	.236	.165
Character of the soil	Virgin soil.	Sub-soil.	Old field.	Sub-soil.	Virgin soil.	Sub-soil.	Old field.	Sub-soil.

For the other soils of this series, collected along the line of the Elizabethtown and Paducah Railroad by Mr. C. Schenk, see Grayson and Ohio counties. The remarks appended to the Grayson county soils will apply to these with some obvious local variations.

HENRY COUNTY.

No. 1575—GALENA. "*From Roberts' lode, north opening. Carefully averaged, by Prof. N. S. Shaler.*"

Cubical and granular galena, disseminated in white, compact, baryta sulphate; with some zinc blende (zinc sulphide).

The galena was selected from the mixed lumps, simply for assaying to determine the presence or proportion of silver.

No. 1576—GALENA "*From Roberts' lode, south opening, &c.*

Like the preceding; but containing a larger proportion of galena. The galena was *selected* from the lumps for analysis.

Fused with the usual flux of carbonate of soda, nitrate of potash and salt; the former, No. 1575, gave 72.70 to 76.585 per cent. of lead; the latter, No. 1576, gave about seventy-one and a half per cent. This does not of course represent all the lead existing in the selected galena, but is supposed to contain all the silver.

The well washed lead buttons were dissolved, severally, in dilute nitric acid; and to the very much diluted solutions a solution of lead chloride was added.

The former, No. 1575, gave a faint precipitate of silver chloride on standing—not enough to justify its extraction; the latter gave no sensible precipitate of the silver chloride. These ores seem, therefore, to be too poor in silver to pay for its extraction.

Another specimen of lead ore, from an unopened lode, on Mill branch of Six Mile Creek, contained so small a proportion of galena to the baryta sulphate that it was not thought proper to analyze it.

No. 1577—MARLY SHALE *or indurated marl.* "*Cut of the Cumberland and Ohio Railroad, Eminence, Henry county. Collected by Prof. N. S. Shaler.*"

An olive-grey, indurated marl; containing nodules of chætetes, and portions of other Silurian fossils.

COMPOSITION, DRIED AT 212° F.

Silica	23.700
Alumina	7.146
Iron and manganese oxides	11.040
Lime carbonate	44.560
Magnesia	.310
Phosphoric acid	1.164
Sulphuric acid	.961
Potash	2.100
Soda	.623
Water expelled at red heat, and loss	8.396
Total	100.000

The large proportions of lime, potash, phosphoric acid, &c., in this marly shale, would doubtless make it valuable as a top-dressing on exhausted light soils; but it is not rich enough in the mineral fertilizers to justify much expenditure for transportation.

HOPKINS COUNTY.

No. 1578—COAL. "*Mr. Wm. Mills' coal, just partially opened. Nortonsville, Hopkins county. Collected by C. J. Norwood.* (*Probably not a fair average sample.*")

Generally a jet-black, glossy coal; breaks in part in thin layers, with some compressed fibrous coal between. Some thin laminæ of pyrites apparent. (Specimen seems to contain an inordinate proportion of pyrites.)

No. 1579—COAL. "*St. Charles Mines. Average sample, by C. J. Norwood.*" (*Coal D.*)

A jet-black, glossy coal; iridescent in parts. Some fibrous coal between the laminæ, and but little appearance of pyrites.

COMPOSITION OF THESE HOPKINS COUNTY COALS, AIR-DRIED.

	No. 1578.	No. 1579.
Specific gravity	1.448	1.322
Hygroscopic moisture	3.40	3.20
Volatile combustible matters	30.00	35.90
Coke	66.60	60.90
Total	100.00	100.00
Total volatile matters	33.40	39.10
Carbon in the coke	51.10	54.00
Ashes	15.50	6.90
Total	100.00	100.00
Character of the coke	Spongy.	Light spongy.
Color of the ash	Dark grey-purple.	Light lilac-grey.
Per centage of sulphur	7.280	2.759

No. 1579 is a very good coal, containing but little earthy matter and a moderate proportion of sulphur. The other exceeds the average proportions of these; but is not probably a fair sample. It is well known that coal beds vary greatly in their different layers; and this may prove to be a good coal when the bed is fairly opened.

No. 1580—"LIMONITE, *ochreous, from near St. Charles Mines, Mr. Norton's land. On the working coal. Collected by C J. Norwood.*"

Flat kidney-form concretions, of a handsome brownish-yellow color, of different shades. Easily scratched with the nail; adheres to the tongue.

COMPOSITION, DRIED AT 212° F.

Iron peroxide	50.850
Alumina	5.462
Manganese oxide	a trace.
Lime carbonate	3.129
Magnesia	1.546
Phosphoric acid	.198
Sulphuric acid	.189
Water expelled at red heat	10.530
Silica and insoluble silicates	27.680
Loss	.416
Total	100.000
Per centage of iron	35.595
Per centage of sulphur	.075
Per centage of silica	22.220
Per centage of phosphorus	.086

This is rich enough to be smelted for iron, and might make a good ochre pigment on grinding.

KENTON COUNTY.

No. 1581—"SILICIOUS GRIT *at first toll-gate, two miles from Covington, on Lexington Turnpike. Collected by Prof. N. S. Shaler.*"

A brownish-grey, ferruginous impure sandy mass.

No. 1582—"SILICIOUS GRIT *from same locality as preceding. Used for moulding sand. Collected by Prof. N. S. Shaler.*"

An impure, reddish-brown friable sandy mass; infiltrated with iron oxide; varying in tint from grey to deep brown. The sand grains are rounded.

COMPOSITION OF THESE KENTON COUNTY GRITS, DRIED AT 212° F.

	No. 1581.	No. 1582.
Silica	77.460	75.700
Alumina, and iron and manganese oxides	16.500	15.793
Lime carbonate	.480	.660
Magnesia	.121	.214
Potash	.828	.847
Soda	.580	.762
Phosphoric acid	not est.	.639
Sulphuric acid	not est.	not est.
Water expelled at red heat	4.500	5.100
Total	100.469	99.716

The amount of alkalies contained in these impure sands is somewhat remarkable. They exist in them, however, mostly in the silicates which are insoluble in acids; and were separated in the analyses, by the process of fusion with the mixture of lime carbonate and ammonium chloride, &c., according to the method of J. Lawrence Smith. Notwithstanding the unavailable condition of these alkalies, these sands might prove useful additions to heavy clay soils, more especially because of their notable proportion of phosphoric acid. For this purpose, however, they could only be employed in the close vicinity of their beds, as they would not pay for long transportation.

No. 1583—"CLAY, *supposed to be in the Cincinnati Group of the Lower Silurian formation. Lexington Turnpike, two miles south of Covington. Top section just below that of the preceding grits. Collected by Prof. N. S. Shaler.*"

A laminated or shaly clay of handsome light-buff and bluish-grey colors, alternating.

No. 1584—CLAY. "*Clay-pit at brick-yard. Head of Russel street, Covington. Average of the nine-feet section. Collected by Prof. N. S. Shaler.*"

A yellowish ferruginous clay; mottled with light bluish-grey; containing fine silicious grains.

No. 1585—MARLY SHALE. "*Junction of the Ohio and Licking rivers, twelve feet above low water mark. Cincinnati (Hudson River) Group. Collected by Prof. N. S. Shaler.*"

A fine-grained, dark-grey shale; dull; adhering somewhat to the tongue.

No. 1586—MARLY SHALE. *Labeled "Fine shales, between impure limestone; five feet above low water mark. Whitehall. No fossils. Collected by Prof. N. S. Shaler.*"

A soft friable shale; dark-grey in the fresh fracture; adhering to the tongue.

COMPOSITION OF THESE KENTON COUNTY MARLY CLAYS AND SHALES DRIED AT 212° F.

	No. 1583.	No. 1584.	No. 1585.	No. 1586.
Silica	56.400	68.360	43.461	47.160
Alumina, and iron and manganese oxides	29.971	22.256	21.000	22.850
Lime carbonate	.760	1.000	27.040	20.140
Magnesia	1.514	1.181	.680	.840
Phosphoric acid	.166	.258	.607	.128
Sulphuric acid	not est.	not est.	not est.	not est.
Potash	3.538	2.139	2.447	2.301
Soda	.551	.906	.915	1.590
Water expelled at red heat	7.100	3.650	3.850	5.200
Total	100.000	99.750	100.000	100.209

These marly shales would undoubtedly be valuable for top-dressing poor light soils in their vicinity, notwithstanding most of their alkaline ingredients are in a state of combination which renders them, for the present, unavailable for plant nourishment. The gradual action of the atmospheric agencies and of humus, as well as that of the lime, will eventually bring them into a soluble state. The latter two may be considered the best for this purpose.

No. 1587—LIMESTONE. *Labeled "Blue argillaceous limestone. Low water mark. Whitehall, near Covington. Collected by Prof. N. S. Shaler.*"

A fine-grained, dark-grey limestone. Not adhering to the tongue.

COMPOSITION, DRIED AT 212° F.—SPECIFIC GRAVITY = 2.720.

Lime carbonate	64.240	= 35.974 per cent. of lime.
Magnesia carbonate	6.152	
Alumina, and iron and manganese oxides	4.960	
Phosphoric acid	.191	
Sulphuric acid	not est.	
Potash	.643	
Soda	.260	
Silex and insoluble silicates	23.860	
	100.306	

This limestone, like most of the layers of the Lower Silurian limestone (or blue limestone, so-called), is, in consequence of its large proportions of alkalies and phosphoric acid, peculiarly suited to agricultural purposes. The use of this lime, in the calcined state, upon our old fields, if properly managed and applied just before the clover crop, in a rotation, would doubtless be quite beneficial in restoring fertility.

LAWRENCE COUNTY.

No. 1588—"COAL. *No. 3, "From McHenry's coal bank, six miles south of Louisa. Average sample, by A. R. Crandall."*

A jet-black coal, with very little fibrous coal and no appearance of pyrites.

No. 1589—"COAL. *No. 1, from F. Swetman's bank, Brushy Creek. Collected by A. R. Crandall."*

A jet-black coal, with some little external earthy or ferruginous staining, and but little fibrous coal or pyrites.

No. 1590—COAL. *No. 1, "From near Henderson, Boggs' Mill, Cane's Creek. Collected by A. R. Crandall."*

Rather a dull-black coal, breaking into thin laminæ, with fibrous coal between, but with little appearance of pyrites. Some external ferruginous stain.

No. 1591—COAL. *No. 3. "Holbrook's coal, Brushy Creek. Collected by A. R. Crandall."*

Rather a dull-black coal, breaking into thin laminæ, with fibrous coal between, but with little appearance of pyrites.

No. 1592—Coal. *No. 3. "Mr. Boggs' bank, one mile from mouth of Cane's Creek. Upper portion of the coal. Collected by A. R. Crandall."*

A jet-black coal, with some fibrous coal between the laminæ, but with little appearance of pyrites.

No. 1593—Coal. *No. 3. "Mr. Boggs' bank, &c., &c. Lower portion of the coal. Collected by A. R. Crandall."*

Breaking into thin laminæ, with fibrous coal between. Some external ferruginous incrustation.

COMPOSITION OF THESE LAWRENCE COUNTY COALS, AIR-DRIED.

	No. 1588	No. 1589	No. 1590	No. 1591	No. 1592	No. 1593
Specific gravity	1.316	1.281	1.376	1.349	1.350	1.284
Hygroscopic moisture	4.60	5.10	3.30	2.10	2.50	2.50
Volatile combustible matters	35.70	35.30	35.16	33.90	38.56	39.00
Coke	59.70	59.60	61.54	64.00	58.94	58.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	40.30	40.40	38.46	36.00	41.06	41.50
Carbon in the coke	53.28	57.80	47.84	56.00	51.44	54.76
Ashes	6.42	1.80	13.70	8.00	7.50	3.74
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Light spongy.	Dense spongy.	Friable.	Light spongy.	Spongy.
Color of the ash	Light lilac-grey	Light grey-buff.	Dark lilac-grey	Yellow-ish-white	Grey-purple.	Brownish grey.
Per centage of sulphur	1.080	0.736	2.109	0.736	3.785	1.066

With one or two exceptions, as is readily to be seen, these are remarkably good and pure coals, which will compare favorably with the best Ohio and Indiana coals.

It is interesting to notice in the above table the nearly constant relation of the specific gravity to the relative proportion of ash, to-wit:

In No.	1589	the specific gravity is	1.281;	per centage of ash =	1.80.
"	1593	" "	1.284;	" "	3.74.
"	1588	" "	1.316;	" "	6.42.
"	1592	" "	1.350;	" "	7.50.
"	1591	" "	1.349;	" "	8.00.
"	1590	" "	1.376;	" "	13.70.

This relation of the specific gravity to the proportion of the ash is not constant in coals generally.

No. 1594—RED HEMATITE "*Found on top of hill near Louisa, Lawrence county. By A. R. Crandall.*"

Nodular lumps, of various sizes, of very hard, dense, dark colored ore, with hardly any soft ochreous material. Powder of a brownish-red or maroon color.

COMPOSITION, DRIED AT 212° F.—SPECIFIC GRAVITY = 4.184.

Iron peroxide	80.004	= 56.028 per cent. of iron.
Alumina	3.474	
Manganese, brown oxide	.250	
Lime	.360	
Magnesia	.396	
Phosphoric acid	.172	= 0.075 per cent. of phosphorus.
Sulphuric acid	.055	= .020 per cent. of sulphur.
Silica and insoluble silicates	14.200	= 13.500 per cent. of silica.
Water and loss	1.089	
	100.000	

The red hematite is an exceptional ore in the coal measures, but is found in abundance in the Clinton Group.

LIVINGSTON COUNTY.

No. 1595—GALENA. "*From Royall Mines, Mineral Point, Cumberland river. Taken one hundred and twenty-five feet from the surface; sloping away from the river. Collected by Prof. N. S. Shaler.*"

The galena is mingled with colorless and violet-colored fluor-spar.

No. 1596—GALENA. "*From same mines, taken forty-five feet from the surface, &c., &c.*"

The galena, separated from the gangue, of both these samples, was reduced by the usual flux and tested for silver.

No. 1595 gave a button of lead weighing 79.34 per cent. of the weight of the galena, and No. 1596 one which weighed 79.052 per cent.

These were severally dissolved in diluted nitric acid and tested for silver by the addition of the watery solution of lead chloride to the diluted nitrate of lead solution; and in neither case was more than a minute trace of silver chloride obtained. So that these galenas cannot be profitably worked for the extraction of silver.

LYON COUNTY.

No. 1597—"LIMONITE *iron ore from old Suwannee Furnace, Big Showing. Sub-carboniferous. Collected by P. N. Moore.*"

A dense, dark-brown limonite, in irregular laminæ, with a small amount of investing soft ochreous ore.

No. 1598—LIMONITE. "*Old Suwannee Furnace. Bank close to the furnace. Sub-carboniferous. Collected by P. N. Moore.*"

A dense, dark-brown ore, in irregular laminæ, with some brown hematite and soft ochreous ore. Some cherty nodules.

No. 1599—"LIMONITE, *with occasional thin layers of brown hematite. Old Suwannee Furnace property. Railroad cut. Sub-carboniferous formation. Average sample of the ore in the railroad cut. Collected by P. N. Moore.*"

A dense, dark-brown limonite, with thin incrustations of brown hematite and some soft ochreous ore.

No. 1600—LIMONITE. "*Old Suwannee Furnace property. Iron Mountain bank. Sub-carboniferous. Average sample, by P. N. Moore.*"

Generally in dark-brown irregular laminæ, with some yellowish and brownish ochreous ore, and occasional small nodules of chert.

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

	No. 1597.	No. 1598.	No. 1599.	No. 1600.
Iron peroxide	59.370	70.518	66.117	69.392
Alumina	1.622	.045	1.064	a trace.
Manganese, brown oxide	.090	.190	.170	.170
Lime carbonate	.170	.090	.090	.140
Magnesia	.100	a trace.	a trace.	a trace.
Phosphoric acid	.179	.275	.434	.303
Sulphuric acid	.508	.113	.213	a trace.
Water expelled at red heat	8.400	9.850	9.800	9.550
Silica and insoluble silicates	30.000	18.910	22.330	20.500
Moisture and loss	. . . . .	.009	. . . . .	. . . . .
Total	100.439	100.000	100.218	100.055
Per centage of iron	41.559	49.363	46.819	48.574
Per centage of phosphorus	.077	.120	.189	.144
Per centage of sulphur	.212	.045	.083	. . . . .
Per centage of silica	26.800	18.160	21.160	19.660

In volume 4 of *Reports of Kentucky Geological Survey*, old series, may be found the amount of the analyses of other materials from this old furnace, beginning at page 209.

