FOURTH CHEMICAL REPORT

OF THE

SOILS, MARLS, ORES, ROCKS, COALS,

IRON FURNACE PRODUCTS, MINERAL WATERS, ETC., ETC.,

OF KENTUCKY,

BY

ROBERT PETER, M. D., etc.,

CHEMICAL ASSISTANT TO THE GEOLOGICAL SURVEY.

INTRODUCTORY LETTER.

CHEMICAL LABORATORY OF THE KENTUCKY GEOLOGICAL SURVEY,
LEXINGTON, KY., *February* 4th, 1860.

D. D. Owen, M. D.:

DEAR SIR: According to your instructions, I herewith transmit to you the report of the chemical work done in my laboratory, for the Kentucky Geological Survey, since the publication of the third volume.

This report embodies the results of more than five hundred analyses, as follows, viz:

Of soils, &c., from the Lower Silurian group	59	
Of soils, &c., from the Upper Silurian group	23	
Of soils, &c., from the Devonian group	27	
Of soils, &c., from the sub-carboniferous group	32	
Of soils, &c., from the coal measures group	25	
Of soils, &c., from Iowa, Illinois, Minnesota, and Wisconsin	7	
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Of limestones, hydraulic and common		75
Of iron ores of the limonite variety		75
Of iron ores;—carbonate of iron		25
Of coals		36
Of sandstones, shales, clays, &c		28
Of iron furnace slags		22
Of pig iron		31
Of mineral waters		20
Of remains of mastodon, &c., &c., &c.		7
Of ashes of various samples of tobacco		30
Of ashes of wheat, Indian corn and cob, wine, &c		8
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In all, five hundred and twenty-nine analyses, made during the past two years of the survey.

The forwarding of the report has been a little delayed by an effort which I have made to reduce its size. Finding, after some fifty pages had been prepared, that it was likely to be quite voluminous, I adopted the plan of *tabulating* the results of the analyses of the soils, ores, &c, &c., which came from the same locality, thus greatly reducing its magnitude and facilitating comparison. It was necessary, therefore, to re-write the first portion, according to this plan. I have also, as usual, tabulated all the principal analyses at the end of the report; the soil analyses being arranged according to the geological formations.

You will observe that there is now reported one hundred and seventy-three new analyses of soils, sub-soils, under-clays, and marls, and that of these seven were of soils principally from the northwestern States, made for the purpose of comparing the soils of Kentucky with the primeval soil of that great region; and that our good lands do not suffer in the comparison.

There have now been analyzed, in this laboratory, as many as three hundred and seventy-five soils, sub-soils, &c., &c., principally from this State; and the results, published in the several volumes of our Reports, form a greater body of statistics, as to the chemical composition of soils, than is to be found in any part of the world.

In the course of these soil analyses, a comparison was made in seventy-nine cases of the analysis of the virgin, or uncultivated soil, with that of some from a neighboring field which had been cultivated for a greater or less term of years; and in seventy-one cases out of the seventy-nine it was demonstrable, by the chemical analyses, that the soil of the "old field" had lost more or less of its essential ingredients, which had probably been mainly removed from it in the crops produced. In eight cases only, out of the seventy-nine, did the soil of the "old field" appear richer than the neighboring uncultivated soil; and in several of these cases a rich sub-soil had probably been mixed with the surface soil by the operations of the plow. So that it is evident that *careful chemical analysis may not only show the relative proportions of the grosser materials of the soil—as the sand, clay, oxide of iron, carbonate of lime, &c.—to which it has hitherto been mainly restricted, but is also competent, with the use of proper precautions, to exhibit the relative proportions of the more essential elements conducive to vegetable nourishment—the phosphoric and sulphuric acid, the potash and soda, &c.—which exist in it only in small, and frequently minute, quantities; so as to enable us to detect the influence of the culture of the soil in producing its gradual, but certain, deterioration.*

A gratifying result is exhibited in these soil analyses, also, in the fact that a large proportion of our Kentucky lands are naturally as rich as any on the continent, and that much of what is commonly denominated poor or thin land, and is consequently very cheap and neglected at present, if properly cultivated, in the light of modern scientific agriculture, and by the energetic use of the necessary capital and labor, might be made as productive as much of the arable lands of Europe, or of the more thickly settled portions of our own country. Large bodies of land, as well as immense deposits of mineral riches, now held much below their value and unappreciated in our State, require only the assistance of judicious *public improvements* to make them highly productive and profitable.

Amongst the limestones analyzed will be found a considerable number from various geological formations which would very probably make good *hydraulic cement*, as their composition is similar to that of known good hydraulic limestones. This kind of limestone is very valuable, and will come more and more into use as the country advances in population. Amongst them will be found, under the head of Jefferson county, a limestone from Indiana, which was used in the construction of the court-house in Louisville, which was found, on examination, to be a good water-lime, and which experience had demonstrated to be unsuited for use as a building-stone, because of its porous and absorbent nature, and its great tendency to scale off under the influence of the atmospheric agents. On the other hand, the *magnesian limestones*, which exist in abundance about Louisville, as well as in various other parts of the State, are amongst the most workable and durable of building stones. In these respects some of the magnesian limestones of the Upper Silurian formation closely resemble that remarkable magnesian limestone which is found amongst the very lowest beds of the Lower Silurian rocks—under the Kentucky and bird's-eye marble—which was used at Lexington in the construction of the Clay monument, and which resembles in composition the Dolomitic marble of the north.

The *limonite* iron ores analyzed are almost uniformly rich and valuable. A large proportion of them were from the furnaces in Crittenden, Livingston, Lyon, and Trigg counties, collected by Mr. John Bartlett; others mainly from the counties in the northeastern coal field. The examination of these ores, as well as of the carbonate of iron ores, the samples of pig iron, and iron furnace slag, will no doubt be of considerable assistance to the iron manufacture. It would appear from the analysis of the slag, or "*cinder*," from the various iron furnaces, that in those of the southern portion of the State generally, it is the practice to use a smaller relative quantity of limestone in the flux than is employed in the Greenup, Carter, and other furnaces, on the northeastern coal field. It is believed that the tendency of the larger proportion of lime in the flux, within proper limits, is to remove more of those injurious elements, sulphur and phosphorus, from the iron. This is true especially of the former element, sulphur; but some doubt exists as to whether lime alone will carry off the *phosphoric acid* which may be present in the furnace charge, and prevent its reduction to phosphorus, which, by uniting with the iron, as is well known, injures its tenacity, by making it "*cold-short.*"

A highly interesting fact, demonstrated in the analyses of the iron-furnace slags is, that phosphorus, in the form of phosphoric acid, is sometimes carried off in considerable quantity in the "cinder." From the known strong affinity which exists between phosphoric acid and alumina, it is probable that this acid exists in the "cinder" in combination with that earth, and that hence the *presence of aluminous materials, in the furnace charge, is favorable to the production of tough iron from ores containing phosphoric acid.* It is therefore recommended, in smelting many of the limonite ores of the southwestern furnaces—which are found to contain very little alumina, and sometimes a considerable proportion of phosphoric acid—not only to add enough limestone to make the cinder a "*bi-silicate,*" like the cinder of the Greenup furnaces, but also to add to the charge some aluminous materials, such as clay, shale, or other argillaceous substances free from phosphoric acid; to carry off as much as possible of this injurious ingredient. In this manner, it is confidently believed, the toughness of the iron will be increased.

Amongst the coals analyzed were two specimens from Carter county of cannel coal, both from the same region, which exceed even the Breckinridge coal in the production of oil, as they also contain less sulphur and earthy matters than that. The manufacture of oils, paraffine, &c., from cannel coal, has, since this survey commenced, taken a wonderful expansion in this country, and is destined still more to increase as experience in the preparation and use of these valuable products of our cannel coal is acquired. There can be no doubt, from the abundance of good cannel coal in our coal fields, and the large quantity of the oil obtained, that cheap production will cause very extensive consumption; and, when the *heavier oils* obtained in this manufacture, have found their appropriate application, a large amount of capital and labor will be profitably used in these new species of industry.

Great drawbacks at present on this manufacture are, the great expense incurred in machinery, &c., in experiments to find the best processes, and the difficulty of obtaining a good market for the heavier oils. The first will cure itself in the end; and it may be that ingenious persons will either find extensive uses for the heavy oil, or that by a new process (of graduated destructive distillation, for example,) it may be converted into oil suitable for burning in lamps; which is the most extensive application of the more volatile and fluid coal oils.

The thirty analyses of the ashes of tobacco, from various parts of the State, as well as from Cuba and Florida, were undertaken with a view to ascertain the relationships of this plant to the soil on which it is grown, as well as the influence of the soil on the character of the tobacco. It is hoped that this investigation, which is more extensive than any other published, so far as the writer is informed, may be serviceable to an important branch of agriculture in our State. The same remarks will apply to the examination of the mineral ingredients of wheat, Indian corn, and the fermented juice of the grape. By the latter examination it is shown that vine culture, if judiciously carried on, need not be as exhausting to the soil as the ordinary corn crop. This branch of agriculture, which has extended greatly in our neighboring State, Ohio, is well adapted to this region, and will find very appropriate soil and location on much of our land which is now considered too poor or too hilly for profitable culture in the ordinary farm crops.

The twenty mineral waters examined are mostly from two of our well-known watering places.

Yours, respectfully,

ROBERT PETER.

GENERAL REMARKS ON AGRICULTURE AND ON SOIL ANALYSIS, &c.

Although Kentucky can justly boast of the great mineral wealth contained in the two extensive coal fields within her northeastern and southwestern boundaries, with their immense deposits of iron ores, &c., &c., which have already given a great impetus to the industry, the manufactures, and commerce of our citizens; yet, when we observe the large body of lands in the center of the State, some of which may be classed amongst the richest on the surface of the globe, and reflect that almost the whole area of the State is susceptible of cultivation, in the hands of industrious and enlightened farmers, we cannot fail to be convinced that agriculture is her largest interest and the cultivation of her lands her greatest source of wealth.

That this will continue to be the case as long as her lands yield abundant products for the support of her inhabitants or for exportation, and will cease to be true when they become worn out or unprofitable, so that the harvest no longer repays the labor spent upon the soil, is a fact obvious to the most casual observer; and that the soil may become thus unprofitable in the course of time, has been demonstrated by lamentable experience in the history of large bodies of land on the Atlantic shores of some of the older States, which once enriched the early settlers of this country by their luxuriant growths of tobacco, and large harvests of wheat and corn, and which now, even after a long season of rest, are too poor to repay the labor of the husbandman, and hopelessly sterile without the application to them of imported manures; as it was still more early exemplified in Europe and in Africa, where extensive regions, now worthless wastes, yielded in ancient times abundant harvests of grain for exportation.

This deterioration of the soil, by ordinary cultivation, is beginning to be shown in the rich new lands of the west and northwest of our own continent; on which, according to reliable statistics, the crops within the last ten years have lamentably diminished on the best cultivated lands, as well as in all parts of our country, where proper care has not been taken to keep up the fertility of the soil; the wheat and corn crops, particularly, being found to be much less on the same extent of ground than formerly. According to J. H. Klippart, Corresponding Secretary of the Ohio State Board of Agriculture, in the preface to his elaborate work, "The Wheat Plant," "Wheat, the staple crop of Ohio"—where scarcely any effort is made to return to the soil the essential elements which are removed from it in the crops—"has been annually diminishing in its yield per acre, and in less than fifty years the average product has been reduced from thirty to less than fifteen bushels per acre, whilst in Great Britain"—by the use of guano, bone dust, super-phosphates, lime, marl, and a more thorough culture—"the yield has increased from sixteen to thirty-six bushels per acre during the same period."* According to Jay, in his "Statistical View of American Agriculture," "in Indiana, the river bottoms, which used to produce an average of sixty bushels of corn to the acre, now yield only forty bushels." Numerous other facts of the kind could be quoted; and we may add, that all who have taken the trouble to collect the statistics on this subject from all parts of the United States, have come to the same conclusion, viz: that under the ordinary system of agriculture in this country, our lands are becoming less fertile, and consequently less profitable to the farmer and to the community than formerly; and thus every year the territory of the nation, on which it depends for food and clothing, undergoes a diminution in value, which, taken in the aggregate, appears immense; rendering labor less productive, and driving population farther and farther west towards the Rocky Mountains. In the same course of events, these new lands, not really richer than were most of those of the older settled regions in their virgin state, will be reduced to the same unprofitable condition, and then by force at last will the husbandman be obliged to study the philosophy of his profession, and to learn the true principles of agriculture,

*This statement of Mr. Klippart is denied in the strongest terms in a review of this work in the Ohio Cultivator, Columbus, Ohio, October 15th, 1859, page 313, in which it is called "a falsehood put forth within the last four years by patent medicine men," &c.; and in an article in the same periodical, November 1st, 1855, headed *Prof. Mapes and the Wheat Crop of Ohio*, in which this statement is called "a favorite scandal of Prof. Mapes," it is asserted—1st. That the average wheat crop of Ohio was *never* thirty bushels per acre; and 2d. That the average per acre of wheat in Ohio amongst the majority of good farmers was never better than at that present time. It is evident that the data quoted by the reviewer are imperfect for either side of the question, and that this statement of Prof. Mapes and Mr. Klippart may not be sufficiently well grounded. But yet the general fact of the gradual deterioration of the soil by thriftless culture, and the consequent diminution of its crops, is unfortunately too widely demonstrated in this country as well as on the older continents.

viz: how to cultivate the soil and enjoy its products without impoverishing it.

That our own soil, in Kentucky, is undergoing this gradual process of deterioration, is fully shown by the comparative analyses detailed in the following pages.

An evil so great as the serious decrease of the profits of labor applied to agriculture, which has so much diminished the intrinsic value of landed property, in many places in the older countries as well as in our own, demands the serious attention of governments and of the people; to discover the cause, and to apply the remedy.

Long experience in agriculture has taught the importance of deep and thorough plowing, of draining, of the proper selection of seeds, and of timely, careful, and clean cultivation, as well as the adaptedness of particular crops to region, locality, soil, and season. It has taught us the advantages of fallow, of rotation of crops, of the uses of green crops, either by plowing in, or by feeding animals and the making of barn-yard manure, for the restoration of tired or worn down fields. Many of the valuable precepts of modern husbandry, verified by long experience as the best for the production of good crops, were indeed known to and followed by the Egyptians, the Greeks, and the Romans; but the constant deterioration of the soil, in all those regions where the crops were permanently removed from the land, to be consumed in a different locality, whether that crop consisted of grain or other vegetable products, or of animals, showed that a perfect system of agriculture has not yet been attained; and that a closer study of the soil and its products than was possible to the ancients is necessary.

The ancient theory, that, with *good cultivation*, the land is inexhaustible, which has brought these disastrous results, is yet maintained, even by some of the leading agricultural authors of Europe, and is practically indorsed by most of the farmers of the world, and especially of this country. In our rich virgin soil, ordinary care in sowing, cultivation, and harvesting, only is necessary to secure good crops, and the partial exhaustion of the soil is scarcely appreciated in the first generation. The farmers, who come after these first, find it advantageous to plow deeper, and to study the rotation of crops and the renovating influence of clover; their successors may be obliged to resort to barn-yard manure, to sub-soil plowing, or may even think it more profitable to seek *new* lands, rather than to endeavor to renovate the old; whilst the experience of older countries have shown that all the manure which can be made on the much exhausted lands which have been cultivated through a long succession of years, is not sufficient, in many cases, to make them produce profitable crops, with all the labor and skill which may be applied to them, and it becomes evident some extraneous fertilizer must be applied to the worn out soil to enable it again to bear remunerative crops.

In England, and other countries in Europe, as well as in some parts of this country, that something extra was found in plaster of paris, in lime, in marls, in guano, in bone-dust or super-phosphates, in phosphatic mineral substances, in various salts of potash and ammonia, or in the contents of the cess-pools and the water closets; and it has been mainly by such means, aided by improved machinery and management, that the products of the fields and the profits of agriculture, in England particularly, have been wonderfully increased, so that the grain crops have been more than doubled on the same space of ground, within the last fifty years.

A difference of opinion has existed, and much debate arisen, as to the *really essential materials* which are taken from the soil in the cultivated crops, and which must be returned to it to restore its fertility. Some; maintaining the opinion, which was held formerly by Dumas and Boussingault, of France, and still upheld by many agricultural writers of England; contend that the relative proportion of nitrogen, or of ammonia, in a manure, determines its value as a fertilizer, and that the atmospheric elements of vegetables are the only really important ones. Others consider what they denominate "*humus*" to be the true food of plants; whilst others, with Sprengel and Liebig, contend, with a somewhat better logic, that the *fixed* or *mineral* ingredients of crops and manures, such as are found in their ashes when burnt; as the phosphates, lime, the alkalies, &c., are the most important for the consideration of the farmer, because, whilst every different element of the vegetable composition is equally essential to the growth of plants, those which are of a fixed nature, and only to be found in the soil, were to be more carefully husbanded and preserved from waste and loss than those elements which are everywhere abundant in the atmosphere.

It is a question of vital importance to agriculture, and, consequently,

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to mankind at large, on which depends the largest and nearest interests of our race, and, as may be understood on reflection, one which can be decided only by the aid of modern science—only by ascertaining the minute composition of the soil, and of the atmospheric agents and water which penetrate and moisten it; of the vegetable and animal bodies produced on it, and of the elementary nature of the food and excretions of plants and animals.

Men of science have, with great activity, thrown themselves into this new field of useful research, and within the last twenty-five years this very important question may be said to be in reality settled. Twenty-five years ago some of the ablest chemists of the world had failed to detect that important ingredient, potash, in soils, and the existence of phosphoric acid in them, or in the rocks whence they were derived, was almost matter of speculation alone; but now careful and minute analyses have been made of many soils in various parts of the world, and the mineral elements of plants of many kinds, and the remarkably constant nature of their ashes, as well as the elementary composition of manures, have been ascertained. Numerous experiments have been made on the growth of plants in pure sand, pure silex, and pure charcoal, &c., with or without the addition of the various materials believed to be essential to their growth—as well as extensive observations in the garden and field with various salts and fertilizing agents—and a body of information has now been obtained which, whilst there yet may be, amongst the imperfectly informed or prejudiced, some warm advocates of the exclusive *humus*, *nitrogen*, or *mineral* theories, has caused the real men of science throughout the world, whatever their supposed partisans may think, to be very much of one opinion upon the subject.

The rational theory, which appears to be based on truth, now generally maintained by men of science throughout the world, is the result of numerous observations and experiments mostly made within the present century, and may be summed up in few words:

All plants and animals are *ultimately* composed of comparatively few elements; of these, some, such as *carbon*, *hydrogen*, *oxygen*, and *nitrogen*, which make up the greater portion of their weight, are derived by vegetables from the atmospheric air and the water which penetrate their tissues, and obtained by animals, directly or indirectly, from vegetable food. The remaining elements, *equally essential to organic existence*, but found in vegetable and animal bodies in much smaller proportions than the *atmospheric elements* above detailed, are derived, mediately or immediately, from the soil, and have been called, by distinction, their *fixed* or *mineral elements;* these are *potassium, sodium, calcium, magnesium, iron, manganese, phosphorus, sulphur, chlorine, silicon, &c.*, mostly existing in the soil and in organic bodies in the state of the oxides, *potash, soda lime, magnesia, oxides of iron and manganese, silex*, or as *chlorides of potassium* and *sodium, &c.* The phosphorus and sulphur, usually found in the soil and absorbed in the form of salts of their acids (phosphoric acid and sulphuric acid), viz: as phosphates and sulphates, exist, also, in some few organic compounds, uncombined with oxygen.

All these elements, whether from the atmosphere or from the soil, are equally necessary to the formation of organic tissues, animal or vegetable, and the absence of any one of them would be fatal to the growth and development of these living beings; consequently, it would appear to be waste of time to theorize as to the relative importance of any of them. But in *practical agriculture* the case is somewhat different, and the one set of elements—the *fixed* or so-called *mineral elements*—become most worthy of consideration and care, because of the greater danger of their alienation and loss, and the greater difficulty experienced in their restoration.

All living plants can, by the aid of solar light, decompose the water and carbonic acid always present in the atmosphere and penetrating the soil; and it is thus they obtain the *carbon, hydrogen*, and *oxygen* necessary to form their tissues; and reliable experiments show, in the air and in the soil, even the most sterile, enough *nitrogen*, in combination either with hydrogen as ammonia, or with oxygen as nitric acid, to supply the most greedy need of this element by vegetables. Indeed it has been proved that many plants, such as the clover, can even work up the gaseous nitrogen existing in such large proportion in the atmosphere, if indeed all vegetables do not exert this power. The supply of these *atmospheric elements*, then, is constant and inexhaustible. For when these organic bodies decay, or are destroyed by any process, these elements are again restored to the atmosphere, the carbon and the oxygen forming carbonic acid again, and the hydrogen and nitrogen producing water and ammonia, or nitric acid, with the aid of the abundant oxygen of the air, and these compounds, as gases and vapors, ceaselessly penetrate the atmosphere, according to known physical laws, causing its composition to be uniformly preserved, and insuring to vegetable life, on every inch of the surface of the globe, a constant and abundant supply of these important elements.

But the *potash*, *soda*, *phosphorus*, *sulphur*, *lime*, *magnesia*, &c., &c., exist only in a fixed condition in the soil, and in the rocks from whence it is derived, and, especially the four first mentioned, in only limited and comparatively minute quantities; and they are not certainly re-supplied by any general natural process, when they have once been removed from it; but when they have been taken up, as they continually are, into the tissues of plants, and secondarily, into the composition of the bodies of animals, they are usually, in the common course of the consumption of agricultural products, entirely alienated from the soil and in great measure lost to it forever; and this is, in reality, the great cause of the gradual deterioration of the arable land observable all over the globe where agriculture is carried on according to the ancient methods.

As long as men congregate in towns and cities, and consume, within the limits of a small space, for food for themselves and their domestic animals, for clothing and for fuel and construction, the products of a large extent of country, without returning to the land which supplies them any of the *phosphates*, the *alkalies*, or other essential materials of the soil; which, on the contrary, are constantly lost in the cess-pool and the sewer, or allowed to find their way into the streams, and finally into the sea; so long will the country be gradually impoverished, whatever care may be taken to retard the process by various modes of culture, unless these elements thus withdrawn from the soil be restored to it from some other source. Science has long since demonstrated that no element, nor the millionth part of a grain of matter of any kind, can be destroyed by any known power of nature or of art, whilst it is equally impossible to originate it or to change its nature. The various products of the soil consumed as food are not really destroyed; their *atmospheric elements* escape mainly from the bodies of the persons and animals who consume them, as gaseous and vaporous emanations, from the lungs and the skin; whilst the *fixed* or *mineral* elements pass out of the body in the liquid and solid excretions. That quantity of these fixed materials which enter into the composition of the body at death, is left in the soil which hides its decomposition, which gradually returns the atmospheric elements to their source; whilst even that portion of the products of the soil which is used as fuel, undergoes the same process, but more quickly, giving its volatile portion to the air in the ascending gases and vapors of the smoke, and leaving the *fixed* elements in its ashes.

As cities will continue to exist and increase, and consume the products of the country, a true system of agriculture, the first principle of which is to maintain the productiveness of the soil, would either provide for the final restoration to the land of all those valuable fixed ingredients which thus accumulate in and around them, or are carried off in the streams into which they are drained, or give it an equivalent quantity of them from some other source.

In China, we are credibly informed, the densely populated land has its fertility perfectly maintained mainly by the former plan alone; and in Belgium, and to some extent in France, the small farms, which are only large enough to support the families which cultivate them, and on which, whilst everything raised is consumed on the place and nothing, or almost nothing, is exported, the careful preservation and application to the soil of all kinds of manures made on it, keeps it constantly in a high state of fertility. The Flemish husbandry has long been noted for its success in this respect. All the fertilizing materials from the dwelling-house, the stable, the barn-yard, or the lane, are collected into a cistern, where they are allowed to undergo a kind of fermentation with an abundance of water, and then the fluid mass, properly diluted, is applied to the land, at appropriate seasons, with very striking results.

But almost insuperable difficulties prevent the practical working of any known plan, in this country or in England, by which the cities may be prevented from draining off the fertilizing elements of the soil of the regions tributary to them, and the nuisances of the towns may be employed to re-enrich the country; and railroads, and other modern improvements, have so facilitated the cheap transportation of agricultural products, that the alienation of the essential elements is greatly increased, as well as the difficulties attending their restoration. The distance between the locality where they are produced and the city where they are consumed being so great, frequently, that the necessity is almost inevitable of looking to some other sources for the supply of the lost mineral elements.

It is fortunate for us that such sources exist, to some extent, in various parts of the country. The rich, fossiliferous, easily disintegrating limestones and marlstones of the Lower Silurian formation—much of the soft black shales, many of our marls and under-clays, in several regions, contain much potash, soda, sulphur, phosphorus, lime, magnesia, oxides of iron and manganese, and soluble silica. The chemical analyses of the various soils of the State and of these rocks, marls, &c., show their relative adaptiveness, and indicate the possibility of obtaining an available supply of mineral fertilizers in many places; and the more thorough study of the essential mineral elements of crops will enable us finally to apply them judiciously.

But agricultural experience has shown that something more is required than the mere *presence* of the essential elements in the soil to make it fertile; it is necessary, also, that they should be in a *soluble condition*, and in proper proportion, to be available for the nourishment of plants. Hence the opinion has occurred in the minds of some that soil analysis is not of any use in determining the intrinsic value of a soil, or its peculiar adaptiveness to any particular crop. Yet this very fact, that the essential elements of vegetables may exist in an *unavailable* condition in the soil, could not have been demonstrated in any other way than by chemical analysis. Common sense teaches us that although all the elements necessary for the vigorous growth of plants may be present in a locality, yet the failure of certain *conditions* would prove fatal to their development. A soil is just as rich, *per se*, during the severity of the winter months, or at the time of a continued drouth—just as full of the elements of vegetable nutrition when drowned by a surplus of water, either of which conditions would wholly prevent the growth of plants, as when the warmth and genial rains of spring cause vegetation to progress with giant strides on the well-drained surface. But all the showers of April and the stimulating warmth of early summer, would fail to produce a crop on land in which these elements were not to be found. The same soil which, in Ohio or Kentucky, would produce a luxuriant growth of Indian corn, transported to Northern Canada would fail to bear any but a scanty and imperfect growth. For these differences of production the *composition* of the soil is not accountable; and in applying the facts given by soil analyses, all those *conditions* which influence vegetable growth must be taken into consideration. The great business of agriculture is to bring together all the favorable conditions which conduce to the productions of large crops, without seriously impoverishing the land; and amongst these a proper mineral composition of the soil is of paramount importance, and indispensable in every climate or situation on the globe.

A great deal has been learnt by experience, and proved by scientific research, as to the best modes of making the essential elements of the soil immediately available for the growth of crops. For example, there is much ground for the high value given to *ammonia* and its salts, in stable manure, guano, poudrette, &c.; because, not only does this alkali and its salts yield the indispensable *nitrogen* to plants, but they are also *solvents*, to some extent, of the earthy *phosphates* and other nutritive mineral materials of the soil, bringing them into a condition favorable for immediate absorption into the tissues of vegetables. The same remarks will apply to the *humus* of some writers. Whilst it is undoubtedly true, as is asserted so strenuously by Liebig, that humus, *per se*, cannot afford any nourishment to plants, yet it must be universally acknowledged that the presence of humus in a soil is highly conducive to its fertility. The term *humus*, as understood by chemists at present, is applied to a mixture of compounds of carbon, hydrogen, and oxygen, and sometimes a little nitrogen, which result from the decomposition of vegetable substances, and which give the dark color to the surface soil called *vegetable mould*. To this humus, or its various derivative compounds, have been applied the terms *humine*, *ulmine*, *geine*, and *humic*, *ulmic*, *geic*, *crenic*, and *apocrenic acids;* none of which substances contain any of the *fixed* or *mineral* elements necessary for vegetable nutrition, when obtained in their separated state by the chemist. But they possess so strong an attraction for potash, soda, lime, magnesia, oxide of iron, &c., &c., that *in the soil* they are always combined with them. They, morever, aid so much in rendering these substances, as well as the phosphates and silica, soluble in water; and, besides, they absorb the gases and vapors, water, and the heat of the sun with such force, that there is much reason for the opinion of Berzelius and others, that *vegetable mould* is the real source of fertility.* On examining the report of the analyses of soils, given in this

* Berzelius says: "Arable soil is a layer of vegetable mould (*terre vegetale*) placed on a layer of earth which does not contain humus. Its fertility depends on the quantity of the latter which it contains. Vegetables diminish constantly the quantity of geine contained in the soil, and when we remove the plants which have vegetated in that earth, as is almost always done with arable land, this in the end becomes exhausted to such a degree that it no longer produces anything. For this reason we manure the soil."—*Berzelius, Traite de Chem., French Ed.*, 1832, *vol.* 6, *p.* 579.

and the preceding volumes of the survey, it will be seen invariably when the sub-soil is poorer in organic matters than the surface soil, that although it is really richer in potash, phosphates, &c., than that, digestion in the carbonated water gives a smaller quantity of *soluble extract* from the sub-soil than is obtained from the surface soil which contains more *humus*. Hence such sub-soils, although proved to be very rich in the essential mineral elements, would be found not to be as fertile, at first, as might be expected from their mineral composition, and would require some time to acquire humus by the decay of vegetables on it, or the application of organic manures, to bring its mineral treasure into a *soluble* or available condition. In this we find *one* reason of the utility of barnyard manures, and for the plowing in of clover and other green crops; whilst for the want of such applications, to bring the essential elements to a soluble condition, to attract moisture and gases, to give a dark color to the soil, favorable to the absorption of heat from the sun, the *mineral* fertilizers alone have, in many instances, appeared to fail to produce the effects which scientific theory seemed confidently to predict.

The conditions which must combine to produce the great result—plentiful and profitable harvests without disastrous injury to the soil—are therefore numerous. The business of the true agriculturist is, consequently, an elevated one, requiring much more preliminary training than is usually given to it by its followers. A great reform is necessary in regard to it throughout our whole country, to prevent the impending evils which will, in time, certainly follow the gradual deterioration of our arable lands. More attention must be given to the *education* of youths destined for the profession of farming, and the scheme of instruction in general must be modified from the time-honored system, almost exclusively pursued in our colleges and academies, according to which the great advances which have been made in modern science, and its applications to the wants of society, are almost entirely ignored; and the training of the young men of the nation should be more fully adapted to our modern pursuits and the requirements of our modern civilization.

It is hoped and believed that some benefit will be ultimately conferred on the community at large, and on agriculture in particular, by the numerous analyses of soils, sub-soils, under-clays, marls, and of the rocks which underlie them and contribute to their formation, contained in these volumes. A prejudice has arisen as to the utility of this kind of examination, even in the minds of some of our best agriculturists; for which, however, there is much appearance of reason; so few analyses of this kind have been made, even yet, relatively to the very extensive field to be explored, that it may well be believed that a fair comparison of results necessary to the full establishment of the truth in regard to vegetable nourishment can hardly yet be made; whilst many of those examinations which have been made, have been so imperfectly done, that some of the most essential elements of the soil have not been detected or estimated, and the analyses, therefore, are worse than useless.

The difficulties attending such examinations as these, when they are made with all the precautions necessary to give value to the results, are so great, and the appreciation of their value so limited, especially amongst practical men, who have not all been educated to comprehend even the terms of modern science, that if left to individual enterprise alone, such a work would not be undertaken for ages, as the comparative analyses of the various soils of a State. Yet it is fully demonstrable that through the scientific investigation of the nature of soils, manures, and of the products of our fields, lies the only pathway for further improvement in agriculture; a matter, now and from henceforth, of vital importance to the world; and it is as much the duty of governments and communities to provide for the prosecution of this, as it is to institute surveys and improvements of coasts and harbors, and to establish geographical lines and boundaries. Such information once obtained and published, however abstruse the details may appear to the casual reader, or the imperfectly trained operative, cannot fail in the end to find its appropriate applications.

Such a work, to be eminently useful, must be thorough and exhaustive, and can in no way be so economically carried on as by the patronage of a State, a government, or a community. When a single soil is to be examined, and the exclusive attention of the chemist is given to it, to secure the nicest accuracy in the results, without which all his labors would be worse than useless, one month of time would be little enough for the purpose. One of our most distinguished chemists in the North [see Patent Office Reports, Agriculture, 1858, page 291] emphatically asserts, that whilst it demands from twenty to twenty-five days to execute an accurate soil analysis, "no chemist can properly attend to more than one analysis at a time." But, with due deference to so distinguished authority, I make bold to assert, as the result of full experience, that, when a large number of soils are collected together at the same time for analysis, with a proper organization of the laboratory and arrangement of the various processes with a view to the saving of time and labor, as many as twenty to twenty-five of these different analyses may be completed within the same space of time, without the slightest neglect of any, or the least sacrifice of accuracy; whilst from twenty to forty different analyses may be in different stages of progress at the same moment, all under the eye of a single experienced analyst. In thus arranging his operations in the laboratory of the Kentucky survey, to effect the largest possible amount of work with the greatest economy of time, labor, and expense, the writer had an eye entirely to the attainment of valuable comparative results, knowing that the true value and utility of such labors can only be established after thorough experience and in a great number of separate examinations. Hence, he has made many other minor and unimportant matters of detail, in common laboratory routine, bend to the great design of completing the greatest possible number of accurate minute analyses. And, as the time of the analyst is usually frittered away in a multitude of small operations, as many of these as possible have been performed simultaneously. His implements have been multiplied to a number sufficient to enable him to digest, filter, ignite, dry, &c., a great number of soils or educts at the same time; his balance and operating table, in continual use, have been placed close to the sand-bath and water-bath, &c., to prevent loss of time in unprofitable motions; and the absence of a separate room for the preservation of the *balance*, has been compensated by very free ventilating flues, so arranged as to carry off any fumes which might injure that delicate instrument, and thus, with the use of fixed counterpoises for his capsules and crucibles, much valuable time has been saved in the numerous weighings. In this manner, with the aid of a young assistant, to perform many of the mechanical operations, a number of minute analyses have been completed, in a given time, which might seem impossible to one who always worked according to the ordinary minor rules of the analytical laboratory; and a great number of valuable results obtained, at a very much smaller expense, than would have been possible, had the investigation been left to individual enterprise alone.

DETERMINATION OF THE PHOSPHORIC ACID IN SOILS, AND SEPARATION OF THE MAGNESIA FROM THE ALKALIES.

Since the publication of the description of the method employed in these soil analyses, (in Vol. III, p. 177 of these Reports,) some improvements have been made in these processes. The use of the molybdate of ammonia for the determination of phosphoric acid, by the process of Sonnenschein, has not met with general approbation amongst chemists, and is liable to great irregularities, unless certain precautions are taken. The description, in Vol. III, of the modification of this process used in my laboratory, is likely to lead to error, especially in the statement that hydrochloric acid is added to the mixture to destroy the ammonia of the test liquid. A certain amount of ammonia, it is well known, is always present in and necessary to the composition of the *yellow molybdo-phosphatic precipitate*, and the presence of any chlorine is very objectionable, by rendering this yellow compound more or less soluble. The precautions to be employed are; first, after having burnt out all the *organic matters* from the soil, which is important, to digest it for a week or ten days at a moderate heat, in an excess of slightly diluted nitric acid, with very little hydrochloric acid added. The filtered solution is now evaporated *nearly to dryness*, at a heat approaching the boiling temperature, with an excess of molybdate of ammonia, (as compared with the phosphoric acid present;) water is then added to the yellow solid residuum, with a little nitric acid, and it is allowed to stand in the cold a few hours, when it is washed on a filter, with a little cold water slightly acidulated with nitric acid. It is now dissolved in ammonia, and the phosphoric acid precipitated with ammonia-sulphate of magnesia. As the yellow precipitate, containing the phosphoric acid, is soluble to some extent in the salts of ammonia, even in the nitrate, the process of Sonnenschein, in which much nitrate of ammonia is present in the test liquid as well as in that which is used for washing the precipitate, is objectionable. This precipitate is also soluble in the chlorides; hence the presence of chlorine must be avoided, and the chlorine, from the little hydrochloric acid used in the original digestion, must be entirely removed by evaporation with the excess of nitric acid. It dissolves in any of the dissolved salts of phosphoric acid, and for this reason an excess of the molybdate of ammonia must be added, (the excess of nitric acid, with the little chlorine present in the acid filtrate, decompose the ammonia which is united with the excess of molybdic acid, and this latter is left on evaporation, mixed with the yellow precipitate in the solid residuum.) According to Craw, (Silliman's Journal,) this precipitate is also soluble in a solution of the alkaline sulphates, and in sulphuric and nitric acids, and in hot water. A soil containing much sulphuric acid would therefore give irregular results, unless this be first removed. A large excess of water or too much nitric acid should also be avoided in the washing process. With these precautions, it is believed that for the ready estimation of the usually very small amount of phosphoric acid which exists in soils, no process yet discovered is as good as this. In all cases, it is found, however, that a quantity of molybdic acid, varying from one to six per cent. of the weight of the substance, goes down with the ammonia-phosphate of magnesia. This can be mainly separated by solution of it in hydrochloric acid, the addition of hydro-sulphuric acid or sulphide of ammonium, and the re-precipitation of the magnesian phosphate from the filtered liquid.

In the *separation of the alkalies from the magnesia*, as described in Vol. III, it is found, that after washing out the carbonates of potash and soda on the filter, the addition of the diluted sulphuric acid alone fails to separate all the magnesia from the baryta salts present, and that consequently there is too much loss of magnesia, especially in the analyses of magnesian limestones, &c. By first drenching the mixed residue of these two earths with the diluted sulphuric acid, and then pouring into the capsule a little pure nitric acid, and diluting the mixture considerably with warm water, the magnesia is completely dissolved, and the loss avoided.

A SUMMARY

OF THE

CHEMICAL ANALYSES

OF

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

OF KENTUCKY,

MOSTLY PROCURED BY D. D. OWEN, M. D., PRINCIPAL GEOLOGIST, AND MESSRS. S. S. LYON AND JOSEPH LESLEY, JR., ASSISTANT GEOLOGISTS, AND MESSRS. LESQUEREUX, DOWNIE, AND BARTLETT, AND ANALYZED BY ROBERT PETER, M. D., ETC., CHEMICAL ASSISTANT TO THE STATE GEOLOGICAL SURVEY.

ARRANGED IN THE ALPHABETICAL ORDER OF THE COUNTIES IN WHICH THEY WERE OBTAINED, AND NUMBERED UNIFORMLY WITH THE SPECIMENS DEPOSITED IN THE STATE GEOLOGICAL CABINET, IN THE CAPITOL AT FRANKFORT, KENTUCKY.

BATH COUNTY.

No. 777—LIMONITE. *Labeled "Slate Furnace Ore Bank, four miles southeast of Owingsville, Bath county, Ky.; Clinton Bed of the Upper Silurian formation. (The three following described specimens will make an average.")*

A dense, dark-brown limonite, with a reddish ochreous incrustation. *Specific gravity* 3.514. Powder yellowish-brown.

No. 778—LIMONITE. (*Labeled as above.*)

Resembles the preceding, but contains more cavities lined with dull-yellowish ochreous ore. Powder of a yellowish-brown color.

No. 779—LIMONITE. (*Labeled as above.*)

A porous, friable, dull-yellow limonite, with some layers of dense dark-brown ore, inclosing cavities The soft portion presents an oolitic appearance, from the presence of numerous small, round, hollow grains. Powder brownish-yellow.