Quite rich ores, and very good, except those which show a large proportion of sulphur or phosphorus.

For an account of the analysis of the water contained in the interior of a geode of "pot ore," see the Appendix.

MENIFEE COUNTY.

No. 1601—COAL. "*Sub-conglomerate, forty feet above the sub-carboniferous limestone. Hawkins' Creek, near the line of Powell county. Menifee county. Average sample, collected by A. R. Crandall.*"

No. 1602—COAL. "*Sub-conglomerate, forty to forty-five feet above the sub-carboniferous limestone, near the mouth of Glady Creek, on Ledford's land. A thin bed. Collected by A. R. Crandall.*"

No. 1603—BITUMINOUS SHALE. "*Sub-conglomerate (mistaken for coal). Twenty to twenty-two feet thick; immediately above the sub-carboniferous limestone. Average sample, by A. R. Crandall.*"

A friable shale, resembling some kinds of cannel coal, of a dull brownish-black, with some thin ferruginous incrustation. Fracture irregular; sub-conchoidal.

COMPOSITION OF THESE COALS AND THE SHALE, AIR-DRIED.

	No. 1601.	No. 1602.	No. 1603.
Specific gravity	1.319	not est.	not est.
Hygroscopic moisture	2.94	2.66	2.80
Volatile combustible matters	33.06	34.04	15.20
Coke (or fixed residue)	64.00	63.30	82.00
Total	100.00	100.00	100.00
Total volatile matters	36.00	36.70	18.00
Carbon in the coke, &c.	56.60	50.24	24.30
Ashes	7.40	13.06	57.70
Total	100.00	100.00	100.00
Character of the coke, &c.	Dense.	Dense.	Pulverulent
Color of the ash	Light brownish-grey.	Dark lilac-grey.	White.
Per centage of sulphur	0.997	4.092	not est.

Some of the sub-conglomerate coals are found to be quite good. The bituminous shale described above, however, hardly contains enough combustible matters (having only eighteen per cent.) to make it available for fuel.

Samples of various rocks and minerals were brought to the laboratory by Mr. J. M. Vanarsdall, from this county, from the vicinity of Glady Creek; consisting of iron ores, pyrites, marly clay, zinc sulphide, &c., with some small globules of a white metal which he obtained from the ashes of the furnace of the so-called "James Kirk's silver mine." The metal contained tin and copper, and the furnace was probably used by counterfeiters, who, selecting out-of-the-way regions for their operations, seem frequently to conceal the character of them by the pretense of working a silver mine.

This county has not as yet been thoroughly examined by the Geological corps; and doubtless contains much more mineral wealth than is indicated by these few analyses here reported.

MONTGOMERY COUNTY.

No. 1604—"QUICKLIME. *Star Lime Company's lime. Burnt at (or near) Mt. Sterling. Obtained from Williamson & Bro., Lexington.*"

Not remarkably white, presenting an oölitic structure in some of the pieces.

COMPOSITION.

Lime	98.301
Magnesia	.092
Alumina, and iron and manganese oxides	.747
Phosphoric acid	.023
Sulphuric acid	not est.
Potash	.012
Soda	.011
Silica and insoluble silicates	.814
Total	100.000

This analysis, made by the youngest son of the writer (Alfred M. Peter) under his inspection, indicates a degree of purity which fits this lime for all purposes of construction, except, perhaps, for the whitest finishing coats in plastering.

MUHLENBURG COUNTY.

No. 1605—LIMONITE *Labeled "Iron ore from near No. 4 entry. Airdrie Furnace. Averaged by P. N. Moore."*

A porous, yellowish, and deep brown ore.

No. 1606—LIMONITE. *"Iron ore from Jerry M. Hope's land, near Muddy river. Average sample, by P. N. Moore, of the surface limonite from the upper part of the bed."*

A cellular limonite (fossiliferous), of a bright yellowish-brown color externally, with darker, hard, curved laminæ included.

NO. 1607—LIMONITE. "*Ore from the lower and middle parts of the bed. Jerry Hope's land, &c., &c. Average sample, by P. N. Moore.*"

A porous, brownish-yellow, fossiliferous ore.

NO. 1608 — LIMONITE. "*Martin ore from near Greenville. Average sample, by P. N. Moore.*"

A cellular limonite, with ochreous incrustation, &c.

NO. 1609—"ROASTED ORE *from the Airdrie Furnace stock pile. Has been weathered seventeen years since roasting. Collected by P. N. Moore.*"

Apparently a "Black-band ore," so-called, originally. The roasted ore is of a dark, reddish-brown color, varying to lighter tints. Some portions are cellular, as though they had been fused.

COMPOSITION OF THESE MUHLENBURG COUNTY LIMONITE IRON ORES, &c., DRIED AT 212° F.

	No. 1605.	No. 1606.	No. 1607.	No. 1608.	No. 1609.
Specific gravity	3.246	. . . . .	. . . . .	. . . . .	3.652
Iron peroxide	63.048	60.492	46.866	69.546	59.810
Alumina	5.290	7.075	5.930	3.914	2.972
Brown oxide of manganese	.090	.360	.103	.230	.720
Lime carbonate	.680	1.980	2.535	.480	*2.263
Magnesia	.930	1.550	1.073	.921	4.270
Phosphoric acid	.147	.083	.179	.115	.223
Sulphuric acid	.112	.185	.059	.216	.065
Water expelled at red heat	12.430	12.530	9.550	11.250	.200
Silex and insoluble silicates	17.250	15.560	33.530	12.730	29.880
Moisture and loss	. . . . .	.185	.175	.598	. . . . .
Total	100.077	100.000	100.000	100.000	100.403
Per centage of iron	44.133	42.344	32.806	48.822	41.867
Per centage of phosphorus	.064	.035	.078	.050	.097
Per centage of sulphur	.044	.074	.024	.086	.026
Per centage of silica	16.500	13.660	32.860	11.300	25.260

* Lime.

These Airdrie Furnace limonites are all good and profitable ores, which would yield a good quality of iron if properly smelted, as they contain but a moderate proportion of the injurious ingredients, phosphorus and sulphur. Although it is probable that the "roasted ore" was from the so-called "Black-band ore" (bituminous clay iron-stone), it is properly tabulated with these limonites. The analyses of other similar iron ores from this region are detailed in the previous volumes of Kentucky Geological Reports. (*See volume* 1, *pages* 345 *and* 346, *and volume* 4, *page* 229.)

No. 1610—CLAY IRON-STONE. *Bituminous. So-called "Black-band" ore. From the Airdrie Furnace stock pile; weathered seventeen years. Not roasted. Collected by P. N. Moore."*

A shaly ore, varying in color, in layers, from nearly black to dark grey-brown.

No. 1611 — CLAY IRON-STONE. *Bituminous. Labeled "Slate iron ore, from Buckner Furnace. Weathered thirty years. Average sample, by P. N. Moore."*

A Black-band ore, of a dark umber-brown color, varying in tint. Shaly, and containing carbonaceous matter.

No. 1612—CLAY IRON-STONE *"From the lower part of the bed at Jerry Hope's bank, near Muddy river. Collected by P. N. Moore."*

A rough, greenish and brownish, fossiliferous and silicious carbonate ore.

COMPOSITION OF THESE CLAY IRON-STONES, DRIED AT 212° F.

	No. 1610.	No. 1611.	No. 1612.
Specific gravity	3.376	not deter'd.	not deter'd.
Iron carbonate	47.810	42.950	26.643
Iron peroxide	9.054	29.618	18.374
Alumina	5.205	2.454	6.548
Lime carbonate	3.740	2.490	13.430
Magnesia carbonate	7.180	4.828	5.698
Manganese carbonate	.797	1.083	a trace.
Phosphoric acid	.179	.083	.211
Sulphuric acid	.237	1.596	.185
Silica and insoluble silicates	17.010	9.030	22.230
Water, bituminous matter, and loss	8.788	5.868	6.681
Total	100.000	100.000	100.000
Per centage of iron	29.418	36.916	27.136
Per centage of phosphorus	.078	.035	.092
Per centage of sulphur	.094	.638	.074
Per centage of silica	12.900	6.220	20.660

These clay iron-stones are not very rich in iron, except the one (No. 1611) from Buckner Furnace, and this has a large proportion of sulphur. The others are probably too poor in iron to be separately smelted with profit; but they might be mixed with richer ores with advantage. Other analyses of the so-called Black-band ores of this region are to be found in volume 1, Kentucky Geological Reports, pages 346 to 350. It will be seen, by reference, that these vary in their proportion of iron from 31.17 to 36.80 per cent. of the ore.

[No. 1314—"LIMESTONE *from Barren river, near the mouth of Jasper Creek. Used formerly as a flux at Airdrie Furnace.*" (*See Butler county.*)]

No. 1613—CLAY "*From Ross coal mines, Owensboro Junction. (Fire-clay below the coal in the lower drift.) Collected by C. J. Norwood.*"

A dark-grey, soft, shaly clay.

COMPOSITION, DRIED AT 212° F.

Silica	63.180	
Alumina, and iron and manganese oxides	26.281	
Lime	.203	
Magnesia	.255	
Phosphoric acid	.179	
Sulphuric acid	3.282	= 1.312 per cent. of sulphur.
Potash	2.000	
Soda	.425	
Water expelled at red heat, and loss	4.195	
	100.000	

Much of the sulphur and iron doubtless exist in the clay, not as sulphuric acid and iron oxide, but in combination, as iron sulphide. The considerable proportions of potash, lime, magnesia, and iron oxide may prevent this from being a *very* refractory clay; although it may very well answer for the manufacture of stone-ware and ordinary fire-bricks.

No. 1614—PIG IRON. (*Silver-grey.*) "*An old sample, from a former smelting at Airdrie Furnace. Collected by P. N. Moore.*"

No. 1615—PIG IRON. (*Silver-grey.*) "*From a former smelting, Airdrie Furnace, &c.*"

No. 1616—" PIG IRON (*silver-grey,*) *&c., &c., as above.*

No. 707—(See volume 3 Kentucky Geological Reports (old series), page 340, for an analysis of a somewhat similar pig iron from this furnace, made when the furnace was in blast.)

COMPOSITION OF THESE AIRDRIE FURNACE PIG IRONS.

	No. 1614.	No. 1615.	No. 1616.	*No. 707.
Specific gravity	6.826	6.826	7.782	7.007
Iron	86.636	85.455	86.842	88.426
Graphite	.900	.480	.740	1.360
Combined carbon	2.080	1.560	1.460	.190
Manganese	.202	.696	.355	.980
Silicon	7.704	7.747	8.614	6.216
Slag	2.260	3.460	2.360	3.090
Aluminum	.123	.098	.054	.099
Calcium	.045	.089	.112	not est.
Magnesium	.035	.017	.056	.309
Potassium	not est.	not est.	not est.	.059
Sodium	not est.	not est.	not est.	.091
Phosphorus	.235	.443	.123	.209
Sulphur	.104	.122	.122	219
Total	100.334	100.167	100.836	101.250
Total carbon	2.980	2.040	2.200	1.550

* Of old series of Reports.

The analyses of these samples of the pig iron of old Airdrie Furnace show inordinate proportions, in all of them, of silicon, slag, phosphorus, and sulphur; which caused the very bad quality of the iron, as they all tend to make it brittle, whether hot or cold. But the examination of the ores, limestone, and coals of the neighborhood of this furnace, shows that, with due care in the selection of these materials, and a proper management of the furnace, as good iron could be produced by it as by any using pit coal or coke for fuel.

It appears that, in its early working, the limestone used for flux was very sulphurous, containing much pyrites; that the manager had too strong a preference for the so-called "Blackband" over the limonite ores, which former frequently contain much sulphur and phosphorus; and that, moreover, the blast was too slow and too hot—conditions which all tended to the production of impure iron.

An account of the examination of some of the coke used formerly in this furnace is appended, as follows:

No. 1617 — COKE. "*Airdrie Furnace coke, weathered sixteen years; made from the No.* 12 *coal. Collected by P. N. Moore.*"

COMPOSITION, AIR-DRIED.

Hygroscopic moisture (expelled at 212° F.)	7.50
Moisture, &c., expelled at red heat	4.20
Dry coke	88.30
Total	100.00
Total moisture and volatile matter	11.70
Fixed carbon	82.90
Ashes, of a light yellowish-grey color	5.40
Total	100.00
Per centage of sulphur	0.64

The ash of this coke was also analyzed.

COMPOSITION OF THE ASH.

	Per cent. of the coke.
Alumina, and iron and manganese oxides	0.40
Lime	.34
Magnesia	.18
Phosphoric acid	.08
Sand and insoluble silicates	4.32
Loss	.08
Total	5.40

The analysis of the coal of which this coke was made is given in the following (Nos. 1618 and 1619):

No. 1618—COAL. "*No.* 12 *of Owen. Airdrie Furnace, near No.* 4 *entry. Average sample, by P. N. Moore.*"
A deep-black coal, with some thin shaly laminæ.

No. 1619—COAL. "*No.* 12 *of Owen. From the old stock pile, at the entrance of the drift; where it has been weathered for sixteen years. Average sample, by P. N. Moore.*"
Like the preceding, but altered somewhat by weathering.

No. 1620—COAL. "*Average sample of the lowest division of the bed at Paradise mines. Airdrie Furnace. (No.* 11 *of Owen.) By P. N. Moore.*"

A bright, deep-black coal; with but little fibrous coal between the layers, but containing small bright crystals and incrusting scales of iron pyrites.

No. 1621—COAL. "*Average sample of the middle stratum of same beds of Paradise mine. By P. N. Moore.*"

A pure looking, deep-black coal, with shining fracture; showing less fibrous coal and iron bi-sulphide than the preceding.

No. 1622—COAL. "*Average sample of the upper stratum of Paradise mine, &c. By P. N. Moore.*"

Like the two preceding; having a shining fracture, like that of asphaltum. Very little fibrous coal or pyrites to be seen in it.

No. 1623—COAL. "*From Muddy river coal mine. Averaged by P. N. Moore.*"

A deep-black, glossy coal, with but little fibrous coal or pyrites apparent in it. Like the Paradise mine coal.

COMPOSITION OF THESE AIRDRIE FURNACE COALS, AIR-DRIED.

	No. 1618.	No. 1619.	No. 1620.	No. 1621.	No. 1622.	No. 1623.
Specific gravity	1.278	1.332	1.331	1.326	1.274	1.221
Hygroscopic moisture	3.60	4.70	4.20	4.10	3.60	3.80
Volatile combustible matters	31.40	30.60	36.10	35.90	38.70	32.70
Coke	65.00	64.70	59.70	60.00	57.70	63.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	35.00	35.30	40.30	40.00	42.30	36.50
Carbon in the coke	58.50	58.80	50.50	53.60	53.70	58.60
Ashes	6.50	5.90	9.20	6.40	4.00	4.90
Total	100.00	100.00	100.00	100.00	100.00	100.00
Character of coke	Dense spongy.	Dense spongy.	Spongy.	Spongy.	Spongy.	Dense spongy.
Color of ash	Lilac-grey.	Light lilac-grey	Dark lilac-grey	Dark lilac-grey	Light lilac-grey	Brownish salmon-grey.
Per centage of sulphur	1.438	1.455	4.573	4.394	3.158	1.923

It appears that the No. 12 coal contains the least sulphur, while the No. 11 coal of the Paradise mine is quite sulphurous, the upper stratum being the least objectionable in this respect. They are all very good coals for ordinary uses, and might be measurably purified from sulphur by careful coking, and thus probably made available in the iron manufacture. The coal of the No. 12 bed of Owen is, however, preferable for this purpose.

No. 1624—COAL. "*Ross coal mine. Owensboro Junction. Top bench; above the clay parting. From the upper drift. Average sample, by C. J. Norwood.*" (*Coal A.*)

A jet-black coal, with fibrous coal between its thin laminæ, and but little apparent pyrites.

No. 1625—COAL. "*Mercer coal mines. Louisville and Paducah and Southwestern Railroad. Collected by C. J. Norwood.*" (*Coal D.*).

A jet-black coal, with shining pyrites, and some fibrous coal between the laminæ.

No. 1626—COAL. "*Upper seam of the old drift. Muhlenburg coal mines. Collected by C. J. Norwood.*" (*Coal A.*)

A glossy, pure-looking, pitch-black coal; with very little fibrous coal or pyrites apparent. Some little incrustation of lime sulphate in the seams.

No. 1627—COAL. "*Muhlenburg mines. Main working bed, near Mercer Station, Louisville and Paducah and Southwestern Railroad. Collected by C. J. Norwood.*" (*Coal B.*)

Like the next preceding, but has a little more fibrous coal than that, and some thin pyritous and lime sulphate incrustations.

No. 1628—COAL. "*Muhlenburg mines (John Pollock, Superintendent), near Mercer Station, &c., &c. Taken from head of main entry. Average sample, by C. J. Norwood.*"

A pure pitch-black looking coal; beautifully iridescent on some of the seam faces. But little fibrous coal or pyrites apparent, but some slight lime sulphate incrustation.

No. 1629—"FIBROUS COAL OR MINERAL CHARCOAL. "*From above the main working. Thickness from one half to one inch. Muhlenburg mines, &c. Collected by C. J. Norwood.*"

A very soft, friable mass of carbonaceous matter. Some in light powder, but much in the form of charred, fibrous, reedy stems, &c.

No. 1630—CARBONACEOUS MUD OR CLAY. "*Filling cavities occurring in the bituminous shale overlying the coal. Muhlenburg mines. Collected by C. J. Norwood.*"

A brownish greyish-black indurated mud, or carbonaceous clay.

COMPOSITION OF THESE MUHLENBURG COUNTY COALS, &c., AIR-DRIED.

	No. 1624	No. 1625	No. 1626	No. 1627	No. 1628	No. 1629	No. 1630
Specific gravity	1.407	1.358	1.297	1.332	1.280	1.503	. . . .
Hygroscopic moisture . .	4.16	3.60	3.10	1.52	2.98	1.20	3.56
Vol'ile combustible matters	37.44	34.00	40.68	40.00	43.08	7.50	13.68
Coke	58.40	62.40	56.22	58.48	53.94	91.30	82.76
Total	100.00	100.00	100.000	100.00	100.00	100.00	100.00
Total volatile matters . .	41.60	37.60	43.78	41.52	46.06	8.70	17.24
Carbon in the coke . . .	49.80	50.60	50.66	50.92	50.22	86.48	6.82
Ashes	8.60	11.80	5.56	7.56	3.72	4.82	75.94
Total	100.00	100.00	100.000	100.00	100.00	100.00	100.00
Character of the coke . .	Light spongy.	Light spongy.	Spongy.	Spongy.	Spongy.	Powdery.	Powdery.
Color of the ash	Light lilac-grey	Lilac-grey.	Lilac-grey.	Lilac-grey.	Lavendar grey.	Dark-brown.	Brownish grey.
Per cent. of sulphur . . .	2.727	4.032	2.779	2.840	3.125	3.431	1.983

These coals are generally of very good quality, although some of them contain a little more than the usual proportion of sulphur. Some of this, however, is in combination, in the form of *lime sulphate*. To ascertain how much was in this state, coals Nos. 1626 and 1629 were boiled in solution of soda carbonate, &c., &c., and the proportions of lime sulphate ascertained. The quantity in No. 1626 was only 0.168 per cent., while No. 1629 was found to contain 3.632 per cent. of this substance. In addition, No. 1629 was treated with bisulphide of carbon, by the method of displacement, and was thus found to contain a certain amount of uncombined sulphur. It is probable that in other coals free sulphur may be found, especially in those which have much fibrous coal between their laminæ.

The fibrous coal above described is remarkable for the large proportion of carbon it contains. The carbonaceous mud, on the contrary, contains but little combustible matter. It would be a bituminous shale if indurated.

OHIO COUNTY.

No. 1631—COAL. "*Rockport mines, one and three quarter miles east of Rockport. Average sample, from along the entry. Collected by C. J. Norwood.*" (*Coal D.*)

Rather friable. Pitch-black, with some incrustations of shining pyrites in the seams, and some fibrous coal between the laminæ.

No. 1632—COAL. "*Same locality, &c. Average sample, by C. J. Norwood.*" *General average of the mine.* (*Coal D.*)

A pitch-black coal, with fibrous coal between the layers; some infiltration of lime sulphate in the seams, and but little pyrites.

No. 1633—COAL. "*Same locality, &c. Averaged by C. J. Norwood.*" (*Coal D.*)

Much like the preceding.

COMPOSITION OF THESE OHIO COUNTY COALS, AIR-DRIED.

	No. 1631.	No. 1632.	No. 1633.
Specific gravity	1.421	1.332	1.334
Hygroscopic moisture	3.50	3.00	3.00
Volatile combustible matters	35.00	36.20	33.50
Coke	61.50	60.80	63.50
Total	100.00	100.00	100.00
Total volatile matters	38.50	39.20	36.50
Carbon in the coke	52.50	53.70	55.10
Ashes	9.00	7.10	8.40
Total	100.00	100.00	100.00
Character of the coke	Light spongy.	Light spongy.	Light spongy.
Color of the ash	Light brownish-grey.	Light lilac-grey.	Lilac-grey.
Per centage of sulphur	3.139	2.837	3.332

These coals are all of very good quality.

[See Appendix for other Ohio county coals.]

No. 1634—"VIRGIN SOIL *from woodland, on Mr. Miller's land, fifteen hundred and twenty feet north to east from Horse Branch Station (Louisville and Paducah Railroad). Collected by C. S. Schenk.*"

Slope 1:16. Depth of sample six inches. Substratum sandstone. Timber: white and black oak, some chestnut, hickory, and poplar. Undergrowth: sassafras, dogwood, and small trees of above named kinds. The new land is said to produce of corn, forty to fifty bushels; wheat, twenty to thirty; oats, forty to fifty; and of tobacco, one thousand pounds to the acre.

Dried soil of a dark brownish-grey color. No gravel.

No. 1635—"SUB-SOIL *of the preceding, taken at depth of from six to thirty-six inches. By C. S. Schenk.*"

Sub-soil of a light grey-buff color. No gravel.

No. 1636—"SOIL *of an old field, forty years in cultivation. Level table land, owned by Mr. Miller, sixteen hundred feet north 20° east, from Horse Branch Station, &c. Collected by C. S. Schenk.*"

Sample taken to the depth of seven and a half inches. Substratum sandstone. Rotation of crops: tobacco two years, corn three years (in some cases corn until it fails to produce it), then wheat and clover, or oats and clover or grass. Yield of corn, twenty to thirty bushels; oats, twenty to thirty-five bushels; tobacco, six hundred pounds per acre. Never plowed over six or seven inches deep. Good quality of table-land; nearly as good as the valley land.

Dried soil of a greyish light-brown color. Contains a few small fragments of ferruginous sandstone.

No. 1637—"SUB-SOIL *of the next preceding, taken to the depth of from seven and a half to thirty-six inches. Collected by C. S. Schenk.*"

Dried sub-soil of a yellowish-grey color. Contains no gravel.

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

	No. 1634.	No. 1635.	No. 1636.	No. 1637.
Organic and volatile matters	4.100	3.500	3.550	3.350
Alumina, and iron and manganese oxides	3.032	7.047	4.066	6.475
Lime carbonate	.170	.095	.095	.095
Magnesia	.131	.258	.104	.171
Phosphoric acid	.093	.093	.124	.140
Sulphuric acid	Not estimated.			
Potash	.125	.273	.333	.269
Soda	a trace.	.144	.012	.230
Sand and insoluble silicates	92.455	88.841	91.990	89.515
Water expelled at 380° F.	.900	.915	.775	.775
Total	101.066	101.165	101.049	101.020
Hygroscopic moisture	1.175	2.400	1.450	2.575
Potash in the insoluble silicates	1.273	1.470	.939	1.107
Soda in the insoluble silicates	.814	.617	.511	.290
Character of the soil	Virgin soil.	Sub-soil.	Old field soil.	Sub-soil.

The old field soil seems to have been naturally richer than the woodland soil, if no mistake has been made in the labels. The considerable proportions of potash and soda in the sandy portion (insoluble silicates) tend to give durability to the soils. With proper culture and the due application of fertilizers, this land may be made quite productive, if well drained

For the analyses of other soils of this serial collection, made by Mr. C. S. Schenk along the line of the Elizabethtown and Paducah Railroad, see Grayson and Hardin counties.

APPENDIX.

BOURBON COUNTY.

No. 1638—"LIMESTONE (*magnesian*). *From Cane Ridge; five miles east of Paris. Used for the foundation of the Bourbon county Court-house at Paris. Sent by Mr. James Stevenson.*"

A somewhat porous, fossiliferous, ferruginous, magnesian limestone, of a light grey-buff color, containing small specks of hydrated oxide of iron. Specific gravity = 2.58 to 2.60 (in the lump).

COMPOSITION, DRIED AT 212° F.

Lime carbonate	79.140	= 44.318 per cent. of lime.
Magnesia carbonate	11.826	= 5.371 per cent. of magnesia.
Alumina	.380	
Iron peroxide	5.510	
Phosphoric acid	.511	
Sulphuric acid	.240	
Potash	.231	
Soda	.252	
Soluble silica	.110	
Insoluble silica	1.160	
Loss	.640	
	100.000	

The magnesian limestones are believed to withstand the atmospheric agencies generally better than the pure limestones. The iron in this rock is all in the state of peroxide, which is also favorable to its durability.

Whether its small cavities or pores may retain enough water to cause disintegration by freezing was not ascertained. It would calcine into lime good for ordinary building purposes or for use on the soil as a fertilizer.

COALS FROM THE STATE OF OHIO.

For the purpose of comparing our Kentucky coals with some of the best of those of our neighboring States, some of these, collected by Messrs. P. N. Moore and A. R. Crandall, were submitted to analysis, as follow:

No. A. 1—"COAL *from Jackson county, Ohio. Star Furnace coal. Averaged by A. R. Crandall.*"

A glossy, jet-black splint coal; breaking into thin laminæ, with fibrous coal between.

No. A. 2—" COAL. *Hocking valley, Athens county, Ohio. Average sample from the whole thickness of the bed. Taken from the pillar, three hundred yards. By A. R. Crandall.*"

A pitch-black, glossy coal, iridescent on some of the faces; having very little fibrous coal, and no pyrites apparent.

No. A. 3—" COAL. *Hocking valley, &c., &c. Average sample from the stock pile, from the whole thickness of the bed. By A. R. Crandall.*"

Like the preceding, but brighter, and showing less fibrous coal.

No. A. 4—COAL. *Hocking valley, &c., &c. Average sample from the upper twenty-eight inches. Taken from two rooms. By A. R. Crandall.*"

Breaks into thinner laminæ than the two preceding, with more fibrous coal between. Some little shining pyrites in thin crusts.

No. A. 5—" COAL. *Hocking valley, &c., &c. Average sample from the middle part (twenty-six inches), taken from two rooms. By A. R. Crandall.*"

In thicker laminæ than preceding, with much less fibrous coal, and no appearance of pyrites between them. Handsomely iridescent on many of the seam faces.

No. A. 6—" COAL. *Hocking valley, &c., &c. Average sample, from the lower part (eighteen inches) of the bed. Taken from two rooms. By A. R. Crandall.*"

Resembles the preceding, but shows some bright pyrites in places.

No. A. 12 — " COAL. *Sheridan coal mines, Lawrence county, Ohio. Collected by P. N. Moore.*"

A pure, pitch-black coal; with very little fibrous coal and some fine-granular pyrites, between the laminæ.

COMPOSITION OF THESE SELECTED OHIO COALS, AIR-DRIED.

	A. 1.	A. 2.	A. 3.	A. 4.	A. 5.	A. 6.	A. 12.
Specific gravity	1.361	1.322	not det'd.	1.346	1.303	1.312	1.322
Hygroscopic moisture	4.54	3.60	4.20	3.26	3.74	4.40	3.46
Vol'ile combustible matters	29.68	33.42	36.68	33.76	36.32	35.08	36.64
Coke	65.78	62.98	59.12	62.98	59.94	60.52	59.90
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total volatile matters	34.22	37.02	40.88	37.02	40.06	39.48	40.10
Carbon in the coke	57.06	55.82	54.16	54.42	55.74	55.20	53.80
Ashes	8.72	7.16	4.96	8.56	4.20	5.32	6.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Character of the coke	Pulverulent.	Dense.	Spongy.	Dense.	Dense spongy.	Dense spongy.	Light spongy.
Color of the ash	Nearly white.	Brownish grey.	Light lilac-grey	Light lilac-grey	Light lilac-grey	Light lilac-grey	Light lilac-grey
Per centage of sulphur	0.756	0.862	1.692	2.247	1.299	1.659	1.947

These are remarkably good coals, and are acknowledged to be amongst the best of the country.

The sample A. 2, taken from the pillar, seems to show the effect of exposure to the atmosphere, which is generally believed to cause a diminution of the proportion of sulphur.

A correspondence may be observed between the proportion of *ash* and the specific gravity, as follows:

A. 5	has specific	gravity =	1.303, and ash	per cent. =		4.20
A. 6	has "	"	1.312,	"	"	5.32
A. 2 and A. 13	have "	"	1.322,	"	"	6.10 and 7.16
A. 4	has "	"	1.346,	"	"	8.50
A. 1	has "	"	1.361,	"	"	8.72

COALS FROM THE STATE OF ILLINOIS.

No. A. 7—COAL. "*Mine near Murphrysboro, Jackson county, Illinois. Block coal. Big Muddy coal. Average sample, by P. N. Moore.*"

A glossy, jet-black splint coal. It has some fibrous coal between the laminæ; with occasional scales of bright pyrites, and some slight lime sulphate incrustation in the seams.

No. A. 8—"COAL. *Big Muddy coal. Mine near Murphrysboro, Illinois. Average sample, by P. N. Moore."*

Like the preceding. Some fine-granular pyrites with the fibrous coal between the laminæ, and occasional lime sulphate incrustation in the seams.

COMPOSITION OF THESE ILLINOIS COALS, AIR-DRIED.

	No. A. 7.	No. A. 8.
Specific gravity	1.310	1.310
Hygroscopic moisture	2.62	3.44
Volatile combustible matters	32.04	31.86
Coke	65.34	64.70
Total	100.00	100.00
Total volatile matters	34.66	35.30
Carbon in the coke	58.58	59.54
Ashes	6.76	5.16
Total	100.00	100.00
Character of the coke	Light spongy.	Spongy.
Color of the ash	Lilac-grey.	Lilac-grey.
Per centage of sulphur	2.472	1.376

These are also remarkably good coals, containing only a moderate proportion of sulphur, which is partly in the form of iron sulphide and partly in that of lime sulphate.

COALS FROM THE STATE OF INDIANA.

No. A. 9—"INDIANA BLOCK COAL. *From near Brazil, Clay county. Upper seam. Average sample, by P. N. Moore."*

A pitch-black splint coal, breaking easily into thin laminæ, with fibrous coal (mineral charcoal) and some fine granular pyrites between them. A few bright scales of iron pyrites and some slight lime sulphate incrustation in the seams.

No. A. 10—"INDIANA BLOCK COAL. *Mine near Brazil, Clay county. Lower seam. Average sample, by P. N. Moore.*"

Like preceding, but little appearance of pyrites or lime sulphate.

No. A. 11—"INDIANA BLOCK COAL. *From mine near Brazil, &c. Lower seam. Average sample, by P. N. Moore.*"

Resembles the others. Shows occasional bright scales of pyrites and lime sulphate incrustation.

COMPOSITION OF THESE INDIANA COALS, AIR-DRIED.

	No. A. 9.	No. A. 10.	No. A. 11.	No. A. 11 (repeated).
Specific gravity	1.313	not est.	not est.	.....
Hygroscopic moisture	2.70	2.68	2.40	2.52
Volatile combustible matters	36.38	36.32	35.10	35.48
Coke	60.92	61.00	62.50	62.00
Total	100.00	100.00	100.00	100.00
Total volatile matters	39.08	39.00	37.50	38.00
Carbon in the coke	55.64	53.58	53.50	53.06
Ashes	5.28	7.42	9.00	8.94
Total	100.00	100.00	100.00	100.00
Character of the coke	Spongy.	Dense spongy.	Dense.	.....
Color of the ash	Lilac-grey.	Light lilac-grey.	Lilac-grey.	.....
Per centage of sulphur	1.664	1.802	2.373	.....

These are remarkably good coals, as is well known by experience, especially in their use in the smelting of iron. Their high reputation and successful application to this industry make the comparison of their composition, with that of our Kentucky coal, an object of interest; and as we could find in the excellent reports of the Chief Geologist of Indiana, Prof. E. T. Cox, no statement as to the amount of *sulphur* which they contain, an ingredient of great and evil influence in iron smelting, these block coals were examined especially for this determination.