No. 780—LIMONITE. *Labeled "From Old Slate Furnace or Wickliffe Bank, a very thick layer near Slate Creek, Bath county, Ky."*

A dense, dark-brown limonite; in some places softer and more porous; presenting a rounded-granular, or oolitic appearance. Powder of a brownish-buff color.

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

	No. 777.	No. 778.	No. 779.	No. 780.
Oxide of iron	76.680	76.774	52.660	80.520
Alumina	.440	.800	2.642	3.482
Carbonate of lime	none.	none.	a trace.	none.
Magnesia	.685	1.018	.781	.558
Brown oxide of manganese	.580	.680	.580	.220
Phosphoric acid	.886	1.206	.438	.758
Sulphuric acid	.235	.221	.235	.201
Potash	.358	.258	.509	.386
Soda	.197	.202	.230	.132
Silex and insoluble silicates	8.080	7.280	32.780	3.280
Combined water	11.200	11.760	9.300	10.900
Loss	.659			
Total	100.000	100.199	100.155	100.437
Moisture, expelled at 212° F.	1.300	1.740	1.900	1.500
Percentage of iron	53.400	53.766	36.878	56.369

These ores are, generally, quite as rich in iron as it is profitable to work in the high furnace. Indeed, Nos. 777, 778, and 780, contain so large a proportion of oxide of iron, and so little of earthy materials for the formation of "*cinder*," that it would be expedient to mix them with poorer ores in the furnace. No. 779, which contains nearly 33 per cent. of silicious matter, and nearly 3 per cent. of alumina, would answer well for this purpose. They are all deficient in lime; but this is easily supplied. The most serious objection to these ores is in the considerable proportion of phosphoric acid which they generally contain; which has a tendency to render the iron brittle which is produced from them, No. 779 is the least objectionable in this respect. The use of a large proportion of lime and pure earthy materials, or clay, in the flux, might somewhat diminish this evil, by carrying off more or less of the phosphoric acid in the *cinder*.

No. 781—PIG IRON. *Labeled "Slate Furnace Pig Iron, Bath county, Kentucky."*

A pretty hard, fine-grained, light-grey iron, which yields with some difficulty to the file. Specific gravity 7.069.

COMPOSITION.

Iron	94.542
Graphite	1.700
Combined carbon	none.
Manganese	.692
Silicon	1.067
Slag	.080
Aluminum	.309
Calcium	trace.
Magnesium	.169
Potassium	.142
Sodium	.050
Phosphorus	.084
Sulphur	.135
Loss	1.030
	100.00

The composition of this iron does not exhibit as large a proportion of phosphorus as might be expected from the ores of Slate furnace. The furnace has not been in operation for some years; but the piece of *hard, white* iron, of which the analysis is given above, was obtained at the old works, and believed to have been smelted there.

No. 782—LIMONITE. *Labeled "Limestone Ore, (No. 7*,) brought by Mr. H. G. Berry, from the east side of Clear Creek. Clear Creek Furnace, (Hunt & Berry,) Bath county, Ky."*

A dark, nearly black, porous, granular ore, with irregular portions of whitish, yellowish, and reddish. It adheres to the tongue. Powder of a reddish-brown, somewhat purplish, color.

No. 783—LIMONITE. *Labeled "Limestone Ore, (No. 9,) west side of Clear Creek. Clear Creek Furnace, &c. Brought by Mr. H. G. Berry.")*

A dark colored, nearly black, fine granular ore; not adhering to the tongue. Powder of a reddish-brown color. *Specific gravity* 2.841.

No. 784—LIMONITE. *Labeled "Limestone Ore, (No. 5,) on limestone and under sandstone, east side of Clear Creek. Clear Creek Furnace, &c. (Brought by Mr. H. G. Berry.")*

A dense, reddish-brown hæmatite, cellular in parts. Powder of a brownish-yellow color.

No. 785—LIMONITE. *Labeled ("No. 6) Jones' Bank, fifteen inches thick, east side of Clear Creek. Clear Creek Furnace, &c. (Brought by Mr. H. G. Berry.")*

A reddish and yellowish friable ore, exhibiting some dense layers, adhering to the tongue. Powder of a light reddish-brown color.

*The numbers in brackets were attached to these ores by Mr Berry.

No. 786—LIMONITE. *Labeled "(No. 8,) ten inches thick, above limestone and under sandstone. Clear Creek Furnace, &c. (Brought by Mr. H. G. Berry.")*

A dark, nearly black, fine granular ore, adhering slightly to the tongue. Powder of a reddish-brown color.

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

	No. 782.	No. 783.	No. 784.	No. 785.	No. 786.
Oxide of iron	82.120	70.935	72.886	68.140	64.306
Alumina	.820	.900	.980	2.733	3.080
Carbonate of lime	trace.	trace.	trace.	trace.	trace.
Magnesia	1.010	1.129	.551	1.171	1.003
Brown oxide of manganese	1.340	1.780	.380	1.680	2.440
Phosphoric acid	.220	.505	.694	.247	.374
Sulphuric acid	.386	.290	.283	.336	.290
Potash	.193	.291	.321	.413	.703
Soda	.180	.180	.048	.132	.312
Silex and insoluble silicates	8.980	18.640	11.880	16.080	21.407
Combined water	5.420	5.400	12.200	9.040	6.200
Loss				.028	
Total	100.669	100.050	100.223	100.000	100.115
Moisture, expelled at 212° F.	3.040	2.700	1.200	4.060	3.400
Percentage of iron	57.510	49.677	51.043	47.719	45.034

No. 787—CARBONATE OF IRON. *Labeled "Kidney Ore (No. 1;) bottom of Clear Creek, near Clear Creek Furnace, Bath county, Kentucky." (Brought by Mr. H. G. Berry.)*

A nodule, with an orange-brown exterior surface, and a grey interior; exhibiting a few minute scales of mica. Not adhering to the tongue. *Specific gravity* 3.339. Powder of a grey-buff color.

No. 788—IMPURE CARBONATE OF IRON. *Labeled "(No. 2,) found in the place of Limestone Ores Nos. 3 and 7. Clear Creek Furnace, &c." (Brought by Mr. H. G. Berry.)*

A greenish-grey, friable, sandy rock. Powder of a light grey color.

No. 789—CARBONATE OF IRON. *Labeled "Carbonate of Iron, just above black slate. Clear Creek Furnace, &c." (Obtained by Dr. Owen.)*

Exterior yellowish and reddish-brown; interior dark grey, fine-grained; with a few minute scales of mica. Not adhering to the tongue. *Specific gravity* 3.370.

THE COMPOSITION OF THESE THREE CARBONATES OF IRON, DRIED AT 212° F., IS AS FOLLOWS:

	No. 787.	No. 788.	No. 789.
Carbonate of iron	47.330	44.575	43.716
Oxide of iron	11.888	7.121	3.937
Alumina	4.180	3.520	1.881
Carbonate of lime	5.480	5.280	1.184
Carbonate of magnesia	7.754	7.187	5.903
Carbonate of manganese	1.987	.722	.873
Phosphoric acid	.886	1.120	.499
Sulphuric acid	.475	.338	.303
Potash	.674	.788	.355
Soda	.071	.347	.286
Silex and insoluble silicates	19.580	27.380	40.880
Water and loss	----------	1.622	.183
Total	100.305	100.000	100.000
Moisture, expelled at 212° F.	0.600	0.800	0.300
Percentage of metallic iron	31.192	26.630	23.838

No. 790—LIMONITE. *Labeled "Clear Creek Furnace Ore; above the sub-carboniferous Limestone, Bath county, Ky."* (*Obtained by Dr. Owen.*)

A somewhat coarse-grained and porous limonite. Adheres to the tongue. Powder of a purplish-brown color.

No. 791—LIMONITE. *Labeled "Ore over the Limestone of Clear Creek, Bath county, Ky. (To be examined for copper.")* (*Obtained by Dr. Owen.*)

A friable, irregularly cellular ore, of a yellowish-brown color. Incrusted with darker material on some of its surfaces. Adheres slightly to the tongue. Powder of a brownish-yellow color.

No. 792—LIMONITE. *Labeled "From Clear Creek Ore Banks, Bath county, Ky., from above the sub-carboniferous Limestone."* (*Obtained by Dr. Owen.*)

A dense, fine-grained, dark-colored ore. Color generally dark yellowish-brown, with some lighter, dirty-buff colored, thin layers, and some dark-purplish incrustation. Not adhering to the tongue. Powder of a yellowish-brown color.

No. 793—IMPURE LIMONITE. *Labeled "Ore over the Limestone of Clear Creek, Bath county, Ky. To be examined for copper."* (*Obtained by Dr. Owen.*)

A fine-granular ore, easily broken. General color dark reddish-brown; a yellowish and reddish-white material appearing amongst the grains in irregular portions. Powder of a purplish-brown color. Resembles No. 782, (No. 7,) but has not so much diffused whitish material. Adheres to the tongue.

No. 794—LIMONITE. *Labeled "Block Kidney Ore, over the Black Slate, Clear Creek Valley, Bath county, Ky."* (*Obtained by Dr. Owen.*)

COMPOSITION OF THESE FIVE LIMONITES, DRIED AT 212° F.

	No. 790.	No. 791.	No. 792.	No. 793.	No. 794.
Oxide of iron	86.268	65.400	77.580	69.940	38.000
Alumina	.480	4.366	1.600	3.297	3.265
Carbonate of lime	a trace.	trace.	trace.	6.504	1.284
Magnesia	.840	.932	.504	2.556	1.565
Brown oxide of manganese	3.580	.580	.580	1.580	.780
Phosphoric acid	.272	1.014	.720	1.783	1.015
Sulphuric acid	.303	.234	.204	.267	.853
Potash	.220	.656	.386	.828	.583
Soda	.123	.245	.260	.202	.147
Silex and insoluble silicates	2.120	15.080	7.040	7.980	44.880
Combined water	6.000	12.100	11.500	6.200	7.900
Total	100.206	100.607	100.374	100.637	100.272
Moisture, expelled at 212° F.	3.300	2.000	1.400	2.500	1.240
Percentage of metallic iron	60.415	45.800	54.330	48.980	26.612

Those ores, amongst the Clear creek *limonites*, which would probably yield the toughest iron, are Nos. 782, 785, 790, and 786, ranged in the order of their relative freedom from phosphoric acid. Some of these ores, containing more than fifty per cent. of metallic iron, especially No. 790, are almost too rich in metal to be profitably smelted in the high furnace, without the addition of poorer ores, or clay, or other earthy matters, with the limestone used for the flux. Ores Nos. 788, 789, and 794, would answer well for this purpose, if their considerable proportions of phosphoric acid were not objectionable. With a proper selection of fluxing materials, these rich ores would undoubtedly make good tough iron.

The *carbonates* of iron Nos. 787, 788, anl 789, all require careful roasting, and contain more phosphoric acid and sulphur than is desirable; for although it is probable much of the latter injurious ingredient might be dissipated by judicious roasting of the ore, and some of the former may be discharged in the cinder, by the use of a large proportion of lime and of some aluminous material, such as clay or poor aluminous ore, yet it is probable that the iron made from ores, which, like the above, contain much phosphorus and sulphur, cannot compare in toughness with that made from a purer mineral. For many purposes to which *cast* iron is applied, however, great toughness, or tenacity, is not required, and the great fluidity of the melted metal which contains much phosphorus makes it run freely and produce sharp castings.

No. 795—Iron. *Labeled "Portion of a Salamander from the bottom of an old furnace hearth. Clear Creek Furnace, Bath county, Ky."*

A flat, rusted, irregular mass of pretty tough iron; presenting quite a brilliant appearance on some of the broken edges; with large shining facets, as though it was crystalline in its structure. It extends under the hammer, and yields easily to the file, like malleable iron, but is rather whiter than most wrought iron. *Specific gravity* 6.912.

COMPOSITION.

Iron	97.060
Graphite	.400
Combined carbon	none.
Manganese	.634
Silicon	.471
Slag	none.
Aluminum	.255
Calcium	trace.
Magnesium	.220
Potassium	.177
Sodium	.140
Phosphorus	.108
Sulphur	.166
Loss	.369
	100.000

This iron has been *de-carbonized*, to a considerable extent, by long fusion in the hearth of the furnace, or by some mismanagement, and consequently became too pasty in consistence to flow out freely. Masses of such iron, chilled in the furnace, are called by the iron men *salamanders*, and frequently cannot be removed without taking down the walls of the furnace.

No. 796—FERRUGINOUS HYDRAULIC LIMESTONE. *Labeled "(No. 4,) same bed as ore (No. 9,) No. 783; two to three feet thick, west side of Clear Creek. Clear Creek Furnace, &c." (Brought by Mr. H. G. Berry.*

A dull, reddish-buff fine-granular rock; adhering to the tongue. Powder of a buff color. *Specific gravity* 2.704.

No. 797—FERRUGINOUS MAGNESIAN LIMESTONE. *Labeled "Magnesian Limestone of the Clinton Groupe, near Owingsville, Bath county, Ky." (Obtained by Dr. Owen.)*

A dull, dark, dirty buff-colored limestone, with dark infiltrations of oxide of iron amongst the fossils, which are abundant in it, especially a peculiar *entrochite* with lobulated periphery. Powder of a light cinnamon color.

COMPOSITION OF THESE TWO LIMESTONES, DRIED AT 212° F.

	No. 796.	No. 797.
Carbonate of lime	53.240	51.580
Carbonate of magnesia	18.531	28.779
Carbonate of iron	----------	3.095
Oxide of iron	8.020	10.627
Alumina	.620	.280
Carbonate of manganese	----------	.752
Brown oxide of manganese	.380	----------
Phosphoric acid	.117	.592
Sulphuric acid	.633	.235
Potash	.444	.209
Soda	.212	trace.
Silex and insoluble silicates	17.540	1.980
Water and loss	.263	1.871
Total	100.000	100.000
Percentage of lime	29.877	28.580
Percentage of magnesia	8.828	13.700
Moisture, expelled at 212° F.	0.700	0.750

The composition of No. 796 is that of a good hydraulic limestone. This rock would also answer for a flux in the iron furnace, if it did not contain so much sulphuric acid; which would, very probably, injure the quality of the iron smelted with it.

No. 797 contains more magnesia and less silica, &c. Similar limestones to this are described under the head of Fleming county. If this rock contained a little more silex, it would, most probably, prove a good hydraulic limestone. Indeed, some magnesian rocks, containing no more silica than this, have the reputation of making good *water lime.* Hence it is worthy of trial in this relation.

No. 798—MINERAL WATER. *Labeled "Salt Sulphur Water, from a well ten feet deep, about sixty steps from the main house, Olympian Springs, Bath county, Ky."* (*Sent by the proprietor, Mr. H. Gill.*)

This water contains free *sulphuretted hydrogen gas*, which, however, had been dissipated by carriage: also, free *carbonic acid gas*, of which a thousand parts still contained 0.318 of a part. Evaporated to dryness, one thousand parts of this water left 5.709 parts of *saline matters, dried at* 212° *F.*, which had the following

COMPOSITION, VIZ:

Carbonate of lime	0.239	Held in solution by carbonic acid.
Carbonate of magnesia	.124	
Carbonate of iron	a trace.	
Alumina	a trace.	
Chloride of sodium	2.847	
Chloride of potassium	.183	
Chloride of magnesium	.950	
Sulphate of lime	a trace.	
Bromine and iodine	traces.	
Silica	.018	
Water and loss	1.348	
In 1000 grains of the water	5.709 grains.	

A sufficient quantity of the water was not sent to the laboratory to enable me to estimate the quantity of the bromine and iodine; which latter is present in a very minute proportion. A visit to the spring will be necessary to estimate the quantity of sulphuretted hydrogen gas which is contained in the water.

Another occasion will be taken, should the survey be continued to completion, to finish the minute analysis of this very pleasant and valuable mineral water.

No. 799—MINERAL WATER. *Labeled "Black Sulphur Water, from a flowing spring, half a mile south of the main house, Olympian Springs, Bath county, Ky."* (*Sent by Mr. H. Gill.*)

This water, when fresh, contains free *sulphuretted hydrogen* and *carbonic acid* gases; also, a considerable proportion of carbonate of soda, giving it an *alkaline* reaction, especially in the concentrated solution. Evaporated to dryness, one thousand parts of the water left 0.558 of a part of *saline matter*, dried at 212° F., which was found to have the following

COMPOSITION, VIZ :

Carbonate of lime	0.114	Held in solution by carbonic acid.
Carbonate of magnesia	.006	
Carbonate of iron	trace.	
Chloride of sodium	.127	
Carbonate of soda	.254	
Sulphate of potash	.002	
Sulphate of magnesia	.012	
Silica	.043	
In 1000 grains of the water	0·558 of a grain.	

A very good alkaline, chalybeate, sulphur water.

No. 800—MINERAL WATER. *Labeled "Epsom Water, from a well ten feet deep, about a half mile northeast from the main house, Olympian Springs, Bath county, Ky."* (*Sent by Mr. H. Gill.*)

One thousand grains of this water, evaporated to dryness, left about seven grains of *saline matter, dried at* 212° *F.*, which was found to have the following

COMPOSITION, VIZ :

Carbonate of lime	0.631	Held in solution by carbonic acid.
Carbonate of magnesia	.218	
Carbonate of iron	a trace.	
Alumina	a trace.	
Chloride of sodium	.830	
Sulphate of magnesia	2.600	
Sulphate of lime	.584	
Sulphate of potash	.041	
Sulphate of soda	1.360	
Sulphate of iron	a trace.	
Silica	.015	
In 1000 grains of the water	6.279 grains.	

The free *carbonic acid gas* which the water contains was not estimated, as a portion had doubtless escaped during carriage.

This water resembles, in composition and strength, the strongest waters of the Crab Orchard Springs, in Lincoln county. The principal differences observed are, that this contains rather more chloride of sodium and sulphate of lime, and rather less sulphate of magnesia, than those. It will doubtless prove equally valuable as a medicinal agent. (See analysis of Crab Orchard Springs, &c., &c., in volume 2, of these Geological Reports.)

No. 801—MINERAL WATER. *Labeled "Chalybeate Water from a flowing spring, about half a mile north of the principal building, Olympian Springs, Bath county, Ky."* (*Sent by Mr. H. Gill.*)

This water contains free *carbonic acid gas ;* the amount of which was not estimated, because a portion had doubtless escaped during carriage to the laboratory.

One thousand grains of this water, evaporated to dryness, left *about a third of a grain of saline matter, dried at 212° F.*, which was found to have the following

COMPOSITION, VIZ:

Carbonate of lime	0.101	Held in solution by carbonic acid.
Carbonate of magnesia	.022	
Carbonate of iron	not estimated	
Chloride of sodium	.035	
Sulphate of magnesia	.021	
Sulphate of lime	.020	
Sulphate of potash	.070	
Silica	.107	
In 1000 grains of the water	0.376	of a grain.

By reference to the qualitative analysis of this water given in Vol. III, of these Reports, it will be seen that the quantity of saline matters contained in it, always small in amount, varies with the season. Doubtless, most of the mineral springs are more or less affected by long seasons of drought, or of wet weather, making them more or less strong; whilst the *relative* proportions of their saline ingredients may remain measurably unchanged.

No. 802—MINERAL WATER. *Labeled "Salt Water, from a flowing well, twelve feet deep, about a hundred yards from the main building, Olympian Springs, Bath county, Ky."* (*Sent by Mr. H. Gill.*)

The free *carbonic acid gas* present in this water was not estimated.

One thousand grains of the water, evaporated to dryness, left about two thirds of a grain of *saline matter*, dried at 212° F., which had the following

COMPOSITION, VIZ:

Carbonate of lime	0.060	Held in solution by carbonic acid
Carbonate of magnesia	.039	
Carbonate of iron	.018	
Chloride of sodium	.246	
Carbonate of soda	.163	
Sulphate of soda	.046	
Sulphate of potash	.015	
Sulphate of magnesia	.017	
Silica	·033	
In 1000 grains of the water	0.637	of a grain.

It will be seen, by reference, that the saline ingredients of this water are very similar, in kind and quality, to those in the "Black Sulpur Water, No. 799," previously described. This contains only *carbonic acid* gas, whilst that has also *sulphuretted hydrogen* gas. This water, like the black sulphur water, is an *alkaline chalybeale.* This contains a little more sulphate of soda and a little less carbonate of soda than that.

No. 803—MINERAL WATER. *Labeled "Mineral Water of unknown properties, (cooking water,) from a well ten feet deep and five feet from the kitchen, Olympian Springs, Bath county, Ky."* (*Sent by Mr. H. Gill.*)

This water contained free *carbonic acid gas*, the quantity of which was not estimated. One thousand grains, evaporated to dryness, left *more than five grains of saline* matter, dried at 212° F., which had the following

COMPOSITION, VIZ:

Carbonate of lime	0.187	Held in solution by carbonic acid.
Carbonate of magnesia	.105	
Carbonate of iron	a trace.	
Chloride of sodium	4.250	
Chloride of potassium	.059	
Chloride of magnesium	.555	
Carbonate of soda	a trace.	
Sulphate of lime	.012	
Sulphate of potash	.265	
Silica	.037	
In 1000 grains of the water	5.470	grains.

It will be seen that its principal saline ingredient is common salt, (chloride of sodium,) and it is slightly alkaline from the presence of a small quantity of bi-carbonate of soda. The chlorides of potassium and magnesium and the sulphate of potash, together with the carbonates of lime, magnesia, and iron, are usually found associated in salt waters. This is a perfectly wholesome water for culinary purposes; and, properly applied as a remedial agent, in some cases, will prove a valuable addition to the mineral springs of this celebrated watering place.

No. 804—SOIL. *Labeled "Best Hemp Soil, from heavy black walnut land, one and a half miles southwest of Sharpsburg, Bath county, Ky." (Blue limestone of Lower Silurian formation.) Strongest soil of Bath county.*

The dried soil is of a light umber color. Some fragments of ferruginous sandstone were sifted out of it.

One thousand grains of the air-dried soil, digested for about a month in water charged with carbonic acid gas, gave up more than *five grains* *of brown extract;* which, dried at 212° F., was found to have the following

COMPOSITION, VIZ:

Organic and volatile matters	1.430
Alumina and oxides of iron and manganese and phosphates	.180
Carbonate of lime	2.663
Magnesia	.193
Sulphuric acid	.045
Potash	.074
Soda	not estimated.
Silica	.114
Loss	.451
Grains	5.150

The air-dried soil lost 4.50 per cent. of *moisture*, when dried at 400° F.

ITS COMPOSITION, DRIED AT 400° F., IS AS FOLLOWS:

Organic and volatile matters	9.527
Alumina	3.990
Oxide of iron	4.235
Carbonate of lime	.620
Magnesia	.700
Brown oxide of manganese	not estimated.
Phosphoric acid	.415
Sulphuric acid	not estimated.
Potash	.290
Soda	.054
Sand and insoluble silicates	80.120
Loss	.049
	100.000

A very good soil, well adapted, by its large amount of soluble nutritious matter, and its considerable proportions of carbonate of lime, phosphoric acid, &c., to the culture of hemp.

No. 805—SOIL. *Labeled "Genuine Clinton Groupe Red Soil, from over the encrinital, flesh-colored, magnesian limestone,* (*see No.* 797,) *two miles west of Owingsville, Bath county, Ky. Primitive growth, blue ash, sugar-tree, hickory, &c., &c."*

Dried soil of a light reddish-brown color, containing some cherty fragments.

No. 806—SOIL. *Labeled "Same soil as the preceding, from an old field twenty years in cultivation, two miles west of Owingsville, &c."*

The dried soil is of a slightly darker color than the preceding.

No. 807—SOIL. *Labeled "Virgin Soil, from woods, over the gravel ore of the Clinton Groupe, near the Slate Furnace ore, Bath county, Ky."*

The dried soil is of a light, ashy-grey color, containing some duck-shot iron ore, which was sifted out before analysis.

No. 808—SOIL. *Labeled "Soil from a corn-field, over the ore-bed of the Slate Furnace, from a formation of the age of the Clinton Groupe of the New York Geologists, Bath county, Ky."*

Dried soil of a light, greyish-umber color. Some shot iron ore and fragments of red ferruginous sandstone and ferruginous chert, were sifted out of it.

One thousand grains of each of these soils, thoroughly air-dried, were digested, severally, for a month, in water charged with carbonic acid gas. The quantity and composition of the *soluble matters* extracted are represented in the following table:

	No. 805. Virgin soil.	No. 806. Old field.	No. 807. Virgin soil.	No. 808. Old field.
Organic and volatile matters	0.900	0.400	0.700	0.617
Alumina and oxides of iron and manganese and phosphates	.147	.130	.431	.281
Carbonate of lime	1.397	1.563	.430	1.047
Magnesia	.133	.183	.061	.160
Sulphuric acid	.033	.039	.054	.045
Potash	.115	.035	not est m'd	.112
Soda	not estim'd	.0575		.038
Silica	.048	.114	.200	.200
Loss	.277	.196	.227	.052
Watery extract, dried at 212° F., (grains)	3.050	2.717	2.103	2.552

The *composition* of these four soils, dried at 400° F., was found to be as follows:

	No. 805. Virgin soil.	No. 806. Old field.	No. 807. Virgin soil.	No. 808. Old field.
Organic and volatile matters	8.165	7.639	5.024	5.118
Alumina	4.565	5.390	3.535	5.115
Oxide of iron	6.960	7.885	3.535	5.150
Carbonate of lime	.570	.420	.095	.170
Magnesia	.710	.615	.385	.523
Brown oxide of manganese	not estim'd	not estim'd	.220	.220
Phosphoric acid	.174	.246	.118	.284
Sulphuric acid	not estim'd	not estim'd	.041	.058
Potash	.290	.249	.246	.210
Soda	.059	.073	.100	.049
Sand and insoluble silicates	79.145	78.270	86.980	83.320
Total	100.638	100.787	100.279	100.217
Moisture, expelled at 400° F.	3.650	3.450	2.475	2.600

These are quite good soils, especially (No. 805.) although probably not quite as productive as the preceding, (No. 804.) The soil of the old field (No. 806) shows, in the diminution of some of its essential elements, the influence of the twenty years cultivation, as may be seen by comparing together the quantities of *soluble matters* extracted by the carbonated water from that and the virgin soil, as well as the relative proportions of *organic matters, carbonate of lime, magnesia, potash, and soda.* The phosphoric acid appears in larger proportion in the soil of the old field, probably from some admixture of the sub-soil.

No. 809—SOIL. *Labeled "Virgin Soil, from woods pasture; from Mr. Sudduth's farm, a mile and a half east of Sharpsburg, Bath county, Ky. Primitive growth, black locust, black walnut, black and blue ash, and sugar-tree. Some of the best blue limestone land of Bath county. Lower Silurian formation."*

Dried soil of a light umber color. Some fragments of dark, soft, ferruginous sandstone were sifted out of it.

No. 810—SOIL. *Labeled "Same Soil, from an old field, fifty years in cultivation. Mr. Sudduth's farm, &c., &c."*

Dried soil of a light umber color, slightly lighter colored and more yellowish than the preceding. Some shot iron ore was sifted out of it.

No. 811—SOIL. *Labeled "Sub-soil from the same old field," &c., &c.*

Dried soil lighter colored and more yellowish than the preceding.

One thousand grains of each of these soils, thoroughly air-dried, were digested severally, for a month, in water charged with carbonic acid under pressure. The analyses of the *soluble materials*, removed from them by the carbonated water, are given in the following table, viz:

	No. 609. Virgin soil.	No. 810. Old field.	No. 811. Sub-soil.
Organic and volatile matters	1.583	0.710	0.400
Alumina and oxides of iron and manganese and phosphates	.781	.147	.097
Carbonate of lime	3.073	1.597	.963
Magnesia	.200	.770	.120
Sulphuric acid	.045	.045	.056
Potash	.144	.085	.020
Soda	.047	.026	.025
Silica	.214	.314	.200
Loss	.313	----------	----------
Watery extract, dried at 212° F., (grains)	6.400	3.694	1.881

By comparing the following analyses of these soils, it will be seen that the sub-soil is very nearly as rich as the virgin (surface) soil; yet, probably, because the former contains less of *organic matters* and of other materials which act as *solvents* in the soil, it does not give one third as much *soluble* extract to the carbonated water, and would not prove to be as productive as that, without the addition of manures. It will be observed in these reports of the analyses of soils, that it is generally the case that the sub-soil gives up less of soluble matter, to the water charged with carbonic acid, than the surface soil; and always the case when the sub-soil is of a more clayey nature than that. Hence these sub-soils require exposure for some time to the atmospheric agencies, and mixture with *organic matters*, (viz: the remains of decaying vegetable and animal bodies,) before they can readily give up their mineral food to plants. From this it will be understood that these two conditions are necessary to the *fertility* of a soil; *first*, that the proper mineral ingredients for vegetable nourishment exist in it; and, *second*, that they are in a *soluble condition*. The *relative amount* of these mineral ingredients in a soil, other things being equal, represents its entire capability of production, up to complete exhaustion; the quantity of these ingredients which are in a *soluble state* may represent its *immediate productiveness*. Much error has occurred in relation to the value of the chemical analyses of soils from want of attention to these facts alone.

The *composition* of these three soils, from Mr. Sudduth's farm, was found to be as follows; *dried at* 400° *F.*:

	No. 809. Virgin soil.	No. 810. Old field.	No. 811. Sub-soil.
Organic and volatile matters	8.376	6.308	4.108
Alumina	5.115	5.266	5.490
Oxide of iron	2.185	4.235	4.235
Carbonate of lime	.580	.445	.370
Magnesia	.660	.617	.613
Brown oxide of manganese	.195	.295	.295
Phosphoric acid	.365	.295	.312
Sulphuric acid	.084	.067	.055
Potash	.372	.280	.367
Soda	.123	.044	.037
Sand and insoluble silicates	82.595	82.270	84.920
Total	100.650	100.121	100.802
Moisture, expelled at 400° F.	4.200	3.300	2.650

All the mineral ingredients, essential for the nourishment of vegetables, may be observed to have been diminished, in the soil of the old field, by the fifty years cultivation; yet, not as much as might have been expected, probably because a rich sub-soil has been somewhat mixed with it, and has gradually, in accordance with well known laws, sent up some of its soluble materials to supply the deficiencies of the surface soil.

No. 812—SOIL. *Labeled "Virgin Soil, from the Valley of McCormick's Run, Bath county, Ky. Geological position: upper part of the Knobstone formation. (Sub-carboniferous Sandstone.) These soils show debris from the Millstone grit, or conglomerate, limestone, olive sandstone, and of the iron and coal horizon."*

(This and the following soils from Bath county, were collected by Joseph Lesley, jr., Esq.)

The dried soil is of a brownish-grey-buff color, and contains much sand; some in rounded grains; with some spangles of mica.

No. 813—SOIL. *Labeled "Soil from a field about ten years in cultivation; the first year in timothy and clover; ever since in corn. This year's* (1858) *crop yielded forty-five to fifty bushels to the acre. McCormick's Valley, below McCormick's house. Same Geological position as the preceding," &c., &c.*

Dried soil of a light-grey-brown color; rather darker colored than the preceding. Sifted out of it, with the coarse seive, more than half its weight of soft olive-colored and ferruginous sandstone and pebbles from the conglomerate, with fragments of limestone. It also contains much sand, some of the grains of which are rounded.

No. 814—SOIL *Labeled "Sub-soil of the preceding," &c., &c.*

Dried soil of a brownish-buff color, lighter than the preceding. Like that, it contains more than half its weight of fragments of soft grey and olive sandstone, and pebbles from the conglomerate, and much sand with rounded grains.

No. 815—SOIL. *Labeled "Soil from a field nine years in cultivation, (the first two years in corn, then two years in timothy, blue-grass, and clover, since then used for pasture;) from the east hillside of McCormick's Valley, directly above the place of the three preceding soils. Geological position: on the olive-colored sandstone of the knobstone terrace. It contains debris from the sub-carboniferous limestone; the millstone grit and the intervening shales; clay, iron ore, and coal."*

The dried soil is of a greyish-buff color. It contained about one fourth its weight of fragments of ferruginous sandstone; (which were separated before analysis;) but does not contain so much coarse sand as the three preceding soils, being in a state of finer division.

No. 816—SOIL. *Labeled "Sub-soil of the preceding, &c., &c., Bath county, Ky."*

The dried soil is of a grey-buff color, lighter than the preceding. About one third of its weight of fragments of shaley sandstone were sifted out of it before it was submitted to analysis.

No. 817—SOIL. *Labeled "Soil from the east hillside of McCormick's Valley, from the same field as the two preceding, and from directly above them.* Geological position: *on the sub-carboniferous limestone terrace. A debris from the over-lying limestones, coal, iron ore, shale, and clay strata, along with the conglomerate, or millstone grit."*

Dried soil of a light-greyish-umber color. About one third of its weight of fragments of soft sandstone, &c., &c., were sifted out of it before submitting it to analysis. This soil is in a state of very fine division.

No. 818—SOIL. *Labeled "Sub-soil of the preceding, &c., &c., Bath county, Ky."*

Dried soil of a light grey-buff color, much lighter than the preceding. About one third of its weight of fragments of shaley sandstone, &c., &c., were sifted out of it before analysis.

One thousand grains of each of these soils, thoroughly air-dried, were digested, severally, for a month, in water charged under pressure with carbonic acid. The analyses and quantities of the *soluble extract* thus obtained are given in the following table:

	No. 812. Virgin Soil.	No. 813. Old field.	No. 814. Sub-soil.	No. 815. Soil.	No. 816. Sub-soil.	No. 817. Soil.	No. 818. Sub-soil.
Organic & volatile matters	0.640	0.407	0.360	1.617	0.560	1.450	0.417
Alumina & oxides of iron & manganese & phosphates	.563	.187	.173	1.507	.123	.830	.280
Carbonate of lime	1.130	.487	.553	1.073	.130	2.397	.360
Magnesia	.106	.089	.019	.015	.144	.016	.083
Sulphuric acid	.062	.029	.041	.041	.033	.025	.045
Potash	.055	.151	.125	.224	.102	.196	.069
Soda	.060	.038	.046	.005	.033	.065	.075
Silica	.197	.214	.131	.453	.214	.154	.297
Loss	.264	.155	.0[illegible]5	--------	--------	.600	--------
Watery extract, dried at 212° F., (grains)	3.077	1.757	1.453	4.975	1.339	5.733	1.637

The *composition* of these seven soils, from McCormick's Run Valley, dried at 400° F., is given in the following table, viz:

	No. 812. Virgin Soil.	No. 813. Old field.	No. 814. Sub-soil.	No. 815. Soil.	No. 816. Sub-soil.	No. 817. Soil.	No. 818. Sub-soil.
Organic & volatile matters	4.251	3.105	2.164	8.198	5.038	10.527	4.418
Alumina	1.515	1.340	1.415	5.490	*3.[illegible]27	4.240	4.540
Oxide of iron	2.210	3.710	4.435	3.360		2.210	2.660
Carbonate of lime	.195	.095	.080	.220	.07	.645	.160
Magnesia	.329	.295	.362	.488	.500	.405	[illegible]
Brown oxide of manganese	.130	.110	.170	.220	--------	.295	.415
Phosphoric acid	.095	.127	.095	.179	.144	.223	.144
Sulphuric acid	.033	.033	.028	.076	.033	.050	.025
Potash	.130	.111	.164	.210	.174	.212	.065
Soda	.050	.040	.018	.018	.119	.046	.181
Sand and insoluble silicates	91.095	89.920	92.270	82.745	86.995	81.295	87.720
Loss	--------	1.114	--------	--------	--------	--------	--------
Total	100.033	100.000	101.201	101.204	100.000	100.142	100.746
Moisture, exp'd at 400° F.	1.425	0.975	0.650	3.025	1.750	3.350	1.550

*And oxide of manganese.

The soils from McCormick's Run Valley show considerable variety of composition within a small space. Nos. 815, and 817, appear to be the richest; giving up more soluble matters to the carbonated water, and containing more *potash, phosphoric acid, sulphuric acid, carbonate of lime and magnesia, and organic matters,* than No. 812. These former are in a finer state of division, and contain less sand than the latter, and appear to be more immediately derived from the sub-carboniferous limestone. They are pretty good soils, notwithstanding the large proportion of fragments of soft sandstone which they contain, and no doubt will prove quite productive with good husbandry. The sub-soils do not appear to be as rich as the surface soils. Hence sub-soil plowing is not likely to prove beneficial.

The productiveness of soil No. 813, compared with its composition, is remarkable; doubtless its very porous nature is favorable to the growth of the Indian corn; a plant which does not require much lime, in which this soil is rather deficient.

Moreover a large proportion of its nutritious mineral ingredients is in a *soluble condition;* for it will be seen, by reference to the composition of the *soluble extract* of this soil, that although the whole quantity dissolved out by the carbonated water does not appear to be relatively great, (only 1.757 grains from the 1000 of the soil,) yet we find in it a considerable proportion of *potash*, and less than the usually large amount of lime and magnesia, which generally make up the greater part of the weight of this extract. Sandy soils always yield up their nutritive ingredients more readily than clay soils, and, therefore, are more quickly exhausted, than the heavier clay or loam soils. Hence they are with more difficulty kept in a fertile condition than the heavier soils; and are said to be *hungry soils*, because of the little durability of the manures applied to them. Soil No. 813, would be doubtless improved by the free application of slacked lime, especially with some plaster of paris and bone earth, animal manures, or other substances containing phosphates; as well as by top-dressing of marl or clay. Most of these soils are deficient in sulphates, hence plaster of paris will have a good effect upon them. By good management and economy of manures, this land might be made and kept quite fertile.

No. 819—COAL. *Labeled "Coal from the Flower Hill Banks,* 28 *inches thick, owned by Morris McCormick, situated about three miles south of the owner's house, on the head waters of Amet's branch of Indian creek, Bath county, Ky."* (*Obtained by Joseph Lesley, jr.*) "Blacksmiths are particularly pleased with this coal."

A pure, shining, pitch-black coal. Very little fibrous coal between the layers, which generally separate with a shining irregular surface, exhibiting many shallow rounded depressions and elevations. Over the spirit lamp it softened somewhat, and agglutinated a little, swelling to a dense coke. *Specific gravity*, 1.288.

PROXIMATE ANALYSIS.

Moisture	2.90	Total volatile matters	40.20
Volatile combustible matters	37.30		
Fixed carbon in the coke	56.50	Dense coke	59.80
Light-grey ashes	3.30		
	100.000		100.000

The percentage of *sulphur* in this coal is 0.806.

ANALYSIS OF THE ASH.

Silica	1.384
Alumina and oxides of iron and manganese	1.380
Lime	a trace.
Magnesia	.566
Sulphuric acid	not estimated.
Potash and soda	traces not estimated.
	3.330

A good, pure, coal, containing but little sulphur, and leaving only a small proportion of ashes.

No. 820—Coal. *Labeled "Lowest Coal, from the new banks,* 22 *inches thick, just opened by Dr. Cox and Morris McCormick, a mile and a half above the house of Dr. Cox, and one and a quarter miles from the State Road, on State Road Fork of Beaver Creek, Bath county, Ky. Underlies the conglomerate, or millstone grit. The same bed as the Flower Hill Bank on the opposite side of the ridge. Highly approved by blacksmiths."* (*Obtained by Joseph Lesley, jr.*)

A pure, shining, pitch-black, somewhat soft, coal; having much fibrous coal between the layers. Over the spirit lamp it softens somewhat, and swells into a moderately dense coke. Resembles the preceding. *Specific gravity* 1.288.