It will be seen on reference to the preceding table that this ingredient exists in them in average proportion. Doubtless to the existence of the sulphur in this fuel may we attribute the fact, given by Prof. Cox, on page 70 of his First Annual Report, 1869, that "the general character of the iron made in Clay county is *red-short*, &c." This, however, may be measurably corrected, and indeed does not prevent the iron from being very good and profitable for many industrial purposes.

It is very probable that all the sulphur which exists in these coals in the free, or uncombined, condition, will be volatilized and burnt out at the upper part of the furnace, long before it encounters the heat necessary to cause its combination with the iron of the ore with which it is mixed. This would be the case also with the second atom of sulphur of the bright pyrites of the coal, the bi-sulphide of iron; so that only that portion of the sulphur which would remain in the resulting iron proto-sulphide could vitiate the cast iron product. Hence we can understand, how a coal which gives a considerable per centage of sulphur in its ultimate analysis, may yet be quite available for the smelting of tough iron.

CALIFORNIA ADOBÉ SOIL.

An opportunity having occurred for procuring a specimen of this remarkably fertile soil, it was analyzed for comparison with our Kentucky soils, with the following results.

No. A. 12—"ADOBÉ SOIL *taken at three inches below the surface. Valley of the Sacramento river. Solano county, California.*" *Collected by Robert Peter, jr.*

Dried soil of a light-umber color; adhering in clods, which are easily crushed in the mortar. The powder (unground) passed wholly through fine bolting-cloth, leaving only a few vegetable fragments.

COMPOSITION OF THE AIR-DRIED SOIL.

	No. A. 12.	No. 1329.
Organic and volatile matters	7.740	7.615
Alumina, and iron and manganese oxides	11.117	12.085
Lime carbonate	.790	.990
Magnesia	1.596	.520
Phosphoric acid	.093	.483
Sulphuric acid	.082	a trace.
Potash	.727	.726
Soda	.983	a trace.
Sand and insoluble silicates	74.070	75.590
Water and loss	2.802	1.891
Total	100.00	100.000
Potash in the insoluble silicates	0.814	2.731
Soda in the insoluble silicates	0.903	.929

It will be seen above that this adobé soil resembles in composition the peculiar rich soil found locally in Campbell county, Kentucky, No. 1329, which is also like the adobé in being a sticky clay when wet, and hard and cloddy when dry. The California soil exceeds our Kentucky soils in soda, the latter has more phosphoric acid.

LYON COUNTY.—(Continued.)

No. 1639—"*Water taken from the interior of a geode of iron ore—pot iron ore. Suwannee, Lyon county. Summit Cut ore bank. Sent by A. L. Anderson, Esq.*"

The water had a strong astringent taste; and had deposited much ferruginous sediment in the bottle. It was analyzed by my youngest son, Alfred M. Peter, in my laboratory.

COMPOSITION IN 100 PARTS OF THE WATER, APART FROM THE SEDIMENT.

Iron protosulphate	0.2435
Alumina sulphate	.4981
Manganese sulphate	.1004
Lime sulphate	.1209
Magnesia sulphate	.0609
Potash sulphate	.0257
Soda sulphate	.0651
Sodium chloride	.0053
Phosphoric acid	.0028
Total	1.1227

The analyses of some other samples of water, from the pot ore of Trigg county, are given in volume 4, page 260–1, of Kentucky Geological Reports.

EDMONSON COUNTY.—(Continued.)

No. 1640—LIMONITE. "*Old Nolin Furnace bank, near the furnace ore. Bank about a quarter of a mile north of the furnace. Davis' branch of Nolin river. Average sample, by P. N. Moore.*"

Generally of a brownish-red color. A porous ore, with some whitish portions.

COMPOSITION, DRIED AT 212° F.

Iron peroxide	27.340	= 19.138 per cent. of iron.
Alumina	5.930	
Manganese oxide	not det'd.	
Lime carbonate	1.090	
Magnesia	.447	
Phosphoric acid	1.068	= .497 per cent. of phosphorus.
Sulphuric acid	not det'd.	
Water expelled at red heat	12.380	
Silica and insoluble silicates	51.230	
Manganese oxide, alkalies, sulphuric acid, &c.	.515	
	100.000	

This ore is too poor in iron to be valuable. It is probable that its phosphorus is somewhat over-estimated.

No. 1643—PIG IRON. "*From old Nolin Furnace. Cold blast.*" *Furnace long since out of blast.*

A fine-grained grey iron, which yields easily to the file, and extends considerably under the hammer. Seems to be tougher than usual cast iron.

COMPOSITION.—SPECIFIC GRAVITY = 7.113.

Iron	94.287	
Graphite	3.100	= 3.800 total carbon.
Combined carbon	.700	
Silicon	.493	including that in the slag.
Phosphorus	1.029	
Sulphur	.012	
Undetermined ingredients and loss	.379	
	100.000	

This appears to be a remarkable instance of cast iron remaining tough although it contains a considerable proportion of phosphorus, which is believed to render it "cold-short," or brittle at the ordinary temperature, in quantities even less than one per cent. Possibly the quite small per centage of silicon, which also renders iron brittle, may have something to do with this apparent anomaly.

The phosphorus in the above analysis was first determined as phosphate of bismuth, by the process of Chancel; but not satisfied with this determination, this phosphate, after solution in chlorohydric acid, was decomposed by sulphydric acid, and the separated phosphoric acid re-determined by means of the magnesia mixture, in the usual way; and this without any material alteration in the result obtained.

GRAYSON COUNTY.—(Continued.)

No. 1641 — "LIMONITE. "*Nolin Furnace ore bank, on the Brownsville road. Average sample, by P. N. Moore.*"

In irregular layers, varying in color and density.

No. 1642—LIMONITE. "*From Meredith Ray's farm, Taylor's Fork of Bear Creek, opposite the Chalybeate Spring. Average sample, by P. N. Moore.*"

A pretty dense ore, generally of a dark-brown color, with some lighter colored portions.

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

	No. 1641.	No. 1642.
Iron peroxide	57.830	44.528
Alumina	6.719	1.368
Manganese oxide	Not determined.	
Lime carbonate	.290	5.590
Magnesia	.122	.609
Phosphoric acid	.921	1.074
Sulphuric acid	not deter'd.	.151
Water expelled at red heat	12.180	8.940
Silica and insoluble silicates	21.040	37.380
Undetermined and loss	.898	.360
Total	100.000	100.000
Iron, per centage	40.481	31.169
Phosphorus, per centage	.412	.468
Sulphur, per centage	not deter'd.	.060
Silica, per centage	14.360	not deter'd.

It is probable the phosphorus is somewhat over-estimated in these ores.

No. 1644 — Clay Iron-stone. "*The glady ore, on the old Brownsville and Litchfield road, west of Bear Creek, Grayson county.*"

A dark-grey, fine-granular clay iron-stone, with much investing limonite ore.

COMPOSITION, DRIED AT 212° F.

Iron carbonate	16.598	= 37.945 per cent. of iron.
Iron peroxide	42.761	
Alumina	4.994	
Lime carbonate	2.840	
Magnesia carbonate	not det'd.	
Phosphoric acid	1.017	= .444 per cent. of phosphorus.
Sulphuric acid	a trace.	
Silica and insoluble silicates	20.830	
Water and loss	8.054	
	100.000	

BOYD COUNTY.—(Continued.)

No. 1645—COAL. No. 7. *Used at Ashland Furnace.*

A bright pure-looking coal, having but little fibrous coal between its laminæ; has some little bright pyrites and thin scales of lime sulphate in the seams.

COMPOSITION, AIR-DRIED.—SPECIFIC GRAVITY = 1.291.

Hygroscopic moisture	4.80	Total volatile matters	= 39.00
Volatile combustible matters	34.20		
Spongy coke	61.00	Carbon in the coke	= 54.90
		Light brownish-grey ash	= 6.10
	100.00		100.00

Per centage of sulphur = 1.312.

A very good and pure coal, which favorably compares with the best so-called "Block coal" of Indiana, and is well adapted to the purpose for which it is used.

CARTER COUNTY.—(Continued.)

No. 1646—COAL. No. 1. "*From Graham bank. Little Fork of Little Sandy river. Collected by P. N. Moore.*"

A pure-looking coal, which has some fibrous coal between its laminæ; but shows very little pyrites.

No. 1647—COAL. No. 1. "*From Graham bank, &c. Sample from all parts of the mine.*"

COMPOSITION OF THESE CARTER COUNTY COALS, AIR-DRIED.

	No. 1646.	No. 1647.
Specific gravity	1.269	not deter'd.
Hygroscopic moisture	3.50	3.60
Volatile combustible matters	36.30	35.40
Coke	60.20	61.00
Total	100.00	100.00
Total volatile matters	39.80	39.00
Fixed carbon in the coke	57.30	57.60
Ashes	2.90	3.40
Total	100.00	100.00
Character of the coke	Spongy.	Spongy.
Color of the ash	Brownish-grey.	Brownish-grey.
Per centage of sulphur	1.148	1.107

Remarkably good and pure coals.

GREENUP COUNTY.—(Continued.)

No. 1648—COAL. No. 1. "*Raccoon Creek. Raccoon Furnace. Collected by P. N. Moore.*"

A splint coal, with quite thin laminæ and considerable fibrous coal between. Some little iron stain, but little appearance of pyrites.

No. 1649—COAL. "*Hunnewell cannel coal. Hunnewell mines.*"

	No. 1648.	No. 1649.
Specific gravity	1.409	1.306
Hygroscopic moisture	4.10	1.50
Volatile combustible matters	28.90	52.20
Coke	67.00	46.30
Total	100.00	100.00
Total volatile matters	33.00	53.70
Fixed carbon in the coke	49.60	40.60
Ashes	17.40	5.70
Total	100.00	100.00
Character of the coke	Pulverulent	Very friable
Color of the ash	Light-grey, nearly white	Light yellowish-grey.
Per centage of sulphur	0.655	0.782

This cannel coal is remarkably pure and good. Its proportion of volatile combustible matters (52.20 per cent.) is remarkably great.

OHIO COUNTY.—(Continued.)

No. 1650—COAL (D.) "*From Taylor coal mines, near Beaver Dam, Ohio county. Collected by C. J. Norwood. (Rather better than a fair average.*")

A bright-looking coal, with but little fibrous coal between the laminæ, but with some scales of bright pyrites.

No. 1651—COAL (D.) "*Stevens' coal mine, near Beaver Dam, &c. Collected by C. J. Norwood.*"

Has more fibrous coal than the preceding, but shows less pyrites. Iridescent in parts.

COMPOSITION, AIR-DRIED.

	No. 1650.	No. 1651.
Specific gravity	1.315	1.316
Hygroscopic moisture	3.30	3.30
Volatile combustible matters	35.84	36.76
Coke	60.86	59.94
Total	100.00	100.00
Total volatile matters	39.14	40.06
Fixed carbon in the coke	54.36	52.60
Ashes	6.50	7.34
Total	100.00	100.00
Character of the coke	Spongy.	Spongy.
Color of the ash	Chocolate-grey.	Brownish-grey.
Per centage of sulphur	3.874	2.608

These are both very good coals; ranking amongst the best.

TABLE I. SOILS, SUB-SOILS, &c., DRIED AT 212° F.

Number in Report.	County.	Organic and volatile matters.	Alumina.	Iron oxide.	Manganese oxide.	Lime carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Water lost at 380°.	Hygroscopic moisture.	Potash in the silicates.	Soda in the silicates.	Extracted from 1000 parts by carbonic acid water.	Remarks.
1298	Boyd	3.140		5.091		0.214	0.034	0.134	a trace	0.317	0.076	90.490	0.650	1.375	not est	not est	not est.	Virgin soil (valley).
1299	Boyd . . .	3.085		6.642		.116	.178	.083	a trace	.307	.099	88.420	.525	1.735	not est	not est	not est.	Sub-soil of same.
1300	Boyd	7.985		7.425		.571	.352	.208	a trace	.435	.045	81.410	.915	2.225	not est	not est	not est.	Virgin soil (slope of hill).
1301	Boyd	5.190		9.984		.392	.251	.191	a trace	.205	.050	83.230	.500	1.700	not est	not est	not est.	Sub-soil of same.
1302	Boyd	4.915		9.019		.259	.333	.156	0.038	.344	.087	83.765	1.235	2.335	not est	not est	not est.	Old field soil.
1303	Boyd	4.905		9.675		.276	.053	.160	a trace	.282	.176	83.385	1.315	2.840	not est	not est	not est.	Sub-soil of same.
1304	Bracken . . .	4.140	5.837	7.150	.225	a trace	.297	.233	a trace	.110	a trace	82.140	1.015	2.200	not est	not est	1.316	Old field.
1305	Bracken . . .	4.775	5.513	6.025	.170	a trace	.269	.424	a trace	.197	.174	81.970	1.100	3.200	not est	not est	0.960	Sub-soil.
1306	Bracken . . .	3.335	3.837	3.965	.070	a trace	.268	.217	a trace	.135	.076	87.815	not est	2.300	not est	not est	0.666	Old field, worn spot.
1324	Campbell . . .	3.650	3.375	3.125	.059	.130	.034	.145	a trace	.120	.047	87.545	1.160	1.765	not est	not est	2.322	Virgin soil.
1325	Campbell . . .	2.555	3.415	3.038	.037	.090	.496	.109	a trace	.062	.132	89.335	1.110	1.550	1.311	0.700	1.876	Old field soil.
1326	Campbell . . .	2.540	3.900	3.274	not est	.125	.008	.093	a trace	.064	.160	88.393	1.020	1.665	not est	not est	1.220	Old field soil.
1327	Campbell . . .	2.435	3.868	3.972	.427	.125	.250	.122	a trace	.062	.109	87.560	1.040	2.235	1.477	.389	0.890	Sub-soil.
1328	Campbell . . .	8.965	4.040	4.787	.471	.450	.250	.093	a trace	.240	.071	78.963	1.500	2.550	not est	not est	1.860	New soil.
1329	Campbell . . .	7.615	5.175	6.750	.260	.990	.520	.483	a trace	.726	a trace	75.590	1.850	5.075	2.731	.929	2.700	Virgin soil (Youtsey's)
1330	Campbell . . .	5.960	5.323	6.890	.08[illegible]	3.890	.500	.313	a trace	.593	.019	75.415	1.017	4.300	not est	not est	5.650	Sub-soil (Youtsey's).
1331	Campbell . . .	5.160	3.185	4.300	.390	a trace	0.474	.420	a trace	0.443	.045	83.775	1.250	4.825	not est	not est	0.726	Gravelly loam.
1332	Campbell . . .	2.775	1.587	2.980	.070	a trace	.191	.256	a trace	.115	.048	91.655	1.035	1.400	not est	not est	1.080	Old field soil.
1333	Campbell . . .	2.135	2.737	4.465	.320	a trace	.300	.240	a trace	.125	.106	89.040	1.010	2.215	not est	not est	1.272	Old field soil.
1395	Carter.	3.110		7.405		.420	.272	.060	a trace	.293	.148	87.630	.885	2.020	0.584	0.165	1.600	Virgin soil, near Olive Hill.
1396	Carter.	4.800		17.360		.270	.124	.045	a trace	.662	.149	74.840	1.400	2.354	not est	not est	.770	Sub-soil, near Olive Hill
1397	Carter.	2.250		4.777		.860	.057	.093	a trace	.213	.132	91.690	.630	1.125	not est	not est	1.66[illegible]	Old field, near Olive Hill.
1398	Carter.	1.815		6.419		.680	.155	.070	a trace	.255	.151	90.515	.480	1.270	not est	not est	1.020	Sub-soil, near Olive Hill.
1399	Carter.	4.165		7.595		.320	.088	.100	a trace	.275	.186	85.465	1.160	1.945	not est	not est	not est.	Virgin soil, near Iron Hill (woods).
1400	Carter.	2.201		8.406		.155	.142	.109	a trace	.385	.169	87.340	.625	1.400	not est	not est	.820	Sub-soil, near Iron Hill.
1401	Carter.	3.925		6.637		.180	.051	.118	a trace	.277	.163	88.140	.900	1.475	not est	not est	2.870	Old field, near Iron Hill.
1402	Carter.	2.315		8.375		.095	.153	.115	a trace	.273	.076	87.740	.555	1.405	not est	not est	.57[illegible]	Sub-soil, near Iron Hill.
1403	Carter.	4.685		4.013		.109	.050	.147	0.00[illegible]	.153	.032	89.515	.090	1.380	not est	not est	not est	Virgin soil (woods), W. Br. Tygert's Cr'k.
1404	Carter.	2.625		5.410		.109	.061	.163	.04[illegible]	.371	.046	89.940	.770	1.270	not est	not est	not est	Sub-soil (woods), W. Br. Tygert's Creek.
1405	Carter.	2.860		4.540		.145	.035	.125	a trace	.111	.157	91.240	.690	1.215	not est	not est	1.18	Old field, West Branch of Tygert's Creek.
1406	Carter.	2.00[illegible]		5.890		.080	.050	.163	a trace	.204	.131	91.575	.450	1.275	not est	not est	.540	Sub-soil, West Branch of Tygert's Creek.
1407	Carter.	3.74[illegible]		6.115		.245	.115	.070	a trace	.279	.286	89.390	.828	1.350	not est	not est	2.070	Old field, West Branch of Tygert's Creek.
1408	Carter.	2.20[illegible]		5.609		.220	.178	.080	a trace	.360	.587	91.215	.450	1.035	not est	not est	not est	Sub soil, West Branch of Tygert's Creek.
1409	Carter.	2.500		11.500		.560	.121	.223	a trace	. . .	. . .	†84.000	not est	. . .	0.366	*0.587	not est.	Sub-soil (Grayson).
1424	Fayette	6.340		8.830		.745	.366	.55	[illegible]	.163	.057	81.467	1.556	. . .	.905	.844	not est	Cultivated field (not old).
1425	Fayette	6.570		8.[illegible]		.410	.221	.316	[illegible]	.247	.263	83.340	. . .	. . .	1.256	.362	not est.	Old field.
1437	Fulton	2.2[illegible]0		6.005		.230	0.414	0.172	no est	0.159	.072	90.490	.650	2.500	1.479	1.306	not est.	Sub-soil, old tobacco field.
1469	Grayson. . . .	3.850		7.215		.345	.240	.076	no est	.243	.125	86.850	.925	2.025	1.039	.479	not est	Old field (on sandstone).
1470	Grayson. . . .	3.375		10.930		.195	.159	.160	not est	.308	.104	84.490	.425	2.925	. . .	. . .	not est	Old field sub soil (on sandstone).
1471	Grayson . . .	4.850		5.515		.145	.140	.125	not est	.112	.051	88.790	1.325	2.125	1.022	.377	not est	Virgin soil (on sandstone).

TABLE I. SOILS, SUB-SOILS, &c.—(Continued.)

Number in Report.	County.	Organic and volatile matters.	Alumina.	Iron oxide.	Manganese oxide.	Lime carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Water lost at 380°.	Hygroscopic moisture.	Potash in the silicates.	Soda in the silicates.	Extracted from 1000 parts by carbonic acid water.	Remarks.
1472	Grayson	3.200		7.497		.045	.140	.093	not est	.105	.044	87.565	.875	2.700	...	...	.....	Virgin soil sub-soil (on sandstone).
1473	Grayson	4.950		6.195		.340	.176	.125	not est	.327	.023	86.78[illegible]	1.075	1.950	...	...	.....	Virgin soil (on limestone).
1474	Grayson	3.350		6.647		.020	.104	.093	not est	.105	.070	88.965	1.100	1.651	...	...	.....	Virgin soil sub-soil (on limestone).
1475	Grayson	4.170		4.172		.220	.167	.118	not est	.120	.045	90.640	1.100	1.775	...	...	.....	Old field (on limestone).
1476	Grayson	3.275		6.022		145	.125	.093	not est	.405	...	89.580	.350	3.500	.828	.624	.....	Old field sub-soil (on limestone).
1537	Greenup	5.050		6.831		a trace	.116	.089	0.058	.217	.055	86.505	1.000	1.650	not est	not est	.....	New soil (coaled land), Pea Ridge.
1538	Greenup	4.030		9.595		.123	.223	.115	.017	.231	.097	84.565	.685	1.775	not est	not est	.....	Sub-soil of same.
1539	Greenup	5.105		9.223		.091	.034	.192	.019	.312	.120	84.695	.615	2.150	not est	not est	.....	Under clay of same.
1540	Hardin	3.675		5.790		.10[illegible]	.250	.160	...	.151	.109	88.59	1.235	1.510	0.803	0.467	.....	Old field (on limestone).
1541	Hardin	2.600		8.617		.195	.431	.123	...	.188	.002	86.975	.925	1.575	not est	not est	.....	Sub-soil of same (on limestone).
1542	Hardin	2.650		10.775		.110	.158	.115	...	.265	.030	84.740	.750	2.14[illegible]	not est	not est	.....	Under clay of same (on limestone).
1543	Hardin	2.950		5.786		.195	.375	.119	...	.404	.030	89.555	.900	1.125	.617	.188	.....	Virgin soil (on limestone).
1544	Hardin	2.500		9.705		.145	.240	.125	...	.462	.035	85.925	.850	1.650	.798	.406	.....	Sub-soil of same (on limestone).
1545	Hardin	3.100		6.905		.245	.258	.204	...	.308	.033	87.465	1.10[illegible]	1.325	.977	.280	.....	Old field (on limestone).
1546	Hardin	2.025		9.190		.195	.140	.125	...	.327	.037	86.840	.725	1.700	not est	not est	.....	Sub-soil of same (on limestone).
1547	Hardin	3.300		7.705		.295	.339	.156	...	.193	.027	86.815	1.050	1.500	not est	not est	.....	Virgin soil (on limestone).
1548	Hardin	3.035		11.625		.110	.267	.216	...	.256	.160	83.925	.600	1.80[illegible]	not est	not est	.....	Sub-soil of same (on limestone).
1549	Hardin	4.150		6.865		.495	.501	.108	a trace	.209	.079	86.50[illegible]	1.250	1.650	not est	not est	.....	New soil (on limestone).
1550	Hardin	2.750		8.870		.245	.284	.134	a trace	.399	.054	86.640	.850	1.875	not est	not est	.....	Sub-soil of same (on limestone).
1551	Hardin	3.535		8.784		.230	.152	.156	a trace	.159	.026	86.215	.800	1.65[illegible]	0.864	0.444	.....	Old field.
1552	Hardin	3.15[illegible]		11.900		.175	.321	.108	a trace	.150	.140	83.315	.700	2.200	not est	not est	.....	Sub-soil of same.
1553	Hardin	1.950		5.926		.130	.167	.076	a trace	.163	.005	90.465	.935	1.585	1.140	0.641	.....	Virgin soil.
1554	Hardin	1.990		8.344		.080	.204	.093	a trace	.298	.120	88.115	.775	2.200	not est	not est	.....	Sub-soil of same.
1555	Hardin	2.185		5.692		.270	.213	.070	a trace	.250	.037	89.965	1.425	1.400	not est	not est	.....	New soil.
1556	Hardin	2.135		9.476		.220	.208	.134	a trace	.313	.045	86.240	.900	2.400	not est	not est	.....	Sub-soil of same.
1557	Hardin	2.100		6.359		.220	.050	.093	a trace	.223	.023	89.79[illegible]	.950	1.485	0.560	0.373	.....	Old field (on limestone).
1558	Hardin	2.935		12.798		.220	.194	.124	a trace	.342	.033	82.165	.975	2.650	not est	not est	.....	Sub soil of same (on limestone).
1559	Hardin	2.625		7.388		.190	.095	.124	a trace	.221	.026	88.090	1.150	1.385	.675	.339	.....	Old field (on limestone).
1560	Hardin	2.525		10.445		.120	.362	.120	a trace	.339	.260	85.140	.950	2.450	not est	not est	.....	Sub-soil of same (on limestone).
1561	Hardin	3.215		6.790		.370	.189	.172	a trace	.202	.049	87.765	1.400	1.630	1.148	.731	.....	Old field (on limestone).
1562	Hardin	3.785		15.763		.620	.095	.124	a trace	.421	.101	77.375	1.515	3.86[illegible]	.974	.470	.....	Sub-soil of same (on limestone).
1563	Hardin	3.080		6.564		.445	.213	.123	a trace	.293	.050	87.975	1.235	1.300	not est	not est	.....	Old field (on limestone).
1564	Hardin	2.785		10.763		.495	.282	.124	a trace	.212	.219	84.290	1.135	1.375	not est	not est	.....	Sub-soil of same (on limestone).
1565	Hardin	3.215		5.365		.445	.168	.172	a trace	.188	.041	87.940	1.525	1.890	1.550	.35[illegible]	....	Virgin soil (on limestone).
1566	Hardin	4.400		6.395		.270	.205	.045	a trace	.202	.050	88.425	.650	1.800	...	...	.....	Sub-soil of same (on limestone).
1567	Hardin	3.050		5.550		.305	.240	.102	a trace	.173	a trace	89.290	1.100	1.690	...	...	....	Old field (on limestone).
1568	Hardin	2.575		5.828		.236	.078	.112	a trace	.183	.053	90.470	.475	2.360	...	...	.....	Sub-soil of same (on limestone).
1569	Hardin	2.600		4.465		.170	.176	.147	a trace	.212	.055	91.79[illegible]	.775	1.225	1.33[illegible]	.444	.....	Virgin soil (on limestone).
1570	Hardin	2.225		7.015		.08[illegible]	.104	.134	a trace	.202	.076	89.855	.450	1.900	...	...	.....	Sub-soil of same (on limestone).
1571	Hardin	2.165		2.740		.180	.087	.067	a trace	.135	.072	94.200	.550	.800	.869	.236	.....	Old field (on sandstone).
1572	Hardin	2.575		6.900		.045	.068	.102	a trace	.181	.045	89.94[illegible]	.225	2.075	.485	.165	.....	Sub-soil of same (on sandstone).

1634	Ohio	4.100	3.032	.174	.131	.093	not est.	.125	a trace.	92.455	.900	1.175	1.273	.814	. . . . .	Virgin soil, woodland (on sandstone).
1635	Ohio	3.500	7.047	.095	.258	.093	not est.	.273	0.144	88.841	.915	2.400	1.470	.617	. . . . .	Sub-soil of same (on sandstone).
1636	Ohio	3.550	4.006	.095	.104	.124	not est.	.343	.012	91.990	.775	1.450	.939	.511	. . . . .	Old field (on sandstone).
1637	Ohio	3.350	6.475	.095	.171	.140	not est.	.269	.230	89.517	.775	2.575	1.107	.290	. . . . .	Sub-soil of same (on sandstone).
A. 12	St. of California	7.740	11.117	.790	1.596	.093	0.082	.727	.983	74.070	2.802		.814	.903	. . . . .	Adobe soil, Sacramento Valley.

* Total alkalies separated by fusion. † Silica separated by fusion with alkaline carbonates, &c.

TABLE II. LIMESTONES, &c., DRIED AT 212° F.

Number in report.	County.	Specific gravity.	Lime carbonate.	Magnesia carbonate.	Alumina.	Iron oxide.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Silica and silicates.	Per centage of lime.	Per centage of phosphorus.	Per centage of sulphur.	Remarks.
1313	Butler	not det.	93.020	2.088	0.917		0.243	0.604	not est.	not est.	2.760	52.091	0.106	0.242	S. C., Barren river, Airdrie Furnace.
1334	Campbell . . .	not det.	93.200	2.291	1.700		.076	.535	0.173	0.384	2.360	52.192	.033	.214	Lower Silurian.
1388	Carter.	2.624	97.720	not est.	0.300		.083	not est.	.115	.167	1.560	54.723	.036	not est.	Boone Furnace (flux).
1389	Carter.	2.700	95.150	.245	1.390		.130	a trace.	not est.	not est.	3.060	53.284	.056	a trace.	Iron Hills Furnace (flux).
1390	Carter.	not det.	75.750	.575	6.403		.057	.775	not est.	not est.	14.700	42.420	.032	.310	Mt. Savage Furnace (flux).
1421	Edmonson. . .	2.678	90.050	.363	0.511		.051	.260	.115	.327	1.060	50.428	.022	.104	Oolitic, sub-carboniferous.
1422	Edmonson. . .	2.721	77.550	13.314	2.680		.051	.192	.154	.188	6.060	43.428	.022	.077	Sub-carboniferous, upper part.
1423	Edmonson. . .	2.689	82.960	7.655	2.680		.115	.260	.135	.156	6.160	46.457	.050	.104	Sub-carboniferous, lithographic.
1426	Fayette	. . . .	. . . .	*.241	4.565		.415	.446	1.330	.099	6.130	68.804	. . . .	. . . .	Quicklime (Lower Silurian).
1426 a	Fayette	. . . .	96.610	.401	1.740		.057	not est.	.443	.275	.360	54.101	. . . .	. . . .	Impure calc. spar (Lower Silurian).
1498	Greenup. . . .	. . . .	88.140	.797	3.760		.178	.044	.269	.240	5.960	49.358	.077	.017	Pea Ridge (ferruginous).
1499	Greenup. . . .	2.680	88.150	.385	.152		.051	not est.	not est.	not est.	9.560	49.359	.022	not est.	Used as flux, Raccoon Furnace.
1500	Greenup. . . .	2.700	92.050	.220	1.490		.128	.199	. . . .	. . . .	4.460	51.548	.056	.079	Used as flux, Kenton Furnace.
1501	Greenup. . . .	2.770	60.750	25.656	4.167	†4.167	.013	.315	. . . .	. . . .	5.680	34.020	.005	.126	Buffalo Creek (ferruginous).
1587	Kenton	2.720	64.240	6.152	4.960		.191	not est.	.643	.260	23.860	35.974	. . . .	. . . .	Blue argillaceous (Lower Silurian).
1604	Montgomery. .	. . . .	. . . .	. . . .	.747		.023	not est.	.012	.011	.814	98.301	. . . .	. . . .	Quicklime (Star Lime Company).
1638	Bourbon. . . .	2.600	79.140	11.826	0.380	5.510	.511	.240	.231	.252	1.270	44.318	. . . .	. . . .	Cane Ridge limestone.

* Magnesia. † Iron carbonate.

TABLE III (A). IRON ORES (LIMONITES), DRIED AT 212° F.