PROXIMATE ANALYSIS.

Moisture	5.30	Total volatile matters	41.14
Volatile combustible matters	35.84		
Fixed carbon in the coke	55.80	Moderately dense coke	58.86
Light greyish-white ashes	3.06		
	100.000		100.000

Total percentage of *sulphur* is only 0.672 per cent.

ANALYSIS OF THE ASH.

Silica	1.594
Alumina and oxides of iron and manganese	1.280
Lime	a trace.
Magnesia	.313
Sulphuric acid	not estimated.
Potash and soda	traces not estimated.
	3.187

Very similar to the preceding; containing more fibrous coal between the layers than the preceding, and hence probably is more *hygroscopic.*

No. 821—COAL. *Labeled "Coal from the 'Big Bank,' near tan-yard, on the head waters of Indian Creek, Bath county, Ky. Bed two feet nine inches thick, and described by Dr. Owen, in Vol. III, page* 132, *of his Report."* (*Obtained by Joseph Lesley, jr.*)

A moderately dull, pitch-black coal; rather tough on the cross fracture, but easily cleaving into thin layers, which are coated with fibrous coal, presenting impressions of slender pointed leaves, &c. Over the spirit lamp it did not soften much, leaving a dense coke. *Specific gravity* 1.268.

PROXIMATE ANALYSIS.

Moisture	2.30	Total volatile matters	42.40
Volatile combustible matters	40.10		
Fixed carbon in the coke	53.86	Dense coke	57.60
Dark, purplish-grey ashes	3.74		
	100.00		100.00

The percentage of *sulphur* in this coal is 2.532.

ANALYSIS OF THE ASH.

Silica	0.484
Alumina and oxides of iron and manganese	2.480
Lime	a trace.
Magnesia	.299
Sulphuric acid	.235
Potash	.270
Soda	.187
	3.955

The excess in the ash analysis may be partly due to the oxidation of sulphuret of iron into sulphuric acid and peroxide of iron. It is probable also that the alkalies are a little over-estimated. A considerable number of analyses have been made of coal ashes, however, and in every instance notable quantities of alkalies are found in them, as well as more or less of earthy phosphates. The value of coal ashes as manure, on heavy clay land especially, is greater than is generally believed.

This coal resembles the two preceding, but contains much more sulphur than they.

BOURBON COUNTY.

No. 822—MAGNESIAN LIMESTONE. *Labeled "Loose slab on the surface of woods pasture, where the soil was collected, at William Buckner's farm, Cane Ridge, Bourbon county, Ky." Lower Silurian formation. (See No. 574 of Chemical Report, Volume III.)*

A fine-granular, grey-buff rock, with numerous pores filled with darker buff material. Powder of a light grey-buff color.

Dried at 212° F., the powdered rock lost 0.24 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	75.980—43.637 lime.
Carbonate of magnesia	15.595— 7.426 magnesia.
Alumina, and oxides of iron and manganese	4.660
Phosphoric acid	.822
Sulphuric acid	.427
Potash	.165
Soda	.042
Silicious residuum	2.640
	100.331

BRACKEN COUNTY.

No. 823—SALT WATER. *"On Big Bracken Creek, Bracken county, Ky. (Bottled up a year, but not diminished by evaporation.) Sent by L. G. Bradford, Esq."*

The cork of the bottle containing the water was slightly blackened, as from the presence of a little salt of iron. No sediment in the bottle. *Specific gravity*, by areometers, about 1.014.

Saline contents, about 1.7 per cent., having the following

COMPOSITION, VIZ:

Carbonates of lime and magnesia, with traces of oxide of iron and sulphate of lime	0.0257
Chloride of sodium, (common salt)	1.1835
Chloride of calcium	.0800
Chloride of magnesium	.3140
Silica	.0009
Water and loss	.0959
	1.7000

Too weak to be profitably evaporated for salt.

No. 824—SANDSTONE. *Labeled "Mudstone, on the road from Dover to Augusta, Bracken county, Ky. Lower Silurian formation."*

A grey-buff, impure, sandstone, easily broken; imperfectly and irregularly laminated; with many impressions of bi-valve fossil shells; adheres slightly to the tongue; powder of a light buff color.

Dried at 212° it lost 0.80 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	88.580
Alumina, and oxides of iron and manganese	6.460
Carbonate of lime	.920
Magnesia	.899
Phosphoric acid	.438
Sulphuric acid	.200
Potash	.560
Soda	.166
Water, expelled at a red heat	1.900
	100.123

Resembles the other specimens of mudstone from the Lower Silurian formation which have been analyzed; as reported in the preceding volumes of these Reports.

No. 825—LIMESTONE. *Labeled "Encrinital Limestone from near Augusta, Bracken county, Ky., where the virgin tobacco soil was collected; (see next number.) Lower Silurian formation."*

A coarse-granular, grey limestone; on the weathered surfaces appearing to be almost entirely made up of small *entrochites*, with a few fragments of *Chætetes lycoperdon, &c.*

Dried at 212°, it gave up 0.30 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	91.040	—51.084 lime
Carbonate of magnesia	3.678	
Alumina and oxides of iron and manganese	1.660	
Phosphoric acid	.182	
Sulphuric acid	.269	
Potash	.200	
Soda	.148	
Silicious residuum	2.880	
	100.057	

No. 826—SOIL. *Labeled "Virgin Tobacco Soil; hillside, north exposure, near Augusta, Bracken county, Ky., on Mr. L. J. Bradford's land."* (Obtained by Dr. Owen.) *Lower Silurian formation.*

Air-dried soil of a light umber color.

No. 827—SOIL. *Labeled "Sub-soil, from the hillside, where the virgin tobacco soil was collected, near Augusta, Bracken county, Ky."*

Dried soil of a light dirty-buff color.

No. 828—SOIL. *Labeled "Soil of Tobacco Land, exhausted by successive crops, from the farm of Col. L. J. Bradford, near Locust Creek, Bracken county, Ky. (Sent by Col. Bradford.")*

Dried soil of a dirty-buff color. intermediate in shade to the two preceding soils. A few fragments of soft, slatey, ferruginous sandstone were sifted out of it.

One thousand grains of each of these tobacco soils, thoroughly air-dried, were digested for a month, severally, in water charged with carbonic acid under pressure. The quantity and *composition* of the *soluble matters* extracted from each by this process, are shown in the following table.

	No. 826. Virgin soil.	No. 827. Sub-soil.	No. 828. Exhausted soil.
Organic and volatile matters	2.250	0.470	0.585
Alumina and oxides of iron and manganese and phosphates	1.063	.130	.147
Carbonate of lime	5.420	.447	1.573
Magnesia	.649	.133	.591
Sulphuric acid	.061	.040	.073
Potash	.104	.048	.071
Soda	trace.	.037	.011
Silica	.314	.149	.147
Loss			.135
Watery extract, dried at 212° F., (grains)	9.861	1.454	3.333

The *composition* of these soils, dried at 400° F., is as follows:

	No. 826. Virgin soil.	No. 827 Sub-soil.	No. 828. Exhausted soil.
Organic and volatile matters	7.981	4.853	5.489
Alumina	6.645	3.680	4.080
Oxide of iron	6.825	5.540	3.215
Carbonate of lime	1.566	.396	.471
Magnesia	1.354	.844	.762
Brown oxide of manganese	.296	.146	.196
Phosphoric acid	.342	.179	.260
Sulphuric acid	.119	.031	.042
Potash	.758	.458	.265
Soda	.047	not estim'd	.029
Sand and insoluble silicates	72 920	83.310	85.300
Loss	1.136	.563	
Total	100.000	100.000	100.109
Moisture, expelled at 400° F.	6.975	2.950	2.525

On comparing this "exhausted" soil with the virgin soil of the same locality, some marked points of difference may be observed between them. In the first place, the quantity of *watery extract*, dissolved out of the soils by digestion in water charged with carbonic acid, is greatly larger from the virgin soil than from the "exhausted soil;" being

9.861 grains from the thousand; equal to twenty-nine thousand five hundred and eighty-three pounds (29,583 lbs.) to the acre in the former case; calculating the weight of the soil on an acre of ground, to the depth of one foot, as equal to three millions of pounds (3,000,000 lbs.;) whilst from the latter soil it is only 3.333 grains to the thousand of soil; equal to nine hundred and ninety-nine pounds (9,999 lbs.) to the acre. In this watery extract, dissolved by the carbonated water from the soil, we find, moreover, that the *potash* and *lime*, as well as the *organic matters*, are greatly reduced in that from the exhausted soil, as compared with that from the virgin soil.

The same reduction, in the proportions of the *essential* ingredients of the soil, may be observed in the general analyses of these two samples. The *organic matters*, the *lime*, the *magnesia*, the *phosphoric and sulphuric acids, the potash, and soda*, are all greatly reduced in quantity in the "exhausted" soil, as compared with that which has not been cultivated. We may sum up these differences, as calculated for one foot depth of soil on an acre, taking the weight of this quantity at three millions of pounds avoirdupois, as follows:

	In virgin soil.	In exhausted soil.	Difference.
	Pounds.	Pounds.	Pounds.
Organic and volatile matters	239,430	164,670	74,760
Carbonate of lime	47,580	14,130	33,450
Magnesia	40,620	22,860	17,760
Phosphoric acid	10,260	7,800	2,460
Sulphuric acid	3,300	1,260	2,040
Potash	22,740	7,950	4,790
Soda	1,410	870	540
Extract, dissolved by carbonated water	29,583	9,999	19,584

During the progress of this survey analyses were made of the ashes of thirty different specimens of tobacco, with the object of ascertaining the nature of the exhausting action of this crop upon the soil, as well as the influence of the soil upon the quality of the tobacco grown on it, &c. A full detail of the results will be found in the appendix to this Report. It will be seen, on examination, that the tobacco plant withdraws a large quantity of mineral matter from the soil, and especially more *potash* and *lime* than any other ingredients. Probably no vegetable exceeds it in this respect. It is a plant which also requires a very large proportion of nitrogen.

Taking the average of the analyses of the Mason county and Bracken county tobacco examined, as given in the appendix; we find the following results as to the *composition of the ashes;* representing the *mineral ingredients* of the plant, which are necessarily withdrawn by it from the soil.

The table shows the quantities contained in one hundred parts of the air-dried tobacco leaf, viz:

Potash	5.23
Soda	.51
Lime	5.10
Magnesia	.65
Oxides of iron and manganese	.05
Phosphoric acid	.61
Sulphuric acid	.63
Chlorine	.08
Silica	.44
Carbonic acid and loss	4.90
Ash, in 100 parts of air-dried leaf	18.20 parts.

Or a little more than eighteen per cent. of ash, or mineral material, in the dried tobacco leaf.

Taking the average crop of tobacco at one thousand pounds, and adding one third more for the stalks, &c., removed from the land, the quantities of the essential mineral ingredients of the soil removed from the acre, in one year, by this crop may, be represented as follows:

	Pounds.	
Potash	69.73	
Soda	6.80	
Lime	68.00	equal to 121.17 pounds carbonate of lime.
Magnesia	8.67	
Phosphoric acid	8.13	
Sulphuric acid	8.40	
Chlorine	1.06	
Silica	5.86	

It may be interesting to compare, in this place, the quantities of these essential mineral substances taken from the ground in average crops of wheat, Indian corn, and tobacco, as based on the analyses of the ashes of these grains to be found also in the appendix to this Report.

Taking the average wheat crop at twenty bushels of 60 pounds to the acre; the average corn crop at fifty bushels of 56 pounds, and the above datum of the tobacco crop, we have the following results; disregarding the straw, stalks, cobs, &c., &c.:

	In a wheat crop of 20 bushels.	In a corn crop of 50 bushels.	In a tobacco crop of 1000 lbs.
	Pounds.	Pounds.	Pounds.
Potash	5.45	8.06	69.73
Soda	.13	6.22	6.80
Lime	1.63	.22	*68.00
Magnesia	2.43	3.61	8.67
Phosphoric acid	9.12	11.85	8.13
Sulphuric acid	.08	not estimated.	8.40
Chlorine	.35	not estimated.	1 06
Silica	.41	.71	5.86

* Equal to more than 121 pounds of *carbonate of lime or limestone.*

The above table is very instructive as to the peculiar *exhausting* action of the tobacco crop. It will be seen, that not only does it require much more of *all* the essential mineral ingredients of the soil than the grain crops, but that the tobacco is especially a *potash* and *lime* plant, robbing the soil of these materials with very great rapidity, and taking up about as much of one of these substances as of the other.

But when we ascertain the number of years which would be required to reduce the valuable ingredients of the virgin soil, described above, to the quantities found in the "exhausted" soil, by the annual removal of an average tobacco crop, we find, *that if these two soils were originally alike in composition*, which is probable, some other causes have been in operation, during the cultivation of the soil, to aid in its deterioration. For it would have taken nearly seventy years to reduce the *potash*, and about two hundred and seventy-six years to reduce the carbonate of lime, from the quantities contained in the virgin soil to those existing in the "exhausted" soil.

I venture to assert that, in all cases where *hoed crops* have been cultivated, the deterioration of the soil takes place more rapidly than can be accounted for in the vegetable products removed from the land; and especially, when, as is the case with the tobacco, large spaces between the plants are kept clean of vegetable growth during the growing season. Because the atmospheric water filtering through the land, and the active agents, heat, light, and oxygen, are continually decomposing and carrying away more or less of its essential ingredients. If the land is well drained, or on a slope, this action is accelerated; but if its surface is covered with growing vegetables of any kind, these are constantly absorbing the water from the depths of the soil with its dissolved materials, employing these materials in the formation of their tissues, and finally, when they decay, leaving them to enrich the surface of the ground. Hence land constantly covered with weeds or grass tends to become richer on the surface, whilst similar soil, kept perfectly clear of all vegetable growth, and subject to the atmospheric agencies, must give to the rain water which flows through it, more and more of its valuable soluble ingredients, and undergo great loss of organic matters, &c., by decomposition.

But the reason why the "exhausted" soil failed any longer to produce profitable crops of tobacco, is not because it did not contain *potash, lime, magnesia*, &c., &c., &c. It will be seen, on the contrary, that it still retains enough of all these essential ingredients to constitute it a *pretty good soil.* Doubtless, it would produce good crops of wheat, corn, grass, &c., &c. The tobacco plant requires much nitrogen in its composition, and, *possibly*, enough of this was not furnished in a given time for its wants; it requires a considerable amount of *sulphuric acid* also; but especially, *it requires a large quantity of dissolved materials from the soil within a short space of time*, so that a large amount of the essential ingredients of the soil must be in a *soluble condition*, or, in an *immediately available state*, to enable it to grow with vigor.

In this "exhausted" tobacco soil, the same thing has occurred as frequently takes place with other crops; with clover, for instance; which, after having grown with great vigor for a few years ceases to do well on the same land, which is hence said to be "clover sick;" although the land is far from being exhausted, as is shown by the fact that other crops are produced on it in great abundance.

Clover, like tobacco, withdraws a large amount of *potash, lime*, &c., &c., from the soil. Clover hay, according to Dr. Emmons, gives 5.56 per cent. of ash;* which is of such a composition that a ton of the clover hay takes from the soil in which it has been grown, the following quantities of its essential ingredients:

	Pounds.
Potash	32.153
Soda	18.594
Carbonate of lime	38.378
Magnesia	4.870
Phosphates	25.341
Sulphuric acid	.625
Chlorine	2.288
Silica	1.054

* Natural History of New York, *Agriculture*, part V, page 86.

Clover, like tobacco, or any other quick growing plant, consumes very rapidly the *soluble* or *immediately available* portion of the soil. Clover may be made to exhaust the soil, by cutting and taking it off the land in large hay crops; or it may be made to enrich its surface by grazing it down by hogs or cattle; when the salts are mainly restored to the soil in the excretions of the animals; or by plowing it under as a green manure. At all events, the large roots of this plant are always left to decay in the soil, and tend greatly to enrich the surface and increase its quantity of *soluble* nutritious matters; whilst in the case of the tobacco crop, the whole plant is removed, and the soluble portion of the soil is thus rapidly diminished. Clover, grazed and plowed in, may be advantageously employed, in rotation with the tobacco crop, to sustain the fertility of the soil, and special manures, as lime, plaster of paris, wood ashes, bone dust, or super phosphate of lime, with guano or other animal manures intended to benefit the tobacco crop, might very well be applied to the previous clover crop.

It has been proposed to restore the fertility of tobacco soil by giving it top-dressings of nitre (nitrate of potash;) but this, as might have been expected, has not been found effectual in practice. By studying the composition of the ashes of tobacco, we learn that *lime*, *sulphuric acid*, and other mineral ingredients, are necessary to this plant as well as *potash;* and common sense tells us that an *occasional* supply is not sufficient, but that it is necessary to furnish the nutritive materials to the plant regularly and constantly during the growing season. A compost, rich in *potash*, *lime*, *magnesia*, *phosphates*, *sulphates*, *chlorides*, and *soluble silica*, with *decomposing organic matters*, and *ammonia salts*, or other *nitrogenous compounds*, would, theoretically, supply to the tobacco plant all that is necessary to its growth Such a mixture is contained in good guano, (except that guano is deficient in potash,) and in the urine and fæces of animals, in good barn-yard manure; but it is found that the direct application of such manures is liable to injure the flavor of the tobacco, although they may cause a heavy growth. There is no doubt that this inconvenience may be averted by applying them to the previous crop, as clover, in rotation with the tobacco. Regular irrigation with a weak watery solution, or mixture, of these materials; especially to the young plants; applied to the soil only and not to the plants, according to the Flemish practice. would be the next most effectual mode of supplying them, and would cause a strong growth of the tobacco, as well as maintain the productiveness of the land. But this mode is not likely to be employed in this region at the present time. It is the practice with some tobacco-growers to manure the hill in which the plant is grown by throwing in a handful of *wheat bran*, which by its speedy decomposition furnishes much nutritive mineral matter, in a soluble condition.

The stalks and roots of the tobacco should in all cases be allowed to decay on the land which produced them, or in compost heaps, to furnish it with manure; or, if burnt, the ashes, which contain the valuable mineral elements, should be restored to the soil at the proper season.

On examining *Table VII*, &c., of the tobacco ash analyses, in the appendix, it will be seen that, in the Mason and Bracken county tobacco, generally, there is a deficiency of *chlorine*, as compared with the Havana and Florida tobacco. It might be well for some intelligent cultivators to experiment, by irrigation with weak solutions of chlorides; especially chloride of *ammonium* (common sal ammoniac) and the chlorides of *potassium*, *sodium*, *magnesium*, and *calcium*, (common salt, &c., &c.) Tobacco raised, in this region, directly from the best imported Havana seed, although like its parent plant at first, soon loses its flavor and increases in size. Whether this deterioration is owing to the properties of the soil; to distance from the sea, the air over which always contains marked traces of chlorine, iodine, and bromine, or to other atmospheric or climatic conditions, might perhaps be ascertained by careful and judicious experiment.

Under the head of MASON COUNTY, in this volume, may be found the analyses of other tobacco soils; and in the appendix are recorded the results of the analyses of the ashes of thirty different samples of tobacco from various parts of the State, and from Florida and Cuba, as well as an abstract of some analyses of the ashes of the tobacco leaf and stalk of Massachusetts and Maryland, made by Chas. T. Jackson, M. D.

No. 829—SOIL. *Labeled "Soil from Dr. J. P. Bradford's grape farm near Augusta, Bracken county, Ky. Lower Silurian formation."*

Dried soil of a dirty-buff color.

One thousand grains of the air-dried soil, digested for a month in water, charged with carbonic acid, gave up about *four and a third grains of soluble extract*, dried at 212° F., which had the following

COMPOSITION, VIZ:

Organic and volatile matters	0.700
Alumina and oxides of iron and manganese and phosphates	.280
Carbonate of lime	2.180
Magnesia	.190
Sulphuric acid	.028
Potash	.063
Soda	.011
Silica	.200
Water and loss	.678
	4.330 grains.

The air-dried soil lost 3.675 per cent. of *moisture*, at 400° F., dried at which temperature it has the following

COMPOSITION, VIZ:

Organic and volatile matters	7.412
Alumina	5.990
Oxide of iron	6.975
Carbonate of lime	.871
Magnesia	1.623
Brown oxide of manganese	.260
Phosphoric acid	.289
Sulphuric acid	.033
Potash	1.164
Soda	.058
Sand and insoluble silicates	74.895
Loss	.430
	100.000

A soil remarkably rich in *potash*, well adapted to the culture of the grape. From its very small proportion of sulphuric acid, it is probable its productiveness may be increased by top-dressing of plaster of paris. In the appendix to this Report will be found some analyses which we have made of the Catawba and Herbemont wine of this region; with remarks on the influence of wine culture on the fertility of the soil, &c.

No. 830—SOIL. *Labeled "Clay in which Indian bones are found at Augusta, Bracken county, Ky. Lower Silurian formation."*

The dried sub-soil or under-clay is of a light chocolate color, and was found to contain a few fragments of decayed bones, which were sifted out before proceeding to the analysis.

One thousand grains of the air-dried soil, digested for a month in water charged with carbonic acid, gave up *more than three and a half grains of drab colored extract*, dried at 212° F., which had the following

COMPOSITION, VIZ:

Organic and volatile matters	0.200
Alumina and oxides of iron and manganese and phosphates	.250
Carbonate of lime	2.230
Magnesia	.449
Sulphuric acid	.028
Potash	.182
Soda	.068
Silica	.246
Loss	.017
	3.670 grains.

The air-dried soil lost 1.635 per cent. of *moisture*, at 400° F., and thus dried, had the following

COMPOSITION.

Organic and volatile matters	3.497
Alumina	3.560
Oxide of iron	4.095
Carbonate of lime	.495
Magnesia	.593
Brown oxide of manganese	.145
Phosphoric acid	.225
Sulphuric acid	.045
Potash	.319
Soda	.029
Sand and insoluble silicates	86.970
Loss	.227
	100.000

The *phosphates* of the bones do not seem to have been diffused, in any marked manner, through this sub-soil.

No. 831—Soil. *Labeled "Virgin Soil; James Dunnivan's land. Growth small white oak. Lower Silurian formation, Bracken county, Ky."*

Dried soil of a chocolate-grey color. Some fragments of soft ferruginous sandstone were sifted out of it.

No. 832—Soil. *Labeled "Soil from an old field, sixty years in cultivation; James Dunnivan's farm, adjoining the preceding," &c., &c.*

Dried soil of a slightly darker color than the preceding; containing some fragments of soft, ferruginous sandstone.

One thousand grains of each of these soils, thoroughly air-dried, were digested, severally, for a month in water charged with carbonic acid. The amount of *soluble materials* extracted is as follows:

	No. 831.	No. 832.
	Virgin soil.	Old field soil.
Organic and volatile matters	0.666	0.283
Alumina and oxides of iron and manganese and phosphates	.150	.047
Carbonate of lime	.530	.680
Magnesia	.166	.096
Sulphuric acid	.037	.022
Potash	.067	.052
Soda	.029	not estimated.
Silica	.197	.081
Loss	.175	.129
Watery extract, dried at 212° F., (grains,)	2.017	1.390

The *composition* of these soils, dried at 400° F., is as follows:

	No. 831.	No. 832.
	Virgin soil.	Old field soil.
Organic and volatile matters	5.931	3.798
Alumina	4.115	3.465
Oxide of iron	3.435	3.210
Carbonate of lime	.170	.220
Magnesia	.836	.869
Brown oxide of manganese	not estimated.	
Phosphoric acid	.254	.227
Sulphuric acid	not estimated.	
Potash	.190	.237
Soda	034	080
Sand and insoluble silicates	84.695	87.070
Loss	.340	.827
Total	100.000	100.000
Moisture, expelled at 400° F.	2.200	2.525

These soils show one of the few exceptions which we have found to the rule, that the long cultivated soil contains less of the essential elements of vegetable composition, than the virgin soil of the same locality. To what cause this apparent anomaly is to be attributed, we do not know, in the absence of any of the sub-soil, which did not come to hand.

BREATHITT COUNTY.

No. 833—Saline Incrustation, *on Sandstone, called "nitre" where found; mouth of Troublesome Creek. Brought by Messrs. Downie and Lesquereux.*

This was found to be gypsum, or sulphate of lime.

No. 834—COAL. *Labeled "Cannel Coal, Round Bottom, Quicksand Creek; three or four miles from Jackson, Breathitt county, Ky. Whole thickness of the bed thirty-seven inches; the lower twenty-one inches being cannel coal."*

A dull black coal, cleaving in layers, with a satiny lustre on the cross-fracture. No fibrous coal between the layers, and no appearance of pyrites. Does not soil the fingers. Resembles Haddock's cannel coal,* but contains more ash. *Specific gravity* 1.278.

Over the spirit lamp, it gave out much flame; does not soften much nor agglutinate, leaving a dense coke.

PROXIMATE ANALYSIS.

Moisture	0.70	Total volatile matters	44.70
Volatile combustible matters	44.00		
Fixed carbon in the coke	39.90	Dense coke	55.30
Light-grey ashes	15.40		
	100.00		100.00

The percentage of *sulphur* in this coal is 0.452.

COMPOSITION OF THE ASH:

Silica	11.584
Alumina, and oxides of iron and manganese	2.980
Lime	.215
Magnesia	.240
Phosphoric acid	a trace.
Sulphuric acid	.100
Potash and soda and loss	.281
	15.400

To test the oil-producing power of this coal, one thousand grains were submitted to distillation; the heat being gradually raised to a dull red heat, and the products collected in a train of three tubulated receivers, with a bell-glass to collect the gas; and the following results were obtained:

120.30	grains=860 cubic inches of pretty good gas.
273.00	grains of moderately thick crude oil.
30 00	grains of ammoniacal water.
576.70	grains of cellular coke
1000.00	

It does not differ much from Haddock's coal in the production of oil, but yields a greater measure of gas. (See Vol. II, p. 217, of these Reports.)

* See Vol. 1, page 354, of these Reports.

No. 835—COAL. "*Cannel Coal from Mr. South's coal bank, (three feet thick,) near Jackson, Breathitt county, Ky.*" (*Brought from Frankfort by John C. Mason, Esq.*)

Resembles Haddock's cannel coal. A tough, pure, dull-black cannel coal. No fibrous coal between the irregular layers. Presenting an approximation to the bird's-eye structure in some pieces. *Specific gravity* 1.219.

Over the spirit lamp it burns with much flame; swells a little, and leaves a dense coke.

PROXIMATE ANALYSIS.

Moisture	0.30	Total volatile matters	57.00
Volatile combustible matters	56.70		
Fixed carbon in the coke	38.10	Dense coke	43.00
Light-purplish-grey ashes	4.90		
	100.00		100.00

The percentage of *sulphur* was found to be 1.513.

COMPOSITION OF THE ASH.

Silica	1.524
Alumina, and oxides of iron and manganese	1.980
Lime	.417
Magnesia	.199
Phosphoric acid	trace.
Sulphuric acid	.240
Potash	.336
Soda	.142
Loss	.062
	4.900

Submitted to destructive distillation, for the estimation of its oil-producing power, the following results were obtained, viz:

IN THE 1000 GRAINS.

Pretty good gas, and loss	134	grains=675 cubic inches.
Moderately thick crude oil	364	"
Ammoniacal water	36	"
Dense, porous coke	466	"
	1000	

In round numbers, it yields about one third of its weight of *crude oil*, besides a considerable quantity of good illuminating gas. The coke which is left will prove an admirable fuel. No doubt it could be profitably worked for coal oil, of which it yields fully as much as the Breckinridge coal. As this coal does not contain large percentages of *sulphur* and *ash*, the gas from it might be easily purified for illuminating purposes, and the coke could be doubtless employed for foundry purposes.

BRECKINRIDGE COUNTY.

No. 836—SANDSTONE. *Labeled "White Sandstone. Cut of the Breckinridge Coal Company's Railroad, Breckinridge county, Ky."*

A very friable sandstone; easily crushed in the fingers into small clear grains of sand, with a few minute dark-colored specks and small scales of mica. Appears to have no cement to hold the grains of sand together.

Dried at 212° it lost 0.01 per cent of *moisture*. Heated to redness, it lost 0.50 per cent. of water more.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	98.340
Alumina and oxides of iron and manganese	.580
Lime	a trace.
Magnesia	266
Phosphoric acid	a trace.
Sulphuric acid	.042
Potash } Soda }	traces.
Water and loss	.772
	100.000

A sandstone pure enough to be employed in the manufacture of white glass. It would be quite refractory in the fire also.

Another specimen was sent to the laboratory labeled "*White Sandstone, Tar Springs, Breckinridge county, base of coal measures,*" which seems to be identical with this.

No. 837—SOIL. *Labeled "Disintegrated Limestone, forty feet below the base of the millstone grit, near the head of Sinking Creek, Breckinridge county, Ky. No plant or tree, nor even moss, grows where this rock furnishes any considerable portion of the soil. Growth, on the top of the sandstone, black jack, and white and red oak; on the face of the limestone, post, and white oak and black jack and a coarse grass." (Sent by Mr. S. S. Lyon.)*

This dried soil or powder is of a greenish-grey color.

One thousand grains, air-dried, were digested for a month in water charged with carbonic acid, to which it gave up *more than seven grains of soluble extract, of a whiteish-grey* color, dried at 212° F., the *composition* of which was found to be as follows, viz:

Organic and volatile matters	0.417
Alumina, and oxides of iron and manganese and phosphates	.064
Carbonate of lime	6.297
Magnesia	.088
Sulphuric acid	not estimated.
Potash	.032
Soda	.028
Silica	.089
	7.015 grains.

The air-dried powder lost 6.25 per cent. of moisture at the temperature of 400° F. Thus dried, its *composition* is as follows, viz :

Organic and volatile matters	1.839
Alumina, and oxides of iron and manganese	2.510
Carbonate of lime	60.050
Carbonate of magnesia	.101
Phosphoric acid	.030
Sulphuric acid	.084
Potash	.217
Soda	.061
Sand and insoluble silicates	34.580
Loss	.528
	100.000

The principal peculiarities in *chemical* composition, presented by the analysis of this disintegrated limestone, are the very large proportion of carbonate of lime and the small amount of phosphoric acid present; with quite a moderate quantity of organic and volatile matters. The carbonated water dissolves a large quantity of the carbonate of lime, causing the soluble extract to appear proportionately great.

This very large amount of carbonate of lime and paucity of phosphoric acid appear to be unfavorable to vegetable life; whilst the peculiar physical condition of this soil contributes to prevent the healthy growth of vegetables upon it. Some remarks by Dr. Owen on a soil of this character, in Vol. I, pages 81 and 82, would seem to apply well in this instance also.

The rock next described is the limestone from whence it is derived.

No. 838—LIMESTONE. *Labeled "Grey Sandy Limestone, from which the above disintegrated limestone was derived, Breckinridge county, Ky."* (*Sent by S. S. Lyon, Esq.*)

A dull, light-grey, granular limestone. Dried at 212° F,. it lost 0.10 per cent. of *moisture*, and has the following

COMPOSITION, VIZ:

Carbonate of lime	80.680
Carbonate of magnesia	1.473
Alumina, and oxides of iron and manganese	1.580
Phosphoric acid	a trace.
Sulphuric acid	.166
Potash	.398
Soda	.090
Silex and insoluble silicates	15.580
Loss	.033
	100.000

This limestone contains less phosphoric acid than is usual in rocks of this kind. Had it a larger proportion of carbonate of magnesia, it might be a good hydraulic limestone.

No. 839—SOIL. *Labeled "Virgin Soil, from Mr. Dent's land, two miles north of the base line; one mile west of Sinking Creek, Breckinridge county, Ky. The waste of the limestone 200 feet below the base of the millstone grit. Hillside with a capping of the lowest sandstone of the millstone grit; twenty feet of which rest on the top." (Obtained by S. S. Lyon, Esq.)*

Dried soil of a dark umber-brown color.

No. 840—SOIL. *Labeled "Sub-soil of the preceding. Mr. Dent's farm," &c., &c.*

Dried soil of a rich light orange-brown color.

No. 841—SOIL. *Labeled "Virgin Soil, farm of Mr. Davis, on Sugar Camp Creek, Breckinridge county, Ky. Geological position; forty-eight feet above the top of the Tar Spring sandstone. Probably the waste of the second limestone above the base of the millstone grit, and of the sandstone above." (Sent by S. S. Lyon, Esq.)*

Dried soil of a dark-grey color.

No. 842—SOIL. *Labeled "Sub-soil of the preceding. Farm of Mr. Davis," &c.*

Dried soil of a greyish-buff color.

No. 843—SOIL. *Labeled "Soil, from a field fifteen years in cultivation, farm of Mr. Davis, &c. Same Geological position as the two preceding," &c.*

Dried soil of a greyish-buff, or dirty-yellowish color.

No. 844—SOIL. *Labeled "Sub-soil of the preceding. Farm of Mr. Davis," &c.*

Dried soil of a rich brownish-buff color, darker than the preceding.

No. 845—SOIL. *Labeled "Soil from Mr. Alexander Jones' farm, near the Litchfield and Big Spring road. Geological position: above the lowest sandstone of the millstone grit. Forest growth, black oak, hickory, post and jack oak. Under-growth, hazel, sassafras, and some black gum. Fine tobacco land; but said not to wear well. On the nearly level plateau lying between the heads of Sinking Creek and the small branches of Rough Creek, Breckinridge county, Ky." (Sent by S. S. Lyon, Esq.)*

Dried soil of a light, yellowish, umber color.

No. 846—SOIL. *Labeled "Sub-soil of the preceding. Mr. Alexander Jones' farm," &c., &c.*

Dried sub-soil of a greyish-buff color.

One thousand grains of each of these eight soils, thoroughly air-dried, were digested severally for a month, in water charged with carbonic acid. The analyses of the *soluble materials* thus extracted from the soils are given in the following table, viz:

	No. 839. Virgin Soil.	No. 840. Sub-soil.	No. 841. Virgin Soil.	No. 842. Sub-soil.	No. 843. Old field Soil.	No. 844. Sub-soil.	No. 845. Soil.	No. 846. Sub-soil.
Organic & volatile matters	0.753	0.250	0.500	0.263	0.300	0.377	1.100	0.390
Alumina & oxides of iron and manganese and phosphates	.147	.046	.131	.081	.107	.081	.230	.047
Carbonate of lime	5.040	.747	1.197	.263	.563	.347	.797	.130
Magnesia	211	.055	·133	.101	.101	.096	.160	.086
Sulphuric acid	--------	--------	--------	--------	.028	.028	.062	.018
Potash	.075	.025	.050	.087	.079	.061	.055	.026
Soda	.025	--------	.046	.017	.013	.028	.025	.022
Silica	.200	.131	.156	.264	.230	.131	.180	.097
Loss	.372	.046	.137	.041	.045	--------	.091	.007
Watery extract, dried at 212° F., (grains)	6.823	1.300	2.350	1.117	1.466	1.149	2.700	0.823

The *composition* of these soils, dried at 400° is given in the following table:

	No. 839.	No. 840.	No. 841.	No. 842.	No. 843.	No. 844.	No. 845.	No. 846.
	Virgin Soil.	Sub-soil.	Virgin Soil.	Sub-soil.	Old field. Soil.	Sub-soil.	Soil.	Sub-soil.
Organic & volatile matters	8.411	4.407	5.141	3.513	2.942	3.678	5.136	3.609
Alumina	5.240	6.590	2.315	3.740	3.215	5.165	2.615	5.315
Oxide of iron	4.838	4.460	2.545	3.970	2.335	5.085	2.935	4.010
Carbonate of lime	1.880	.570	.420	.195	.145	.220	.170	.110
Magnesia	.830	.559	.366	.474	.488	.542	.345	.392
Brown oxide of manganese	.345	.120	.120	.195	.095	.070	.195	.170
Phosphoric acid	.130	.152	.160	.094	.085	.095	.095	.095
Sulphuric acid	.076	.016	.059	.033	.028	.033	.055	.041
Potash	.434	.378	.118	.198	.183	.347	.119	.327
Soda	.099	.178	.032	.078	.050	.113	.033	.041
Sand and insoluble silicates	77.495	82.270	88.810	87.120	90.930	83.720	87.645	85.220
Loss	.222	.300	--------	.390	--------	.932	.657	.670
Total	100.000	100.000	100.076	100.000	100.496	100.000	100.000	100.000
Moisture, expelled at 400° F.	4.000	3.000	1.775	1.975	1.425	2.825	2.650	2.350

Soil No. 845 contains too little *lime*, *potash*, and *phosphoric* and *sulphuric acids*, and gives too small a quantity of *soluble matter* to the carbonated water, to prove a very good or durable tobacco soil. The sub-soil contains more potash than the surface soil.

(In the appendix to this Report will be found analyses of the ashes of Indian corn and tobacco from this county.)

BULLITT COUNTY.

No. 847—SANDSTONE. *Labeled "Building Stone. Knob at Bullitt's Lick, Bullitt county, Ky."*

A dull, dirty grey-buff and greenish-grey, rather friable stone. Does not look like a good building material, but may possibly harden by exposure to the weather.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	90.380
Alumina, and oxides of iron and manganese	5.660
Lime	a trace.
Magnesia	.800
Phosphoric acid	.118
Sulphuric acid	.231
Potash	.463
Soda	.142
Water and loss	2.206
	100.000

Dried at 212° F., it lost 0.60 per cent. of *moisture*.

No. 848—Soil. *Labeled "Virgin Soil. from woods west of the Louisville and Nashville railroad, and north of the Gap o' the Knobs, on H. C. Pindell's farm, in Bullitt county, Ky. Sub-soil resting on the Devonian Black Slate formation."* (*Sent by H. C. Pindell, Esq.*)

Dried soil of a light-chocolate color. Some quartzose and ferruginous fragments were sifted out of it.

No. 849—Soil. *Labeled "Soil from a garden, near the 'Gap o' the Knobs,' which has been cleared twelve years, and badly cultivated as a 'truck patch,' or vegetable garden; mostly in corn. On H. C. Pindell's farm, Bullitt county, Ky."*

This garden adjoins the woods from which the preceding specimen of soil was taken. It has a clayey sub-soil, resting on the black slate. The dried soil resembles the preceding, but is a slight shade darker in color. Some quartzose and ferruginous fragments were sifted out of it with the coarse seive.

No. 850—Soil. *Labeled "Sub-soil, from the same hole as the preceding sample. H. C. Pindell's farm," &c., &c.*

Dried sub-soil of a dirty-buff color.

No. 851—Soil. *Labeled "Virgin Soil, from Blue Lick Run bottom, on the Brook's Road from Louisville to Shepardsville. H. C. Pindell's farm, &c."*

Dried soil of a grey-brown color; considerably darker than the two preceding soils. A considerable amount of somewhat rounded fragments of quartzose and ferruginous rock were sifted out of it with the coarse seive.

No. 852—Soil. *Labeled "Virgin Soil, from the top of the hill, north side of Blue Lick Run. H. C. Pindell's farm, &c., Bullitt county, Ky."*

Dried soil of a buff-grey color. Some fragments of quartzose and ferruginous rocks, somewhat rounded, were sifted out of it.

No. 853—Soil. *Labeled "Soil from a field adjoining the woods from which the next preceding sample was taken. The field has been cleared about twenty-five years, and has been cultivated until within the last seven years, when it has been 'turned out.' H. C. Pindell's farm, &c., Bullitt county, Ky."*

Dried soil of a darker color than the preceding. A considerable quantity of fragments of dark ferruginous sandstone was sifted out of it with the coarse seive.