Number in report.	County.	Iron peroxide.	Iron carbonate.	Alumina.	Manganese brown oxide.	Lime carbonate.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Water (combined).	Silica and silicates.	Moisture and loss.	Per cent. of iron.	Per cent. of phosphorus.	Per cent. of sulphur.	Per cent of silica.	Remarks.
1269	Bath	76.077	...	2.592	0.430	0.130	0.281	0.731	0.030	12.300	8.180	...	53.254	0.319	0.011	6.160	Old Slate Furnace.
1273	Boyd	53.653	...	4.324	.368	a trace	.101	.313	.220	10.150	30.940	...	37.551	.137	.086	29.560	Slate ore, Cane Creek.
1274	Boyd	58.960	...	7.284	.380	.430	.227	.370	.206	10.800	21.210	0.127	41.272	.164	.082	19.980	Star Furnace yellow kidney.
1275	Boyd	51.802	10.569	4.523	a trace	7.480	.440	.570	.089	8.772	15.730	...	41.357	.231	.035	13.160	Bellefont Furnace limestone ore.
1276	Boyd	61.344	...	4.230	a trace	.750	.208	.795	.041	11.200	21.480	...	42.941	.347	.016	18.560	Buena Vista Furnace yellow kidney.
1277	Boyd	56.022	8.821	7.194	a trace	2.520	1.271	.526	.090	10.126	13.430	...	43.473	.229	.036	11.660	Buena Vista Furnace, Straight Creek.
1278	Boyd	54.055	...	4.919	.420	.080	a trace	.076	.096	10.450	30.080	...	37.838	.033	.018	24.260	Star Furnace black kidney.
1309	Butler	48.049	...	8.171	.140	.540	.195	.345	.473	9.750	41.900	.437	33.634	.150	.189	29.460	J. E. Taylor's (L. Reedy).
1310	Butler	44.794	...	2.391	a trace	.643	.234	.535	.158	7.900	44.180	...	31.482	.233	.063	42.200	Stevens' coal mine.
1371	Carter	81.640	...	3.16	a trace	.180	.919	.000	not est	11.280	2.600	.221	57.148	.026	...	not est	Horsley bank, Boone Furnace.
1372	Carter	52.460	...	7.504	a trace	a trace	.155	1.224	.268	12.360	25.360	.669	36.722	.534	.107	23.980	Main Block, Lambert.
1373	Carter	65.657	...	4.921	a trace	a trace	.040	.893	.604	10.740	17.780	...	45.959	.391	.241	15.960	Potato Knob ore.
1374	Carter	57.092	...	4.438	a trace	a trace	.086	.374	.391	11.100	26.760	...	39.963	.161	.156	22.256	Main Block, Stewart bank.
1375	Carter	38.285	...	5.455	.120	.460	.065	1.004	.071	9.500	44.760	.284	26.799	.436	.030	40.960	Royster Hill (Lambert).
1376	Carter	57.557	...	2.727	a trace	a trace	.065	1.746	.185	11.700	26.180	...	40.292	.762	.074	...	Smith Hill (German).
1377	Carter	52.736	...	3.531	.320	a trace	.065	.800	.171	10.700	31.840	...	36.815	.349	.068	27.360	Smith Hill crown ore.
1378	Carter	40.139	5.731	8.030	*.422	.380	*.254	.038	.177	7.715	37.220	...	29.816	.013	.071	...	Lower Block ore.
1379	Carter	56.670	8.538	4.405	.180	a trace	*.883	.337	.130	9.447	19.480	...	44.736	.147	.060	...	Lower Block ore.
1380	Carter	59.950	...	5.234	...	4.580	.343	.842	.845	11.860	16.860	...	41.965	.367	.335	16.860	Garvin's Hill Block.
1381	Carter	71.502	...	8.557	a trace	a trace	.054	.466	.800	9.500	9.030	.092	50.051	.203	.320	7.64	Old Mount Tom Main Block.
1382	Carter	61.316	19.435	3.537	a trace	a trace	.212	.166	1.009	3.545	10.780	...	48.585	.072	.403	9.960	Kibby Diggings Main Block.
1383	Carter	51.623	...	1.671	a trace	a trace	.483	.081	.408	9.232	36.830	...	36.136	.035	.163	11.560	Means & Russell's.
1384	Carter	71.680	...	4.155	0.090	0.380	.050	.084	.270	10.800	12.650	...	50.176	.036	.108	11.560	Graham Bank.
1385	Carter	66.200	...	3.907	.030	.430	.345	.130	.182	11.730	16.530	0.633	46.340	.057	.072	13.860	Mt. Savage yellow kidney.
1386	Carter	59.347	9.599	1.957	.030	.830	2.027	.153	.302	5.945	19.810	...	45.347	.066	.120	15.060	Stinson Creek Main Block.
1387	Carter	52.238	...	4.512	.130	.650	.641	1.695	.230	10.650	30.580	...	36.566	.740	.091	24.260	Clark's branch Tygert Creek.
1410	Edmonson	55.028	...	1.006	.040	a trace	.108	.312	.133	8.300	35.180	...	35.519	.135	.053	33.700	Bythe Meredith farm.
1411	Edmonson	76.284	...	2.361	.032	.180	.068	1.055	.151	12.000	7.951	...	53.399	.460	.059	7.660	Proctor ore bank.
1412	Edmonson	52.926	...	4.792	.210	.180	.425	.355	.143	10.400	30.580	...	37.048	.154	.057	29.160	Frederick's bank.
1445	Grayson	27.192	...	4.299	a trace	.410	.317	.249	.103	5.600	61.730	.103	19.344	.109	.041	25.500	Rock Creek.
1509	Greenup	80.040	...	2.680	...	a trace	.425	.115	.264	10.000	6.560	...	56.280	.050	.107	...	Limestone ore, Tygert Creek.
1510	Greenup	41.556	...	8.604	...	.180	not est	.882	.851	10.100	38.160	...	29.089	.358	.340	...	Lower Block, Tygert Creek.
1511	Greenup	60.576	15.623	2.860	...	a trace	.619	.632	not est	7.040	12.650	...	49.945	.267	not est	...	Limestone ore, Hood's Branch.
1512	Greenup	54.703	17.758	2.300	.440	.340	.499	.128	.680	7.194	15.958	...	46.865	.055	.272	12.960	Poynter Bank, Raccoon Furnace.
1513	Greenup	67.859	...	1.160	.980	.120	1.275	.143	not est	12.903	15.560	...	47.501	.062	not est	11.560	Limestone ore, Two Lick.
1514	Greenup	54.530	...	2.120	1.380	.040	1.823	.908	.336	10.900	28.360	...	38.171	.428	.134	...	Lower Block, Louder bank.
1515	Greenup	46.984	7.890	5.580	*.572	21.240	2.904	.371	not est	6.999	7.860	...	39.025	.162	not est	...	Limestone ore, Coon Fork.
1516	Greenup	72.957	...	1.660	.640	.380	.083	.500	.178	9.344	15.160	...	51.070	.218	.071	...	Limestone ore, Shover drift.
1517	Greenup	49.770	...	6.315	.640	.380	.115	.166	a trace	9.020	33.200	.304	34.839	.072	a trace	32.96	Limestone ore, Powder-mill Hollow.
1518	Greenup	50.006	...	8.317	a trace	.380	.801	.767	.350	11.760	28.880	...	35.004	.330	.142	...	Lower Block, J. Thompson's.
1519	Greenup	[illegible]	...	6.777	.180	a trace	.065	.570	.154	9.700	40.380	.775	28.973	.252	.061	...	Lower Block, Allen bank.

1520	Greenup. . . .	24.396	14.972	4.077	*.421	33.775	*.968	.537	.157	5.457	16.240	. . .	23.507	.224	.070	13.510	Main Block (calcareous).
1521	Greenup. . . .	68.928	. . .	2.708	.290	.680	.641	.249	.748	11.160	15.240	. . .	48.240	.098	.290	13.610	Main Block, L. Morton bank.
1522	Greenup. . . .	56.279	11.392	4.700	a trace	.180	.476	.601	.260	9.173	16.930	. . .	44.890	.262	.104	15.260	Kidney ore, Buffalo Farm.
1523	Greenup. . . .	56.840	not est	not est	not est	not est	not est	not est	not est	not est	not est	. . .	39.788	not est	not est	24.060	Main Block, Brushy Knob bank.
1524	Greenup. . . .	67.984	not est	not est	not est	not est	not est	not est	not est	not est	not est	. . .	47.589	not est	not est	12.900	Kidney ore, Osenton bank.
1525	Greenup. . . .	42.560	not est	not est	not est	not est	not est	not est	not est	not est	not est	. . .	29.792	not est	not est	40.160	Rough ore, Clay Lick Creek.
1526	Greenup. . . .	64.577	not est	not est	1.360	.440	.820	.172	.151	11.250	21.230	. . .	45.204	.075	.070	18.600	Kidney Block, McAllister Point.
1527	Greenup. . . .	36.985	not est	5.508	.040	.520	533	.367	.116	8.330	46.760	.810	25.889	.160	.040	44.460	Rough Block, below Main Block.
1528	Greenup. . . .	44.876	not est	4.083	.260	.990	.357	.166	.123	9.850	39.080	.215	31.413	.061	.049	35.960	Lower Block, Old Town Creek.
1529	Greenup. . . .	57.551	not est	6.017	.130	.150	.758	.057	.105	10.300	25.450	. . .	40.285	.025	.042	18.860	Limestone ore (slate ore).
1530	Greenup. . . .	60.206	not est	1.044	a trace	.285	.381	.161	.852	9.500	29.930	‡1.802	42.144	.070	.341	20.860	Lime kidney ore, Brush Creek.
1580	Hopkins . . .	50.850	. . .	5.482	a trace	3.129	1.546	.198	.189	10.530	27.680	.416	35.595	.086	.075	22.220	Ochreous, near St. Charles' mine.
1597	Lyon	59.370	. . .	1.622	.090	.170	.100	.179	.908	8.400	30.000	. . .	41.559	.077	.212	26.800	Suwannee Furnace (Big Showing).
1598	Lyon	70.518	. . .	.045	.090	.090	a trace	.275	.113	9.850	18.910	.009	49.363	.120	.045	18.160	Suwannee Furnace, bank near furnace.
1599	Lyon	66.117	. . .	1.064	.170	.090	a trace	.434	213	9.800	22.230	. . .	46.819	.189	.083	21.160	Suwannee Furnace, railroad cut.
1600	Lyon	69.392	. . .	a trace	.170	.140	a trace	.303	a trace	9.550	20.500	. . .	48.574	.144	. . .	19.660	Suwannee Furn., Iron Mountain bank. Av'ge sample.
1605	Muhlenburg . .	63.048	. . .	5.290	.090	.680	.930	.147	.112	12.430	17.250	. . .	44.133	.064	.044	16.500	Airdrie Furnace (near No. 4 entry).
1606	Muhlenburg . .	60.492	. . .	7.075	.360	1.980	1.550	.083	.185	12.530	15.560	.185	42.344	.035	.074	13.660	From J. M. Hope's land, upper part.
1607	Muhlenburg . .	46.866	. . .	5.930	.103	2.535	1.073	.179	.059	9.550	33.530	.175	32.806	.078	.024	32.860	From J. M. Hope's land. Average sample.
1608	Muhlenburg . .	69.546	. . .	3.914	.230	.480	.921	.115	.216	11.250	12.730	.598	48.822	.050	.086	11.300	Martin ore.
1609	Muhlenburg . .	59.810	. . .	2.972	.720	†2.263	4.270	.223	.065	.200	29.880	. .	41.867	.097	.026	25.260	Roasted ore, Airdrie Furnace.
1640	Edmonson. . .	27.340	. . .	5.930	not est	1.090	.447	1.068	not est	12.380	51.230	not est	19.138	.497	. . .	not est	Near Nolin Furnace.
1641	Grayson. . . .	57.830	. . .	6.719	not est	.290	.122	.921	not est	12.180	21.040	.898	40.481	.412	not est	14.360	Near Nolin Furnace, Brownsville road.
1642	Grayson. . . .	44.528	. . .	1.368	not est	5.590	.609	1.074	.151	8.940	37.380	.360	31.169	.468	.060	not est	Taylor's Fork, Bear Creek.

*Carbonates. †Lime. ‡And carbonic acid.

TABLE III (B). 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.
1270	Boyd	. . .	32.285	12.784	11.968	21.125	0.691	0.465	0.377	0.267	19.730	0.308	24.591	0.164	0.107	. . .	J. P. Jones' drift.
1271	Boyd	3.362	06.854	.276	4.262	2.460	4.086	.574	.709	.885	18.360	1.538	32.466	.308	.354	15.50	Wilson Creek Blue Block, Star Furnace.
1272	Boyd	. . .	19.802	21.433	1.193	30.205	a trace	.242	.257	.157	23.080	3.633	23.109	.112	.063	18.96	Williams' Creek limestone ore, Star Furnace.
1311	Butler	. . .	29.914	17.945	3.583	12.036	3.677	a trace	.467	.381	28.040	3.957	27.041	.204	.152	25.26	John Hudson's.
1312	Butler	. . .	22.583	17.313	.835	6.714	2.830	a trace	.972	.473	44.240	4.040	22.969	.423	.189	42.76	Knob Lick.
1361	Carter	2.879	24.406	. . .	.562	45.200	24.328	.391	.147	.439	2.420	1.768	10.960	.064	.203	not est	Ferruginous limestone.
1362	Carter	. . .	61.220	4.410	2.260	4.480	a trace	.150	.313	not est	21.260	5.367	32.578	.136	. . .	not est	Old Orchard diggings.
1363	Carter	. . .	62.662	10.024	1.602	.240	2.838	3.251	.127	.521	13.720	3.017	37.285	.055	.208	not est	Old Orchard diggings.
1364	Carter	. . .	65.018	5.945	1.062	2.720	9.038	2.332	.255	1.280	10.260	. . .	35.549	.111	.533	not est	Horsley bank.
1365	Carter	. . .	44.242	27.296	1.560	6.580	1.046	.842	.732	4.587	11.160	1.955	40.465	.321	1.855	not est	Horsley bank.
1366	Carter	. . .	27.511	26.240	9.021	2.320	2.838	.270	.499	.116	25.180	6.005	31.598	.208	.046	23.82	Tygert Creek.
1367	Carter	. . .	62.321	4.989	7.901	12.00	.222	.121	.684	.206	10.740	.816	33.348	.298	.082	8.98	Sinking Creek.
1368	Carter	. . .	46.893	9.255	5.703	12.460	.250	not est	.978	a trace	23.510	.951	29.116	.447	. . .	20.86	Foxden ore.
1369	Carter	. . .	30.708	31.544	1.779	2.730	.144	.060	.421	.491	25.430	6.523	36.627	.184	.196	10.56	Mt. Savage Furnace.
1370	Carter	. . .	47.391	9.734	4.197	5.220	7.893	.346	.121	.151	20.230	4.717	29.685	.052	.060	19.76	Barrett's Creek.
1444	* Grayson	. . .	60.466	6.536	7.179	4.050	6.378	a trace	.102	.054	14.450	.785	33.630	.035	.022	11.90	J. H. Higden's.
1502	Greenup	3.880	54.773	8.648	7.800	3.780	3.088	1.204	.447	.298	20.250	. . .	29.851	.195	.105	18.56	Lower Block, Alcorn Creek.
1503	Greenup	3.297	78.722	.204	2.746	2.250	.380	.421	.505	1.160	11.340	2.272	38.146	.221	.524	9.70	Blue Kidney, Kenton Furnace.
1504	Greenup	. . .	33.321	21.270	4.991	.980	.439	a trace	.434	1.208	31.730	5.627	30.975	.189	.483	29.52	Main Block, Amanda Furnace.
1505	Greenup	. . .	30.516	14.271	6.197	16.980	.591	a trace	.614	2.332	28.980	. . .	22.270	.267	.905	27.36	Conglomerate ore, Buffalo Furnace.
1506	Greenup	3.263	44.678	6.500	4.178	2.230	1.903	a trace	.204	.250	36.880	3.177	26.073	.089	.104	34.360	Lower Block ore, Womack's bank.
1507	Greenup	not de	55.258	13.468	.670	4.880	4.528	.060	.368	1.043	15.660	4.065	36.103	.200	.416	13.360	Main Block or grey ore, Laurel Furnace.
1508	Greenup	not de	64.624	4.044	4.414	1.340	.836	not est	.217	.503	20.310	3.650	33.627	.095	.225	14.440	Grey ore, Raccoon Furnace.
1610	Muhlenburg	3.376	47.810	9.054	5.205	3.740	7.180	0.797	.179	.237	17.010	8.788	29.418	.078	.094	12.900	"Black-band ore," Airdrie Furnace.
1611	Muhlenburg	not de	42.050	29.618	2.454	2.490	4.848	1.083	.083	1.596	9.030	5.868	36.916	.035	.638	6.220	"Slate Iron ore," Buckner Furnace.
1612	Muhlenburg	not de	26.645	18.374	6.548	13.430	5.698	a trace	.211	.185	22.230	6.681	27.136	.092	.074	20.660	Jerry Hope's bank (lower part).
1644	Grayson	not de	19.598	42.761	4.994	2.840	not est	not est	1.017	a trace	20.830	8.054	37.945	.444	a trace	not est	"Glady ore," west of Bear Creek.

* See 1644.

TABLE IV. COALS, AIR-DRIED.

Number in Report.	County.	Specific gravity.	Hygroscopic moisture.	Volatile combustible matters.	Coke.	Total volatile matters.	Carbon in the coke.	Ashes.	Character of the coke.	Color of the ash.	Per centage of sulphur.	Remarks.
1279	Boyd	1.328	6.50	33.90	59.60	40.40	52.78	6.82	Dense	Light lilac-grey	3.765	Buena Vista Furnace (coal 7), Straight Creek.
1280a	Boyd	1.358	3.40	32.30	64.30	35.70	55.40	8.90	Dense	Light purple-grey	1.230	Bellefont Furnace (coal 6), Turkey-pen Hollow.
1280b	Boyd	not est	4.70	34.30	61.00	39.00	59.04	1.96	. . . . . .	. . . . . .	.982	Bellefont Furnace (coal 6). Selected sample.
1281	Boyd	1.304	3.50	34.16	62.34	37.66	55.30	7.10	Dense	Purple-grey	2.370	Chadwick Creek (coal, No. 7).
1282	Boyd	1.364	3.20	32.30	64.50	35.50	53.00	11.50	Dense	Lilac-grey	1.990	Buena Vista Furnace, Straight Creek (coal 5).
1283	Boyd	1.279	2.94	32.56	64.50	35.50	56.76	7.74	Spongy	Lilac-grey	1.972	Key's Creek coal.
1284	Boyd	1.306	3.20	29.70	67.10	32.90	55.10	12.00	Friable	Drab-grey	1.793	Bellefont Furnace, Hood's Creek (coal 3).
1285	Boyd	1.315	2.70	36.70	60.60	39.40	52.60	8.00	Spongy	Dark lilac-grey	1.711	Horse Run coal (No. 6).
1286	Boyd	1.308	3.30	33.30	63.40	36.60	57.60	5.80	Moderately dense	Light lilac-grey	2.480	Ashland Company, mine 4, Coalton (No. 7).
1287	Boyd	1.340	4.40	31.1	64.50	35.50	57.90	6.60	Spongy	Lilac-grey	2.098	Ashland Company, Dry Branch (No. 7).
1288	Boyd	1.336	4.06	34.24	61.70	38.30	54.70	7.00	Spongy	Lilac-grey	1.854	Ashland Company, Trace Creek (No. 7).
1289	Boyd	1.320	5.00	34.50	60.50	39.50	55.40	5.10	Spongy	Light brown-grey	1.285	Ashland Company (Coalton, No. 7).
1290	Boyd	1.365	4.00	34.06	61.94	38.06	53.20	8.74	Spongy	Dove colored	1.890	Mr. Bryan's bank, Four-mile Creek (No. 7).
1291	* Boyd	1.404	2.60	35.80	61.60	38.40	46.86	14.74	Spongy	Brownish-grey	5.361	W. A. Bolt's coal, Little Sandy (No. 11).
1313	Butler	1.378	3.40	30.66	65.94	34.06	54.94	11.00	Spongy	Brownish lilac-grey	2.544	Stevens' coal, Bear Creek.
1344	Carter	1.330	7.00	36.26	56.74	43.26	44.64	12.10	Pulverulent	Nearly white	not est	Old Orchard diggings (sub-conglomerate?).
1345	Carter	1.377	7.70	28.16	64.14	35.86	53.04	11.10	Very friable	Lilac-grey	1.055	Star Furnace (coal, No. 7, upper layer).
1346	Carter	1.288	6.60	34.36	59.04	40.96	54.64	4.40	Dense porous	Lilac-grey	.724	Star Furnace (bottom layer).
1347	Carter	1.290	6.40	27.22	66.38	33.62	58.88	7.50	Very friable	Light-brown	.973	Star Furnace (middle layer).
1348a	Carter	1.435	5.40	32.70	61.90	38.10	52.52	9.38	Dense porous	Lilac-grey	2.356	W. Pritchard's bank (No. 7 coal).
1348b	Carter	not est	4.50	37.10	58.40	41.60	56.40	2.00	. . . . . .	. . . . . .	.571	W. Pritchard's bank. A selected sample.
1349	Carter	1.347	6.90	33.96	59.14	40.86	51.04	8.10	Dense porous	Yellowish lilac-grey	2.430	Mt. Savage property (coal, No. 7).
1350	Carter	1.340	6.40	31.40	62.20	37.80	57.66	4.54	Dense porous	Purplish-grey	1.670	Mt. Savage property (coal, No. 7, lower part).
1351	Carter	1.323	6.06	32.94	61.00	39.00	54.80	6.20	Dense porous	Dark purplish-grey	1.867	Mt. Savage property (coal, No. 7, upper part).
1352	Carter	1.326	4.40	33.60	62.00	38.00	52.86	9.14	Dense porous	Brownish-grey	2.210	Watson's bank, No. 7 coal, "Coalton" Creek.
1353	Carter	1.274	3.80	34.50	61.70	38.30	58.50	3.20	Dense porous	Brownish-grey	2.164	Graham bank, coal, No. 1, near Willard.
1354	Carter	1.352	3.20	35.06	61.74	38.26	54.40	7.34	Spongy	Lilac-grey	2.631	Coal, No. 7, "Coalton" coal, west of Dry Fork.
1355	Carter	1.337	3.70	35.96	60.34	39.66	52.94	7.40	Dense spongy	Grey-brown	2.727	Coal, No. 7, "Coalton" coal, old Lost Creek drift.
1356	Carter	1.289	4.10	34.60	61.30	38.70	56.525	7.775	Dense porous	Lilac-grey	1.414	Coal, No. 2, Kibby drift, Everman's Creek.
1357	Carter	1.298	4.60	33.50	61.90	38.10	51.60	10.30	Dense porous	Yellowish-grey	1.200	Coal, No. 1, Stone-coal, branch of Tygert's Creek.
1358	Carter	1.307	4.20	33.70	62.10	37.90	51.40	10.70	Spongy	Brownish-grey	3.483	Coal, No. 2? Barrett's Creek.
1359	Carter	1.385	3.00	36.2	60.80	39.20	49.24	11.56	Spongy	Lilac-grey	1.381	Coal, No. 3? Carter farm, near Grayson.
1360	† Carter	. . .	2.46	1.84	95.70	4.30	87.34	8.36	Dense spongy	Lilac-grey	2.026	Coke, from No. 7 coal, Willard.
1413	Edmonson	1.282	2.30	32.10	65.60	35.40	56.30	9.30	Cellular	Light lilac-grey	1.059	Tar Lick coal, five and a half feet thick.
1414	Edmonson	1.350	3.60	33.00	63.40	36.60	54.40	9.00	Spongy	Lilac-grey	2.101	Mill Branch.
1415	Edmonson	1.367	3.20	33.8	63.00	37.00	52.60	10.40	Moderately dense	Lilac-grey	2.923	Mill Branch (much weathered).
1416	Edmonson	1.345	2.60	33.80	63.60	36.40	53.14	10.46	Spongy	Light lilac-grey	2.425	Knob Lick, Dismal Creek.
1417	Edmonson	1.429	1.20	39.00	59.80	40.20	45.46	14.34	Dense	Dark grey-purple	8.685	and 0.178 phosphoric acid. Gross, Bear Creek.
1418	Edmonson	1.336	3.66	35.14	61.20	38.80	54.26	6.94	Light cellular	Lilac-grey	2.706	Shoal Branch
1419	Edmonson	1.335	4.06	33.24	62.70	37.30	51.70	11.00	Spongy	Light lilac-grey	1.670	Tar Lick, branch of Davis Creek.
1420	Edmonson	1.437	4.06	32.0	63.94	36.06	52.84	13.10	Light spongy	Grey-lilac	4.938	Mill branch of Bear Creek.

TABLE IV. COALS, AIR-DRIED.—(Continued.)

Number in Report.	County.	Specific gravity.	Hygroscopic moisture.	Volatile combustible matters.	Coke.	Total volatile matters.	Carbon in the coke.	Ashes.	Character of the coke.	Color of the ash.	Per centage of sulphur.	Remarks.
1448	Grayson	1.305	4.70	31.40	63.90	36.10	52.20	11.70	Spongy	Light brownish-grey	1.945	Tar Lick Coal, Dismal Creek.
1449	Grayson	1.395	4.14	30.52	65.34	34.66	50.08	15.26	Dense spongy	Brownish-grey	3.565	Gravelly Lick, Miller's Fork of Bear Creek.
1450	Grayson	1.346	6.26	32.44	61.30	38.70	53.80	7.50	Light friable	Greyish-salmon	1.476	Brushy branch of Calloway Creek.
1451	Grayson	1.378	3.50	33.40	63.10	36.90	47.50	15.60	Light spongy	Lilac-grey	2.041	Copperas bank, branch of Hunting Fork of Rock Creek.
1452	Grayson	1.364	3.60	35.80	60.60	39.40	49.40	11.20	Light spongy	Light-chocolate	3.158	L. Higdon's, sub-conglomerate.
1453	Grayson	1.446	6.50	29.10	64.40	35.60	49.60	14.80	Friable	Light-brownish	.818	Gum Spring Fork of Cane Camp Creek.
1454	Grayson	1.512	4.40	25.86	69.74	30.26	40.14	29.60	Friable	Nearly white	.777	Gum Spring Fork (below slate parting).
1455	Grayson	1.338	4.24	30.82	64.94	35.06	55.52	9.42	Light friable	Brownish salmon-grey	2.892	In the sub-carboniferous limestone.
1484	Greenup	1.316	4.82	32.90	62.28	37.72	55.18	7.10	Friable	Chocolate	1.409	Coal, No. 1, Kenton Furnace.
1485	Greenup	1.345	4.96	32.98	62.06	37.94	55.46	6.60	Light spongy	Lilac-grey	4.774	J. Thompson's bank, Kenton Furnace (sixteen inches).
1486	Greenup	1.250	4.80	34.64	60.56	39.44	52.58	7.98	Dense	Lilac-grey	1.331	Coal, No. 3, Main coal, average sample, Raccoon Furn.
1487	Greenup	1.420	4.28	36.52	59.20	40.80	47.00	12.20	Dense	Lilac-grey	5.934	Coal, No. 3 (upper part), Raccoon Furnace.
1488	Greenup	1.374	3.20	36.26	60.54	39.46	47.54	13.00	Spongy	Dark lilac-grey	3.647	Coal, No 3 (lower part), Raccoon Furnace.
1489	Greenup	1.389	2.90	33.76	63.34	36.66	51.34	12.00	Dense	Dark lilac-grey	4.911	Coal, No. 3 (above shale parting), Raccoon Furnace.
1490	Greenup	1.374	3.30	31.90	64.80	35.20	52.20	12.60	Friable	Lilac-grey	2.507	Alcorn Creek, probably sub-conglomerate.
1491	Greenup	1.389	4.00	31.66	64.34	35.66	53.44	10.90	Spongy	Dark lilac-grey	4.633	Hanna bank (average of upper portion).
1492	Greenup	1.292	3.20	33.90	62.90	37.10	56.70	6.20	Spongy	Lilac-grey	0.746	Hanna bank (average of lower portion).
1493	Greenup	1.289	4.10	34.96	60.94	39.06	55.54	5.40	Spongy	Dark-brick	1.590	Coal (No. 3?), Laurel Furnace.
1494	Greenup	1.335	4.04	33.62	62.34	37.66	53.34	9.00	Dense	Light lilac-grey	1.318	Coal, No. 6, Amanda Furnace.
1495	Greenup	1.365	4.30	35.60	60.10	39.90	50.24	9.86	Spongy	Grey-purple	5.263	Coal, No. 6, Hunnewell Furnace.
1496	Greenup	1.300	3.20	36.60	62.20	39.80	53.14	7.06	Dense spongy	Lilac-grey	2.264	Coal, No. 6, Pennsylvania Furnace.
1497	†Greenup	1.355	3.80	37.70	58.50	41.50	47.20	11.30	Spongy	Dark brownish-purple	4.213	Coal, No. 6, Hunnewell Furnace (new bed).
1578	Hopkins	1.448	3.40	30.00	66.60	33.40	51.10	15.50	Spongy	Dark grey-purple	7.280	Wm. Mills' coal, Nortonsville.
1579	Hopkins	1.322	3.20	35.90	60.90	39.10	54.00	6.90	Light spongy	Light lilac-grey	2.759	St. Charles' mines.
1588	Lawrence	1.316	4.60	35.70	59.70	40.30	52.28	6.42	Spongy	Light lilac-grey	1.080	McHenry's coal bank (No. 3), near Louisa.
1589	Lawrence	1.281	5.10	35.30	59.60	40.40	57.80	1.80	Light spongy	Light grey-buff	.736	F. Swetman's bank (Coal, No. 1), Brushy Creek.
1590	Lawrence	1.376	3.30	35.16	61.54	38.46	47.84	13.70	Dense spongy	Dark lilac-grey	2.109	Coal, No. 1, Boggs' Mill, Cane's Creek.
1591	Lawrence	1.349	2.10	33.90	64.00	36.00	56.00	8.00	Friable	Yellowish-white	.736	Coal, No. 3, Holbrook's coal, Brushy Creek.
1592	Lawrence	1.350	2.50	38.56	58.94	41.06	51.44	7.50	Light spongy	Grey-purple	3.785	Coal, No. 3, Mr. Bogg's bank, upper part.
1593	Lawrence	1.284	2.50	39.00	58.50	41.50	54.76	3.74	Spongy	Brownish-grey	1.066	Coal, No. 3, Mr. Bogg's bank, lower part.
1601	Menifee	1.319	2.94	33.06	64.00	36.00	56.60	7.40	Dense	Light brownish-grey	.997	Sub-conglomerate, Hawkins' Creek.
1602	Menifee	not est	2.66	34.04	63.30	36.70	50.24	13.06	Dense	Dark lilac-grey	4.092	Sub-coglomerate, on Ledford's land.
1603	Menifee	not est	2.80	15.20	82.00	18.00	24.30	57.70	Pulverulent	White	not est	Bituminous shale above S. C. limestone.
1617	Muhlenburg	not est	7.50	4.20	88.30	11.70	82.90	5.40	. . . .	Light yellowish-grey	.640	Coke, from No. 12 coal (sixteen years weathered).
1618	Muhlenburg	1.278	3.60	31.40	65.00	35.00	58.50	6.50	Dense spongy	Lilac-grey	1.438	Coal, No. 12, Airdrie Furnace. Average sample.
1619	Muhlenburg	1.332	4.70	30.60	64.70	35.30	58.80	5.90	Dense spongy	Light lilac-grey	1.455	Coal, No. 12, Airdrie Furnace, weathered eighteen years.
1620	Muhlenburg	1.331	4.20	36.10	59.70	40.30	50.50	9.20	Spongy	Dark lilac-grey	4.573	Paradise mine (Airdrie), coal 11, lower division.
1621	Muhlenburg	1.326	4.10	35.90	60.00	40.00	53.60	6.40	Spongy	Dark lilac-grey	4.394	Paradise mine (Airdrie), middle layer.
1622	Muhlenburg	1.274	3.60	38.70	56.70	42.30	53.70	4.00	Spongy	Light lilac-grey	3.158	Paradise mine (Airdrie), upper layer.
1623	Muhlenburg	1.221	3.80	32.70	63.50	36.50	58.60	4.90	Dense spongy	Brownish salmon-grey	1.923	Muddy river coal mine.
1624	Muhlenburg	1.407	4.16	37.44	58.40	41.60	49.80	8.60	Light spongy	Light lilac-grey	2.727	Ross' coal mine, upper portion.