No. 854—SOIL. *Labeled "Sub-soil of the preceding; resting on sandstone with nuggets of quartz interspersed through it. H. C. Pindell's farm, &c."*

Dried soil of a light grey-buff color. Some fragments of dark ferruginous sandstone were sifted out of it.

(These soils were collected by H. C. Pindell, Esq.)

One thousand grains of each of these soils, thoroughly air-dried, were digested, severally, for a month, in water charged with carbonic acid. The *soluble materials* extracted from each, by this process, are detailed in the following table, viz:

	No. 848. Virgin Soil.	No. 849. Garden Soil.	No. 850 Sub-soil.	No. 851. Virgin Soil.	No. 852. Virgin Soil.	No. 853. Old field Soil.	No. 854. Sub-soil.
Organic & volatile matters	0.670	0.600	0.185	0.800	Extract accidentally lost after weighing it.	0.337	0.300
Alumina, & oxides of iron & manganese & phosphates	.097	.250	.080	.330		.280	.030
Carbonate of lime	1.130	1.347	.414	2.710		1.613	.097
Magnesia	.400	.222	.222	.620		.166	.100
Sulphuric acid	.033	.028	.034	.022		.028	.041
Potash	.081	.082	.042	.044		.110	048
Soda	.033	.024	.004	.047		.035	.039
Silica	.240	.250	.124	.081		.131	.081
Loss	--------	--------	--------	.716	--------	.130	--------
Watery extract, dried at 212° F., (grains)	2.684	2.803	1.105	5.370	2.725	2.830	0.736

The *composition* of these seven soils is as follows, viz:

	No. 848. Virgin Soil.	No. 849. Garden Soil.	No. 850. Sub-soil.	No. 851. Virgin Soil.	No. 852. Virgin Soil.	No. 853 Old field Soil.	No. 854. Sub-soil.
Organic & volatile matters	5.159	5.142	3.591	7.033	3.674	5.827	3.261
Alumina	3.540	3.515	6.440	3.840	2.390	4.065	6.290
Oxide of iron	3.875	3.125	4.840	5.840	3.290	4.165	5.390
Carbonate of lime	.210	.271	.170	1.621	a trace.	.395	trace.
Magnesia	.416	.431	.562	1.643	.451	.828	.569
Brown oxide of manganese	.071	.121	.070	.110	.145	.145	.195
Phosphoric acid	.209	.150	.127	.281	.129	.159	.094
Sulphuric acid	.059	.065	.033	.050	not esti'd	not esti'd	not esti'd
Potash	.256	.217	.278	.211	.125	.082	.477
Soda	.037	.062	.005	.170	.040	.132	.081
Sand and insoluble silicates	86.070	87.345	84.110	80.220	88.745	84.395	83.395
Loss	.098	--------	--------	--------	1.011	--------	.248
Total	100.000	100.444	100.226	101.019	100.000	100.193	100.000
Moisture, exp'd at 212° F.	2.075	1.800	2.550	2.465	2.725	3.525	3.100

These soils, if well drained, and judiciously managed, ought to yield profitable harvests. They are well adapted to the growth of Indian corn, to the culture of the grape, or the peach, &c., &c. The limestone and soft shales, in this neighborhood, some analyses of which follow, might be employed to restore some of the essential ingredients which are removed in the crops or naturally deficient in some of the soils. Soil No. 852 in particular, would no doubt be benefited by liberal top-dressing of slacked lime. The sub-soil No. 854, being quite rich in *potash*, might with great propriety be mixed with the surface soil by means of deep plowing, or the sub-soil plow. Top-dressings of the black slate of this neighborhood, after it has been disintegrated by exposure to the weather, will also tend to increase the proportion of potash in the soil, and aid in the production of herbaceous crops, potatoes, fruits, &c.

No. 855—SHALE. *Labeled "Black (Devonian) Shale, from the Gap o' the Knobs; on H. C. Pindell's farm, Bullitt county, Ky."* (*Sent by H. C. Pindell, Esq.*)

A dark, umber-colored shale; not adhering to the tongue. Dried at 212° it lost 0.90 per cent. of *moisture*, and has the following

COMPOSITION:

Alumina and oxides of iron and manganese	12.725
Lime	1.458
Magnesia	.367
Phosphoric acid	.246
Sulphuric acid	3.830
Potash	1.271
Soda	.217
Sand and insoluble silicates	69.420
Bituminous matters, water, &c.	12.040
	101.574

In this shale the sulphur, estimated in the above table in the form of sulphuric acid, is mainly combined with iron as sulphuret of iron. The oxidation of these two ingredients accounts, in part, for the excess observed in summing up the analysis. If this shale is easily disintegrated by exposure to the frosts and other atmospheric agents, as is possible, it would be valuable as a top-dressing to the poor, thin lands of this region.

No. 856—MAGNESIAN LIMESTONE. *Labeled "Limestone found under the two preceding soils, Nos. 853 and 854, from H. C. Pindell's farm, Bullitt county, Ky."* (*Sent by H. C. Pindell, Esq.*

A compact grey limestone; containing many fossil remains; as small encrinital stems, &c., &c. Belonging to the Upper Silurian period.

No. 857—MAGNESIAN LIMESTONE. *Labeled "Limestone from the lime quarry on H. C. Pindell's farm, Bullitt county, Ky," showing the two varieties of limestone taken from the same quarry.*

A portion is of a dull bluish-grey color; the adjoining layer is yellowish-grey; both are fossiliferous and dull, except from the presence of some facets of calc. spar. *Upper Silurian formation.*

No. 858—LIMESTONE. *Labeled "Limestone found in large lumps under the soil, on H. C. Pindell's farm, Bullitt county Ky."*

Encrinital (sub-carboniferous?) limestone; a detached mass.

The *composition* of these three *limestones*, dried at 212° F., is as follows:

	No. 856. Mag'n limestone.	No. 857. Mag'n limestone.	No. 858. Limestone.
Carbonate of lime	50.980	52.880	93.600
Carbonate of magnesia	37.747	37.577	3.314
Alumina, and oxides of iron and manganese	2.700	1.640	.780
Phosphoric acid	a trace.	trace.	trace.
Sulphuric acid	not estimated.	.067	not estimated.
Potash	.463	.270	.297
Soda	.226	.198	.090
Silex and insoluble silicates	6.380	5.980	1.980
Water and loss	1.504	1.388	----------
	100.000	100.000	100.061

No. 856 would most probably be the best limestone for agricultural purposes, whilst No. 858 will make the whitest lime. A little more silex in these magnesian limestones would make them hydraulic limestones; indeed, as they are, they may yield a lime which may set well under water, if it be mixed with the proper quantity of clean sand.

CAMPBELL COUNTY.

No. 859—IMPURE LIMONITE. *Labeled "Bog Iron Ore, Yeton farm, southern part of Campbell county, Ky."*

Irregular grains, and portions of dark brown limonite, cemented into a porous, friable mass by a dirty brownish-yellow ocherous clay-like substance. Adheres to the tongue. Powder of a dirty-brown color.

Dried at 212° F., it lost 4.90 per cent. of *moisture*.

COMPOSITION, DRIED AT 212° F.

Oxide of iron	16.600
Alumina	6.920
Carbonate of lime	.980
Carbonate of magnesia	2.396
Brown oxide of manganese	3.480
Phosphoric acid	.950
Sulphuric acid	.269
Potash	.596
Soda	.003
Sand and insoluble silicates	61.280
Combined water	6.500
Loss	.026
	100.000

Too poor and impure to be employed with advantage as an iron ore.

CARTER COUNTY.

No. 860—LIMONITE, INCLUDING CARBONATE OF IRON. *Labeled "Red Kidney Ore, (No. 1*,) from the Star Furnace, Carter county, Ky." (Sent by Messrs. Lampton, Nicholl & Co., the proprietors.)*

An irregular, rounded mass; *exterior layers* of brownish and yellowish limonite, which adheres slightly to the tongue; *interior*, an irregular nucleus of fine-grained carbonate of iron. Some of the exterior portion was taken for analysis. The powder of which is of a brownish-yellow color.

No. 861—LIMONITE. *Labeled "Limestone Ore, (No. 5,) Star Furnace," &c., &c.*

A brownish and yellowish ore. Powder of a yellowish-brown color.

No. 862—LIMONITE. *Labeled "Black Ore, (No. 6,) Star Furnace, &c., &c.*

A dark-colored, friable, porous ore; a nodular mass, with a soft, brownish-yellow, ochreous nucleus. Powder brownish-black.

No. 863—LIMONITE. *Labeled "Yellow Kidney Ore, (No. 7,) Star Furnace," &c., &c.*

An irregular mass, composed of dense, dark-brown, curved, layers; which do not adhere to the tongue; inclosing cavities, generally filled with soft, brownish-yellow, ochreous ore. Powder yellowish-brown.

* The numbers in brackets were attached by Messrs. Lampton, Nicholl & Co.

No. 864—LIMONITE. *Labeled "Limestone Ore, (No. 8,) Star Furnace," &c. &c.*

A dark, rust-red, and dark purplish ore; mottled with lighter colored. Porous; adhering to the tongue. Powder of a red color.

The *composition* of these limonite ores, dried at 212° F., is as follows:

	No. 860. (No. 1.) Red kidney	No. 861. (No. 5.) Limestone Ore.	No. 862. (No. 6.) Black ore	No. 863. (No. 7.) Yel. kidney Ore.	No. 864. (No. 8.) Limestone Ore.
Oxide of iron	69.740	43.740	39.440	73.872	68.880
Alumina	1.680	1.380	.240	.720	.980
Carbonate of lime	trace.	17.680	1.800	a trace	6.880
Magnesia	1.114	3.022	.816	.999	2.444
Brown oxide of manganese	1.780	1.880	39.677	1.280	.580
Phosphoric acid	.375	2.293	2.101	1.268	1.140
Sulphuric acid	.272	.460	not estim'd	.647	.681
Potash	.270	.374	.270	.386	.231
Soda	trace.	.025	.039	.152	.057
Silex and insoluble silicates	11.680	19.380	1.380	12.950	10.840
Combined water	12.800	9.726	14.300	10.500	6.700
Loss	.329		----------	.216	.787
Total	100.000	100.000	100.123	100.000	100.000
Moisture expelled at 212°	2.200	2.000	3.700	1.740	1.100
Percentage of metallic iron	48.840	30.666	27.620	49.633	48.238

The *purest* of these ores, and that which will yield the toughest iron, is the "*red kidney ore*," No. 860, (No. 1.)

The "black ore," No. 862, (No. 6,) is peculiar in containing as much oxide of manganese as oxide of iron. It owes its dark color to the former oxide. The oxide of manganese is supposed to be useful in ores which are smelted for the manufacture of steel. It unites readily with earthy matters at a high heat and forms quite a fluid "cinder." This black ore contains so much phosphoric acid, however, that it is probable good tough steel metal could not be made from it.

Ore No. 861, (No. 5,) contains a considerable proportion of carbonate of lime, and hence would require very little limestone to flux it; but this also contains so much phosphoric acid, that the iron made from it would probably be brittle or "cold-short;" it would, however, be quite thin when melted, and hence would make sharp castings. This injurious ingredient, which exists in too large proportion in most of the above ores, can be partly removed, in smelting, by the use of an excess of good limestone and of pure *argillaceous* matter, such as pure clay, &c.;

the alumina of which tends to combine with the phosphoric acid, and to carry it off in the cinder. The limestone and clay, or other aluminous material used for the flux, should themselves, of course, be as free as possible from phosphoric acid.

Ore No. 860 should be carefully roasted before smelting, to decompose the interior nucleus of carbonate, which, without roasting, would tend too much to melt and run off in the "cinder."

No. 865—CARBONATE OF IRON. *Labeled "Little Block Ore, (No. 2,) from Star Furnace, Carter county, Ky," &c.*

Interior of the mass a fine-grained, grey, carbonate of iron. *Exterior*, thin layers of brown limonite, which adheres to the tongue. Powder of a brownish-yellow color; an average portion taken for the analysis.

No. 866—CARBONATE OF IRON. *Labeled "Blue Kidney Ore, (No. 3,) Star Furnace," &c.*

An irregularly rounded, nodular mass of fine-grained, dark lead-colored carbonate of iron; with an infiltrated whitish substance in the fissures, and some specks of yellow pyrites. Powder of a yellowish-grey color.

No. 867—CARBONATE OF IRON. *Labeled "Blue Block Ore, (No. 4,) Star Furnace," &c., &c.*

A block of dark-grey, fine-grained carbonate, about five inches thick; apparently a portion of a layer. Powder of a grey color.

Composition of these three *carbonates of iron*, dried at 212° F.

	No. 865. (No. 2.) Little Block.	No. 866. (No. 3.) Blue Kidney.	No. 867. (No. 4.) Blue Block.
Carbonate of iron	20.190	87.527	60.134
Oxide of iron	51.310	.778	4.775
Alumina	.380	.984	.480
Carbonate of lime	.880	trace.	1.060
Carbonate of magnesia	2.926	1.924	5.105
Carbonate of manganese	1.475	1.524	1.987
Phosphoric acid	.822	.207	.540
Sulphuric acid	.441	.613	.819
Potash	.374	.181	.193
Soda	.010	trace.	.159
Silex and insoluble silicates	11.780	6.680	21.480
Water and loss	9.412	----------	3.248
Total	100.000	100.218	100.000
Moisture, expelled at 212° F.	1.200	0.400	0.54
Percentage of iron	45.688	42.807	32.396

The "blue kidney ore" would probably make the toughest iron. In each of these carbonates, there is a considerable proportion of sulphuric acid; but the use of an excess of limestone in the flux would carry some of it off and prevent the combination of the sulphur with the iron, which would make it "*hot-short*," or brittle when hot.

A very good mode of removing the sulphur from ores which contain yellow pyrites (bi-sulphuret of iron) is, first, carefully to roast them, and then to expose them for some time to the air and rains. The proto-sulphuret of iron, left after the roasting, is thus oxidated into sulphate of iron, (copperas,) which is easily to be washed out of the crumbling ores by water.

No. 868—Impure Limestone. *Labeled "Limestone, (No. 9,) Star Furnace, Carter county, Ky."* (*Sent by Lampton, Nicholl & Co. Found about forty feet above the yellow kidney ore, used as a flux.*

A dark-brown, almost black, ferruginous limestone; exhibiting some glimmering facets. Powder of a dark-umber color, nearly black. Specific gravity, 2.782. Dried at 212°, it lost 3.00 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.:

Carbonate of lime	50.780
Carbonate of magnesia	3.220
Alumina	.880
Oxide of iron	3.960
Peroxide of manganese	30.260
Phosphoric acid	.950
Sulphuric acid	.475
Potash	.135
Soda	.067
Silex and insoluble silicates	1.880
Water and loss	7.393
	100.000

The very large amount of peroxide of manganese which this limestone contains does not probably injure it for use as a flux in the smelting of iron; especially as the oxide of manganese forms quite fusible compounds when melted with earthy materials. But the considerable proportions of *phosphoric and sulphuric acids* contained in it, render it desirable to substitute a more pure limestone.

No. 869—Pig Iron. *"Pig Iron, made from a mixture of the preceding ores, at Star Furnace, Carter county, Ky."* (*Sent by Lampton, Nicholl & Co.*)

A rather coarse-grained, specular, grey iron, which yields with some difficulty to the file. Small fragments flatten a little under the hammer, but easily break to pieces. Exterior of the pig presenting quite a bright appearance, with small shining specular plates. It does not seem to rust very easily. *Specific gravity*, 7.0927.

COMPOSITION.

Iron	90.606	
Graphite	2.100	Total carbon, 3.620
Combined carbon	1.520	
Manganese	1.507	
Silicon	2.181	
Slag	.284	
Aluminum	.201	
Calcium	a trace.	
Magnesium	.203	
Potassium	.473	
Sodium	a trace.	
Phosphorus	1.404	
Sulphur	.1[illegible]5	
	100.414	

It contains too much phosphorus to be very tough iron. The quality of the iron at this furnace might be improved, as to *strength* particularly, by selecting the best ores—those which contain the least phosphorus and sulphur—and by using a purer limestone for the flux.

No 870—COAL. *Labeled "Bituminous Coal, found from thirty-five to forty feet above the yellow kidney ore, in bed varying from four to six feet thick. Star Furnace, Carter county, Ky."* (*Sent by Lampton, Nicholl & Co.*)

A shining, pitch-black coal, with very little fibrous coal between the layers. Exhibiting some reed-leaf like impressions. Scarcely soiling the hands. Over the spirit lamp it decrepitated, swelled up considerably, but the fragments did not agglutinate. Specific gravity, 1.266.

PROXIMATE ANALYSIS.

Moisture	7.70	Total volatile matters	44.20
Volatile combustible matters	36.50		
Fixed carbon in the coke	53.80	Dense coke	55.80
Grey-buff ashes	2.00		
	100.00		100.00

The percentage of *sulphur* in this coal is 1.267.

COMPOSITION OF THE ASH.

Silica	0.900
Alumina, and oxides of iron and manganese	.220
Lime	.120
Magnesia	.340
Potash	.100
Soda	.120
Loss	.100
	2.000

This is quite a pure coal, retaining, however, more than the usual proportion of *moisture*, to which no doubt is owing its decrepitation when suddenly heated.

No. 871—COAL. *Labeled "Cannel Coal, twenty-one inches, with a clay parting of four inches, over which four to six inches. Stinson Bank, Carter county, Ky." Obtained by Dr. Owen.*

A dull-black, very tough coal; cleaving in very thin layers, which have impressions of quite small narrow reed-like leaves in fibrous coal. Specific gravity, 1.200.

Over the spirit lamp it did not swell nor alter much in form.

PROXIMATE ANALYSIS.

Moisture	0.60	Total volatile matters	66.90
Volatile combustible matters	66.30		
Fixed carbon in the coke	28.30	Dense coke	33.10
Tawny yellowish ashes	4.80		
	100.00		100.00

The percentage of sulphur in this coal is 1.320.

COMPOSITION OF THE ASH.

Silica	1.884
Alumina, and oxides of iron and manganese and phosphates	1.680
Lime	.271
Magnesia	.633
Sulphuric acid	.304
Potash	.127
Soda	.170
	5.067

Submitted to destructive distillation, in an iron retort, at a heat slowly raised to dull redness, the following results were obtained from one thousand grains of this coal, viz:

Crude oil, thin	436 grains.
Ammoniacal water	40 grains.
Coke	384 grains.
Combustible gases and loss	140 grains=to 670 cubic inches.
	1000

It will be seen, by reference to Vol. II, p. 217, of these Reports, that this yield of *crude oil* exceeds that obtained from any other Kentucky cannel coal hitherto submitted to experiment, including the celebrated Breckinridge coal. This coal is also superior to that because of its small percentage of sulphur and of ashes. For these reasons the coke would be a much better fuel than that from the Breckinridge coal, and the gas might be easily purified for illuminating purposes. If the process were carried on in a city, where it might be advantageously employed: for although it does not give as much light as gas made from the Pittsburg coal, distilled at a higher temperature; yet, sold at a lower price, it would doubtless find a ready sale.

The yield of crude oil in the experiment above described is quite remarkable; equal to (872 lbs.) eight hundred and seventy-two pounds, or nearly one hundred and ten gallons to the ton, (2000 lbs.) Whether the specimen tried is richer than the average of the bed can only be ascertained by trial. But the probability is that this bed of coal is peculiarly fitted for the manufacture of coal oils. See further on for the examination of another specimen of cannel coal from Stinson creek.

No. 872—Coal. *Labeled "Sample of Coal from the upper eighteen inches of openings on Carter's Hill; (property of Robert Carter, of Grayson;) half a mile north of Grayson Court-House, Carter county, Ky."* (*Obtained by Joseph Lesley, jr., Esq.*)

A dull black, very friable, coal; separating easily into thin layers. Over the spirit lamp it does not change form nor give much flame; leaving a soft friable coke, easily incinerated.

PROXIMATE ANALYSIS.

Moisture	1.26	Total volatile matters	40.90
Volatile combustible matters	39.64		
Fixed carbon in the coke	49.40	Pulverulent coke	59.10
Buff-grey ashes	9.70		
	100.00		100.00

The percentage of *sulphur* is 0.694.

The ash contains large proportions of alumina, oxide of iron, carbonate of lime, and magnesia, so that they are probably easily to be melted into clinker.

No. 873—Coal. *Labeled "Sample of the under eighteen inches of opening on Carter's Hill, half a mile north of Grayson Court-House, Carter county, Ky."* (*Obtained by Joseph Lesley, jr., Esq.*)

A somewhat dull, pitch-black, coal; some portions deep shining black; not much fibrous coal between the layers. Some thin incrustations of pyrites in the cracks and joints.

Over the spirit lamp, it softened somewhat, and agglutinated into a moderately dense coke. Specific gravity, 1.298.

PROXIMATE ANALYSIS.

Moisture	4.40	Total volatile matters	39.40
Voluble combustible matters	35.00		
Fixed carbon in the coke	52.70	Moderately dense coke	60.60
Purplish-grey ashes	7.90		
	100.00		100.00

The percentage of *sulphur* in this sample is 3.261.

COMPOSITION OF THE ASHES.

Silica	3.584
Aluminia and oxides of iron and manganese and phosphates	3.680
Lime	a trace.
Magnesia	.279
Sulphuric acid	.166
Potash	.251
Soda	.107
	8.067

No. 874—Coal. *Labled "Bituminous Coal, from the upper part, (above the slate parting,) of the bed on Tar Kiln branch of Stinson's creek; and on the Mount Savage property, Carter county, Ky."* (*Obtained by Joseph Lesley, jr., Esq.*)

A shining, deep pitch-black, rather brittle coal. Much soft fibrous coal between the layers. Over the spirit-lamp it softens and agglutinates, and swells up into a spongy coke. Specific gravity, 1.299.

PROXIMATE ANALYSIS.

Moisture	.26	Total volatile matters	40.20
Volatile combustible matters	35.94		
Fixed carbon in the coke	53.30	Moderately dense coke	59.80
Purplish-grey ashes	6.50		
	100.00		100.00

The percentage of *sulphur* in this coal, is 2.339.

COMPOSITION OF THE ASH.

Silica	1.644
Alumina, and oxides of iron and manganese and phosphates	4.080
Lime	trace.
Magnesia	.133
Sulphuric acid	.013
Potash	.011
Soda	.012
Carbonic acid and loss	.607
	6.500

No. 875—Coal. *Labeled "Cannel Coal from the under part of the bed on Tar Kiln branch of Stinson's Creek, on the Mount Savage property, Carter county, Ky. This coal is used in Ashlaud for making oil."* (*Obtained by Joseph Lesley, jr., Esq.*)

A dull black, very tough coal, breaking with difficulty and irregularly, into thin layers; the fragments generally with sharp edges. No fibrous coal between the layers. The cross-fracture is somewhat conchoidal, with a satiny lustre.

Over the spirit lamp, it gives much smoky flame; does not soften, nor swell much; leaving a friable quite combustible coke. Specific gravity 1.145.

PROXIMATE ANALYSIS.

Moisture	0.90	Total volatile matters	65.06
Volatile combustible matters	64.16		
Fixed carbon in the coke	27.04	Friable coke	34.94
Purplish-grey ashes	7.90		
	100.00		100.00

The percentage of *sulphur* in this coal is 2.843.

COMPOSITION OF THE ASH.

Silica	2.784
Alumina, and oxides of iron and manganese	4.240
Lime	.550
Magnesia	.299
Sulphur, phosphoric acid, and alkalies	not estimated
	7.873

One thousand grains, submitted to destructive distillation in an iron retort, at a heat gradually raised to dull redness, gave of

Thin crude oil	411 grains.	
Ammoniacal water	40 "	
Porous coke	367 "	
Combustible gases and loss	182 "	=675 cubic inches.
	1000	

This yield of crude oil is second only to that from a similar specimen of cannel coal from Stinson's bank, (described above,) amongst all the Kentucky coals which have been examined. It is equal to eight hundred and twenty-two pounds, (822 lbs.) or about one hundred gallons of crude oil to the ton (of two thousand pounds) of the coal. It is doubtful whether the Boghead coal of Scotland gives so large a product of oil.

CLARKE COUNTY.

No. 876—Magnesian Limestone. *Labeled "Building Stone; quarry mouth of Lower Howard's Creek, Clarke county, Ky. Lower Silurian formation."*

A dull, light-buff, fine-granular rock; resembling that from Grimes' quarry in Fayette county. Specific gravity 2.735.

Dried, in powder, at 212° F., it lost only 0.30 per cent. of *moisture.*

COMPOSITION DRIED AT 212° F.

Carbonate of lime	60.640=34.029 lime.
Carbonate of magnesia	32.500=15.040 magnesia.
Alumina, and oxides of iron and manganese	.560
Phosphoric acid	.207
Sulphuric acid	.124
Potash	.374
Soda	.250
Silex and insoluble silicates	3.520
Moisture and loss	1.865
	100.000

This is doubtless a good and durable building stone; resembling that employed in the construction of the Clay Monument at Lexington.

No. 877—LIMESTONE. *Labeled "Rock from which the soil is derived, collected on Judge Simpson's farm, near Winchester, Clarke county, Ky. Lower Silurian formation."*

A coarse-granular limestone; very much weathered and disintegrated, and very full of fossil shells. Exterior surface coated with dirty-grey-buff soil.

Dried at 212° F. it lost 0.20 per cent. of *moisture*.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	85.560=48.017 lime.
Carbonate of magnesia	3.567
Alumina, and oxides of iron and manganese	3.280
Phosphoric acid	.118
Sulphuric acid	.474
Potash	.422
Soda	.462
Silex and insoluble silicates	5.920
Loss	.187
	100.000

A limestone remarkably rich in the alkalies and sulphuric acid, and containing a considerable proportion of phosphoric acid.

No. 878—SOIL. *Labeled "Virgin Soil, from woods pasture, on Judge Simpson's farm, near Winchester, Clarke county, Ky. Primitive growth, black walnut, locust, mulberry, blue ash, &c. Lower Silurian formation."* (*Obtained by Dr. Owen.*)

Dried soil of a light-greyish-brown color.

No. 879—SOIL. *Labeled "Soil from an old field, thirty years or more in cultivation, adjoining the preceding, Judge Simpson's farm," &c.*

Dried soil of a light grey-brown color; lighter colored than the preceding.

No. 880—Soil. *Labeled "Sub-soil of the same old field. Judge Simpson's farm," &c., &c.*

Dried soil a little darker and more yellowish than the preceding.

No. 881—Soil. *Labeled "Virgin Soil, from Wm. R. Duncan's farm, Clarke county, Ky. (From a lower situation than the old field from which the next preceding soil was taken; and more of a meadow soil.) Forest growth, sugar-tree, black locust, white and blue ash. Blue limestone formation." (Collected by Dr. Owen.)*

Dried soil of a dark, dirty, grey-buff color.

No. 882—Soil. *Labeled "Soil from an old field, upwards of forty years in cultivation, on Wm. R. Duncan's farm," &c., &c.*

Dried soil slightly darker colored than the preceding.

No. 883—Soil. *Labeled "Sub-soil, from the same old field, Wm. R. Duncan's farm," &c.*

Dried soil slightly darker than the preceding.

One thousands grains of each of these soils, thoroughly air-dried, were digested for a month, severally, in water charged with carbonic acid; the *soluble matters* extracted are detailed in the following table, viz:

	No. 878. Virgin Soil.	No. 879. Old field.	No. 880. Sub-soil.	No. 881. Virgin Soil.	No. 882. Old field.	No. 883. Sub-soil.
Organic and volatile matters	1.717	0.533	0.500	0.705	0.467	0.833
Alumina, and oxides of iron and manganese and phosphates	.280	.114	.080	.167	.181	.114
Carbonate of lime	2.887	2.231	1.447	1.347	.781	.814
Magnesia	.149	.092	.067	.089	.110	.067
Sulphuric acid	.041	.032	.030	.033	.045	.041
Potash	.094	.087	.061	.035	.054	.058
Soda	.008	.004	.030	.009	.024	.013
Silica	.147	.264	.181	.147	.180	.254
Loss	.310	.243	.004	.101	.075	--------
Watery extract, dried at 212° F., (grains)	5.633	3.600	2.400	2.633	1.917	2.194

The sub-soil No. 883, gives up more *soluble matter* to the carbonated water than the surface soil above it, which is quite an unusual circumstance, and may, most probably, be attributed to the fact that it contains as much organic matters and lime, and more magnesia, potash, sulphates and phosphates, than that. (See following table.) Sub-soil plowing would, therefore, be *immediately* beneficial to this old field.

The composition of these soils, dried at 400° F., is as follows:

	No. 878.	No. 879.	No. 880.	No. 881.	No. 882.	No. 883.
	Virgin Soil.	Old field.	Sub-soil.	Virgin Soil.	Old field.	Sub-soil.
Organic and volatile matters	9.028	6.379	5.797	7.764	5.985	5.923
Alumina	6.565	4.240	7.165	6.790	6.240	6.290
Oxide of iron	5.600	4.960	5.460	5.860	5.785	5.885
Carbonate of lime	.545	.695	.320	.345	.195	.195
Magnesia	.687	.563	.859	.883	.719	1.133
Brown oxide of manganese	.545	.320	.370	.330	.320	.895
Phosphoric acid	.366	.211	.228	.306	.245	.296
Sulphuric acid	.064	.084	.050	.092	.067	.076
Potash	.475	.296	.583	.589	.396	.507
Soda	.124	.056	.053	.005	.034	.065
Sand and insoluble silicates	76.070	81.920	79.620	76.820	79.945	79.970
Loss	--------	.276	--------	.216	.069	--------
Total	100.089	100.000	100.505	100.000	100.000	100.735
Moisture, expelled at 400°	4.750	3.125	3.400	4.050	3.350	3.350

These are rich soils, like the blue limestone soils generally. The sub-soil is quite rich in potash, like much of the sub-soil and under-clays on this formation. As usual, the soils of the old fields show evident signs of deterioration, in the reduction of the proportions of the essential elements of vegetable nutrition. Soil No. 881 contains less of its elements in an immediately soluble condition than soil No. 878; probably because it has less *organic matters*, and less lime than that.

No. 884—SOIL. *Labeled "Virgin Soil, from Woodland, on the farm of Mr. John Goff, near Kiddville, Clarke county, Ky. Indian old fields. Forest growth, oak and hickory. Devonian Sandstone formation."* (*Obtained by Messrs. Downie and Lesquereux.*)

The dried soil is of a light, greyish umber color. A considerable quantity of iron gravel, or shot iron ore, was sifted out with the coarse seive.

No. 885—SOIL. *Labeled "Soil from an old field, adjoining the preceding, fifteen years in cultivation; taken three inches below the surface; farm of Mr. John Goff," &c., &c.*

Dried soil of a dark umber color, contains iron gravel.

No. 886—Soil. *Labeled "Sub-soil, from a corn-field adjoining the two preceding, taken nine inches below the surface. Mr. Jno. Goff's farm," &c., &c.*

Dried soil darker colored than the preceding, of a dark umber color, verging to soot colored. More than a third of its weight of iron gravel was removed from it, with the coarse seive, before analysis.

One thousand grains of each of these soils were digested, severally, for a month, in water charged with carbonic acid; the analyses of the *soluble materials* extracted are given in the following table, viz:

	No. 884. Virgin soil.	No. 885. Old field.	No. 886. Sub-soil.
Organic and volatile matters	1.327	1.190	0.750
Alumina, and oxides of iron and manganese and phosphates	.853	1.454	.330
Carbonate of lime	.987	2.296	1.113
Magnesia	.172	.2[illegible]3	.259
Sulphuric acid	.027	.056	.045
Potash	.093	.026	.015
Soda	.028	.049	.067
Silica	.198	.198	.314
Loss	.092	.289	---------
Watery extract, dried at 212° F., (grains)	3.777	5.7[illegible]0	1.893

The soil of the old field gives up a larger quantity of soluble matters than the virgin soil, principally because it contains more carbonate of lime and sulphuric acid.

The *composition* of these soils, dried at 400° F., is as follows, viz:

	No. 884. Virgin soil.	No. 885. Old field.	No. 886. Sub-soil.
Organic and volatile matters	7.195	6.842	9.263
Alumina	5.615	5.690	6.815
Oxide of iron	6.635	9.535	12.310
Carbonate of lime	.120	.820	.345
Magnesia	.048	.772	.855
Brown oxide of manganese	.220	.145	.170
Phosphoric acid	.346	.384	.217
Sulphuric acid	.050	.127	.067
Potash	.580	.265	.463
Soda	.409	.122	.088
Sand and insoluble silicates	78.470	75.170	69.220
Loss	---------	.128	.187
Total	100.588	100.000	100.000
Moisture, expelled at 400° F.	3.750	5.000	5.275

These soils have the composition of very rich soils, and if they are well drained, and otherwise under favorable physical circumstances, they ought to produce large crops. The proportions of carbonate of lime, and of sulphuric and phosphoric acids, in the virgin soil are below those contained in the soil of the old field, and it gives up much less soluble matter to carbonated water than that; it also exhibits a larger proportion of sand and insoluble silicates, but a much greater quantity of potash. Top-dressings of lime and of plaster of paris would be advantageous to the virgin soil for most crops. The proportions of oxide of iron in soils Nos. 885 and 866 are unusually large, and contribute to give them their dark color. The organic matter contained in the sub-soil is also unusually large in quantity.

No. 887—LIMONITE. *Labeled "Iron gravel from the sub-soil of Indian old fields, Clarke county, Ky."* (*See the preceding soil.*)

COMPOSITION, DRIED AT 212° F.

Oxides of iron and manganese and alumina	66.060
Carbonate of lime	.054
Magnesia	.266
Phosphoric acid	1.015
Sulphuric acid	.132
Potash	.349
Soda	.181
Silex and insoluble silicates	19.040
Water, organic matter, and loss	12.873
	100.000

It contains a considerable proportion of phosphoric acid, but this, being combined with the per oxide of iron, or alumina, is not easily taken up by the atmospheric water.

No. 888—LIMESTONE. *Labeled "Hydraulic Limestone; base of the Black Slate, Clarke county, Ky. Found also in Madison, Bath, Powell, Estill, &c."* (*Sent by S. S. Lyon, Esq.*)

The dense calcareous portion of the grey-black slate.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	40.280
Carbonate of magnesia	15.903
Alumina, and oxides of iron and manganese and phosphates	9.460
Sulphuric acid	1.025
Potash	.436
Soda	.164
Silex and insoluble silicates	23.180
Bituminous matter, water, and loss	9.552
	100.000

It is probable that with proper management this limestone will make a good hydraulic cement.

No. 889—LIMESTONE. *Labeled "Sandstone? with oil, (bitumen,) base of the Marcellus shale, Oil Springs, Clarke county, Ky."* (*Obtained by Messrs. Downie and Lesquereux.*)

A dark-grey limestone, with its calcareous-spar-lined cavities impregnated with fluid bitumen. Weathered surfaces of a dull buff color.

Dried at 212°, it lost 0.01 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	56.760
Carbonate of magnesia	21.302
Alumina, and oxides of iron and manganese	11.260
Phosphoric acid	.438
Sulphuric acid	.372
Potash	.193
Soda	.103
Silex and insoluble silicates	2.480
Bituminous matters and loss	7.092
	100.000

CRITTENDEN COUNTY.

No. 890—CARBONATE OF IRON. *Labeled "Iron Ore, Sneed's mines on Tradewater River, Crittenden county, Ky."*

A dense, dark-reddish-brown ore; not adhering to the tongue. A whitish incrustation in the fissures. Specific gravity 3.1066. Powder brownish-drab color.

Dried at 212° F., it lost 0.40 per cent. of moisture.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	64.239	32.843 per cent. of iron.
Oxide of iron	2.723	
Alumina	1.120	
Carbonate of lime	.680	
Carbonate of magnesia	2.118	
Carbonate of manganese	.662	
Phosphoric acid	.758	
Sulphuric acid	.372	
Potash	.379	
Soda	trace.	
Sand and insoluble silicates	26.480	
Water and loss	.469	
	100.000	

Sufficiently rich to be smelted, but containing rather too much phosphorus and sulphur to make a very *tough* malleable iron.

ORES, &c., FROM CRITTENDEN FURNACE.

No. 891—LIMONITE. *Labeled "Pipe Ore. Crittenden Furnace, Crittenden county, Ky, (G. D. Cobb & Co.")* (*Obtained by John Bartlett, Esq.*)

A dark brown limonite ore; some of it exhibiting an irregular tuberculated, columnar, structure. Exterior covered with reddish and yellowish ochreous ore. Powder of a rich brownish-yellow color.

No. 892—LIMONITE. *Labeled "Pot Ore" Crittenden furnace," &c.*

A layer of dense, dark-colored limonite ore, (nearly of the color of blacksmith's anvil scales,) forming a geode; the interior surface of which exhibits iridescence, and is studded with small tubercles. The cavity contained, on what appeared to have been the lower surface, a thin layer of pink-grey silicious matter easily reduced to powder. Exterior of the geode of an umber-brown color. Powder of a reddish-brown color.

No. 893—LIMONITE. *A portion of the exterior oxidated layer of the "Block Ore, (No. 896, described below.) Crittenden furnace," &c.*

A dense, compact limonite; not adhering to the tongue. Powder of a rich brownish-yellow color. Specific gravity 3.5195.

No. 894—LIMONITE. *Labeled "Brown Ore." Crittenden Furnace, &c., &c. "A large solid specimen of unique form."*

A dense, dark-brown limonite, coated with yellow ochreous ore, in the shape of a knotty branching stem. Not adhering to the tongue. The fractured surface glimmers, in some places, from the presence of small scales of mica. Powder of a rich brownish-yellow color.

No. 895—LIMONITE. *Labeled "Honey-comb Ore, Crittenden Furnace."*

A dark-brown, porous limonite ore; incrusted with light red ochreous ore.

The *composition* of these five limonite ores, from Crittenden furnace, dried at 212° F., is as follows:

	No. 891. Pipe Ore.	No. 892. Pot Ore.	No. 893. Ext'r layer. Black Ore.	No. 894. Brown Ore.	No 895. Honey-comb Ore.
Oxide of iron	78.140	80.940	81.000	72.140	81.340
Alumina	.530	.580	.580	.480	1.340
Carbonate of lime	a trace	trace.	trace.	trace.	trace.
Magnesia	.680	.474	.796	.508	.503
Brown ox. of manganese	.580	.380	.180	.880	.360
Phosphoric acid	.502	.502	.886	.418	1.204
Sulphuric acid	.183	.201	trace.	.166	.132
Potash	.328	.328	.320	.417	.181
Soda	.014	.202	.150	.180	.064
Silex & insol'ble silicates	7.780	11.520	5.180	16.980	4.380
Combined water	11.000	5.300	10.900	10.200	11.140
Loss	.263	----------	.008	----------	----------
Total	100.000	100.427	100.000	102.189	100.644
Moist., exp'd at 212° F.	0.800	1.100	0.800	0.200	1.000
Percentage of iron	54.722	56.684	56.725	50.521	56.954

Ore No. 895, honey-comb ore, contains more phosphoric acid than any of the Crittenden furnace ores; and the "brown ore," No. 894, contains the least of this injurious ingredient, and would probably yield the toughest iron. These ores are all quite rich in iron, and contain but little alumina, and hardly a trace of lime. The quality of the iron produced would, no doubt, be improved by the use of a large proportion of pure limestone with the addition of pure clay or some other aluminous material, for the flux. This would carry off some of the phosphoric acid in the "cinder."