1625	Muhlenburg . .	1.358	3.60	34.00	62.40	37.60	50.80	11.80	Light spongy . . .	Lilac-grey	4.032	Mercer coal mines.
1626	Muhlenburg . .	1.279	3.10	40.68	56.22	43.78	50.66	5.56	Spongy	Lilac grey	2.779	Muhlenburg coal mines, upper seam.
1627	Muhlenburg . .	1.332	1.52	40.00	58.48	41.52	50.92	7.56	Spongy	Lilac-grey	2.840	Muhlenburg coal mines, main working bed.
1628	Muhlenburg . .	1.284	2.98	43.08	53.94	46.06	50.22	3.72	Spongy	Lavender-grey . . .	3.185	Muhlenburg coal mines, average head of main entry.
1629	Muhlenburg . .	1.503	1.20	7.50	91.30	8.70	86.48	4.82	Powdery	Dark-brown	3.431	Fibrous coal or mineral charcoal.
1630	Muhlenburg . .	not est	3.56	13.68	82.76	17.24	6.82	75.94	Powdery	Brownish-grey . . .	1.983	Carbonaceous mud.
1631	Ohio	1.421	3.50	35.00	61.50	38.50	52.50	9.00	Light spongy . . .	Light brownish-grey .	3.139	Rockport coal mines, average sample along entry.
1632	Ohio	1.332	3.00	36.20	60.80	39.20	53.70	7.10	Light spongy . . .	Light lilac-grey . . .	2.837	Rockport coal mines, general average of mine.
1633	§Ohio	1.334	3.00	33.50	63.50	56.50	55.10	8.40	Light spongy . . .	Lilac grey	3.332	Rockport coal mines.
A. 1	State of Ohio .	1.361	4.54	29.68	65.78	34.22	57.06	8.72	Pulverulent . . .	Nearly white	.756	Star Furnace coal, Jackson county, Ohio.
A. 2	State of Ohio .	1.322	3.60	33.42	62.98	37.02	55.82	7.16	Dense.	Brownish-grey . . .	.802	Hocking Valley coal, average sample whole bed.
A. 3	State of Ohio .	not est	4.20	36.68	59.12	40.88	54.16	4.96	Spongy	Light lilac grey . . .	1.692	Hocking Valley (stock pile), average sample.
A. 4	State of Ohio .	1.346	3.26	33.76	62.98	37.02	54.42	8.56	Dense.	Light lilac-grey . . .	2.247	Hocking Valley, average of upper twenty-eight inches.
A. 5	State of Ohio .	1.303	3.74	36.32	59.94	40.06	55.74	4.20	Dense spongy . . .	Light lilac-grey . . .	1.299	Hocking Valley, average of middle twenty-six inches.
A. 6	State of Ohio .	1.317	4.40	35.08	60.52	39.48	55.20	5.32	Dense spongy . . .	Light lilac-grey . . .	1.659	Hocking Valley, average of lower eighteen inches.
A. 12	State of Ohio .	1.312	3.46	36.64	59.90	40.10	53.80	6.10	Light spongy . . .	Light lilac-grey . . .	1.947	Sheridan coal mines, Lawrence county, Ohio.
A. 7	State of Illinois	1.310	2.62	32.04	65.34	34.66	58.58	6.76	Light spongy . . .	Lilac-grey	2.472	Big Muddy coal, Jackson county, Illinois.
A. 8	State of Illinois	1.310	3.44	31.86	64.70	35.30	59.54	5.16	Spongy	Lilac-grey	1.376	Big Muddy coal, Jackson county, Illinois.
A. 9	State of Indiana	1.313	2.70	36.38	60.92	39.08	55.64	5.28	Spongy	Lilac-grey	1.664	Indiana Block coal, near Brazil, Clay county.
A. 10	State of Indiana	not est	2.68	36.32	61.00	39.00	53.58	7.42	Dense spongy . . .	Light lilac-grey . . .	1.802	Indiana Block coal.
A. 11	State of Indiana	not est	2.40	35.10	62.50	37.50	53.50	9.00	Dense.	Lilac-grey	2.373	Indiana Block coal, lower seam.
1645	Boyd	1.291	4.80	34.20	61.00	39.00	54.90	6.10	Spongy	Light brownish-grey .	1.312	Coal, No. 7, used at Ashland Furnace.
1646	Carter.	1.269	3.50	36.30	60.20	39.80	57.30	2.90	Spongy	Brownish-grey . . .	1.148	Coal, No. 1, Graham bank.
1647	Carter.	not est	3.60	35.40	61.00	39.00	57.60	3.40	Spongy	Brownish-grey . . .	1.107	Coal, No. 1, Graham bank.
1648	Greenup. . . .	1.409	4.10	28.90	67.00	33.00	49.60	17.40	Pulverulent	Nearly white (l't-grey)	.655	Coal, No. 1, Raccoon Creek.
1649	Greenup. . . .	1.306	1.50	52.20	46.30	53.70	40.60	5.70	Very friable	Light yellowish-grey .	.782	Cannel coal, Hunnewell mine.
1650	Ohio	1.315	3.30	35.84	60.86	39.14	54.36	6.50	Spongy	Chocolate-grey. . . .	3.874	Coal D, Taylor's coal mines.
1651	Ohio	1.316	3.30	36.76	59.94	40.06	52.60	7.34	Spongy	Brownish-grey . . .	2.608	Coal D, Stevens' coal mines.

*See 1645. †See 1646. ‡See 1648. §See 1650.

TABLE V (A). MARLY SHALES, MARLES, SILICIOUS CONCRETIONS, &c., DRIED AT 212° F.

Number in Report.	County.	Silica and silicates.	Silica.	Alumina.	Iron oxide.	Lime carbonate.	Lime.	Magnesia carbonate.	Magnesia.	Phosph'ic acid.	Sulphuric acid.	Potash.*	Soda.*	Total potash.	Total soda.	Water, &c.	Remarks.
1292	Boyd	77.560	...	12.643		0.480	...	.929	...	.217	.079	1.387	.080	3.989	.639	5.830	Marly shale, near Clinton Furnace.
1307	Bracken	...	76.060	14.959		.500	...	.345	..	.486	a trace	...	...	2.735	1.515	3.400	Silicious mudstone.
1308	Breckinridge	66.680	...	20.860		1.060	...	...	0.684	.230	.061	...	...	.982	.501	...	Red under clay (ferruginous).
1315	Campbell	...	47.320	28.050		13.490	...	1.135	...	.345	not est	...	...	3.254	.641	4.800	Marly shale, Cincinnati Group.
1316	Campbell	...	68.760	12.050		9.860	...	3.859	...	.223	not est	...	...	1.329	.976	2.200	Marl (mudstone).
1317	Campbell	...	58.080	31.490		.660	...	1.135	...	.255	not est	...	...	3.045	.986	4.700	Clay shale, Newport Reservoir.
1318	Campbell	...	51.420	29.450		6.850	...	1.256	...	.122	not est	...	...	4.124	.567	4.400	Clay shale, Newport Reservoir.
1319	Campbell	...	72.660	20.500		a trace	...	.832	...	.192	not est	...	...	1.243	not est	4.200	Clay, brick clay.
1320	Campbell	...	82.560	12.223		.160	...	a trace	...	not est	not est	...	...	.675	.282	4.100	Sandy, ferruginous clay.
1321	Campbell	...	57.160	33.540		.860	...	1.776	...	not est	not est	...	...	2,698	.555	3.411	Ferruginous clay.
1322	Campbell	...	81.660	12.700		a trace	...	a trace	...	a trace	not est	...	...	.756	.637	4.400	Sand, moulding sand.
1323	Campbell	...	85.840	3.500		7.400	...	not est	...	not est	not est	...	...	not est	not est	2.200	Sand, beneath brick clay.
1335	Campbell	...	54.160	12.269	15.550	7.800	...	.165	...	.281	.659	...	...	3.298	.926	4.892	Marly shale, Cincinnati Group.
1336	Campbell	...	57.260	16.782	11.500	4.560	...	.778	...	.008	.233	...	...	4.471	1.072	3.336	Marly shale, Cincinnati Group.
1409	Carter	...	84.000	11.500		.560	...	...	.121	.223	not est	...	...	.366	.587	2.500	Sandy sub-soil, Little Sandy river.
1431	Franklin	77.380	...	10.415		1.440	...	...	.800	.435	.738	3.488	.042	8.479	.696	5.350	Green marly shale.
1432	Franklin	70.060	...	15.395		...	.875	...	2.298	.460	.570	3.565	.318	7.130	.748	6.400	Olive marly shale.
1433	Franklin	...	50.360	16.816	6.997	...	8.736	...	.936	.217	2.280	...	...	3.623	1.731	8.304	Marly shale (mineral paint).
1434	Franklin	...	52.060	18.831	9.200	...	3.666	...	1.210	.319	.920	...	...	5.402	.720	7.672	Marly shale (mineral paint).
1439	Fulton	...	74.960	18.350		.560	...	...	.309	.051	.501	...	...	.230	.124	5.800	Silicious clay (indurated).
1440	Fulton	...	81.060	13.609		.560	...	...	.139	.051	.844	...	...	.231	.021	3.600	Soft sandstone or silicious concretion.
1441	Fulton	...	89.160	7.809		.380	...	...	.086	.051	.707	...	...	.115	.084	2.400	Soft sandstone or silicious concretion.
1442	Fulton	...	94.060	3.129		.380	...	...	.173	.051	.481	...	...	.230	.124	1.600	Soft sandstone or silicious concretion.
1443	Illinois	...	70.660	20.309		.960	...	...	.307	.051	1.188	...	...	.819	.487	5.219	Post Tertiary clay, Grand Chain.
1446	Grayson	71.560	...	19.133		...	.269	...	.353	.267	.027	2.910	.052	4.115	.602	6.230	Marly shale, Sunset Lick.
1446	Grayson	...	60.060	14.130	13.480	...	.538	...	1.158	.280	.204	...	...	4.625	.783	6.000	Same, analyzed by fusion.
1447	Grayson	87.700	...	7.040		.100	...	...	.245	.370	.049	.975	.401	...	...	3.000	Soft sandstone, Horse Branch.
1577	Henry	...	23.700	7.146	11.040	44.560	...	...	.310	1.164	.961	...	...	2.100	.623	8.396	Marl (cut of Cumberland & Ohio Railr'd, Eminence).
1581	Kenton	...	77.460	16.500		.480	...	...	.121	not est	not est	...		.828	.580	4.500	Silicious grit.
1582	Kenton	...	75.700	15.793		.660	...	...	.214	.639	not est	...	...	.847	.762	5.100	Silicious grit.
1583	Kenton	...	56.400	29.971		.760	...	...	1.514	.166	not est	...	...	2.538	.551	7.100	Marly clay, Cincinnati Group, Lower Silurian.
1584	Kenton	...	68.360	22.256		1.000	...	...	1.181	.258	not est	...	...	2.139	.906	3.650	Brick clay.
1585	Kenton	...	43.461	21.000		.680	...	...	.680	.607	not est	...	...	2.447	.915	3.850	Marly shale, Cincinnati Group.
1586	Kenton	...	47.160	22.850		.840	...	...	.840	.128	not est	...	...	2.301	1.592	5.200	Marly shale, Cincinnati Group.

* Extracted by digestion in acids.

TABLE V (B). CLAYS, &c., DRIED AT 212° F.

Number in Report.	County.	Silica.	Alumina.	Iron oxide.	Lime.	Magnesia.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Water expelled at red heat.	Remarks.
1337	Carter.	48.560	37.471	a trace.	.112	a trace.	.255	not est.	.289	.283	13.030	Fire-clay, Boone Furnace property.
1338	Carter.	45.900	38.531	a trace.	.145	a trace.	.563	not est.	.250	.341	14.210	Fire-clay, Boone Furnace property.
1339	Carter.	54.620	32.466	a trace.	a trace.	a trace.	.243	not est.	.212	.679	11.780	Fire-clay, Boone Furnace property.
1340	Carter.	62.460	27.203	a trace.	a trace.	a trace.	.147	not est.	1.850	.584	7.756	Fire-clay, under coal, Old Orchard diggings, Boone Furn. property.
1341	Carter.	45.560	43.775	a trace.	.145	a trace.	.307	not est.	.963	.728	8.522	Fire-clay, Boone Furnace property.
1342	Carter.	64.260	24.604	not est.	.538	.209	.946	.157	.751	.515	8.300	Fire-clay, under twelve inch coal, Geo. Ossenton's.
1343	Carter.	66.060	23.726	not est.	*.300	*.121	.127	not est.	2.093	2.273	5.300	Clay shale, Grayson.
(a.)	France	48.680	36.920	not est.	not est.	.520	not est.	not est.	not est	not est.	13.130	Porcelain clay, of St. Yrieiex.
(b.)	China	55.300	30.300	2.000	not est.	.400	not est.	not est.	1.100	not est.	8.200	Porcelain clay, of China.
(c.)	England. . . .	63.400	31.700	3.000	not est.	not est.	not est.	not est.	1.900		not est.	Stourbridge fire-clay.
(d.)	Germany(?) . .	47.500	34.370	1.240	.500	1.000	not est.	not est.	not est.	not est.	1.000	Crucible clay, of Almerode.
1443	Illinois	70.660	20.309		*.960	.307	.051	1.188	.819	.487	5.219	Post Tertiary clay, foot of Grand Chain.
1477	Greenup . . .	49.680	35.281	traces.	.213	.136	.626	not est.	.193	.211	13.660	Fire-clay, Kenton Furnace, Louder's land.
1478	Greenup . . .	62.920	20.735	3.820	.213	2.281	.371	not est.	2.601	.659	6.400	Fire-clay, Kenton Furnace, Powder-mill Hollow.
1479	Greenup . . .	66.560	22.679	traces.	.157	.605	.563	not est.	1.946	.690	6.800	Clay, Pea Ridge.
1480	Greenup. . . .	47.060	36.620	traces.	.615	.389	.626	not est.	1.156	.234	13.300	Clay, Pea Ridge, near Hunnewell.
1481	Greenup. . . .	67.700	22.092	traces.	.101	.285	.498	not est.	1.156	.268	7.900	Clay, Pea Ridge, two and a half feet bed.
1482	Greenup. . . .	55.560	31.027	traces.	.325	.403	.358	not est.	1.167	.560	10.600	Clay, Pea Ridge, fourteen inch, third bed.
1483	Greenup. . . .	47.560	40.661	a trace.	.280	.497	.249	a trace.	.308	.409	10.036	Fire-clay, Thomas' bank, Shultz's Creek.
1613	Muhlenburg . .	63.180	26.281		.203	.255	.179	3.282	2.000	.425	4.195	Ross' coal mines, fire-clay, below the coal.

* Carbonate.

TABLE VI. PIG IRONS.

Number in Report.	County.	Specific gravity.	Iron.	Graphite.	Combined carbon.	Manganese.	Silicon.	Slag.	Aluminum	Calcium.	Magnesium.	Potassium.	Sodium.	Phosphorus.	Sulphur.	Total carbon.	Remarks.
1293	Boyd	7.132	93.208	3.350	.220	.054	2.389	1.160	.193	.144	.095	.047	.032	.104	.005	3.570	Hot blast, No. 2, Bellefont Furnace.
1294	Boyd . . .	7.127	93.712	2.990	.210	.056	1.908	.600	.644	.104	.095	.063	.010	.380	.066	3.200	Hot blast, No. 1, Buena Vista Furnace.
1295	Boyd	6.410	91.420	2.460	.240	.195	3.709	.540	not est	.176	.233	not est	not est	.385	.082	2.700	Stone-coal, No. 1 mill, Ashland Furnace.
1296	Boyd	6.503	90.899	2.560	.160	.236	5.121	.760	not est	.072	.100	not est	not est	.394	.045	2.720	Stone-coal, No. 2 mill, Ashland Furnace.
1297	Boyd	6.406	89.731	1.660	.790	.471	6.308	1.120	not est	.152	.060	not est	not est	.461	.015	2.450	Stone-coal, foundry iron, Ashland Furnace.
1391	Carter.	6.423	90.958	2.164	.116	.115	2.682	4.180	.479	not est	not est	not est	not est	.304	not est	2.280	Foundry iron, No. 2, Boone Furnace.
1392	Carter.	6.905	93.212	2.940	.060	.083	1.634	2.460	.330	not est	not est	not est	not est	.486	.079	3.000	Foundry iron, No. 1, Boone Furnace.
1393	Carter.	7.021	92.387	3.340	.760	.056	2.240	.620	.120	.120	.036	.080	. . .	.836	.057	4.100	Hot blast, No. 1, Iron Hills Furnace.
1394	Carter.	6.889	91.502	2.670	.030	.123	4.470	1.160	.128	.144	.112	.076	.023	.203	.041	2.700	Hot blast, No. 1, Mt. Savage Furnace.
1531	Greenup. . . .	6.825	91.636	2.790	a trace	.084	4.106	.600	.399	.168	.095	.086	.016	.695	.150	2.790	Hot blast, No. 1, Buffalo Furnace.
1532	Greenup. . . .	6.944	94.739	3.620	.780	.056	.877	.120	.060	.104	.082	.048	.041	.609	.037	4.400	Cold blast, No. 1, Buffalo Furnace.
1533	Greenup. . . .	6.872	88.106	1.950	.570	.014	7.317	.900	.165	.128	.123	.048	.002	not est	.019	2.520	Hot blast, silver-grey, Buffalo Furnace.
1534	Greenup. . . .	6.897	92.724	3.320	.660	.612	2.090	.300	.442	.184	.190	.104	.004	.622	.046	3.980	Hot blast, No. 1 foundry, Kenton Furnace.
1535	Greenup. . . .	7.117	91.668	2.950	. . .	.332	3.817	1.200	.128	.075	.122	not est	not est	.334	.041	2.950	Hot blast, No. 1, Raccoon Furnace.
1536	Greenup. . . .	7.041	92.368	3.690	. . .	.020	2.515	1.130	.582	.048	a trace	.056	a trace	.684	.026	3.690	Hot blast, No. 2, Hunnewell Furnace.
1614	Muhlenburg . .	6.826	86.636	.900	2.080	.202	7.704	2.260	.123	.045	.035	not est	not est	.235	.104	2.980	Silver-grey, Airdrie Furnace.
1615	Muhlenburg . .	6.826	85.455	.480	1.560	.696	7.747	3.460	.098	.089	.017	not est	not est	.445	.122	2.040	Silver-grey, Airdrie Furnace.
1616	Muhlenburg . .	7.782	86.842	.740	1.460	.355	8.614	2.360	.054	.112	.056	not est	not est	.123	.122	2.200	Silver-grey, Airdrie Furnace.
1643	Edmonson. . .	7.113	94.287	3.100	.700	not est	.493	not est	not est	not est	not est	not est	not est	1.029	.012	3.800	Cold blast, old Nolin Furnace.