No. 896.—CARBONATE OF IRON. *Labled "Block Ore. Crittenden furnace, Crittenden county, Ky."*

A fine-grained, dark-grey carbonate, not adhering to the tongue; with a thin layer of yellowish-brown limonite on the exterior, (the composition of which is given above, (No. 894.) (A portion of the grey interior taken for the present analysis.) Powder of a yellowish-grey color. Specific gravity 3.353. Dried at 212° it lost 0.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	64.191	32.943 per cent. of iron.
Oxide of iron	2.948	
Alumina	.470	
Carbonate of lime	2.124	
Carbonate of magnesia	13.205	
Carbonate of manganese	1.324	
Phosphoric acid	.822	
Sulphuric acid	.201	
Potash	.704	
Soda	.260	
Silex and insoluble silicates	12.980	
Loss	.761	
	100.000	

This analysis and that of the exterior layer of this ore, (No. 894,) illustrate the manner in which the ores of the *carbonate of the protoxide of iron* become gradually converted, by exposure to the atmospheric agencies, into ores of *hydrated peroxide of iron,* or *limonites.* The oxygen of the air gradually displaces the carbonic acid in the ore, and this latter acid, with the water which frequently washes the ore, gradually remove the carbonates of lime, magnesia, and manganese, and a portion of the alkalies and sulphuric acid, leaving, however, most of the phosphoric acid in insoluble combination with the peroxide of iron.

No. 897—Limestone. *Labeled "Blue Limestone, used as a flux at Crittenden Furnace, Crittenden county, Ky. Found near the Furnace. Very good."* (*Obtained by Mr. Bartlett.*)

A light slate-colored, fine-grained limestone, giving a bituminous odor when hammered, and presenting a black thin coating on some of the layers, probably bituminous. Dull in appearance generally, but presenting a few facets of calc. spar. Not adhering to the tongue.

No. 898—Limestone. *Labeled "Grey Limestone, used as a flux at Crittenden Furnace, &c. Found near the Furnace Inferior to the blue."*

A light, reddish-grey, dull, fine-grained limestone; adhering slightly to the tongue.

COMPOSITION OF THESE TWO LIMESTONES, DRIED AT 212° F.

	No. 897. Blue limestone.	No. 898. Grey limestone.
Carbonate of lime	52.880	55.280
Carbonate of magnesia	25.858	29.246
Alumina, and oxides of iron and manganese	1.460	1.323
Phosphoric acid	.098	.117
Sulphuric acid	.003	a trace.
Potash	.394	.344
Soda	.255	.056
Silex and insoluble silicates	18.880	14.280
Loss	.172	------------
	100.000	100.646
Specific gravity	2.719	2.723
Moisture lost at 212° F.	0.10	none.
Percentage of lime	29.675	31.020

These are both magnesian limestones; resembling each other a good deal in composition. No good reason can be given, from the analyses, why the one is preferred to the other; except that the *blue* contains a little less of phosphoric acid and of magnesia, and a little more of the alkalies and silica than the grey. The former may therefore be a little more fusible; but the latter contains a larger percentage of lime. These limestones would, no doubt, make good hydraulic cement.

No. 899.—Sandstone. *Labeled "Hearthstone, (best,) found two miles from Crittenden Furnace, Crittenden county, Ky."*

A light-salmon-colored sandstone, so friable as to be easily crushed in the fingers. Under the lens the clear quartz grains do not appear to be united by any cement. Some small black specks and a little oxide of iron give the color to it.

No. 900.—SANDSTONE. *Labeled "Hearthstone, (second quality,) same locality as the last, Crittenden Furnace, &c., &c."*

Lighter colored, finer grained, and apparently more pure than the preceding, which it resembles; nearly white.

COMPOSITION, &C., DRIED AT 212°.

	No. 899. Best.	No. 900. Second quality.
Sand and insoluble silicates	99.080	98.680
Alumina and oxides of iron and manganese	.080	.380
Lime	trace.	trace.
Magnesia	.360	.400
Phosphoric acid	trace.	trace.
Sulphuric acid	.063	trace.
Potash	.386	.464
Soda	.121	.058
Water expelled at a red heat	.300	.500
	100.390	100.482

Neither of them lost an appreciable quantity of *moisture* at 212° F.

Experience, with the intense heat of the iron furnace, have demonstrated which is *really* the purest sandstone, and, consequently, which is the least fusible.

Four specimens of the pig iron of Crittenden furnace were selected for analysis by Mr. John Bartlett, described as follows:

No. 901.—PIG IRON. *Labeled "Grey iron from mixed ores," Crittenden Furnace, Crittenden county, Ky.*

A moderately fine-grained, grey iron. Small fragments are easily broken under the hammer. Yields with difficulty to the file.

No. 902—PIG IRON. *Labeled "Lively Grey Iron, (No. 1, forge iron,) Crittenden Furnace, &c."*

Rather finer-grained than the preceding. Small fragments flatten under the hammer, but soon break to pieces. Yields easily to the file.

No. 903—PIG IRON. *Labeled "Grey Iron from 'Pipe Ore' alone, Crittenden Furnace, &c."*

Coarser grained and somewhat lighter colored than the two preceding; presenting more distinct brilliant, (specular,) scales. More tough than the preceding; small fragments extend a little under the hammer, but soon break. Yields more easily to the file.

No. 904—Pig Iron. *Labeled "White Iron, Crittenden Furnace, &c."*

Hard; yields with difficulty to the file; somewhat tough; small fragments flatten under the hammer. White; fracture presenting a confused bladed crystalline appearance.

COMPOSITION OF THE FOUR PIG IRONS.

	No. 901.	No. 902.	No. 903.	No. 904.
Iron	90.733	91.094	91.111	93.879
Graphite	1.884	2.024	2.224	.384
Combined carbon	1.716	.340	.420	4.500
Manganese	.129	.633	.417	.344
Silicon	3.490	3.777	3.508	.623
Slag	.664	.724	.984	.084
Aluminum	.084	.202	.202	.202
Calcium	trace	trace.	trace.	trace.
Magnesium	.271	.414	.417	.451
Potassium	.102	.080	.054	.080
Sodium	.065	.097	.077	.097
Phosphorus	.664	.443	.320	.451
Sulphur	.1[illegible]7	.052	.052	.127
	100.129	99.880	99.766	101.222
Total carbon	3.600	2.364	2.642	4.884
Specific gravity	6.9833	6.9902	6.6033	7.3988

The "white iron" is purer than any of the other samples. As is well known, it owes its whiteness and hardness to the carbon being in a *chemically combined* state; whilst in the soft *grey iron* the carbon is in a separated state, and simply *mixed* in the iron, in the form of fine scales of *graphite* or plumbago.

There is rather more *phosphorus* in most of these specimens than is desirable, and the *silicon* is also in considerable proportion. Both tending to make the iron brittle or "cold short." It would no doubt improve the toughness of the metal to use a larger proportion of *good* limestone in the flux; say one half more than has generally been used at this furnace; so that *bi-silicates*, instead of *tri-silicates*, would be formed, with the earthy matters, in the cinder.

Four characteristic specimens of "cinder" or furnace slag, were collected for analysis, at this furnace, by Mr. John Bartlett. The details of the examination of which are as follows:

No. 905—IRON FURNACE SLAG. *Labeled "Cinder from the 'white iron,' Crittenden Furnace, Crittenden county, Ky."*

A vitrified greyish-bottle-green, tending to olive green, slag; transparent on the edges; containing bubbles. Easily fusing, before the blow-pipe, into a blebby globule.

No. 906—IRON FURNACE SLAG. *Labeled "Cinder from the grey iron from mixed ores, Crittenden Furnace, &c."*

A dark, smokey-blue dense glass; with striæ of darker and lighter; transparent in thin fragments; contains no bubbles. In oxidating flame of blow-pipe easily melts into a blebby globule.

No. 907—IRON FURNACE SLAG. *Labeled "Cinder from the lively grey, forge iron, Crittenden Furnace, &c."*

An opake grey-blue, vescicular slag; translucent on the edges and containing brilliant plates of graphite and involved charcoal. In oxidating flame of the blow-pipe, very easily fusible into a clear, bottle-green globule.

No. 908—IRON FURNACE SLAG. *Labeled " Cinder from the 'Pipe Ore' alone, Crittenden Furnace, &c."*

A dense purplish, smoky-colored slag; transparent in thin fragments; containing no bubbles. In the oxydating flame of the blow-pipe, melts easily with much intumescence, into a whitish, blebby globule.

COMPOSITION OF THESE FOUR SLAGS.

	No. 905. Slag from white iron.	No. 906. From mixed ores.	No. 907. From lively grey iron.	No. 908. From pipe ore alone.
Silica	59.580	61.980	64.880	65.520
Alumina	7.980	9.080	7.480	8.280
Lime	23.164	24.623	15.847	22.155
Magnesia	1.358	1.538	1.287	1.645
Protoxide of iron	4.464	.963	7.164	1.584
Protoxide of manganese	.260	.446	.781	.353
Sulphuric acid	.135	.052	.080	.149
Potash	1.425	1.317	2.047	1.692
Soda	.130	.275	.271	.162
Loss	1.504	----------	.163	----------
	100.000	100.274	100.000	101.740
Proportion of oxygen in the *bases* to the oxygen in the *silica*,	As 12.258:30.050 or As 1:2.451	As 12.495:32.182 or As 1:2.575	As 10.692:33.688 or As 1:3.150	As 11.599:34.021 or As 1:2.941

The considerable loss of iron, in the form of protoxide, as shown in the analyses of Nos. 905 and 907, would be avoided by the use of more lime in the flux.

In the analyses of these slags, it will be seen that the proportion of *sulphur* (sulphuric acid) is estimated. Doubtless, much of this injurious ingredient may occasionally be thus carried off, where the alkalies and alkaline earths are in large proportion in the flux. As to the quantity of phosphoric acid removed in this manner, the estimation was not made in these analyses. This is, however, a question of great importance, especially in relation to the quality of the iron made with more or less limestone to the flux.

ORES, &c., FROM HURRICANE FURNACE.

No. 909—LIMONITE. *Labeled "Block Ore, (No. 1,) found in 'nests' or beds five to seventy-five feet below the surface. Banks about a mile and a quarter from Hurricane Furnace, (formerly Jackson Furnace,) Crittenden county, Ky."*

This and the next ore ('honey-comb ore') are principally used at this furnace; say about three fourths. Obtained by Mr. John Bartlett.

A dense, dark-brown limonite, in irregular shaped masses; cellular in the interior; coated with ochreous ore of a rich reddish-yellow color. Powder of a dark, brownish-yellow color.

No. 910—LIMONITE. *Labeled "Honey-comb Ore, (No. 2,) Hurricane Furnace, Crittenden county, Ky., &c."*

The dense hard layers are in smaller proportion to the handsome yellowish ochreous ore than in the preceding specimen. This being mostly composed of soft ochreous ore. Powder of a light, brownish-yellow color.

No 911—LIMONITE. *Labeled "Pipe Ore, (No. 3,) Hurricane Furnace, Crittenden county, Ky."*

A dense, dark-brown limonite, adhering slightly to the tongue; mainly made up of adhering, tuberculated, columnar, or stalactite concretions; with some light, reddish-brown and yellow, ochreous ore between. Powder of a dark, brownish-yellow color.

No. 912—LIMONITE. *Labeled "Pot Ore, (No. 4,) Hurricane Furnace, Crittenden county, Ky."*

Irregular shaped, hollow masses, or geodes, of dark-brown limonite.

incrusted with dirty, yellowish-brown ochreous ore. Dense portion does not adhere to the tongue. Powder of a dark, brownish-yellow color.

No. 913—LIMONITE. *Labeled "Slate Ore, (No. 5,) Hurricane Furnace, Crittenden county, Ky."*

A portion of a flat layer, about half an inch thick, of brown limonite, not adhering to the tongue; coated on both sides with yellow ochreous ore. Powder of a light, brownish-yellow color.

No. 914—LIMONITE. *Labeled "Sand Ore, (No. 6,) Hurricane Furnace, Crittenden county, Ky.," &c.*

Dark, reddish-brown, with darker spots; granular; containing sand. Powder of a rich, brownish-yellow color.

COMPOSITION OF THE PRECEDING SIX ORES, DRIED AT 212° F.

	No. 909. Block ore.	No. 910. Honey-comb ore.	No. 911. Pipe ore.	No. 912. Pot ore.	No. 913. Slate ore.	No. 914. Sand ore.
Oxide of iron	80.940	56.840	82.540	83.060	84.640	25.940
Alumina	.420	8.980	.580	.480	.560	.590
Lime	trace.	trace.	trace.	trace,	trace.	trace.
Magnesia	.713	.936	.541	.513	.471	.654
Brown oxide of manganese	.280	.320	.240	.240	.680	.180
Phosphoric acid	.438	.591	.502	trace.	.464	trace.
Sulphuric acid	.200	.040	.083	.248	.097	.132
Potash	.200	.301	.162	.135	.143	.169
Soda	trace.	trace.	.076	.104	.145	trace.
Silex and insoluble silicates	7.380	20.880	5.380	4.080	2.920	68.160
Combined water	10.000	11.600	10.560	11.600	10.800	3.490
Loss						.745
Total	100.571	100.488	100.664	100.460	100.940	100.000
Percentage of iron	56.684	39.806	[illegible]	58.168	59.275	18.166
Moisture, lost at 212° F.	0.70	1.60	1.00	0.50	0.50	0.40

These ores are all quite rich, except the "sand ore;" which may very well be used in mixture with some of the richer sorts. The pot ore seems to contain the least phosphoric acid amongst the richer specimens. All are devoid of any marked quantity of *lime*. (See, under the head of Trigg county, the examination of some of the water and sediment obtained from the interior of the "pot ore" of this region.)

No. 915—LIMESTONE. *Labeled "Blue Limestone used as a flux (good) at Hurricane Furnace, Crittenden county, Ky. Found near the Furnace." (Obtained by Mr. John Bartlett.)*

A fine-grained, dark lead-colored limestone; containing fossil shells, and sparkling with facets of calc. spar.

Dried at 212° F., it lost 0.10 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	79.380	=50.156 per cent. of lime
Carbonate of magnesia	8.463	
Alumina, and oxides of iron and manganese	2.580	
Phosphoric acid	a trace.	
Sulphuric acid	.587	
Potash	.353	
Soda	.233	
Silex and insoluble silicates	7.580	
Loss	.919	
	100.000	

This limestone contains but little phosphoric acid, which is in its favor as a flux for iron; but it would be better did it contain less sulphuric acid.

No. 916—SANDSTONE. *Labeled "Sandstone used for the bosh and inner wall, at Hurricane Furnace, Crittenden county, Ky. Found two miles from the furnace." (Obtained by Mr. John Bartlett.)*

A moderately firm, fine-grained sandstone; colored more or less with oxide of iron, in bands.

No. 917—SANDSTONE. *Labeled "Hearthstone, found two miles from Hurricane Furnace, &c."*

Coarser grained than the preceding; quite friable; less colored with oxide of iron. Composed of rounded grains of nearly clear quartz, with no other cement than oxide of iron.

No. 918—SANDSTONE. *Labeled "Hearthstone, (superior,) from the same locality as the last, &c."*

Firmer and coarser-grained than the preceding; containing small rounded quartz pebbles, and peroxide of iron in spots.

COMPOSITION OF THESE THREE SANDSTONES, DRIED AT 212° F.

	No. 916.	No. 917.	No. 918.
Sand and insoluble silicates	97.400	98.580	98.640
Alumina, and oxides of iron and manganese	.980	.640	.580
Lime	trace.	trace.	trace.
Magnesia	.566	.606	.206
Phosphoric acid	trace.	trace.	trace.
Sulphuric acid	trace.	trace.	trace.
Potash	.213	.231	.212
Soda	.156	.121	.028
Loss, and water expelled at red heat	.685	.240	.460
Total	100.000	100.481	100.126
Moisture, lost at 212° F.	0.20	0.30	0.40

That sandstone which is the most esteemed for resisting the action of the strong heat of the furnace, is the purest; containing less of foreign materials with its clear quartz sand than any of the others.

No. 919—PIG IRON. *Labeled "Grey Iron, (not dead grey,) for forging and foundry purposes. Hurricane Furnace, Crittenden county, Ky."* (*Obtained by Mr. John Bartlett.*)

A coarse-grey, specular, grey iron. Yields easily to the file. Small fragments break easily under the hammer.

No. 920—PIG IRON. *Labeled "Lively-grey Iron, Hurricane Furnace, &c., &c."*

Somewhat finer-grained, and a little lighter colored than the preceding. Yields easily to the file. Small fragments flatten somewhat under the hammer, but soon break to pieces.

No. 921—PIG IRON. *Labeled "White Iron, Hurricane Furnace, &c., &c."*

Very hard, and difficult to break; tougher than white iron generally. Yields with difficulty to the file. Fracture presenting a confused, bladed, semi-crystalline appearance, radiating from the under side of the pig.

No. 922—PIG IRON. *Labeled "Iron intermediate between White Iron and Lively-grey. Hurricane Furnace, &c., &c."*

A moderately fine-grained, light-grey iron. Yields with some difficulty to the file. Small fragments extend a little under the hammer, but soon break to pieces.

COMPOSITION OF THESE FOUR SPECIMENS OF IRON.

	No. 919.	No. 920.	No. 921.	No. 922.
Iron	91.871	92.143	92.263	92.336
Graphite	2.040	2.624	.984	2.224
Combined carbon	2.284	1.560	5.360	2.860
Manganese	.172	.433	.417	.345
Silicon	2.180	2.065	.142	.624
Slag	.184	.284	.184	.084
Aluminum	.202	.170	.262	.149
Calcium	trace.	trace.	trace.	trace.
Magnesium	.368	.348	.328	.220
Potassium	.064	.149	.105	.089
Sodium	.054	.082	.177	.012
Phosphorus	.727	.540	.464	.446
Sulphur	.066	.066	.108	not estim'd
Loss	-------	-------	-------	.611
Total	100.212	100.[illegible]63	100.7[illegible]4	100.000
Total carbon	4.324	4.184	6.344	5.084
Specific gravity	7.0657	7.1060	7.9263	7.2778

The iron from Hurricane furnace has maintained a good character for softness and toughness. By the following analyses of the slags from this furnace, it will be seen that they have a larger proportion of *bases* to the silica, especially of lime, magnesia, and alumina, than is contained in the Crittenden furnace "cinders," reported above.

No. 923—Iron Furnace Slag. *Labeled "Slag from the grey iron, Hurricane Furnace, Crittenden county, Ky."* (*Obtained by Mr. John Bartlett.*)

A glossy, dark-bluish-smoky slag; translucent on the thin edges. A portion of the lump is opake and blebby, and is of an olive-grey color. Before the blow-pipe, in the oxidating flame, it easily melts into a blebby globule.

No. 924—Iron Furnace Slag. *Labeled "Slag from the lively grey iron, Hurricane Furnace," &c., &c.*

A dark glossy slag; of a smoky black color; translucent on the thin edges. Before the blow pipe, in the oxidating flame, easily melting into a blebby globule.

No. 925—Iron Furnace Slag. *Labeled "Slag from the white iron, Hurricane Furnace, &c., &c."*

A dark, bottle green blebby slag; translucent on the thin edges. Before the blow pipe, melts quite easily into a dark bottle-green globule

No. 926—Iron Furnace Slag. *Labeled "Slag from iron intermediate between white and lively grey, Hurricane Furnace, &c., &c."*

A frothy greenish-grey slag; full also of large bubbles, some of which are incrusted with oxide of iron. Before the blow-pipe it melts easily into a frothy globule.

The formation of bubbles in the dense slags, when fused in the oxidating flame of the blow-pipe, is doubtless owing to the oxidation of the involved smoky, or carbonaceous matters, which give to it the fuliginous color. In the slag from the white iron, this *oxidation* seems to have taken place in the furnace; by an excess of the blast, perhaps.

THE COMPOSITION OF THESE SLAGS IS AS FOLLOWS:

	No. 923.	No. 924.	No. 925.	No. 926.
Silica	55.380	55.590	56.980	59.980
Alumina	14.440	13.380	13.280	11.880
Lime	25.578	25.241	16.936	21.066
Magnesia	3.304	3.660	2.845	3.566
Protoxide of iron	1.494	1.854	10.495	4.014
Protoxide of manganese	trace.	trace.	trace.	trace.
Potash	1.815	1.495	1.398	1.151
Soda	.173	.199	.016	.368
Total	102.184	101.409	101.950	102.045
Proportion of oxygen in the bases to oxygen in the silica	As 16.017:28.755 or As 1:1.798	As 15.611:28.859 or As 1:1.848	As 14.729:29.585 or As 1:2.008	As 14.154:31.143 or As 12.200

It is instructive to observe, in the above slags, how the proportion of protoxide of iron, (and consequent waste of metal,) increases as the quantity of lime is diminished. That which was formed with the "white iron" contains the least lime of all. These slags approach to *bi-silicates* in their composition; whilst those of Crittenden furnace arte nearly *tri-silicates.*

No. 927—Clay. *Labeled "Clay; found plenty near Hurricane Furnace. (Is it fire clay?) Crittenden county, Ky."*

Of a light greenish-grey color. Before the blow-pipe it melts with difficulty into a whitish slag.

Dried at 212° it lost 4.00 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Silica	62.280
Alumina	18.880
Oxide of iron	3.560
Lime	.325
Magnesia	1.815
Phosphoric acid	.115
Potash	3.358
Soda	trace.
Water and loss	9.667
	100.000

This contains too much of the alkalies and alkaline earths to prove a very refractory fire-clay. But it would answer exceedingly well for a potter's clay.

No. 928—Silicious Concretion. "*Found in the preceding clay, at Hurricane Furnace, &c., &c.*" *Sent for examination.*

Porous; and in some parts presenting some appearance of fossil remains.

COMPOSITION, DRIED AT 212° F.

Silex and insoluble silicates	96.980
Alumina, and oxides of iron and manganese	.680
Lime	trace.
Magnesia	.599
Phosphoric acid	not estimated.
Sulphuric acid	.058
Potash	.162
Soda	.129
Water and loss	1.392
	100.000

Of no especial interest.

No. 929—Coal. *Labeled "Cannel part of Coal of Sneed's mine, Tradewater river, Crittenden county, Ky."*

A handsome, pitch-black coal; with a bird's-eye, or curled maple like structure on the cross-fracture. No fibrous coal between the layers; and very little pyrites, in thin patches.

Over the spirit lamp, it burnt with considerable flame; swelled up and agglutinated, somewhat, into a cellular coke. Specific gravity, 1.297.

PROXIMATE ANALYSIS.

Moisture	1.00	Total volatile matters	37.50
Volatile combustible matters	36.50		
Fixed carbon in the coke	51.90	Spongy coke	62.50
Light yellowish-grey ash	10.60		
	100.00		100.00

Its composition and properties hardly entitle it to the name of a *cannel coal.*

Its percentage of *sulphur* is 0.686.

COMPOSITION OF THE ASH.

Silica	6.244
Alumina, and oxides of iron and manganese	3.080
Lime	.384
Magnesia	.260
Phosphoric acid	.300
Sulphuric acid	.012
Potash and soda, notable quantities	not estimated.
	10.280

DAVIESS COUNTY.

No. 930—LIMESTONE (HYDRAULIC?) *Labeled "Limestone from a well, seven miles east of Owensboro, Daviess county, Ky."*

A dull, dark, greenish-grey, fine-grained limestone; mottled with darker; full of fossils—corals, encrinites and shells.

Dried at 212° F., it lost 0.50 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	37.900
Carbonate of magnesia	16.665
Alumina, and oxides of iron and manganese	10.440
Phosphoric acid	.207
Sulphuric acid	3.155
Potash	.366
Soda	.063
Silex and insoluble silicates	28.320
Water and loss	2.884
	100.000

This, if properly prepared, would no doubt make good hydraulic cement.

EDMONSON COUNTY.

No. 931—LIMONITE. *Labeled "Nautilus sp? Nolin Furnace, Edmonson county, Ky. How much iron?"*

The fossil shell or cast of a nautilus, completely filled, and mineralized, with oxide of iron. Quite friable; adheres to the tongue. Color brownish-yellow and dark brown.

Dried at 212° F., it lost 1.70 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	37.240	=26.039 per cent. of iron.
Alumina	2.057	
Carbonate of lime	1.180	
Magnesia	.419	
Brown oxide of manganese	.680	
Phosphoric acid	2.423	
Sulphuric acid	.544	
Potash	.201	
Soda	.066	
Silex and insoluble silicates	45.520	
Combined water and loss	9.670	
	100.000	

ESTILL COUNTY.—ORES, &c., OF COTTAGE FURNACE.

No. 932—LIMONITE. *Labeled "Block Ore; worked at Cottage Furnace, Estill county, Ky."*

Friable; dark-brown, irregular layers of dense ore, (not adhering to the tongue,) involving yellowish and reddish ochreous ore. Powder yellowish-brown.

No. 933—LIMONITE. *Labeled "Speckled Pink Ore; worked at Cottage Furnace, Estill county, Ky."*

Granular; adhering to the tongue; under the lens appearing to be made up of dark red grains, with intervening yellowish material. General color grey-brown, with shades of yellow and red. Powder reddish-brown.

No. 934—LIMONITE. *Labeled "Rough Ore; worked at Cottage Furnace, Estill county, Ky. Superior quality; makes high white iron."*

Irregularly laminated and cellular dark brown dense ore, including dirty-yellow ochreous ore. Powder yellowish brown.

No. 935—LIMONITE. *Labeled "Kidney Ore, over the Sandstone, thirty feet above the main Ore, Cottage Furnace, &c., &c."*

A brownish-yellow, friable ore, laminæ and cells of denser, dark-brown ore. Adhering to the tongue. Powder yellowish-brown.

No. 936—LIMONITE. *Labeled "Ore from the Buzzard Banks of Cottage Furnace, &c., &c. (Does it contain copper?")*

A friable, dark, grey-brown ore, with portions of dirty, greenish-yellow; adhering to the tongue. Under the lens it exhibits fine rounded grains of dark brown color, with a lighter colored material intervening. Powder of a yellowish-brown color, darker than the preceding.

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

	No. 932. Block ore.	No. 933. Speckled ore.	No. 934. Rough ore.	No. 935. Kidney ore.	No. 936. Buzzard Bank ore.
Oxide of iron	60.800	66.140	52.454	45.540	62.200
Alumina	3.060	1.460	.660	3.496	.440
Lime	trace.	trace.	trace.	trace.	trace.
Magnesia	.642	.803	.852	1.028	2.742
Brown oxide of manganese	2.360	1.140	2.480	.980	1.620
Phosphoric acid	.800	.310	.740	.925	.502
Sulphuric acid	.107	.213	.107	.145	.135
Potash	.413	.475	.366	.434	.308
Soda	.185	.053	.167	.190	.192
Silex and insoluble silicates	21.360	22.360	33.980	39.080	21.080
Combined water	10.540	7.560	8.900	8.700	10.760
Total	100.267	100.444	100.506	100.518	100.179
Percentage of iron	42.635	46.303	36.755	31.891	43.559
Moisture lost at 212° F.	2.860	3.100	1.600	----------	----------

All good, and sufficiently rich ores. With the exception of the "rough ore," those which contain the most phosphoric acid also possess the largest quantity of alumina; which tends, more perhaps than any other base, to carry off this injurious ingredient in the cinder.

No. 937—CARBONATE OF IRON. *Labeled "Grey Ore, associated with the 'Rough Ore,' Cottage Furnace, Estill county, Ky."*

A grey, fine-granular carbonate of iron; not adhering to the tongue. Weathered surfaces of a dark reddish-brown color. Powder light grey buff. Specific gravity, 3.5762.

No. 938—CARBONATE OF IRON. *Labeled "White Ore, from the Buzzard Bank, Cottage Furnace, &c." Sub-carboniferous.*

Interior, grey, with a few small white specks; granular, adhering slightly to the tongue. *Exterior*, dark brown; adhering to the tongue; in parts presenting irregular bladed shining facets like those of some forms of zinc blende. Powder of a brownish-yellow color.

COMPOSITION OF THESE TWO CARBONATES OF IRON, DRIED AT 212° F.

	No. 937. Grey ore.	No. 938 White ore.
Carbonate of iron	78.086	54.147
Oxide of iron	1.050	16.197
Alumina	2.460	1.160
Carbonate of lime	1.290	6.190
Carbonate of magnesia	4.508	3.885
Carbonate of manganese	3.492	2.680
Phosphoric acid	.438	.438
Sulphuric acid	.176	.303
Potash	.231	.250
Soda	.198	.321
Silex and insoluble silicates	8.670	13.120
Water and loss	----------	1.309
Total	100.599	100.000
Percentage of iron	38.461	37.495
Moisture, expelled at 212° F.	0.400	----------

These are both very good iron ores; requiring only careful roasting and management of the flux to yield good iron. They are sufficiently rich for profitable smelting; as the *roasted* ores would contain fifty per cent. of metal.

No. 939—LIMESTONE. *Labeled "Sub-carboniferous Limestone, used as a flux at Cottage Furnace, Estill county, Ky."*

A grey, fine-granular limestone; with some blotches of dirty-buff color; no appearance of fossils. Specific gravity 2.6823.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	92.020=50.515 per cent. of lime.
Carbonate of magnesia	.629
Alumina, and oxides of iron and manganese	1.120
Phosphoric acid	.310
Sulphuric acid	.166
Potash	.193
Soda	.083
Silex and insoluble silicates	4.580
Water and loss	.899
	100.000

Dried at 212° F., it lost 0.40 per cent. of *moisture*.

No. 940—IRON FURNACE SLAG. *Labeled "Purple Slag, produced at Cottage Furnace when making soft iron, Estill county, Ky."*

A glassy, dark, smoky-purple slag; transparent on the thin edges, and in thin splinters. Before the blow-pipe, it is easily fusible, with intumescence.

No. 941—IRON FURNACE SLAG. *Labeled "Green Slag, produced at Cottage Furnace when working 'rough ore' and 'high white' iron, Estill county, Ky."*

A greenish-grey, frothy slag; inflated with air-bubbles and containing many particles of reduced iron. Before the blow-pipe easily fused into a greenish globule.

COMPOSITION OF THESE TWO SLAGS.

	No. 940. Purple slag.	No. 941. Green slag.
Silica	56.300	58.040
Alumina	16.100	12.360
Lime	21.414	18.058
Magnesia	1.845	1.333
Protoxide of iron	1.170	6.122
Protoxide of manganese	.595	1.060
Potash	1.757	1.970
Soda	.190	.309
Phosphoric acid	.654	.117
Loss	----------	.631
Total	100.025	100.000
Proportion of oxygen in the *bases* to oxygen in the *silica*,	As 15.070:29.232 or As 1:1.930	As 12.496:30.136 or As 1:2.331

In these slags, the presence of *phosphoric acid* was verified and the amount in each estimated. It is a fact of great importance to the iron manufacturer, that this injurious ingredient may be carried off more or less in the cinder; and it is interesting to note, in the above analyses, that the slag which contains the most *lime* and *alumina*, (especially of alumina,) also has the largest proportion of phosphoric acid, although the "*rough ore*," used in the production of the *green slag*, is probably more contaminated with this acid than the ores employed when *purple slag* was formed. It has generally been believed and asserted by the authors, even by Karsten, that, in consequence of the strong affinity existing between phosphorus and iron, in the melted state, almost all the phosphoric acid in the mixture of ores, flux, &c., in the high furnace, reduced to phosphorus by the excess of carbonaceous matters present, would find its way into the iron; communicating to it "*cold short*" properties. But the affinity between phosphoric acid and *alumina* is quite strong; and, very probably, tends more to counteract its reduction and union with the melted iron than any other agency present. Hence one reason perhaps, why the aluminous ores generally give tough iron; and why, also, the addition of pure clay or aluminous earth, or ores, will improve the toughness of iron made from "cold short" (or phosphatic) ores. This idea, if fully verified in practice, will prove of very great value to the smelter of iron.

Another fact will be noted in the analyses of these slags, viz: that the loss of iron in the form of *protoxide* is greater in the *green slag*, which contains the least *lime* and *alumina*, than in the other. This makes the cinder more fluid, causing what is called *scouring* of the furnace, and gives it the bottle-green color, sometimes very dark.

It will also be observed in the following analyses of the iron made with these two slags, that the "white iron," made with the *green slag*, contains the most *phosphorus* and *sulphur*.

No. 942—Pig Iron. *Labeled "Soft Iron, produced at Cottage Furnace, when making dark, purple slag, Estill county, Ky."*

A dark-grey, fine-granular iron; yields easily to the file; flattens somewhat under the hammer, but soon breaks.

No. 943—Pig Iron. *Labeled "High White Iron, produced when working rough ore, and making green slag, Cottage Furnace, Estill county, Ky."*

A little harder, coarser grained, and lighter colored than the preceding, but not much. Yields to the file, and flattens a little under the hammer. It cannot properly be called a *high white iron*. It is rather *grey* iron.

COMPOSITION OF THESE TWO SAMPLES OF PIG IRON.

	No. 942 Soft Iron.	No. 943 High White Iron.
Iron	93.689	93.793
Graphite	3.150	3.220
Combined carbon	.610	.550
Manganese	.669	.548
Silicon	.989	.793
Slag	.320	.260
Aluminum	.047	.055
Calcium	trace.	trace.
Magnesium	.258	.215
Potassium	.068	not estimated.
Sodium	.098	
Phosphorus	.344	.474
Sulphur	.060	.120
Total	100.322	100.084
Total carbon	3.760	3.770
Specific gravity	7.1117	7.1212

No. 944—LIMONITE. *Labeled "Old Furnace Ore Banks, Estill county, Ky."* (*Sub-carboniferous.*)

A dense, fine-grained, yellowish-brown ore, with streaks of lighter and darker color; dull, with some minute specks of mica. Adheres to the tongue. *Specific gravity*, 2.9131.

No. 945—LIMONITE. *Labeled "Old Furnace Ore Banks, Estill county, Ky."* (*Sub-carboniferous.*)

An irregularly rounded mass, made up of irregular, thin layers of dark brown and bluish-black, involving soft brownish-yellow ochreous ore. Powder dark brownish-yellow.

COMPOSITION OF THESE TWO LIMONITES, DRIED AT 212° F.

	No. 944.	No. 945.
Oxide of iron	71.600	62.486
Alumina	.520	3.349
Carbonate of lime	.680	trace.
Magnesia	1.408	.513
Brown oxide of manganese	1.680	.920
Phosphoric acid	.822	.591
Sulphuric acid	.303	.372
Potash	.494	.714
Soda	.202	.143
Silex and insoluble silicates	11.120	20.580
Combined water	11.200	10.800
Total	100.029	100.462
Percentage of iron	50.042	43.756
Moisture, lost at 212° F.	2.010	1.700

Both good ores. The second, No. 945, would probably make the tougher iron of the two.

A collection of the ores, pig iron, slag, fire-clay, and limestone, used at Estill furnace, as sent to this laboratory by the enterprising proprietors, but time did not permit their analysis in season for this report.

No. 946—CLAY. *Labeled "Potter's Clay? four miles northwest of Irvine, on the Richmond turnpike, Estill county, Ky."*

Of a light buff-grey color, with stratified lines of reddish. Before the blow-pipe it is not evidently fusible. Changes to handsome salmon-color in burning. Appears to be, principally, fine quartzose sand; sparkling with a few minute scales of mica.

COMPOSITION, DRIED AT 212° F.

Silica	71.780
Alumina	17.580
Oxide of iron	2.420
Lime	none.
Magnesia	.547
Sulphuric acid	.112
Potash	2.271
Soda	.322
Water expelled at red heat	4.400
Loss	.568
	100.000

Quite a refractory clay; but probably not sufficiently so to be a *very good* fire clay. It will answer exceedingly well for the use of the potter.

No. 947—LIMESTONE (HYDRAULIC?) *Labeled "Building Stone, five miles from Irvine, on the Richmond Turnpike, Estill county, Ky." (Upper Silurian formation.)*

A dark-grey, fine-grained limestone, containing many small scales of mica. Does not adhere to the tongue.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	41.380=23.221 lime.
Carbonate of magnesia	30.019
Carbonate of iron	4.321
Oxide of iron	2.360
Alumina	.806
Brown oxide of manganese	.460
Phosphoric acid	.374
Sulphuric acid	1.471=.590 sulphur.
Potash	.482
Soda	.019
Silex and insoluble silicates	18.680
	100.392

There is but little doubt that this would make very good hydraulic cement, if properly burnt and prepared; but it is not so probable that it would prove a durable building stone. Rocks containing so much *carbonate* of *iron* and so much *sulphur*, are liable to disintegration when exposed to the atmospheric influences.

No. 948—CARBONATE OF IRON. *Labeled "Carbonate of Iron from the ash-colored shales, above the Black Devonian Slate. Red Lick Fork of Station Camp Creek, Estill county, Ky."*

Fine-granular; grey in the interior; light brownish-buff and reddish-brown on the exterior. Does not adhere to the tongue. Powder of a buff-grey color.

Dried at 212° F., its powder lost 0.40 per cent. of *moisture*.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	64.210	=34.203 iron.
Oxide of iron	4.543	
Alumina	.580	
Carbonate of lime	1.920	
Carbonate of magnesia	9.335	
Carbonate of manganese	2.077	
Phosphoric acid	.464	
Sulphuric acid	.200	
Potash	.424	
Soda	.281	
Silex and insoluble silicates	13.180	
Water and loss	2.796	
	100.000	

A very good ore, sufficiently rich for profitable smelting.

No. 949—LIMESTONE (HYDRAULIC?) *Labeled "Argillaceous Limestone, (hydraulic?) below the magnesian building stone at the Covered Rock, three miles below Irvine, Estill county, Ky."*

A fine-grained rock of a greenish-grey color; not adhering to the tongue. Powder, light greenish-grey. Specific gravity 2.7163.

No. 950—LIMESTONE (HYDRAULIC?) *Labeled "Limestone Shale, (hydraulic?) Covered Rock, three miles below Irvine, Estill county, Ky."*

A brownish-black, fine-granular rock. Flat conchoidal fracture. Not adhering to the tongue. Powder of a dirty-buff, or light-umber color.

No. 951—LIMESTONE (HYDRAULIC?) *Labeled "Hydraulic Limestone? two miles west of Red River Iron Works, Estill county, Ky. (Devonian.")*

A brownish-black, or dark-umber colored, fine-granular rock; easily broken. Does not adhere to the tongue. Powder of a light-umber color.

COMPOSITION OF THESE THREE LIMESTONES, DRIED AT 212° F.

	No. 949. Argillaceous Limestone.	No. 950. Limestone Shale.	No. 951. Hydraulic Limestone.
Carbonate of lime	27.980	37.480	36.580
Carbonate of magnesia	19.022	22.927	19.792
Alumina, and oxides of iron and manganese	9.660	6.160	6.260
Phosphoric acid	.246	.182	.079
Sulphuric acid	.544	1.368	1.561
Potash	.618	.695	.482
Soda	.296	.372	.231
Silex and insoluble silicates	38.480	28.580	28.240
Water and loss	3.154	2.236	[*]6.775
Total	100.000	100.000	100.000
Moisture lost at 212° F.	0.700	0.700	0.740

Although these limestones contain more silicious and aluminous matters than the best water limes, they are all worthy of trial as hydraulic cement.

MINERAL WATERS OF ESTILL SPRINGS.

No. 952—MINERAL WATER. *Labeled "Red Sulphur Water, near the Saloon. Estill Springs, near Irvine, Estill county, Ky."*

No. 953—MINERAL WATER. *Labeled "White Sulphur Water, at the Saloon, &c., &c."*

No. 954—MINERAL WATER. *Labeled "Chalybeate Water, northwest side of Sweet Lick Knob, &c., &c."*

No. 955—MINERAL WATER. *Labeled "Red Sulphur Water; four hundred yards east of the buildings at Estill Springs, &c."*

No. 956—MINERAL WATER. *Labeled "Black Sulphur Water, Estill Springs, &c."*

These waters were carefully bottled and sealed by Mr. S. S. Lyon, Topographical Assistant, and sent by stage to the laboratory, where they were examined with as little delay as possible. It was impossible, however, to avoid the loss of some of the gases, especially of sulphuretted hydrogen; and hence the estimation of the gaseous ingredients of these waters, given below, is doubtless too low in every case. To estimate fully the amount of the gaseous ingredients, the operations must be performed at the springs.

[*] This includes some *bituminous matters.*

COMPOSITION OF THESE ESTILL WATERS; IN 1000 PARTS OF THE WATER.

	No. 952. Red Sulphur.	No. 953. White Sulphur.	No. 954. Chalybeate.	No. 955. Red Sulphur.	No. 556 Black Sulphur.
Carbonic acid gas	0.3256	0.360	0.269	0.228	0.263
Sulphuretted hydrogen gas	.0045	.003		.012	.035
Carbonate of lime	0.2920	0.303	0.159	0.021	0.113
Carbonate of magnesia	.0832	.011	.046	.025	.027
Carbonate of iron			.032	trace.	.069
Carbonate of soda	.0237	.083			
Chloride of sodium	.0842	.009	.009	.099	.036
Chloride of calcium				.106	
Sulphate of lime			.286		
Sulphate of magnesia	.0105	.105	.168	.035	.018
Sulphate of soda	.1723	.043	.012		.035
Sulphate of potash	.0926	.072	.011	.011	.017
Sulphate of alumina					.023
Alumina and trace of phosphates		.016	trace.		
Organic and volatile matters	.0400	.050	.141	.044	.059
Silica	.0068	.004	.032	.029	.013
Saline matters in 1000 parts of the water	0.7153	0.696	0.896	0.370	0.410

The carbonates of lime, magnesia, and iron are held in solution by the free carbonic acid; or, in other words, exist in the waters as *bi-carbonates*. The soda is also in the form of bi-carbonate, which salt is not incompatible with the sulphate of magnesia present in the same water.

The chalybeate water owes its name and peculiar virtues to its bi-carbonate of iron, of which the red sulphur water, most distant from the house, contains traces, (as doubtless the other also,) and the "black sulphur" even more than the chalybeate, (as tested at the laboratory.) The latter contains a small proportion of sulphate of alumina, (alum.) The change of the dissolved *bi-carbonate of protoxide of iron* to *insoluble hydrated peroxide of iron*, which always takes place when these waters are exposed to the air, is the cause of the formation of the brownish deposit, and their loss of virtues, when they are carried any distance from the spring.

No. 957—MINERAL WATER. *Obtained by D. C. Winburn, from where he formerly procured the Copper Ore, (described in Vol. II of these Reports,) near Irvine, Estill county, Ky.*"

SALINE MATTERS IN 1000 PARTS OF THE WATER.

Carbonate of lime	0.527	Held in solution by carbonic acid.
Carbonate of magnesia	.044	
Carbonate of iron	.02	
Sulphate of lime	.547	
Sulphate of magnesia	4.515	
Sulphate of potash	.043	
Chloride of sodium	.362	
Chloride of calcium	.029	
Silica	.069	
Water of crystallization and loss	1.473	
	7.572	

This water nearly resembles some of the Epsom Spring waters found in the neighborhood of Crab Orchard, Lincoln county.

No. 958—SOIL. *Labeled "Soil, from a cultivated field; from and immediately resting on Black Devonian Slate. Thos. H. Carson's farm, Irvine, Estill county, Ky., (grows excellent corn.")* (*Obtained by Dr. Owen.*)

Dried soil of a dark-umber color. It contains numerous fragments of soft dark-umber colored shale, which were sifted out before the analysis was made.

One thousand grains of the air-dried soil, digested for a month in water, charged with carbonic acid, gave up more than three grains of *dark chestnut-brown extract*, dried at 212° F., which had the following

COMPOSITION, VIZ:

Organic and volatile matters	0.547
Alumina, and oxides of iron and manganese and phosphates	.320
Carbonate of lime	1.430
Magnesia	.162
Sulphuric acid	.025
Potash	.077
Soda	.059
Silex and insoluble silicates	.231
Loss	.206
	3.057 grains.

The air-dried soil lost 4.275 per cent. of *moisture*, at 400° F.; dried at which temperature its *composition* is as follows, viz:

Organic and volatile matters	10.942
Alumina	3.290
Oxide of iron	6.635
Carbonate of lime	.420
Magnesia	.392
Brown oxide of manganese	.145
Phosphoric acid	.347
Sulphuric acid	.578
Potash	.697
Soda	.309
Sand and insoluble silicates	74.895
Loss	1.350
	100.000

This is quite a rich soil, containing a large quantity of potash, in particular; derived no doubt from the black slate which produced it, as the following analysis will show:

No. 959. "*Devonian Black Slate, sifted out of the preceding soil, from Thos. Carson's farm, near Irvine, Estill county, Ky.*"

COMPOSITION, DRIED AT 212° F.

Alumina, and oxides of iron and manganese	6.860
Carbonate of lime	.244
Magnesia	.433
Phosphoric acid	.310
Sulphuric acid	.132
Potash	1.101
Soda	.340
Sand and insoluble silicates	82.280
Bituminous matters, water and loss	8.300
	100.000

The soft aluminous shales are very generally rich in potash, and where they are easily decomposable they yield a rich soil; subject, however, to be wet, heavy, or swampy, because of the considerable amount of clay present and imperfect natural drainage. When well drained, these lands may be made quite productive.

No. 960—Soil. *Labeled "Virgin Soil, taken from north of the house of Mr. James Townsend, on Billy's creek, a branch of Miller's creek, Estill county, Ky. Geological position, on the terrace of sub-carboniferous limestone.*"

Dried soil of a light yellowish-umber color. Fragments of ferruginous sandstone and gravel iron-ore were sifted out of it with the coarse seive.

No. 961—Soil. *Labeled "Surface Soil from a field thirty-six years in cultivation; (twenty-five years in corn; never manured;) adjoining the house of Mr. James Townsend, on Billy's creek, &c., &c.*"

Dried soil of a dark, dirty grey-buff color; lighter than the preceding. Contains fragments of ferruginous sandstone, and gravel iron ore, like the preceding.

No. 962—Soil. *Labeled "Sub-soil from the preceding old field; James Townsend's farm, on Billy's creek, &c., Estill county, Ky.*"

Dried soil of a greyish-buff color, lighter than the preceding.

Fragments of ferruginous *sandstone* and gravel iron ore sifted out of it. One thousand grains of each of these three soils, digested for a month in water charged with carbonic acid, gave up of *soluble matters*, as follows:

	No. 960. Virgin soil.	No. 961. Old field.	No. 962. Sub-soil.
Organic and volatile matters	1.617	1.100	0.333
Alumina, and oxides of iron and manganese and phosphates	1.030	.697	.063
Carbonate of lime	.320	1.230	.540
Magnesia	.180	.193	.061
Sulphuric acid	.039	.033	.022
Potash	.060	.157	.125
Soda	.020	.036	.045
Silica	.104	.198	.247
Loss	.696	.533	.097
Soluble extract, dried at 212° F., (grains)	4.066	4.077	1.533

THE COMPOSITION OF THESE THREE SOILS IS AS FOLLOWS, DRIED AT 212° F.:

	No. 960. Virgin soil.	No. 961. Old field.	No. 962. Sub-soil.
Organic and volatile matters	8.483	4.647	2.957
Alumina	6.750	4.535	5.110
Oxide of iron	3.210	2.270	2.910
Carbonate of lime	.030	.181	.096
Magnesia	.460	.451	.417
Brown oxide of manganese	.460	.310	.180
Phosphoric acid	.318	.274	.192
Sulphuric acid	.055	.033	.016
Potash	.408	.295	.316
Soda	.068	.086	.093
Sand and insoluble silicates	79.695	86.610	87.970
Loss	.063	.308	---------
Total	100.000	100.000	100.257
Moisture, lost at 400° F.	3.510	2.100	1.615

The original, virgin soil is quite a good soil, with the exception of a deficiency of lime, which, added in the form of top-dressings in the air-slacked state, would, no doubt, improve its fertility. The soil of the "old field" shows the usual diminution of most of the essential ingredients, as compared with the virgin soil.

No. 963—SOIL. *Labeled "Virgin Soil, from the top of Dividing Ridge, between Estill and Powell and Owsley and Powell counties, Ky. From near the Standing Rock. Not much cultivated at present, as the* *limestone valleys below are better for farms; good for grass. Geological position: on the conglomerate or millstone grit."* (*This and the preceding three soils were obtained by Joseph Lesley, jr.*)

Dried soil, of a yellowish-grey color.

One thousand grains of the air-dried soil, digested for a month in water charged with carbonic acid, gave up *more than a grain and a half of dark umber-colored extract,* dried at 212°, which had the following

COMPOSITION, VIZ:

Organic and volatile matters	0.590
Alumina, and oxides of iron and manganese and phosphates	.420
Carbonate of lime	.097
Magnesia	.096
Sulphuric acid	.033
Potash	.090
Soda	.058
Silica	.194
Loss	.022
	1.600 grains.

The air-dried soil lost 1.125 per cent. of *moisture* at 400° F., dried at which temperature its *composition* is as follows:

Organic and volatile matters	2.680
Alumina	3.220
Oxide of iron	1.485
Carbonate of lime	.021
Magnesia	.297
Brown oxide of manganese	.110
Phosphoric acid	.128
Sulphuric acid	trace.
Potash	.166
Soda	.064
Sand and insoluble silicates	92.095
	100.266

One of the poorest soils of the State; yet susceptible of cultivation, if suitably located. The application of lime and plaster of paris would much increase its present productiveness.

No. 964—COAL. *Labeled "Coal, (under the conglomerate,) supposed to be twenty inches thick. Farm of Mr. James Townsend, Billy's Fork of Miller's Creek, Estill county, Ky."* (*Obtained by Joseph Lesley, jr.*)

"It is said to be excellent for working steel, and small quantities have been 'packed' from the opening for that purpose."

A somewhat brittle, dark shining coal; cleaving into thin layers, which are coated with fibrous coal. Exterior stained with ochreous mud.

Over the spirit lamp, it softens and agglutinates; swells up considerably, and leaves a dense porous coke. Specific gravity 1.336.

PROXIMATE ANALYSIS.

Moisture	2.90	Total volatile matters	40.66
Volatile combustible matters	37.76		
Fixed carbon in the coke	50.84	Dense coke	59.34
Grey-purple ashes	8.50		
	100.00		100.00

The percentage of *sulphur* is 4.35.

COMPOSITION OF THE ASH.

Silica	1.884
Alumina and oxides of iron and manganese and phosphates	6.180
Lime	trace.
Magnesia	.233
Sulphuric acid	.077
Potash	.077
Soda	.147
	8.598

FAYETTE COUNTY.

No. 965—LIMESTONE. *Labeled "Lowest Rock at Clay's Ferry; below the bird's-eye limestone, Fayette county, Ky."*

A compact, light dove-grey, fossiliferous rock; fracture approaching conchoidal, containing specks of calc. spar, in some cases replacing fossil shells; presenting irregular veins of dirty yellowish-grey, less compact material.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	92.640
Carbonate of magnesia	3.999
Alumina, and oxides of iron and manganese	.440
Phosphoric acid	small trace.
Sulphuric acid	.441
Potash	not estimated.
Soda	not estimated.
Silex and insoluble silicates	2.480
	100.000

No. 966—MINERAL WATER. *"Sent by Rev. J. Bullock, from Walnut Hill, Fayette county, Ky., from a bored well of the depth of ninety feet in blue limestone of the Lower Silurian formation."*

The water contains free carbonic acid gas, and a small quantity of sulphuretted hydrogen. The amount of these gases was not estimated in the water sent to the laboratory for analysis.

SALINE CONTENTS IN 1000 PARTS OF THE WATER.

Carbonate of lime	0.126	Held in solution by carbonic acid.
Carbonate of magnesia	.045	
Carbonate of iron	trace.	
Carbonate of soda	trace.	
Chloride of sodium	4.012	
Chloride of potassium	0[illegible]0	
Chloride of calcium	.014	
Chloride of magnesium	.317	
Sulphate of lime	.337	
Iodine	Marked traces; not estimated.	
Bromine		
Silica	.018	
	4.949	

A mild, salt-sulphur water, alkaline in its reaction.

No. 967—LIMESTONE. *Labeled "Magnesian Limestone, one hundred and ninety feet above low water. Stratum five feet thick; layers ten to eighteen inches thick, Raven Creek, Fayette county, Ky."* (*Obtained by Messrs. Downie and Lesquereaux.*)

A dull, fine-grained, homogeneous rock of a grey reddish-buff color; contains no fossils.

No. 968—LIMESTONE. *Labeled "Kentucky Marble, (Bird's-eye.) From Daniel Brink's quarry, fourteen and a half miles from Lexington, in Fayette county, Ky. Layer five and a quarter feet above Philip Brink's branch."* (*Obtained by Messrs. Downie and Lesquereux.*)

A compact warm light grey, brittle limestone, mottled with darker, and containing small veins of calc. spar.

No. 969—LIMESTONE. *Labeled, "Kentucky Marble, not so compact as the preceding. From Daniel Brink's quarry, twenty-six feet above Philip Brink's branch, Fayette county, Ky."* (*Obtained by Messrs. Downie and Lesquereux.*

A dull, fine-grained rock, dark warm-grey, mottled with darker bluish grey. Brittle.

No. 970—LIMESTONE. *Labeled "Coarse Fossiliferous Limestone, Daniel Brink's quarry, one hundred and one feet above Philip Brink's branch, Fayette county, &c., &c."*

A bluish-grey limestone, full of entrochites, broken bi-valve shells, coral, &c. Weathered surfaces dirty-buff.

These limestones are of the Lower Silurian formation.

COMPOSITION OF THESE FOUR LIMESTONES, DRIED AT 212° F.

	No. 967. Magnesian Limestone.	No. 968. Bird's-eye Limestone.	No. 969. Kentucky Marble.	No. 970. Fossiliferous Limestone.
Carbonate of lime	77.460	95.680	62.690	91.480
Carbonate of magnesia	15.426	2.044	23.079	1.044
Alumina, and oxides of iron and manganese	1.280	.380	6.060	3.980
Phosphoric acid	.246	.182	.246	.848
Sulphuric acid	.166	.166	.441	.317
Potash	.193	.193	.162	.232
Soda	.363	.048	.182	.336
Silex and insoluble silicates	2.980	1.580	5.280	2.380
Water and loss	1.886	----------	1.670	----------
Total	100.000	100.273	100.000	100.617
Moisture, lost at 212° F.	0.010	0.010	0.006	0.010

A little more silica in the composition of the Kentucky marble No. 969, would make it a good water lime. The fossiliferous limestone would answer very well for use in agriculture; to be used as top-dressing to land deficient in phosphoric and sulphuric acids, lime, and the alkalies.

No. 971—MARLY CLAY. *From "Daniel Brink's place; one hundred and two feet above Philip Brink's branch, Fayette county, Ky."* (*Brought by Messrs. Downie and Lesquereux.*)

A light grey clay, mottled with buff.

COMPOSITION, DRIED AT 212° F.

Silica	56.880
Alumina, with some oxides of iron and manganese	24.656
Carbonate of lime	2.480
Carbonate of magnesia	3.276
Phosphoric acid	.182
Potash	6.655
Soda	.195
Water expelled at red heat and loss	5.676
	100.000

Contains an extraordinary quantity of potash, &c., and hence might profitably be used as a *marl*, on land which had been deteriorated by long cultivation.

For analyses of Catawba wine, and white wheat, produced in this county, see the appendix.

FLEMING COUNTY.

No. 972—MARL. *Labeled "Clay found at the junction of the Upper and Lower Silurian, of Fleming county, Ky."*

A greenish and reddish brown clay. Before the blow-pipe, melting at the edges, and burning of light umber color. Powder light dirty-buff. Dried at 212°, it lost 1.20 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Silica	39.780
Alumina	10.401
Oxide of iron	10.760
Carbonate of lime	16.880
Magnesia	6.385
Brown oxide of manganese	1.084
Phosphoric acid	.079
Sulphuric acid	.338
Potash	1.147
Soda	not estimated
Water, expelled at a red heat	13.900
	100.754

May be employed as a marl on land, with the addition of bone dust, or *super-phosphate*, or other phosphatic material.

No. 973—MAGNESIAN LIMESTONE. "*Belonging to the age of the Clinton Groupe, Hillsborough, Fleming county, Ky.*"

A dull, dirty-buff, impure limestone, containing entrochites, and exhibiting small specks of mica and brownish stains of oxide of iron. Powder of a greyish-buff color. Dried at 212° F., it lost 0.55 per cent. of *moisture ;* and its *composition* is as follows:

Carbonate of lime	42.680	=23.951 per cent. of *lime*.
Carbonate of magnesia	25.358	
Carbonate of iron	5.155	
Carbonate of manganese	.421	
Oxide of iron	11.073	
Alumina	1.080	
Phosphoric acid	.848	
Sulphuric acid	.324	
Potash	.290	
Soda	.033	
Silex and insoluble silicates	10.880	
Water and loss	1.858	
	100.000	

This ferruginous, silicious, magnesian limestone, deserves trial as a water lime.

No. 674—LIMESTONE. *Labeled "Yellow-red Porous Rock, over the encrinital limestone, one and a half miles east of Mount Carmel, Fleming county, Ky.*"

A dull, brownish-yellow, fine granular rock, glimmering with small crystalline facets of colored calc. spar., containing small cavities, or pores, some of which are infiltrated with carbonate of lime; others lined with dark colored oxide of iron. Adheres to the tongue. Powder of a buff color.

Dried at 212°, it lost 0.70 per cent. of *moisture*, and has the following

COMPOSITION:

Carbonate of lime	71.700
Carbonate of magnesia	9.931
Alumina, and oxides of iron and manganese	12.240
Phosphoric acid	.630
Sulphuric acid	.337
Potash	.341
Soda	.139
Silex and insoluble silicates	2.880
Water and loss	1.802
	100.000

No. 975—SOIL. *Labeled "Virgin Soil, derived from the yellow limestone. Charles Marshall's dairy farm, near Mount Carmel, Fleming county, Ky. (At the junction of the Lower and Upper Silurian formations.) Growth, sugar-tree, walnut, buck-eye, &c."*

Dried soil of a dark-grey-brown, or light chocolate color.

No. 976—SOIL. *Labeled "Soil from an old field twenty-five years in cultivation; the last eight years in grass. Charles Marshall's dairy farm, near Mount Carmel, Fleming county, Ky. (Upper Silurian formation."*

Dried soil a little lighter-colored than the preceding. Some rounded ferruginous particles were sifted out of it with the coarse seive.

No. 977—SOIL. *Labled "Sub-soil from the same old field, Chas. Marshall's dairy farm, &c., &c."*

Dried soil lighter-colored and more yellowish than the preceding.

One thousand grains of each of these (air-dried) soils, digested in water charged with carbonic acid, for about a month, gave up of *soluble extract*, dried at 212°, as follows:

	No. 975. Virgin soil.	No. 976. Old field.	No. 977. Sub-soil.
Organic and volatile matters	0.800	0.517	0.450
Alumina, and oxides of iron and manganese and phosphates	.147	.180	.130
Carbonate of lime	2.097	1.063	.860
Magnesia	.366	.245	.162
Sulphuric acid	.034	.022	.025
Potash	.135	.066	.042
Soda	.006	.033	.046
Silica	.231	.397	.347
Loss	.434		
Soluble extract, dried at 212° F.	4.250	2.523	2.062

The *composition* of these three samples of soils, dried at 400° F., is as follows:

	No. 975. Virgin soil.	No. 976. Old field.	No. 977. Sub-soil.
Organic and volatile matters	11.315	7.335	* 7.675
Alumina	5.060	4.190	10.335
Oxide of iron	11.675	11.210	14.930
Carbonate of lime	.420	.395	.470
Magnesia	.874	.679	.868
Brown oxide of manganese	.290	.395	.370
Phosphoric acid	.251	.181	.236
Sulphuric acid	.084	.042	.059
Potash	.349	.202	.439
Soda	.224	.011	.050
Sand and insoluble silicates	69.145	75.645	64.995
Loss	.313		
Total	100.000	100.285	100.427
Moisture lost at 400° F.	5.525	4.225	6.650

The soil of the old field has undergone considerable deterioration. The sub-soil is as rich as the virgin soil.

The influence of dairy-farming upon the soil can be learnt by studying the composition of the *saline* portion of cows' milk. According to M. Haidlen, a thousand parts of fresh cow-milk contain:

Phosphate of lime	2.31	=about 1.33 *phosphoric* acid.
Phosphate of magnesia	.42	
Phosphate of iron	.07	
Chloride of potassium	1.44=0.95 *potash.*	
Chloride of sodium	.24	=0.55 *soda.*
Soda in combination with casein	.42	

It is easy, when we know how much milk is taken from the cows grazed on the land, to calculate how much of these essential ingredients are removed from the soil in a given time, in this manner.

The earthy phosphates and the alkalies are thus taken up in considerable quantities, and hence it has been found to be advantageous to apply top-dressings of powdered bones, or super-phosphates, with ashes, to ground which has been long used for pasturage for dairy purposes.

No. 978—SOIL. *Labeled "Virgin Soil, from blue ash land, on the Delthyris Lynx beds of the upper part of the blue limestone formation, (Lower Silurian.) Mr. Fitzgerald's farm, northern part of Fleming county, Ky."*

Dried soil of a light yellowish-umber color. A little shot iron ore was sifted out of it.

* A large proportion of this is water

No 979—Soil. *Labeled "Same Soil, from an adjoining field, in corn. Farm of Mr. Fitzgerald, northern part of Fleming county, Ky."*

Dried soil a little lighter colored and more yellowish than the preceding. A little shot iron ore was sifted out of it.

No. 980—Soil. *Labeled "Sub-soil from the same field. Mr. Fitzgerald's farm, northern part of Fleming county, Ky., &c., &c."*

Dried soil of a dirty-buff color. Contains a little shot iron ore, which was sifted out before analysis.

One thousand grains of each of these three soils, air-dried, were digested for a month in water charged with carbonic acid, and gave the following quantities of *soluble materials* severally, viz:

	No. 978. Virgin soil.	No. 979. Old field.	No. 980. Sub-soil.
Organic and volatile matters	0.950	0.566	0.366
Alumina, and oxides of iron and manganese and phosphates	.231	.187	.134
Carbonate of lime	2.563	1.573	1.130
Magnesia	.165	.061	.100
Sulphuric acid	.039	.033	.030
Potash	.109	.058	.032
Soda	.032	.028	.023
Silica	.281	.251	.264
Loss	.196	.093	----------
Soluble extract, dried at 400° F., (grains)	4.566	2.850	2.079

The *composition* of these three specimens of soil, dried at 400° F., is as follows:

	No. 978. Virgin soil.	No. 979. Old field.	No. 980. Sub-soil.
Organic and volatile matters	8.523	5.211	4.195
Alumina	6.840	5.275	6.265
Oxide of iron	5.760	5.510	6.035
Carbonate of lime	.870	.370	.395
Magnesia	.798	.736	.580
Brown oxide of manganese	.170	.270	.095
Phosphoric acid	.228	.409	.223
Sulphuric acid	.075	.093	.058
Potash	.526	.468	.700
Soda	.128	.043	.168
Sand and insoluble silicates	76.445	80.945	80.745
Loss	----------	.670	.541
Total	100.363	100.000	100.000
Moisture, lost at 400° F.	4.675	3.100	2.875

FRANKLIN COUNTY.

No. 981—LIMESTONE. *Labeled "Building Stone; a bed in the Blue Limestone, in the northwest part of Franklin county, Ky. Said to be fire and frost proof."*

A brownish-grey, granular limestone; with many irregular pores, and small branching cavities, which are colored dirty-grey-brown; grains crystalline.

Dried at 212° it lost 0.200 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	93.580	=52.511 per cent. of lime.
Carbonate of magnesia	3.663	
Alumina, and oxides of iron and manganese	.880	
Phosphoric acid	.117	
Sulphuric acid	.441	
Potash	.057	
Soda	.165	
Silex and insoluble silicates	.380	
Loss	.717	
	100.000	

Quite a pure limestone.

No. 982—SOIL. *Labeled "Virgin Soil, from the Blue-grass lands of Franklin county, Ky." Farm of Isaac Wingate. Primitive growth, large ash, burr oak, black locust, walnut, &c.*

Dried soil of a light chocolate color. Some chert and iron gravel were sifted out from it with the coarse seive.

No. 983—SOIL. *Labeled "Soil from an old field, fifty to sixty years in cultivation. Blue-grass land of Franklin county, Ky. Farm of Isaac Wingate, &c."*

Dried soil of a light chocolate color, a slight shade *darker* than the preceding. Some iron gravel was sifted out of it.

No. 984—SOIL. *Labeled "Sub-soil from the old field, &c. Blue-grass lands of Franklin county, Ky. Farm of Isaac Wingate," &c.*

Dried soil of a light chocolate color, a slight shade darker than the preceding.

One thousand grains of each of these soils, air-dried, were digested for a month in water charged with carbonic acid, to which they gave *soluble extracts* of the following *composition* and quantities :

	No. 982. Virgin soil.	No. 983. Old field.	No. 984. Sub-soil.
Organic and volatile matters	0.583	0.633	0.367
Alumina and oxides of iron and manganese and phosphates	.145	.230	.064
Carbonate of lime	.787	.1507	1.130
Magnesia	.123	.144	.113
Sulphuric acid	.041	.050	.033
Potash	.066	.077	.038
Soda	.017	.055	.012
Silica	.314	.200	.297
Soluble extract dried at 212° F., (grains)	2.076	2.696	2.054

Dried at 400° F., these soils had the following

COMPOSITION.

	No. 982. Virgin soil.	No. 983. Old field.	No. 984. Sub-soil.
Organic and volatile matters	6.372	6.147	4.281
Alumina	4.185	5.435	5.035
Oxide of iron	4.310	4.560	4.785
Carbonate of lime	.320	.320	.520
Magnesia	.563	.801	.526
Brown oxide of manganese	.320	.445	.095
Phosphoric acid	.350	.270	.553
Sulphuric acid	.076	.076	.050
Potash	.222	.288	.290
Soda	.052	.058	.073
Sand and insoluble silicates	82.270	81.470	83.445
Loss	.960	.130	.347
Total	100.000	100.000	100.000
Moisture, lost at 400° F.	2.700	2.400	2.125

With the exception of the phosphoric acid contained in it, the soil of the old field is yet as rich as the virgin soil; probably because of some admixture of the sub-soil with it by the use of the plow.

GARRARD COUNTY.

No. 985—LIMESTONE. *Labeled "Hydraulic? Limestone, Burdett's Knob, Garrard county, Ky. (Upper Silurian formation.")*

A greenish-grey, dull, fine granular limestone; not adhering to the tongue. Weathered surface brownish.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	34.780
Carbonate of magnesia	21.470
Alumina, and oxides of iron and manganese	5.200
Phosphoric acid	.310
Sulphuric acid	.956
Potash	.471
Soda	.130
Silex and insoluble silicates	35.180
Loss	1.503
	100.000

Although this contains a larger proportion of silica than the best water-limes, yet it is probable, that with proper management in its preparation, it will make a very good hydraulic cement.

No. 986—SOIL. *Labeled "Soil from woodland pasture, (pastured seven years,) from the farm of Chas. E. Spilman, on base-line 178th mile, one mile east of Dick's river, Garrard county, Ky."*

Dried soil of a greyish-light-chocolate color. Some shot ore and fragments of chert were sifted out of it with the coarse seive.

No. 987—SOIL. *Labeled "Sub-soil of the preceding, (7 to 15 inches deep.")*

Dried soil deeper and more brownish colored than the preceding. Some shot iron ore was sifted out of it with the coarse seive.

No. 988—SOIL. *Labeled "Soil from an old field fifty years or more in cultivation. Farm of Chas. J. Spilman, one mile east of Dick's river, Garrard county, &c."*

Lower Silurian formation; forty to fifty feet above the spring member of the sink country; near the top of the bird's-eye limestone. This field, after having been cultivated in grain of various kinds, was pastured for ten years; and is now in timothy and orchard grass.

Dried soil of a light-chocolate color. Some shot iron ore and small cherty fragments were sifted out of it.

No. 989—SOIL. *Labeled "Sub-soil, fifteen inches deep, mixed with all under a foot in depth; from the same place as the preceding, Garrard county, Ky., &c."*

Dried soil of a greyish-buff color. Some little shot iron ore was sifted out of it with the coarse seive.

These soils were collected by S. S. Lyon, Topographical Assistant.

One thousand grains of each of these soils, air-dried, were digested, for a month, in water charged with carbonic acid. The quantities and *composition* of the *soluble extract* dissolved out of them are as follows, viz:

	No. 986. Woodland soil.	No. 987. Sub-soil.	No. 988. Old field.	No. 989. Sub-soil.
Organic and volatile matters	0.533	0.366	0.483	0.273
Alumina, and oxides of iron and manganese, and phosphates	.081	.063	.060	.088
Carbonate of lime	.263	.080	1.330	1.185
Magnesia	.073	.089 }		.093
Sulphuric acid	.022	.022 }	.310	.022
Potash	.102	.146 }		.054
Soda	.038	.037 }		.078
Silica	.232	.181	.180	.181
Loss	.056	.149	----------	----------
Soluble extract, dried at 212°, (grains)	1.400	1.133	2.363	1.974

The *composition* of these four soils, dried at 400° F., may be stated as follows:

	No. 986. Woodland.	No. 987. Sub-soil.	No. 988. Old field.	No. 989. Sub-soil.
Organic and volatile matters	4.200	2.988	5.294	3.411
Alumina	3.790	4.840	5.090 }	& ox. man.
Oxide of iron	3.310	3.970	3.910 }	13.635
Carbonate of lime	.170	.120	.110	2.470
Magnesia	.506	.540	.973	.325
Brown oxide of manganese	.295	.245	.245	----------
Phosphoric acid	.243	.260	.244	.249
Sulphuric acid	.096	.024	.050	.059
Potash	.135	.237	.190	.347
Soda	.032	.026	.026	.092
Sand and insoluble silicates	87.670	86.645	82.945	79.960
Loss	----------	.105	.923	----------
Total	100.447	100.000	100.000	100.548
Moisture, lost at 400° F.	2.400	2 460	2.725	2.525

GRANT COUNTY.

No. 990—MARL. *Labeled "Marl, alternating with Blue Limestone; in the Milk-sick region, at Moses Theobald's, Grant county, Ky."*

A greenish-grey, friable, marly clay.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	4.980
Carbonate of magnesia	3.285
Alumina and oxides of iron and manganese	16.250
Phosphoric acid	.310
Sulphuric acid	1.197
Potash	.988
Soda	.178
Sand and insoluble silicates	71.280
Water and loss	1.532
	100.000

The air-dried marl lost 1.00 per cent. of *moisture* at 212° F. Containing considerable proportions of potash, carbonate of lime, magnesia, and sulphuric and phosphoric acids, it would be a useful top-dressing to exhausted land.

No. 991—SHALE. *Labeled "Shale from the Milk-sick region, Moses Theobald's, Grant county, Ky. Lower Silurian."*

A greenish-grey and buff-grey, soft shale, or indurated clay. Dried at 212° F., it lost 1.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	78.480
Alumina and oxides of iron and manganese	12.340
Carbonate of lime	2.780
Magnesia	1.401
Phosphoric acid	.630
Sulphuric acid	.338
Potash	.957
Soda	trace.
Water and loss	3.074
	100.000

Contains also a considerable quantity of potash.

GRAYSON COUNTY.

No. 992—LIMESTONE. *Labeled "Coralline Limestone, Falls of Rough Creek, Grayson county, Ky. Upper member of sub-carboniferous limestone."*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	85.680
Carbonate of magnesia	2.503
Alumina and oxides of iron and manganese	2.560
Phosphoric acid	.182
Sulphuric acid	.839
Potash	.359
Soda	trace.
Silex and insoluble silicates	7.480
Loss	.397
	100.000

GREENUP COUNTY.

No. 993—LIMONITE. *Labeled "Blue Limestone Ore, Kenton Furnace, Greenup county, Ky. Said to have yielded well. Ore used without roasting. Is the light-colored, in the center of the ore, as rich as the outside?"*

Exterior portion dull yellowish-brown, fine-granular; adhering strongly to the tongue; separates easily from the interior light-grey portion. (See next number.) Powder yellowish-brown. Dried at 212° F., it lost 1.60 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	46.640	=32.663 per cent. of iron.
Alumina	2.440	
Carbonate of lime	.380	
Magnesia	1.902	
Brown oxide of manganese	1.380	
Phosphoric acid	.412	
Sulphuric acid	.255	
Potash	.656	
Soda	.192	
Silex and insoluble silicates	36.240	
Combined water	9.300	
Loss	.203	
	100.000	

No. 994—CARBONATE OF IRON. *Labeled "Interior grey portion of the Blue Limestone Ore, Kenton Furnace, Greenup county, Ky."*

Dull, fine-granular; adheres slightly to the tongue. Powder of a light grey color. Specific gravity 2.9851.

Dried at 212° F., it lost 0.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	41.260	=22.788 per cent. of iron.
Oxide of iron	4.760	
Carbonate of lime	1.880	
Carbonate of magnesia	5.981	
Carbonate of manganese	2.980	
Alumina	1.580	
Phosphoric acid	.374	
Sulphuric acid	.290	
Potash	.579	
Soda	.150	
Silex and insoluble silicates	40.080	
Loss	.086	
	100.000	

These analyses illustrate the changes of composition which occur during the gradual convertion of *carbonate* of iron into limonite (hydrated peroxide of iron) ore.

No. 995—CARBONATE OF IRON. *Labeled "Limestone Ore, Kenton Furnace, Greenup county, Ky."*

A dull, dark grey, fine-granular ore. Adheres to the tongue. Exterior surface brownish-yellow and reddish. Specific gravity 3.2750.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	56.267	=29.024 per cent. of iron.
Oxide of iron	3.882	
Alumina	5.980	
Carbonate of lime	4.980	
Carbonate of magnesia	3.626	
Carbonate of manganese	.873	
Phosphoric acid	2.029	
Sulphuric acid	.750	
Potash	.347	
Soda	.186	
Silex and insoluble silicates	20.640	
Loss	.410	
	100.000	

Although this ore is not too poor to be employed alone for the production of iron, it is objectionable, because of the large proportion of phosphoric acid which it contains; which would injure the quality of the iron produced, by making it brittle or cold-short.

The composition of the following limonite ores, of Kenton furnace, will be presented in a tabular form.

No. 996—LIMONITE. *Labeled "Block Ore, three feet above the 'Little Block,' bed six inches thick, Kenton Furnace, Greenup county, Ky."*

Irregular thin layers of dark-brown fine-granular limonite, inclosing yellow and brownish-yellow ochreous ore. Powder brownish-yellow.

No. 997—LIMONITE. *Labeled "Ore associated with sub-carboniferous limestone, Kenton Furnace, &c."*

A pretty dense, dark-brown ore, in irregular curved layers, with irregular cavities between; adheres very slightly to the tongue. Contains very little soft ochreous ore. Powder yellowish-brown.

No. 998—LIMONITE. *Labeled "John Conley Ore, imperfectly roasted, Kenton Furnace, &c."*

A dull, nearly black, ore; adheres strongly to the tongue. Powder nearly black.

No. 999—LIMONITE. *Labeled "Rough Big Block Ore, now rejected at Kenton Furnace, &c. Near the top of millstone grit. Specimen above average."*

Dark-brown, dense, irregular curved thick layers; sparkling with small specks of mica and crystalline facets; not adhering to the tongue; incrusted with reddish and whitish soft material. Powder yellowish-brown.

No. 1000—LIMONITE. *Labeled " Little Block Ore, five inches thick, bedded between clays, of which the lowest bed is white, Kenton Furnace, &c."*

A dull, fine-granular, porous ore; adhering strongly to the tongue; formed of irregular curved layers, of a dark-yellowish-brown color, involving yellow and brownish-yellow soft ochreous material. A few minute specks evident, and, in some places, a fine-grained oolitic appearance. Powder brownish-yellow.

No. 1001—LIMONITE. *Labeled " Marl Ore, from the bed of pink ferruginous clay, Kenton Furnace, &c."*

Dull, dark greyish purple, oolitic; composed of dark colored grains mingled with whitish ones. Adheres to the tongue. Powder greyish dull-red.

No. 1002—LIMONITE. *Labeled " Flat Kidney Ore, Kenton Furnace, &c."*

Dull, fine granular, purplish-brown, with grains of darker and lighter-color mixed, and a brownish-yellow incrustation. Adheres to the tongue. Powder dull red, or spanish brown color.

No. 1003—IMPURE LIMONITE. *Labeled " Near the Pink Clay Ore, Kenton Furnace, &c."*

Compact, brittle, fracture uneven; dense; general color, dark olive-grey, approaching umber; exterior and in the fissures iron-rust brown. Does not adhere to the tongue. Specific gravity 2.772. Powder yellowish-grey.

No. 1004—LIMONITE. *Labeled " Dogstone Ore, Kenton Furnace, &c."*

Dull, dark purplish and reddish-brown, nearly black; very fine granular with small irregular pores. Adheres strongly to the tongue. Powder dark-brown, nearly black.

No. 1005—LIMONITE. *Labeled "Ferruginous Fossiliferous Knob-stone, near Kenton Furnace, Greenup county, Ky."*

Dull, with a few minute scales of mica: containing numerous impressions of bi-valve shells. General color brownish-yellow, with darker and lighter shades; adheres strongly to the tongue.

COMPOSITION OF THESE TEN LIMONITES, DRIED AT 212° F.

	No. 996.	No. 997.	No. 998.	No. 999.	No. 1000	No. 1001	No. 1002	No. 1003	No. 1004	No. 100
Oxide of iron	33,540	78,840	82,240	44,980	51,400	49,740	59,080	21,740	83,880	46,540
Alumina	4,867	,980	,580	2,580	3,720	3,000	5,120	19,160	,280	3,148
Lime	trace.	trace.	trace.	trace.	trace.	trace.	trace.	trace.	trace.	trace.
Magnesia	1,635	,471	1,041	,894	1,343	,603	,763	,028	,543	,919
Brown oxide of manganese	,280	2,264	5,984	,080	,890	,480	1,060	,080	5,380	1,080
Phosphoric acid	,733	,541	,310	,694	2,402	1,742	2,037	trace.	,822	1,232
Sulphuric acid	,290	,166	,269	,372	,386	,269	,303	,990	,236	,303
Potash	,502	,127	,224	,135	,440	,106	,251	,165	,252	,618
Soda	,205	,319	,093	,260	trace.	,179	,264	,119	trace.	,015
Silex & insoluble silicates	49,480	3,980	1,920	41,680	28,520	35,180	23,560	47,480	1,680	37,320
Combined water	8,860	11,960	7,340	8,400	10,600	8,000	7,160	10,300	7,760	9,340
Loss	....	,352	....	....	,249	,041	....	....	....	....
Total	100,472	100,000	100,001	100,075	100,000	100,000	100,218	100,662	100,833	100,515
Percentage of iron	23,488	55,213	57,596	31,500	35,996	26,594	33,000	15,225	58,742	39,396
Moisture lost at 212 deg. F.	2,140	1,100	1,260	1,200	2,340	2,800	2,700	2,300	2,140	1,600

There is considerable variety of composition amongst these ores. Nos. 1000, 1001, 1002, and 1005 contain a large amount of phosphoric acid; and No. 1003 has a considerable quantity of sulphuric acid. This latter, indeed, is too poor to be used for itself as an ore. They all are destitute of any notable quantity of lime.

A specimen labeled "*From Kenton Furnace, per Basil Waring, examined for manganese,*" is a porous limonite, not containing an extraordinary quantity of manganese. (See Vol. I, page 197, and Vol. II, page 204, of these Reports, for other notices of Kenton furnace ores.)

No. 1006—FERRUGINOUS CLAYSTONE. *Labeled "Clay Iron Stone, Kenton Furnace, Greenup county, Ky."* (*Is it workable?*)

A dull pink, in some parts grey, indurated clay; too hard to be scratched with the nail; containing very small cavities or pores, some of which are filled with infiltrated spar. Exterior weathered surface of a brownish-yellow color. Adheres strongly to the tongue. Powder of a pink color.

No. 1007—FERRUGINOUS CLAYSTONE. *Labeled "Clay Iron Stone, Kenton Furnace, &c. Variety (a). How much iron?"*

Harder and more compact than the last; does not adhere much to the tongue. Color, dirty-salmon. Weathered surface, brown; when burnt, of a cinnamon color.

No. 1008—FERRUGINOUS CLAYSTONE. *Labeled "Variety (b,) Kenton Furnace, &c."*

Dull, of a light yellow ochre color; adheres strongly to the tongue; not scratched by the nail. Powder of a light salmon color, deepened a little by burning.

COMPOSITION OF THESE THREE FERRUGINOUS CLAYSTONES.

	No. 1006.	No. 1007.	No. 1008.
Silica	44.020	42.920	43.780
Alumina	32.810	37.440 }	41.000
Oxides of iron and manganese	7.680	4.94 }	
Lime	a trace.	a trace.	a trace.
Magnesia	.373	.245	.251
Phosphoric acid	.310	.207	.246
Potash	.146	.135	.193
Soda	1.121	.205	.856
Combined water	13.360	13.700	13.360
Loss	----------	.208	.264
Total	100.020	100.000	100.000
Moisture, lost at 212° F.	1.300	1.700	0.400

These are strikingly alike in composition, and of no value as iron ores.

No. 1009—LIMESTONE. *Labeled "Limestone used as a flux at Kenton Furnace, Greenup county, Ky. (Sub-carboniferous.")*

A dense, very fine-grained, light-grey limestone; traversed by small veins of calc. spar. Specific gravity 2.7065.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	94.980=53.298 per cent. of lime.
Carbonate of magnesia	1.583
Alumina, and oxides of iron and manganese	.580
Phosphoric acid	a trace.
Sulphuric acid	.317
Potash	.212
Soda	.149
Silex and insoluble silicates	2.080
Loss	.108
	100.000

Quite a pure limestone, well suited to the purpose for which it is used.

No. 1010—Pig Iron. *Labeled "Soft Iron from Kenton Furnace. Furnace making grey slag and producing much carburet of iron."*

A moderately coarse-grained, light-grey, iron. Yields easily to the file. Fragments flatten considerably under the hammer, but soon break to pieces.

No. 1011—Pig Iron. *Labeled "Hard Iron, Kenton Furnace. Made when producing green slag, and when the furnace is supposed not to be hot enough. Furnace will not make as much as when producing grey iron."*

A fine-grained, light colored iron; too hard to be acted on by the file.

COMPOSITION OF THESE TWO SAMPLES OF IRON.

	No. 1010. Soft grey iron.	No. 1011. Hard whitish iron.
Iron	94.162	94.057
Graphite	2.120	1.556
Combined carbon	.180	.914
Manganese	.078	.345
Silicon	1.085	.507
Slag	.284	.284
Aluminum	.255	.149
Calcium		trace.
Magnesium	.675	.179
Potassium	.112	.640
Sodium	.049	.109
Phosphorus	1.030	.823
Sulphur	.252	.259
Loss		.178
Total	100.282	100.000
Total carbon	2.300	2.470
Specific gravity	6.8613	

The *slags* which accompanied these specimens of iron not having been sent for analysis, it is not possible to say *positively* why the hard white iron was produced; but the probability is that some irregularity had occurred in the quantity of flux used, and that the limestone was in smaller proportion than usual. The *green* slag always contains a considerable amount of iron in the form of protoxide, and hence the reduction in the amount of iron turned out.

No. 1012—Impure Carbonate of Iron. *Labeled "Lowest Ore of Greenup county, Ky., north of Little Sandy river, a few feet above the Knob-stone. The sub-carboniferous limestone and millstone grit both absent. The coal measures resting on the Knob-stone." How much iron?*

A dark-grey, dense, fine granular ore; containing a few minute scales of mica. Exterior weathered surface dark brown. Powder dark drab-grey color.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	50.936	=24.609 per cent. of iron.
Alumina	2.200	
Carbonate of lime	1.980	
Carbonate of magnesia and loss	4.365	
Carbonate of manganese	1.445	
Phosphoric acid	.482	
Sulphuric acid	.612	
Potash	not estimated.	
Soda	not estimated.	
Silex and insoluble silicates	37.980	
	100.000	

No. 1013—Ferruginous Limestone. *Labeled "Iron Ore, No. 11, from Steam Furnace, Greenup county, Ky."*

A compact, fine-grained grey limestone; with a few small shining facets on the fractured surface. Not adhering to the tongue. Weathered surface reddish-brown. Powder of a light-grey color. Specific gravity 2.8358.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	65.280
Carbonate of iron	28.841
Carbonate of magnesia	4.346
Brown oxide of manganese	.380
Alumina	.280
Phosphoric acid	a trace.
Sulphuric acid	1.196
Potash	.027
Soda	.191
Silex and insoluble silicates	.380
	100.921

Dried at 212° F., it lost 0.300 per cent. of *moisture.*

A specimen labeled *"Looped Ore, rejected when thus roasted, at Steam Furnace," &c.*, is of a dark color, almost black; having a somewhat glistening appearance on the fractured surfaces, and, although somewhat cellular, does not adhere to the tongue. It has been heated too much, or too suddenly, in roasting; so that it has undergone partial fusion, and has lost its porosity. Hence it is smelted with difficulty, because the combustible gases cannot easily penetrate it to cause the reduction of the oxide of iron and the carbonation of the iron, &c.

No. 1014—CARBONATE OF IRON. *Labeled "Ore, (No. 1,) from Drift bank, side of hill, Caroline Furnace, Greenup county, Ky. Rejected at the Furnace."*

Fine-granular, of a dark grey-drab color, with mottlings of lighter colored, and darker horizontal lines of deposition. Weathered surface, to the depth of one third of an inch, of a bright reddish-brown color. General appearance dull when viewed perpendicularly, but by reflected light exhibiting glistening, apparently crystalline surfaces, even in the weathered portion, like sparry iron or some kinds of *blende*. Adheres slightly to the tongue. Powder brownish-grey. An average portion taken for analysis. Specific gravity 3.4463.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	67.624	=36.234 per cent. of iron.
Oxide of iron	5.086	
Alumina	.780	
Carbonate of lime	17.680	
Carbonate of magnesia	4.933	
Carbonate of manganese	1.650	
Phosphoric acid	1.053	
Sulphuric acid	.990	
Potash	.380	
Soda	.202	
Silex and insoluble silicates	.520	
	100.558	

This ore contains so little alumina and silex, that it could not be smelted in the usual way, by the addition of limestone alone; but, mixed with silicious and aluminous ores, or even with ferruginous clay, or good common clay, it would smelt very well. It contains, however, considerable proportions of phosphoric and sulphuric acids, which would tend to injure the quality of the iron made from it. A portion of these might be removed, however, by the use of much pure clay and limestone in the flux.

No. 1015—IRON FURNACE SLAG. *Labeled "Green Slag, with ore involved, Clinton Furnace, Greenup county, Ky."* (*See Vols. I and II of these Reports for Clinton Furnace ores, &c., &c.*)

A glassy, bottle-green slag, involving some particles of iron; transparent in thin fragments. Very fusible before the blow-pipe, melting without intumescence.

COMPOSITION.

Silica	52.580	Containing oxygen=27.301
Alumina	11.280	5.272
Lime	16.905	4.806
Magnesia	2.141	.855
Protoxide of iron	10.763	2.393
Protoxide of manganese	2.121	.476
Phosphoric acid	a trace.	
Potash	3.121	.527
Soda	.265	.068
Loss	.804	
	100 000	

The oxygen in the *bases* is to that in the silica, as 14.397 is to 27.301
or as 1. is to 1.896

Too small a quantity of lime in the flux caused the loss of much iron, in the form of protoxide of iron, in the slag; which gave it the bottle-green color, and increased its fusibility. When the cinder is very dark colored and fluid from this cause, the furnace is said to "scour."

No. 1016—CARBONATE OF IRON. *Labeled "Rejected Ore, Bellefonte Furnace, Greenup county, Ky."* *Obtained by S. S. Lyon, Esq.*

A dark-grey carbonate; not adhering to the tongue; under the lens appears to be made up of dark grains with a lighter colored cement; some whitish substance infiltrated in the fissures. Weathered surfaces brownish. Powder brownish-grey.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	81.448	=40.646 per cent. of iron.
Oxide of iron	1.490	
Alumina	.240	
Carbonate of lime	2.580	
Carbonate of magnesia	2.584	
Carbonate of manganese	1.926	
Phosphoric acid	.374	
Sulphuric acid	1.197	
Potash	.366	
Soda	.011	
Silex and insoluble silicates	7.924	
	100.140	

Dried at 212° F., it lost 0.60 per cent. of *moisture.*

The only objectionable feature in the composition of this ore is the considerable proportion of sulphuric acid; otherwise it is good and quite rich ore. By careful roasting, the use of much lime for flux, and mixture with other ores which contain more alumina and silica, or with pure clay or earth, it may be used with advantage.

No. 1017—LIMONITE. *Labeled "Rejected Ore, at Bellefonte Furnace, Greenup county, Ky."* (*Obtained by S. S. Lyon, Esq.*)

A dark-brown limonite, in curved irregular layers, involving small cavities; incrusted with brownish-yellow, soft ochreous ore. Powder of a light yellowish-brown color.

Dried at 212° F., it lost 1.00 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	74.740	=52.342 per cent. of iron.
Alumina	.980	
Carbonate of lime	a trace.	
Carbonate of magnesia	1.180	
Carbonate of manganese	1.629	
Phosphoric acid	.758	
Sulphuric acid	.544	
Potash	.243	
Soda	.114	
Silex and insoluble silicates	6.984	
Combined water and loss	12.828	
	100.000	

Quite a rich ore. Rejected, probably, because it does not contain enough earthy materials to form "*cinder,*" to protect the reduced iron in the furnace. By mixture with poorer aluminous ores, or by the addition of ferruginous clay, or even common pure clay, or earth, or shale, and a sufficient amount of limestone, it may be smelted without difficulty.

No. 1018—CARBONATE OF IRON. *Labeled "Company Bank, (No.* 500,) *Raccoon Furnace, Greenup county, Ky." (Obtained by the late Mr. Mylott.)*

Interior portion, (see next number for the *exterior portion,*) grey, granular, with some glimmering scales of mica. Under the lens appears to be made up of brownish grains, mixed with a lighter colored material. Powder grey. Specific gravity 3.1778.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	17.763	=23.488 per cent. of iron.
Oxide of iron	21.286	
Alumina	.680	
Carbonate of lime	37.580	
Carbonate of magnesia	2.901	
Carbonate of manganese	1.475	
Phosphoric acid	.310	
Sulphuric acid	1.470	
Potash	.270	
Soda	.166	
Silex and insoluble silicates	8.440	
Combined water and loss	7.659	
	100.000	

A poor ore, which contains enough lime for its own flux. The *exterior* portion is richer.

No. 1019—LIMONITE. *Labeled "Exterior portion of Company Bank Ore, Raccoon Furnace, Greenup county, Ky."* (*Obtained by the late Mr. Mylott.*)

Of a dark-brown color; made up of minute dark-colored rounded grains, involved in a lighter colored cement. Powder of a rich yellowish-brown color. Dried at 212° F., it lost 1.60 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	43.280=30.309 per cent. of iron.
Alumina	1.580
Carbonate of lime	33.180
Carbonate of magnesia	2.337
Brown oxide of manganese	1.180
Phosphoric acid	.508
Sulphuric acid	.338
Potash	.374
Soda	.120
Silex and insoluble silicates	13.184
Combined water and loss	3.919
	100.000

This ore contains enough lime for its own flux, but not enough earthy material. It would be best smelted in mixture with more aluminous and silicious ores.

No. 1020—IMPURE LIMONITE. *Labeled "Ferruginous Conglomerate, seventy-five feet above Company Bank, on the hill north of Raccoon Furnace. Highest measures seen here; equivalent to the limestone ore horizon."* (*Obtained by S. S. Lyon, Esq.*)

A dark-brown, compact limonite, involving rounded pebbles of milky quartz, and quartz sand. Powder of a rich yellowish-brown color.

Dried at 212° F., it lost 0.80 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	45.070=31.563 per cent. of iron.
Alumina	.730
Carbonate of lime	trace.
Magnesia	.808
Brown oxide of manganese	.355
Phosphoric acid	1.056
Sulphuric acid	.165
Potash	.337
Soda	.114
Silex and insoluble silicates	44.720
Combined water	7.800
	101.155

This ore contains much silex and very little, if any, lime. It might be smelted in mixture with the preceding and some more aluminous ore. It is quite rich enough in iron; but contains its silex mainly in the form of pebbles, and has a considerable percentage of *phosphoric acid.*

No. 1021—COAL. *Labeled "Cannel Coal, sent by Col. L. G. Bradford, of Augusta; obtained from a bed about four feet ten inches thick, on the farm formerly owned by Levin Shreve, of Louisville; known as Fulton Forge; three miles above Greenupsburg, and one mile from the Ohio river, Greenup county, Ky."*

In large blocks; not soiling the fingers; cleaving in irregular layers with no fibrous coal between them; of a jet black color. A small portion more slatey, with pyritous impressions of vegetable remains. Over the spirit-lamp it softened and agglutinated somewhat; but did not swell much. Specific gravity 1.271.

PROXIMATE ANALYSIS.

Moisture	4.70	Total volatile matters	44.90
Volatile combustible matters	40.20		
Fixed carbon in the coke	52.40	Dense coke	55.10
White ashes	2.70		
	100.00		100.00

The percentage of *sulphur* is 0.837.

Submitted to destructive distillation, in an iron retort, at a heat gradually raised to dull redness, the following products were obtained in three several experiments:

	First trial.	Second trial.	Third trial.
Crude oil, (dark and thick)	209.	200.	189.
Black ammoniacal water	78.	99.	111.
Coke	543.	548.	555.
Combustible gas, and loss	170.	153.	145.
	1000.	1000.	1000.

The gases collected in each experiment, varied in quantity from seven hundred and ten to seven hundred and sixty cubic inches in volume, from the thousand grains; and possessed good illuminating power.

This is a good pure cannel coal, which would answer well for domestic purposes, and for the production of steam on steamboats, &c. The specimens tried fall below the Breckinridge and Haddock's cannel coals in the proportion of coal oil.

No. 1022—LIMONITE. *Labeled "Best Chocolate, or Red Ore, Pennsylvania Furnace, new bank: tail six inches, thickening to four feet and upward; Greenup county, Ky."*

A deep brownish-red ore; mottled with lighter orange red; adhering to the tongue. Specific gravity 3.153.

Dried at 212° F., it lost 1.40 per cent. of *moisture*.

COMPOSITION, DRIED AT 212° F.

Oxide of iron	61.640=43.167 per cent. of iron
Alumina	1.200
Carbonate of lime	14.380
Magnesia	1.818
Brown oxide of manganese	.380
Phosphoric acid	1.591
Sulphuric acid	.067
Potash	.324
Soda	.205
Silex and insoluble silicates	10.800
Combined water	7.640
	100.045

Quite a rich ore; which contains a considerable proportion of lime. It should be mixed with more aluminous ores, or earthy material, to furnish "*cinder*," and to aid in getting rid of some of its *phosphoric acid.*

HANCOCK COUNTY.

No. 1023—IMPURE LIMONITE. *Labeled "Ferruginous Conglomerate, associated with the Lewisport coal, Hancock county, Ky."* (*Sent by S. S. Lyon, Esq.*)

A portion of the mass uniform in structure, fine-granular, dark-grey, with brownish weathered surfaces; the other portion a conglomerate of irregular ferruginous pebbles, generally rounded, of a dull reddish-brown color; containing fibrous coal and small scales of mica. Powder yellowish-brown.

Dried at 212° F., it lost 1.15 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	33.640=23.658 per cent. of iron.
Alumina	2.980
Carbonate of lime	.580
Carbonate of magnesia	10.693
Brown oxide of manganese	.784
Phosphoric acid	.374
Sulphuric acid	.612
Potash	.424
Soda	.249
Silex and insoluble silicates	44.180
Combined water and loss	5.484
	100.000

Rather too poor to be profitably smelted for iron.

No. 1024—CARBONATE OF IRON. *Labeled "Carbonate of Iron, associated with the Lewisport coal, Hancock county, Ky."* (*Obtained by S S. Lyon, Esq.*)

A dense, fine-grained dark-grey ore. Large conchoidal fracture.

Weathered surfaces yellowish and reddish-brown. Powder, buff-grey. Specific gravity 3.5482.

Dried at 212° F., it lost 0.550 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	73.626	=39.596 per cent. of iron.
Oxide of iron	5.752	
Alumina	1.460	
Carbonate of lime	1.380	
Carbonate of magnesia	7.020	
Carbonate of manganese	.584	
Phosphoric acid	.694	
Sulphuric acid	.248	
Potash	.201	
Soda	.172	
Silex and insoluble silicates	9.080	
	100.217	

No. 1025—SOIL. *Labeled "Soil, (for eighteen inches in depth,) under the Lewisport coal; in the Ohio Bottom, above overflow, Pell and Brother's land, Hancock county, Ky." (Obtained by S. S. Lyon, Esq.)*

Dried soil of a light-umber color.

No. 1026—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil of a dirty-buff color.

One thousand grains of each of these soils, digested for about a month in water charged with carbonic acid gas, gave to it the following *soluble materials*, viz:

	No. 1025. Soil.	No. 1026. Sub-soil.
Organic and volatile matters	1.333	0.323
Alumina, and oxides of iron and manganese and phosphates	.730	.115
Carbonate of lime	.963	.063
Magnesia	.161	.094
Sulphuric acid	.039	.039
Potash	.127	.120
Soda	.296	.372
Silica	.214	.154
Loss	.454	.310
Soluble extract from 1000 grains of the air-dried soil	4.317	1.590

Dried at 400° F., the air-dried soils lost of *moisture,* as follows: the *soil* lost 1.30 per cent. and the *sub-soil* lost 0.923 per cent. Their *composition* thus dried, is as follows:

	No. 1025. Soil.	No. 1026. Sub-soil.
Organic and volatile matters	3.865	2.019
Alumina	3.465	3.390
Oxide of iron	1.970	2.690
Carbonate of lime	.170	.021
Magnesia	.393	.439
Brown oxide of manganese	.233	.095
Phosphoric acid	.143	.190
Sulphuric acid	.042	.042
Potash	.150	.181
Soda	.100	.057
Sand and insoluble silicates	90.520	90.720
Loss	---------	.156
Total	101.051	100.000

No. 1027—SOIL. *Labeled "Soil, forty-five feet above the Lewisport Coal. From an old field on Bush and Williams' land, Hancock county, Ky." (Obtained by S. S. Lyon, Esq.)*

Dried soil of a light, yellowish-umber color.

No. 1028—SOIL. *Labeled "Sub-soil of the preceding; (eighteen inches deep,) &c., &c."*

Dried sub-soil of a brownish-buff color.

One thousand grains of each of these soils, air-dried, were digested for about a month in water charged with carbonic acid gas, to which they gave up *soluble extract*, as follows, dried at 212° F.:

	No. 1027. Soil.	No. 1028. Sub-soil.
Organic and volatile matters	1.250	0.377
Alumina, and oxides of iron and manganese and phosphates	1.663	.117
Carbonate of lime	2.713	.070
Magnesia	.166	.190
Sulphuric acid	.070	.045
Potash	.190	.046
Soda	.183	.084
Silica	.200	.267
Loss	.317	----------
Soluble extract from 1000 grains of air-dried soil, (grains)	6.752	1.196

The *composition* of these soils, dried at 400° F., is as follows:

	No. 1027. Soil.	No. 1028. Sub-soil.
Organic and volatile matters	6.071	4.129
Alumina	3.465	5.440
Oxide of iron	3.710	5.725
Carbonate of lime	.346	.246
Magnesia	.544	.797
Brown oxide of manganese	.095	.170
Phosphoric acid	.187	.145
Sulphuric acid	.050	.047
Potash	.367	.391
Soda	.077	.349
Sand and insoluble silicates	84.945	82.745
Loss	.143	----------
Total	100.000	100.184
Moisture, lost at 400° F	2.400	2.525

No. 1029—SOIL. *Labeled "Soil, top of hill, woods; farm of George Smith, Esq., waters of Blackford creek; two and a half miles in the rear of Lewisport, Hancock county, Ky." (Obtained by S. S. Lyon, Esq.) On the coal measures, above the Lewisport coal.*

Dried soil of a light, yellowish-umber color.

No. 1030—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil of a dirty-buff color.

The quantity and *composition* of the *soluble extract* given up by one thousand grains of these two soils, air-dried, and digested for about a month in water charged with carbonic acid, are as follows:

	No. 1029. Soil.	No. 1030. Sub-soil.
Organic and volatile matters	1.267	0.393
Alumina, and oxides of iron and manganese and phosphates	1.213	.213
Carbonate of lime	1.307	.207
Magnesia	.205	.017
Sulphuric acid	.045	.041
Potash	.059	.034
Soda	.109	.054
Silica	.200	.200
Loss	.346	----------
Soluble extract, from 1000 grains of air-dried soil, (grains)	4.751	1.159

The *composition* of these two soils, dried at 400° F., is as follows:

	No. 1029. Soil.	No. 1030. Sub-soil.
Organic and volatile matters	4.422	3.678
Alumina	3.215	4.890
Oxide of iron	3.285	5.135
Carbonate of lime	.171	.071
Magnesia	.446	.799
Brown oxide of manganese	.241	.120
Phosphoric acid	.161	.152
Sulphuric acid	.059	.016
Potash	.205	.328
Soda	.040	.051
Sand and insoluble silicates	88.130	84.720
Loss	---------	.040
	100.375	100.000
Moisture, lost a 400°, (per cent.)	2.200	2.125

Mem.—Nos. 1031 and 1032, accidentally omitted, will be found under the head of Owsley and Powell counties.

No. 1033—Soil. *Labeled "Soil from Mr. Greathouse's farm, one hundred feet above Hawes'. Thin soil, soon tired, Hancock county, Ky."* (*Obtained by S. S. Lyon, Esq.*)

Dried soil of a dark umber-grey color.

No. 1034—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil of a rich brownish-orange color.

One thousand grains of each of these two soils, air-dried, digested for a month in water charged with carbonic acid, gave up as follows:

	No. 1033. Soil.	No. 1034. Sub-soil.
Organic and volatile matters	0.767	0.850
Alumina, and oxides of iron and manganese and phosphates	.196	.063
Carbonate of lime	1.230	.230
Magnesia	.116	.129
Sulphuric acid	.024	.037
Potash	.182	.064
Soda	.149	.114
Silica	.281	.147
Loss	.305	.166
Total *soluble extract*, dried at 212° F., (grains)	3.250	1.800

The *composition* of these two soils, dried at 400° F., is as follows:

	No. 1033. Soil.	No. 1034. Sub-soil.
Organic and volatile matters	4.729	3.642
Alumina	2.115	5.390
Oxide of iron	1.900	6.400
Carbonate of lime	.196	.071
Magnesia	.408	.585
Brown oxide of manganese	.070	.095
Phosphoric acid	.185	.151
Sulphuric acid	.042	not estim'd
Potash	.212	.413
Soda	.062	.131
Sand and insoluble silicates	91.170	83.320
	101.089	100.198
Moisture, lost at 400° F.	1.475	1.850

No. 1035—COAL. *Labeled "Upper part of Mayo's Coal, Hawesville, Hancock county, Ky."*

A dull, pitch-black, cannel coal; with a large conchoidal fracture. Over the spirit lamp does not soften nor alter its form. Specific gravity 1.359.

PROXIMATE ANALYSIS.

Moisture	4.30	Total volatile matters	41.50
Volatile combustible matters	37.20		
Fixed carbon in the coke	42.60	Dense coke	58.50
Buff-grey ashes	15.90		
	100.00		100.00

The proportion of *sulphur* is 1.306 per cent.

COMPOSITION OF THE ASHES.

Silica	9.980
Alumina, and oxides of iron and manganese and trace of phosphates	5.180
Lime	trace.
Magnesia	.166
Sulphuric acid	.063
Potash	.347
Soda	.186
	15 922

The large percentage of ash in this specimen of coal detracts from its value.

No. 1036—COAL. *Labeled "Boyd's Coal, Hawesville, Hancock county, Ky."*

A pretty firm, shining, dark pitch-black coal; cleaving generally with shining irregular surfaces. A little granular pyrites on some of the layers. Over the spirit lamp it softened and agglutinated; swelling up into a spongy coke. Specific gravity 1.268.

PROXIMATE ANALYSIS.

Moisture	5.46	Total volatile matters	46.60
Volatile combustible matters	41.14		
Fixed carbon in the coke	48.80	Moderately light coke	53.40
Grey-purple ashes	4.60		
	100.00		100.00

The percentage of *sulphur* is 3.361.

COMPOSITION OF THE ASHES.

Silica	1.184
Alumina, and oxides of iron and manganese and trace of phosphates	3.080
Lime	a trace.
Magnesia	.067
Sulphuric acid	a trace.
Potash	.270
Soda	.038
	4.639

HARDIN COUNTY.

No. 1037—LIMESTONE. *Labeled "Lithographic? Stone, Sinking creek, Hardin county, Ky. Sub-carboniferous."*

Of a light buff-grey color. Fine granular; pretty uniform in structure; only a few specks of oxide of iron in places; and some signs of fossils on the weathered surfaces. Fracture large-conchoidal.

Dried at 212° F., its powder lost 0.30 per cent. of *moisture.*

No. 1038—LIMESTONE. *Labeled "Sub-carboniferous Limestone, four miles west of Big Spring, Hardin county, Ky."*

A fine-granular, dull, grey rock, with a few small glimmering facets of calc. spar.

Dried at 212° F., its powder lost 0.34 per cent. of *moisture.*

No. 1039—LIMESTONE. *Labeled "Oolitic Limestone. Sub-carboniferous. One and a half miles south of Big Spring, Hardin county, Ky. On the farm of Mr. Mooreman, about the level of the first red soil and sub-soil of the sub-carboniferous. The first bed under the millstone grit."* (*Sent by S. S. Lyon, Esq.*)

A dull, chalky-white rock, principally made up of very small, round, oolitic grains. Reddish on the exterior surface, where it is porous from the dropping out of the round grains.

Dried at 212° F., it lost 0.30 per cent. of moisture.

COMPOSITION OF THESE THREE LIMESTONES, DRIED AT 212° F.

	No. 1037. Lithographic	No. 1038. Limestone.	No. 1039. Oolitic.
Carbonate of lime	79.180	82.280	99.580
Carbonate of magnesia	11.469	7.300	.629
Alumina, and oxides of iron and manganese	.880	.660	.460
Phosphoric acid	.156	.182	.125
Sulphuric acid	.338	.417	.274
Potash	.173	.386	.154
Soda	.098	.090	.022
Silex and insoluble silicates	6.980	9.220	.380
Loss	.726		
	100.000	100.535	100.624

The "oolitic" is a remarkably *pure* limestone, and could be employed in all cases where a *pure white* lime is required. Whether No. 1037 would answer for a lithographic stone, will depend upon its freedom from pores and flaws, &c. It appears to be sufficiently fine in its grain, and of the proper composition.

No. 1040—Soil. *Labeled "Virgin Soil, from woods; from the farm of Bernard Eskridge, head waters of Otter Creek, Hardin county, Ky." Growth, white oak, hickory, and sassafras. (Sub-carboniferous; below the cavernous members.*

The dried soil is of a light, greyish-umber color.

No. 1041—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

The dried sub-soil is much lighter colored than the preceding.

No. 1042—Soil. *Labeled "Soil from an old field, in cultivation since* 1812, *in corn, oats, and tobacco. Farm of Bernard Eskridge, head waters of Otter creek, &c., &c."*

The dried soil is of a dirty, greyish-buff color. It contains fragments of ferruginous chert.

No. 1043—Soil. *Labeled "Sub-soil of the preceding."*

It contains fragments of chert; is of a dirty-buff color, much lighter than the preceding.

One thousand grains of each of these soils, air-dried, were severally digested in water charged with carbonic acid, for a month, and gave up to it *soluble matters*, as follows:

	No. 1040. Virgin soil.	No. 1041. Sub-soil.	No. 1042. Old field.	No. 1043. Sub-soil.
Organic and volatile matters	0.741	0.267	0.417	0.233
Alumina, and oxides of iron and manganese and phosphates	.231	.031	.121	.047
Carbonate of lime	1.213	.297	.730	.447
Magnesia	.256	.072	.129	.127
Sulphuric acid	not estim'd	not estim'd	.028	.028
Potash	.089	.029	.061	.032
Soda	.023	.019	.028	.017
Silica	.156	.114	.320	.147
Loss	.134	.021	.092	----------
Soluble extract, dried at 212° F., (grains)	2.823	0.850	1.917	1.078

The *composition* of these four soils, dried at 400° F., is as follows:

	No. 1040. Virgin soil.	No. 1041. Sub-soil.	No. 1042. Old field.	No. 1043. Sub-soil.
Organic and volatile matters	5.207	2.865	3.378	2.561
Alumina	2.990	3.540	3.020	2.990
Oxide of iron	2.235	3.260	2.260	2.545
Carbonate of lime	.370	.245	.245	.170
Magnesia	.392	.483	.321	.315
Brown oxide of manganese	.320	.245	.120	.195
Phosphoric acid	.183	.078	.137	.119
Sulphuric acid	.040	.059	.041	.028
Potash	.169	.183	.121	.101
Soda	.042	.063	.040	trace.
Sand and insoluble silicates	88.130	87.570	90.220	90.495
Loss	----------	1.409	.097	.491
Total	100.078	100.000	100.000	100.000
Moisture, lost at 400° F.	2.100	1 750	1.265	1.425

On comparing the composition of the soil from the "old field," with that of the virgin soil, the usual diminution of the essential ingredients will be observed. The sub-soil does not appear to be richer in these mineral ingredients than the surface soil.

No. 1044—Soil. *Labeled "Soil from an old field, thirty years in cultivation, on the farm of Mr. Taber; on the hills two miles south of Big Spring, Hardin county, Ky. Mr. Taber has taken from this soil three crops of tobacco, nine of corn, and nine of wheat. Last year no crop was raised on it. He does not consider it worn out."* (*Obtained by S. S. Lyon, Esq.*)

"This field lies on the top of the intercalated bed of oolitic limestone, in the millstone grit. The soil is partly derived from the sandstone called Tar Rock, and partly from the limestone under it."

The dried soil is of a greyish-buff, or dirty yellowish-grey color.

No. 1045—Soil. *Labeled "Sub-soil of the preceding, &c, &c."*

The dried sub-soil is of a greyish-buff color.

One thousand grains of each of these soils, air-dried, were digested for a month in water charged with carbonic acid, to which they gave up the following materials, viz:

	No. 1044. Soil.	No. 1045. Sub-soil.
Organic and volatile matters	0.400	0.443
Alumina, and oxides of iron and manganese and phosphates	.121	.080
Carbonate of lime	.546	.160
Magnesia	.116	.087
Sulphuric acid	.056	.022
Potash	.064	.035
Soda	.035	.050
Silica	.200	.147
Soluble extract, dried at 212° F., (grains)	1.538	1.044

The *composition* of these soils, dried at 400° F., is as follows:

	No. 1044. Soil.	No. 1045. Sub-soil.
Organic and volatile matters	3.197	2.615
Alumina	2.015	2.015
Oxide of iron	2.035	2.885
Carbonate of lime	.130	.095
Magnesia	.472	.411
Brown oxide of manganese	.170	.080
Phosphoric acid	.072	.072
Sulphuric acid	.021	.021
Potash	.164	.169
Soda	.021	.049
Sand and insoluble silicates	91.345	89.770
Loss	.358	1.818
Total	100.000	100.000
Moisture, lost at 400° F.	1.475	1.525

The soil and sub-soil do not differ very much in mineral composition. They cannot be considered exhausted, but yet would be much improved by the application of slacked lime, plaster of paris, and bone dust or super-phosphate of lime, as top-dressings. The phosphoric and sulphuric acids being particularly small in quantity in them.

HENDERSON COUNTY.

No. 1046—LIMESTONE. *Labeled "Limestone, from Mount Zion, Henderson county, Ky. (Coal Measures.")*

A dull, fine-grained, fossiliferous limestone, with a few glimmering facets of calc. spar.

Dried at 212° F., it lost 0.20 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	88.380
Carbonate of magnesia	3.678
Alumina and oxides of iron and manganese	1.760
Phosphoric acid	.246
Sulphuric acid	.166
Potash	.289
Soda	.068
Silex and insoluble silicates	3.280
Water and loss	2.133
	100.000

This limestone contains enough of potash and phosphoric and sulphuric acids, &c., to make it valuable as a top-dressing to exhausted soils; at the same time it is pure enough to be burnt for building purposes.

HENRY COUNTY.

No. 1047—BONES OF MASTODON. *"Eminence, Henry county, Ky."*

A fragment of one of the vertebræ. Exterior surface of a dirty buff-grey color; adheres strongly to the tongue. *Cancellæ* of the interior lined with a ferruginous infiltration. Dried at 212° F., it lost 6.56 per cent. of *moisture*, after having been thoroughly air-dried.

COMPOSITION, DRIED AT 212° F.

Phosphoric acid	23.603	of which 13.546 was combined with lime and magnesia, and 10.057 was united with alumina and oxide of iron.
Sulphuric acid	.509	
Chlorine	a trace.	
Hydro-fluoric acid	not estimated.	
Lime combined with phosphoric acid	15.189	=28.322 phosphate of lime (3 CaO, PO5)
Magnesia combined with phosphoric acid	.231	= .644 phosphate of magnesia.
Carbonate of lime	25.680	
Oxides of iron and manganese	15.980	
Alumina	3.780	
Potash	.347	
Soda	.218	
Silex and insoluble silicates	13.620	
Organic matter? and loss	.843	
	100.000	

No. 1048—(a. and b.) "FRAGMENT OF TOOTH OF MASTODON. *Eminence, Henry county, Ky.*"

Portion of one of the tubercles of the grinders. *Enamel*, yet hard and shining; nearly white; not adhering to the tongue. *Interior osseous portion* adheres strongly to the tongue; friable; grey, and dark-grey in parts.

Interior portion (a) lost 4.86 per cent. of *moisture* at 212° F.

Enamel (b) lost 1.20 per cent. of *moisture* at 212° F.

Neither contained enough organic matter to blacken when ignited.

COMPOSITION, DRIED AT 212° F.

	No. 1048 (a). Interior Osseous portion.	No. 1048 (b). Enamel.
Phosphate of lime	80.576	92.070
Phosphate of magnesia	1.284	1.084
Carbonate of lime	13.720	2.300
Magnesia	.366	.166
Chlorine	a trace.	a trace.
Hydro-fluoric acid	not estimated.	not estimated.
Sulphuric acid	.588	.248
Potash	.139	.173
Soda	.467	.633
Silex and insoluble silicates	.124	.124
Water and loss, &c.	2.736	3.202
	100.000	100.000

Most of the *loss* stated above is believed to be of *magnesia;* a very small proportion only being organic matter.

No. 1049—CLAY. *Labeled "Clay in which bones of mastodon are found, at Eminence, Henry county, Ky.*"

A light, grey colored clay, when dry, with ferruginous discolorations in places.

No. 1050—CLAY. *Labeled "Ferruginous Clay, over and mixed with the clay of the mastodon bed, Eminence, Henry county, Ky.*"

A friable ochreous earth; generally of a brownish-yellow color, with pores and cavities lined with dark brown oxide of iron.

COMPOSITION OF THESE CLAYS, DRIED AT 212° F.

	No. 1049. Bone clay.	No. 1050. Ferrug clay
Sand and insoluble silicates	80.380	46.480
Alumina with a little oxide of iron	11.650	------
Oxide of iron with some alumina	------	40.172
Carbonate of lime	.780	a trace.
Magnesia	.933	.566
Phosphoric acid	.310	3.128
Sulphuric acid	.304	.304
Potash	.490	.463
Soda	.257	.141
Water and loss	4.896	8.746
Total	100.000	100.000
Moisture expelled at 212° F.	4.060	4.900

HOPKINS COUNTY.

No. 1051—SOIL. *Labeled "Soil from east side of Whiteside's creek, Hopkins county, Ky. (Coal Measures.") Obtained by S. S. Lyon, Esq.*

The dried soil is of a light umber color. Some few rounded fragments of sandstone were sifted out of it.

No. 1052—SOIL. *Labeled "Sub-soil from east side of Whiteside's creek, Hopkins county, Ky. (Coal Measures.")*

Dried soil light umber colored; lighter and more yellowish than the preceding.

No. 1053—SOIL. *Labeled "Soil from three miles north of Madisonville, Hopkins county. (Coal Measures.")*

Dried soil brownish grey-buff color.

No. 1054—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil lighter colored than preceding and of a more pure buff.

No. 1055—SOIL. *Labeled "Soil, from near the road, southeast side of Pond creek, Hopkins county. (Coal Measures.")*

Dried soil of a dark, dirty-buff color.

No. 1056—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil of a brownish-buff color.

One thousand grains of each of these six coal measures soils, thoroughly air-dried, were digested, severally, for a month in water charged with carbonic acid, to which they gave up the following materials, &c., quantities stated in grains and decimals:

	No. 1051. Soil.	No. 1052. Sub-soil.	No. 1053. Soil.	No. 1054. Sub-soil.	No. 1055. Soil.	No. 1056. Sub-soil.
Organic and volatile matters	2.100	0.717	0.600	0.300	0.566	0.277
Alumina, and oxides of iron and manganese and phosphates	1.930	.540	.296	.060	.257	.080
Carbonate of lime	2.547	.696	.113	.063	1.097	.051
Magnesia	.099	.066	.044	.073	.160	.110
Sulphuric acid	.030	.030	.067	.025	.033	.055
Potash	.107	.081	.064	.037	.133	.034
Soda	.060	.048	.054	.045	.060	.025
Silica	.220	.214	.114	.164	.264	.164
Loss	.040	.591	.425	.083	--------	--------
Soluble extract, dried at 212° F.	7.133	2.983	1.777	0.850	2.570	0.796

The *composition* of these six soils, dried at 400° F., is as follows:

	No. 1051. Soil.	No. 1052. Sub-soil.	No. 1053. Soil.	No. 1054. Sub-soil.	No. 1055. Soil.	No. 1056. Sub-soil.
Organic and volatile matters	6.263	4.295	3.843	3.756	2.887	3.629
Alumina	3.390	4.845	4.165	5.890	3.415	6.590
Oxide of iron	2.700	2.910	2.985	4.700	2.385	4.600
Carbonate of lime	.445	.160	.095	.070	.220	.045
Magnesia	.491	.507	.393	.584	.344	.656
Brown oxide of manganese	.295	.370	.280	.120	.095	.170
Phosphoric acid	.148	.078	.118	.096	.173	.053
Sulphuric acid	.076	.059	.025•	.016	.016	.033
Potash	.158	.330	.225	.323	.198	.331
Soda	.034	.113	.090	.047	.073	.067
Sand and insoluble silicates	85.970	86.070	87.945	84.445	90.745	84.445
Loss	.030	.263	--------	--------	--------	--------
Total	100.000	100.000	100.164	100.047	100.551	100.619
Moisture, lost at 400° F.	2.600	1.900	1.775	2.150	1.300	1.915

The sub-soils are generally richer in potash and magnesia, and poorer in lime and phosphoric and sulphuric acids, than the surface soil. They contain also larger proportions of alumina and oxide of iron.

No. 1057—Coal. *Labeled "Arnold's Coal, bed eight feet thick, four and a half miles south of Madisonville, Hopkins county, Ky."*

A pure shining, deep-pitch-black coal; iridescent in parts. Brittle. Fibrous coal between some of the layers; the surfaces of which are generally irregular and shining. Over the spirit lamp it swells up, agglutinates; burns with a very smoky flame, and leaves a light coke. Specific gravity 1.274.

PROXIMATE ANALYSIS.

Moisture	4.00	Total volatile matters	41.50
Volatile combustible matters	37.44		
Fixed carbon in the coke	54.80	Moderately light coke	58.50
Grey ashes	3.70		
	100.00		100.00

The percentage of *sulphur* is 2.796.

JACKSON COUNTY.

No. 1058—Soil. *Labeled "Virgin Soil, on dividing ridge between Jackson and Estill counties, farm of Wm. Roberts; head waters of Grassy branch of Sturgeon creek, Jackson county, Ky. Geological position: top of the millstone grit ridge; above the sandstone cliffs." (Obtained by Jos. Lesley, jr., Esq.)*

Dried soil of a greyish-buff color. Some fragments of ferruginous sandstone were sifted out of it.

No. 1059—Soil. *Labeled "Surface Soil, field adjoining the preceding; cleared four or five years ago; in corn ever since, &c., &c."*

Dried soil of a greyish-buff color; lighter than the preceding. Some iron gravel and ferruginous sandstone were sifted out of it with the coarse seive.

No. 1060—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried soil of a light greyish-buff color; lighter than the preceding. It also contained some iron gravel and fragments of ferruginous sandstone.

One thousand grains of each of these soils were digested, severally, for a month, in water charged with carbonic acid, which extracted the following materials; stated in grains and decimals:

	No. 1058. Virgin soil.	No. 1059. Old field.	o. 1060. Sub-soil.
Organic and volatile matters	0.917	0.700	0.467
Alumina, and oxides of iron and manganese and phosphates	.813	.463	.246
Carbonate of lime	.130	.497	.163
Magnesia	.090	.159	.060
Sulphuric acid	.028	.034	.045
Potash	.045	.093	.148
Soda	.042	.052	.035
Silica	.147	.281	.314
Loss	.238	.204	.002
Soluble extract, dried at 212° F., (grains)	2.450	2.483	1.500

The *composition* of these soils, dried at 400° F., is as follows:

	No. 1058. Virgin soil.	No. 1059. Old field.	No. 1060. Sub-soil.
Organic and volatile matters	4.999	3.390	2.433
Alumina	5.560	3.055	5.583
Oxide of iron	2.970	1.860	
Carbonate of lime	.011	.031	.011
Magnesia	.414	.298	.117
Brown oxide of manganese	.120	.045	----------
Phosphoric acid	.126	.062	.142
Sulphuric acid	.042	trace.	.016
Potash	.243	.252	.238
Soda	.074	.012	.078
Sand and insoluble silicates	85.860	91.160	90.905
Loss	----------	----------	.387
Total	100.448	100.125	100.000
Moisture, lost at 400° F.	1.915	1.115	0.965

This land would be improved by top-dressings of lime and of plaster of paris.

No. 1061—Soil. *Labeled "Virgin Soil, from the land of Mr. Sloan, (opposite his house,) on Indian Fork of Rockcastle river, Jackson county, Ky., four miles from McKee, on the Big Hill and Richmond road. Geological position: slopes of the coal-bearing shales and sandstones; the soil has been formed from these and of the debris of the massive sandstone of the millstone grit; between which and the sub-carboniferous limestone they lie." (Obtained by Joseph Lesley, jr.)*

Dried soil of a light yellowish-umber color. Some ferruginous sandstone and gravel iron ore were sifted out of it with the coarse seive.

No 1062—Soil. *Labeled "Surface Soil from an adjoining field which has been in cultivation six years; now in corn," &c, &c.*

Dried soil of a light yellowish-umber color; a slight shade darker than the preceding. It contained, also, fragments of ferruginous sandstone and gravel iron ore.

No. 1063—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried soil of a light yellowish-umber color; much like the preceding. Contains fragments of ferruginous sandstone and gravel iron ore.

One thousand grains of each of these soils, digested for a month in water containing carbonic acid, severally, yielded the following quantities of soluble matters, viz:

	No. 1061. Virgin soil.	No. 1062. Old field.	No. 1063. Sub-soil.
Organic and volatile matters	1.067	1.883	0.450
Alumina, and oxides of iron and manganese and phosphates	1.163	1.030	.480
Carbonate of lime	.580	1.140	.230
Magnesia	.141	.161	.133
Sulphuric acid	.030	.022	.022
Potash	.066	.135	.173
Soda	.068	.037	.042
Silica	.381	.297	.364
Loss	.337	.045	.389
Soluble extract, dried at 400 F., (grains)	3.833	4.750	2.283

The *composition* of these soils, dried at 400° F., is as follows:

	No. 1061. Virgin soil.	No. 1062. Old field.	No. 1063. Sub-soil.
Organic and volatile matters	.4737	6.425	4.812
Alumina	9.210	6.320	6.870
Oxide of iron		3.360	3.710
Carbonate of lime	.080	.110	.180
Magnesia	.306	.529	.456
Brown oxide of manganese	----------	.270	.120
Phosphoric acid	.176	.194	.160
Sulphuric acid	.050	.045	.050
Potash	.373	.306	.521
Soda	.085	.070	.083
Sand and insoluble silicates	84.620	82.670	83.270
Loss	.363	----------	----------
Total	100.000	100.499	100.232
Moisture, lost at 400° F.	1.850	2.500	2.035

The considerable proportion of *potash* in these soils was doubtless derived from the shales of the coal measures. The amount of lime in them being much below the average, they would doubtless be improved by the application of slacked lime as manure.

No. 1064—COAL. *Labeled "Coal from the land of Mr. Isaacs, on Birch Lick Fork of Indian creek, Jackson county, Ky. Geological position: fifty feet above the sub-carboniferous limestone."* (*Obtained by Joseph Lesley, jr.*)

A fine, deep, pitch-black coal. Some fibrous coal between the layers. Exterior surface coated with ochreous. Over the spirit lamp it softens, agglutinates, and swells into a spongy coke, giving much smoky flame. Specific gravity, 1.290.

PROXIMATE ANALYSIS.

Moisture	1.10	Total volatile matters	39.30
Volatile combustible matters	38.20		
Fixed carbon in the coke	50.80	Moderately light coke	60.70
Light-grey ashes	9.90		
	100.00		100.00

The percentage of *sulphur* is 0.962.

COMPOSITION OF THE ASH.

Silica	3.784
Alumina, and oxides of iron and manganese and trace of phosphates	4.680
Carbonate of lime	.184
Magnesia	.346
Sulphuric acid	.097
Potash	.077
Soda	.277
Loss	.495
	9.900

JEFFERSON COUNTY.

No. 1065—LIMESTONE. *Labeled "Variegated Limestone; near the base of the Upper Silurian, of Jefferson county, three miles from Middletown, on the Shelbyville road."*

A fine-granular limestone, of a brownish-yellow, or dirty-orange color, mottled and striped with greenish-grey. Powder light-yellowish. Dried at 212° F., it lost 0.35 per cent. of *moisture.*

COMPOSITION, DRIED AT 400° F.

Carbonate of lime	52.080
Carbonate of magnesia	31.473
Alumina, and oxides of iron and manganese	4.473
Phosphoric acid	.208
Sulphuric acid	.303
Potash	.606
Soda	.307
Silex and insoluble silicates	10.480
	100.009

This magnesian limestone would no doubt prove a durable building stone; if the protoxide of iron in it, which gives to it the greenish color, does not by oxidation cause any exfoliation. It deserves trial as a *hydraulic* limestone; and would no doubt be valuable for agricultural purposes; as a manure to exhausted land; in its burnt and slacked, or powdered condition.

No. 1066—LIMESTONE. *Labeled "Hydraulic? Limestone, Chenowick creek, Jefferson county. (Upper Silurian.")*

A fine-granular, dull, greenish-grey rock. Adheres slightly to the tongue. Dried at 212° F., it lost 0.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	42.819	=24.118 lime.
Carbonate of magnesia	21.619	=10.395 magnesia.
Alumina, and oxides of iron and manganese	6.560	
Phosphoric acid	.214	
Sulphuric acid	1.284	
Potash	.233	
Soda	.372	
Silex and insoluble silicates	23.980	
Water and loss	2.558	
	100.000	

This is probably a good hydraulic limestone.

No. 1067—LIMESTONE. *Labeled "Hydraulic Cement, overflowed in the bin in* 1832; *since then exposed to the atmosphere. Hardened without sand, under water. Old Mill: Canal at Louisville. How much water? Does it contain hydrated silicate of lime?"*

Of a light-grey color; quite firm and hard; adheres slightly to the tongue; uneven; somewhat hackly fracture.

Dried at 212°, it lost 4.80 per cent. of *moisture* in its air-dried state.

COMPOSITION, DRIED AT 212° F.

Lime	28.260	=50.260 carbonate of lime.
Magnesia	10.095	
Carbonic acid	22.140	
Phosphoric acid	.156	
Sulphuric acid	not estimated.	
Alumina, and oxides of iron and manganese	10.460	
Potash	.214	
Soda	.672	
Soluble silica	6.340	
Insoluble silica	11.380	
Combined water	10.340	
	100.057	

The solution of this cement in hydrochloric acid gelatinized on evaporation. The quantity of *soluble silica*, indicated above, shows how much had chemically combined with the lime (or magnesia, or both) in the form of *silicate*. It is believed that the property of hardening under water is due to the formation of *silicates* of lime, or magnesia, in the act of burning the lime; and it is probable that the considerable proportions of *potash* and *soda* usually found in hydraulic limestones, aid in the production of these compounds. Moreover, almost all the best water cements contain considerable quantities of *magnesia*, and it would seem that this earth sometimes communicates *hydraulic* properties to limestones which contain only a small proportion of silicious matter.

No. 1068—LIMESTONE. *Labeled "Banded Building Stone; seventy-five feet above the Dean Marble; used in the construction of the Court-House at Louisville, Ky. From Madison, Indiana, quarries. Hydraulic limestone?"*

A dull, fine-granular rock, with horizontal bands of reddish and greenish grey-buff colors. Adheres slightly to the tongue. Specific gravity 2.7562.

Dried at 212°, it lost 0.46 per cent. of *moisture*.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	45.880	=25.746 per cent. of lime.
Carbonate of magnesia	22.911	=10.914 per cent. of magnesia
Alumina, and oxides of iron and manganese	5.760	
Phosphoric acid	.220	
Sulphuric acid	.269	
Potash	.347	
Soda	.372	
Silica, soluble in boiling solution of carbonate of soda	3.000	
Silica, insoluble in boiling solution of carbonate of soda	18.520	
Water and loss	2.721	
	100.000	

This, having the composition of a good water-lime, or hydraulic limestone, was tested, by burning some for two days at a moderate red heat; pulverizing and mixing with sand and water; and it was found to harden very well under water. Some of the calcined rock, dissolved in hydrochloric acid, formed a solution which gelatinized on partial evaporation, proving the presence of soluble silicates.

The *composition* of the *calcined* portion was found to be as follows:

Lime	38.718
Magnesia	15.337
Alumina, and oxides of iron and manganese, (with some magnesia)	14.960
Silica, soluble in boiling carb. soda solution	14.160
Silica, insoluble in boiling carb. soda solution	14.880
Alkalies and acids (not estimated) and loss	1.945
	100.000

There is no doubt that this would make good hydraulic cement, if properly calcined and prepared. But experience has proved that these porous, absorbent, hydraulic limestones are unfit for architectural purposes, in consequence of their rapid disintegration, by scaling from the surface, under the influence of moisture and frost.

No. 1069—MARL. *Labeled Marl? from Chenowick creek, Jefferson county, Ky.*"

A greenish-grey, clay-like substance; with some thin brownish infiltrations.

Dried at 212° F., it lost 0.90 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	26.880
Carbonate of magnesia	1.687
Alumina, and oxides of iron and manganese	7.260
Phosphoric acid	.694
Sulphuric acid	.406
Potash	.965
Soda	.012
Silex and insoluble silicates	59.900
Combined water, expelled by ignition	2.196
	100.000

This would prove a valuable application to exhausted land.

No. 1070—SOIL. *Labeled "Virgin Soil; eight inches of the surface, taken immediately under the sod of native blue-grass, in Woodland pasture. Principal growth walnut, with black locust, wild cherry, elm, ash, hackberry, box-elder, buckeye, pignut and shellbark hickory, coffee-nut, red and over-cup oak, large sugar maple, and root-covered beech. Farm of Theodore Brown, six miles east of Louisville, on the Lexington turnpike, waters of Middle Fork of Beargrass creek, Jefferson county, Ky." Upper Silurian formation.* (Some of the best "Beargrass" land.)

Dried soil of a dark, dirty-buff color.

No. 1071—SOIL. *Labeled "Sub-soil, (ten inches,) from immediately under the preceding, &c., &c."*

Dried soil much lighter and more yellowish than the preceding.

No. 1072—SOIL. *Labeled "Ten inches of the top soil from an old field about thirty years in cultivation. For eleven successive years in hemp; (the last crop averaging* 900 *pounds to the acre,) and the remainder of the time in hemp in rotation with corn, wheat, and clover. Farm of Theodore Brown, Jefferson county, Ky., &c., &c."*

Dried soil of a color like that of the virgin soil, a slight shade darker than that.

No. 1073—SOIL. *Labeled " Ten inches of the sub-soil of the preceding, &c., &c."*

Color like that of the sub-soil of the virgin soil.

No. 1074—SOIL. *Labeled "Eight inches of the top-soil of a field which has been cultivated about seventy years; for the first thirty years in corn, and the remaining forty years in this crop alternating with wheat, clover, and hemp. Farm of Theodore Brown, Jefferson county, &c., &c."*

Color of the dried soil slightly lighter than that of the virgin soil.

No. 1075—SOIL. *Labeled "Ten inches of the sub-soil of the old field next preceding, &c., &c."*

The soluble materials extracted from one thousand grains of each of these soils, severally, by digestion for about a month in water charged with carbonic acid, may be summed up as follows:

	No. 1070. Virgin soil.	No. 1071. Sub-soil.	No. 1072. Soil 30 yr. old field.	No. 1073. Sub-soil.	No. 1074. Soil 70 yr. old field.	No. 1075. Sub-soil.
Organic and volatile matters	0.600	0.300	0.467	0.270	0.466	0.127
Alumina, and oxides of iron and manganese and phosphates	.114	.047	.081	.047	.131	.031
Carbonate of lime	1.580	.747	1.730	.780	.897	.577
Magnesia	.144	.111	.105	.111	.141	.094
Sulphuric acid	.028	.022	.081	.033	.022	.054
Potash	.103	.066	.077	.031	.106	.051
Soda	.049	trace.	.023	trace.	.059	trace.
Silica	.131	.187	.147	.114	.200	.121
Loss	.043	----------	.355	.114	.096	----------
Soluble extract, dried at 400° F.	2.783	1.480	3.066	1.500	2.120	1.055

The *composition* of these six soils, dried at 400° F., is as follows, viz:

	No. 1070. Virgin soil.	No. 1071. Sub-soil.	No. 1072. Soil of 30 yr. old field.	No. 1073. Sub-soil.	No. 1074. Soil of 70 yr. old field.	No. 1075. Sub-soil.
Organic & vol. matters	5.173	3.417	5.457	3.406	4.389	3.105
Alumina	2.900	3.665	2.365	3.365	2.690	4.115
Oxide of iron	3.085	3.410	2.510	3.410	2.985	3.320
Carbonate of lime	.370	.270	.370	.290	.270	.245
Magnesia	.719	.621	.467	.576	.484	.513
Brown oxide of manganese	.395	.270	.320	.220	.245	.220
Phosphoric acid	.203	.127	.160	.127	.258	.176
Sulphuric acid	.076	.042	.059	.025	.067	.041
Potash	.208	.212	.167	.257	.253	.275
Soda	.154	.077	.072	.127	.026	.047
Sand & insol. silicates	86.370	87.995	87.170	87.795	87.345	87.670
Loss	.347	----------	.883	.402	.788	.073
Total	100.000	100.106	100.000	100.000	100.000	100.000
Moisture, lost at 400° F	2.100	1.650	1.975	1.650	1.685	1.775

The soil of the old field, seventy years in cultivation, appears to be fully as rich as the virgin soil analyzed; whether it was originally richer than that, either on the surface or in its sub-soil, or whether its fertility has been maintained by a judicious system of culture, is not known to the writer. That of the old field, thirty years in cultivation, shows the usual evidence of deterioration, in the decreased quantities of potash, phosphoric acid, sulphuric acid, &c.; but its fertility is indicated by the large amount of *soluble extract* which it gives up to the water charged with carbonic acid; although this *extract* does not contain as large a proportion of *potash* as that from the virgin soil. These Beargrass lands are eminently fertile, and are based on a limestone sub-stratum, which by its gradual decomposition will tend continually to renew its fertility; imparting to it not only carbonates of lime and magnesia, but also potash, phosphoric and sulphuric acids, and other essential elements of vegetable composition. But they do not contain quite as much of these essential elements as the best "bluegrass" land of the Lower Silurian blue limestone region; nor is the limestone on which they rest quite as quickly decomposable as that blue limestone.

No. 1076—MARL. *Labeled "Loose dirt taken from between some of the upper layers of rock in a well on the land of the Rev. George Bickett, adjoining that of Theodore Brown. This abounds in all the neighboring quarries, around and above loose stones and thin sheets. Is it of a marly nature? Jefferson county, Ky., &c., &c."*

Color of the dried earth, like that of the sub-soil of Theodore Brown's land, (next preceding,) a little darker, with whitish particles of decomposed chert mixed with it. Some fragments of soft, decomposing chert were sifted out of it.

One thousand grains of the air-dried soil, digested for a month in water charged with carbonic acid, gave up *more than seven and a half grains of yellowish-grey extract*, dried at 400° F., which had the following composition:

Organic and volatile matters	0.560
Alumina, and oxides of iron and manganese and phosphates	.134
Carbonate of lime	5.747
Magnesia	.188
Sulphuric acid	.049
Potash	.411
Soda	.061
Silica	.214
Loss	.402
Extract, dried at 212°	7.766 grains.

The *composition* of this soil, dried at 400° F., is as follows:

Organic and volatile matters	8.284
Alumina, and oxides of iron and manganese	19.310
Carbonate of lime	2.595
Magnesia	.071
Phosphoric acid	.269
Sulphuric acid	.062
Potash	.874
Soda	.090
Sand and insoluble silicates	68.820
	100.375

This marly clay is rich enough in carbonate of lime and potash to make it a valuble mineral manure for land exhausted of these materials.

No. 1077—LIMESTONE. *Labeled "Top layer, usually found at the depth of from five to eight feet below the surface of the ground. (These upper layers are not more than a few inches thick.) Farm of Theodore Brown, &c., &c., Jefferson county, Ky." Upper Silurian or Devonian formation.*

A grey limestone, with the exterior of the layers, to the depth of half an inch or more, of a dirty-grey buff color; sparkling with small crystalline facets, and containing a great number of small entrochites and encrinital stems, with a few bi-valve shells.

No. 1078—LIMESTONE. *Labeled "Same level as the preceding, a more certain representative of the upper layers. Farm of Theodore Brown, &c., &c."*

Resembles the preceding; a little finer in grain. Encrinital stems larger.

No. 1079—LIMESTONE. *Labeled "Layer next to the top; the upper ones being only a few inches thick, and the lower two feet or more. Theodore Brown's farm, &c., &c."*

A light grey, fine-grained limestone, containing much coral, (Fenestrella,) and some bi-valve shells, (Atrypa?)

No. 1080—LIMESTONE. *Labeled "Blue, or dark-grey Limestone, found one or two feet above the level of Beargrass creek; sometimes in thin layers, but generally in thick ones. Theodore Brown's farm, &c., &c."*

A bluish-grey limestone; dirty-buff on the weathered surfaces; sparkling with facets of calc. spar; containing small encrinital stems and some bi-valve shells.

No. 1081—LIMESTONE. *Labeled "Limestone, full of fossils, resting on the layer which forms the bed of Middle Fork of Beargrass creek. Theodore Brown's farm, six miles east of Louisville, Jefferson county, &c., &c."*

Appears to be made up of fossil shells, corals, &c., mineralized with carbonate of lime. General color light-grey, with some oxide of iron giving it a mottling of yellowish; presenting irregular pores.

These limestones and the preceding soils, were collected and sent for analysis by Mr. Theodore Brown.

The *composition* of these five limestones, dried at 212° F., may be tabulated as follows:

	No. 1077. Top layer.	No. 1078. Top layer.	No. 1079. Next to top layer.	No. 1080. Dark grey or blue.	No. 1081. Fossiliferous.
Carbonate of lime	89.060	92.560	82.960	68.060	86.260
Carbonate of magnesia	6.783	4.615	14.014	7.493	2.587
Alumina and oxides of iron and manganese	1.480	.480	.880	.208	.580
Phosphoric acid	.310	trace.	.182	.669	trace.
Sulphuric acid	.475	.166	.272	.647	.132
Potash	.154	.166	.013	.252	.115
Soda	.163	.074	.212	not estimated	.116
Silex and insoluble silicates	2.680	2.580	.880	1.680	9.560
Loss	----------	----------	.587	1.001	.730
Total	101.105	100.641	100.000	100.000	100.000
Moisture lost at 212° F.	0.100	0.060	0.060	0.100	0.100

The limestone of the blue or dark-grey layer would prove the best for application to land; because it contains the most phosphoric acid, potash, &c., &c.

LAUREL COUNTY.

No. 1082—CARBONATE OF IRON. *"From the land of John Robeson, seven miles from London; a mile and a quarter west of the Crab Orchard road, on Gillis' branch, a quarter of a mile from the mouth. Layer eighteen inches thick, in the face of a bluff of fifty or sixty feet of coarse grey sandstone. Some distance under the coal beds of London, and just above the upper part of the millstone grit."*

A dense, dull, brownish-grey, fine-granular ore; with a white incrustation in the fissures; and containing a few small specks of yellow iron pyrites. Weathered surfaces brownish. Powder buff-grey.

Dried at 212° F., it lost 0.600 per cent. of moisture.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	72.960=35.284 per cent. of iron.
Alumina	1.900
Carbonate of lime	3.180
Carbonate of magnesia and loss	4.759
Carbonate of manganese	1.264
Phosphoric acid	1.963
Sulphuric acid	.454
Potash	not estimated.
Soda	not estimated.
Silex and insoluble silicates	13.520
	100.000

Rich enough in iron to be profitably smelted, but containing rather more than the usual proportion of phosphoric acid.

LEWIS COUNTY.

No. 1083—SALINE EFFLORESCENCE. *Labeled "Copperas from Devonian Black Slate, near David Mifford's, eight miles from Clarksburg, Lewis county, Ky."*

Yellowish-white, porous, light lumps of saline efflorescence mixed with small fragments of slate.

COMPOSITION, DRIED AT 212° F.

Sulphate of alumina	25.585
Sulphate of iron	15.653
Sulphate of magnesia	1.000
Alkaline sulphates	8.000
Slate and insoluble portion	1.000
Water and loss	48.762
	100.000

This, if abundant, might be employed in the manufacture of alum; with Venitian red as an incidental product.

No. 1084—FERRUGINOUS LIMESTONE. *Labeled "Ferruginous Calcareous concretion in black shale, mouth of Salt Lick Creek, Lewis county, Ky. Base of the sub-carboniferous formation."*

A dull, umber-colored mineral; imperfectly laminated. Not adhering to the tongue. Powder umber-grey. Specific gravity 2.687.

Dried at 212°, it lost 0.80 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	42.490
Carbonate of magnesia	15.225
Carbonate of manganese	.571
Carbonate of iron	10.612
Oxide of iron	.446
Alumina	1.360
Phosphoric acid	.182
Sulphuric acid	.192
Potash	.560
Soda	.326
Silex and insoluble silicates	23.380
Organic matters and loss	4.656

These concretions would, very probably, make very good hydraulic cement, if properly prepared.

No. 1085—Yellow Magnesian Limestone. *Probably belonging to the age of the Upper Silurian. Salt Lick creek, four miles above Clarksburg, Lewis county, Ky.*

A brownish-buff, porous limestone. Exterior surface so soft as to be scratched by the nail, and full of fossil casts of entrochites and bi-valve shells. Interior not adhering to the tongue, and glimmering with numerous facets of yellow-brown calcareous spar. Powder of a grey-buff color.

Dried at 212° F., it lost 0.40 per cent of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	55.240
Carbonate of magnesia	27.820
Alumina, and oxides of iron and manganese	12.280
Phosphoric acid	.207
Sulphuric acid	.152
Potash	.167
Soda	.126
Silex and insoluble silicates	2.580
Water and loss	1.428

No. 1086—Sandstone. *Labeled "Soft Yellow Rock, associated with the Yellow Magnesian Limestone, at the Forks of Salt Lick creek, near Adam Bartram's farm, Lewis county, Ky."*

A soft sandstone of a handsome dark-buff color. Adheres to the tongue. Scratched by the nail. After ignition, it is of a brick-red color. Powder of a handsome buff-color. Dried at 212° F., it lost 2.10 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	90.920
Alumina, and oxides of iron and manganese	5.800
Lime	trace.
Magnesia	.732
Phosphoric acid	.118
Sulphuric acid	.200
Potash	trace.
Soda	trace.
Water, expelled at a red heat	2.100
Loss	.130
	100.000

No. 1087—Soil. *Labeled "Soil derived from the Yellow Magnesian Limestone, under the Black Slate of Lewis county. From the farm of Adam Bartram, near the forks of Salt Lick. Growth white poplar, black walnut; red oak the principal growth."*

Dried soil of a light grey-brown color. Some fragments of yellowish and brown, soft ferruginous sandstone sifted out of it with the coarse seive.

No. 1088—Soil. *Labeled "Virgin Soil, from the Hendrick farm, on Poplar Ridge; over Magnesian Limestone. Waters of Cabin creek, Lewis county, Ky. Upper Silurian." Primitive growth, poplar, black ash, buck-eye, and sugar-tree.*

Dried soil of a greyish light chocolate color. A few fragments of soft ferruginous sandstone, and small ferruginous concretions, were sifted out of it.

No. 1089—Soil. *Labeled "Same Soil, from an old field fifty to sixty years in cultivation, now in wheat, Hendrick farm, Poplar Ridge, Lewis county, Ky."*

Dried soil of a light yellowish-umber color. Some fragments of ferruginous sandstone and iron gravel were sifted out of it.

No. 1090—Soil. *Labeled "Sub-soil from the same old field, Hendrick farm, Poplar Ridge, Lewis county, Ky."*

Dried soil of a greyish-buff color. Contains rather more iron gravel, &c., than the preceding.

The soluble materials, extracted from one thousand grains of each of these soils, by digestion for a month in water charged with carbonic acid, are as follows:

	No. 1087. Yel. mag. lim't soil.	No. 1088. Virgin soil.	No. 1089. Soil of old field.	No. 1090. Sub-soil.
Organic and volatile matters	0.633	0.820	0.733	0.290
Alumina, and oxides of iron and manganese and phosphates	.361	.100	.413	.173
Carbonate of lime	.030	.930	1.247	.730
Magnesia	.096	.245	.194	.203
Sulphuric acid	.028	.022	.048	.028
Potash	.067	.137	.033	.022
Soda	.048	.024	.068	.049
Silica	.181	.197	.200	.200
Loss	.389	.175	----------	----------
Soluble extract, dried at 212° F., (grains)	1.833	2.650	2.936	1.695

The *composition* of these four soils, dried at 400° F., is as follows:

	No. 1087. Yel. mag. lim't soil.	No. 1088. Virgin soil Hendrick's.	No. 1089. Old field soil.	No. 1090. Sub-soil.
Organic and volatile matters	4.809	5.915	4.613	4.403
Alumina	2.595	1.865	1.990	4.040
Oxide of iron	4.485	2.340	3.510	3.585
Carbonate of lime	.221	.245	.195	.230
Magnesia	.542	.426	.426	.475
Brown oxide of manganese	.220	.045	.120	.045
Phosphoric acid	.112	.144	.118	.062
Sulphuric acid	.045	.050	.042	.011
Potash	.338	.159	.130	.195
Soda	.050	.005	.063	.127
Sand and insoluble silicates	86.495	88.295	87.470	87.120
Loss	.088	.511	1.323	----------
Total	100.000	100.000	100.000	100.896
Moisture, lost at 400° F.	2.065	2.125	1.850	1.825

LINCOLN COUNTY.

No. 1091—MINERAL WATER. *Labeled "Sulphur Water, sent by Mr. A. M. Bacon, from the place of Mr. Stanton Pollard, on his premises, directly in front of his house; within three rods of the turnpike leading from Crab Orchard to Lancaster: about a mile and an eighth from Crab Orchard. Found by boring seven feet in the rock, which is grey limestone. Surface of the rock six feet below the general surface. Well thirteen feet deep. The water is brought up by a pump. Lincoln county, Ky."*

The *sulphuretted hydrogen* gas contained in this water having been mainly decomposed by carriage, was not estimated; nor was the *carbonic acid* gas, which it contains in notable proportion.

SALINE CONTENTS OF 1000 GRAINS OF THIS WATER.

Carbonate of lime	0.142	held in solution by carbonic acid.
Carbonate of magnesia	.149	
Chloride of sodium	.692	
Chloride of potassium	.022	
Chloride of magnesium	.122	
Carbonate of soda	.018	
Sulphate of lime	a trace.	
Sulphate of potash	.065	
Silica	.010	
	1.221 grains.	

This appears to be a pleasant weak salt-sulphur water.

LIVINGSTON COUNTY.

OZEORO (FORMERLY HOPEWELL) FURNACE ORES, SLAG, PIG IRON, &c. (PROCURED BY MR. JOHN BARTLETT.)

No. 1092—LIMONITE. *Labeled "Brown Ore, Ozeoro Furnace, (formerly Hopewell Furnace.) Livingston county, Ky."*

A dense, dark-brown limonite, in irregular layers, incrusted with yellow and reddish colors. Powder of a yellow-brown color.

No. 1093—LIMONITE. *Labeled "Pot Ore, Ozeoro Furnace, &c., &c."*

A flattened geode of dense, brown limonite, incrusted with yellowish ochreous ore. Powder of a yellow-brown color.

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

	No. 1092. Brown ore.	No. 1093. Pot ore.
Oxide of iron	78.310	76.340
Alumina	.780	.180
Lime	a trace.	trace.
Magnesia	.851	.850
Brown oxide of manganese	.684	.884
Phosphoric acid	.680	.438
Sulphuric acid	.166	a trace.
Potash	.154	.126
Soda	.242	a trace.
Silex and insoluble silicates	6.480	8.780
Combined water	11.800	11.900
Loss	----------	.502
Total	100.056	100.000
Percentage of iron	54.840	53.462
Moisture, lost at 212° F.	0.900	0.900

These ores resemble each other a good deal in composition, but the "pot ore" is rather the purer. Both are very good.

No. 1094—LIMESTONE. *Labeled "Blue Limestone used as a flux at Ozeoro Furnace, Livingston county, Ky."*

A dark-grey, fine-granular limestone; sparkling with small facets of calc. spar. Giving a bituminous odor when hammered.

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COMPOSITION, DRIED AT 212° F.

Carbonate of lime	91.680=51.447 lime.
Carbonate of magnesia	3.168
Alumina, and oxides of iron and manganese	.264
Phosphoric acid	a trace.
Sulphuric acid	.372
Potash	.224
Soda	.024
Silex and insoluble silicates	4.280
	100.032

Dried at 212°, it lost 0.20 per cent. of *moisture.*

With the exception of its 0.372 per cent. of sulphuric acid, this is quite a pure limestone. This, however, does not appear to injure the iron made with it.

No. 1095—SANDSTONE. *Labeled "Hearth-stone from Illinois. Used at Ozeoro Furnace, Livingston county, Ky."*

A reddish-grey sandstone, composed of clear grains of quartz, more or less rounded, mixed with oxide of iron and small scales of mica.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	93.280
Alumina, and oxides of iron and manganese	3.360
Lime	a trace.
Magnesia	.513
Phosphoric acid	a trace.
Sulphuric acid	.132
Potash	.193
Soda	.050
Water, expelled at a red heat	2.100
Loss	.372
	100.000

This is quite a refractory sandstone.

No. 1096—PIG IRON. *Labeled "Grey Iron, from Ozeoro Furnace, &c."*

A moderately coarse-grained grey iron, with brilliant specular scaly grains. Small fragments extend a little under the hammer, but soon break to pieces. Yields easily to the file.

No. 1097—PIG IRON. *Labeled "Lively Grey Iron, Ozeoro Furnace, &c."*

A little finer-grained, and a little lighter colored specular grey iron than the preceding. Yields easily to the file, and flattens a little under the hammer.

No. 1098—Pig Iron. *Labeled "Close (Hard) Iron, Ozeoro Furnace, &c., &c."*

A very fine-grained light-grey iron; yields with some difficulty to the file; flattens a little under the hammer.

COMPOSITION OF THESE THREE SAMPLES OF IRON.

	No 1096. Grey iron.	No. 1097. Lively grey iron.	No. 1098. Close iron.
Iron	91.714	92.548	93.459
Graphite	2.624	2.524	1.964
Combined carbon	1.700	1.360	2.360
Manganese	.634	.417	.201
Silicon	1.796	1.853	.892
Slag	.244	.394	.184
Aluminum	.063	.095	.202
Calcium	trace.	trace.	trace.
Magnesium	.263	.222	.165
Potassium	.089	.092	.096
Sodium	.012	trace.	.006
Phosphorus	.755	.671	.502
Sulphur	.053	.061	.071
Loss	.053	----------	----------
Total	100.000	100.247	100.122
Total carbon	4.324	3.904	4.344
Specific gravity	7.0291	7.0824	7.2950

No. 1099—Iron Furnace Slag. *Labeled "Cinder from the Grey Iron, Ozeoro Furnace, Livingston county, Ky."*

Perfectly vitrified; of a handsome smoky-purple color, streaked with lighter shades of greyish-blue. Transparent in the thin edges. Before the blow-pipe, it melts readily into a whitish, blebby globule.

No. 1100—Iron Furnace Slag. *Labeled "Cinder from the Lively Grey Iron, Ozeoro Furnace, &c."*

Dark bottle-green; perfectly vitrified, with some streaks of light grey-blue. Transparent on the thin edges. Before the blow-pipe fuses into a bottle-green globule without frothing. Not quite as fusible as the preceding.

No. 1101—Iron Furnace Slag. *Labeled "Cinder from the Close (Hard) Iron, Ozeoro Furnace, &c."*

Olive-grey with streaks of bluish; filled with small air-bubbles, and involving graphite and lumps of whitish material, probably chert.

Translucent on the thin edges. Before the blow-pipe, it is less fusible than the preceding; melting into a blebby globule.

COMPOSITION OF THESE THREE SAMPLES OF "CINDER."

	No. 1099. Cinder from the grey iron.	No. 1100 Cinder from lively grey iron.	No. 1101. Cinder from the close iron.
Silica	62.580	63.380	63.380
Alumina	7.380	8.960	9.560
Lime	25.465	20.751	19.461
Magnesia	1.214	1.462	2.543
Protoxide of iron	.882	3.456	2.914
Protoxide of manganese	.539	.450	.487
Potash	1.313	1.649	1.680
Soda	.965	.207	.202
Total	100.308	100.315	100.227
Proportion of the oxygen in the bases to the oxygen in the silica As	11.959 : 32.493 or 1 : 2.717	11.881:32.939 or 1 : 2.790	12.074:32.909 or 1 : 2.725

The presence of sulphur and phosphorus in these slags was not verified although they are no doubt present. It will be seen, in these analyses, how deficiency of lime in the flux tends to the formation of white iron, and a bottle-green cinder; and how an excess of protoxide of iron supplies to some extent the deficiency of the lime in the flux.

LYON COUNTY.

MAMMOTH FURNACE ORES, PIG IRON, SLAG, LIMESTONE, &c. OBTAINED BY MR. JOHN BARTLETT.

No. 1102—LIMONITE. *Labeled "Brown Ore, (bed A,) within half a mile of Mammoth Furnace, Lyon county, Ky."*

A dense, dark-brown limonite, in pretty thick irregular layers; not adhering to the tongue; involving small irregular cavities, and incrusted with yellowish and reddish ochreous ore. Powder of a yellow-brown color.

No. 1103—LIMONITE. *Labeled "Brown Ore, (bed B,) Mammoth Furnace, &c."*

Resembles the last; rather darker colored in the dense layers. Powder yellowish-brown.

No. 1104—LIMONITE. *Labeled "Brown Ore, (bed C,) Mammoth Furnace, &c."*

A dense, dark-brown limonite; not adhering to the tongue; portions of the surface presenting a glazed appearance, almost black; surface generally covered with cinnamon-colored ochreous ore. Powder of a yellowish-brown color.

No. 1105—LIMONITE. *Labeled "Brown Ore, (bed D,) Mammoth Furnace, &c."*

The specimen is a large mass of dense, dark-brown limonite; not adhering to the tongue; incrusted with greyish-salmon colored and reddish ochreous material. Powder yellowish-brown.

No. 1106—LIMONITE. *Labeled "Brown Ore, (bed E,) Mammoth Furnace, &c., &c."*

A dense, dark-brown limonite; not adhering to the tongue; in irregular layers, covered with greyish-buff ochreous material. Powder yellowish-brown. Specific gravity 4.2425.

No. 1107—LIMONITE. *Labeled "Honey-comb Ore, not worked at present. Mammoth Furnace, &c."*

A porous (or cellular) mass made up of very thin layers of dense dark-brown limonite, with irregular small cavities between them, incrusted with reddish and yellowish and grey-buff ochreous material. Powder yellowish-brown.

No. 1108—LIMONITE. *Labeled "Brown Ore, (No. 11,) from a bed not worked at present, Mammoth Furnace, &c., &c."*

A dense, dark-brown limonite in thick layers; not adhering to the tongue; including very small flattened cavities; some of which are lined with small white quartz crystals. Exterior covered with brownish and yellowish ochreous ore. Powder brownish yellow.

COMPOSITION OF THESE SEVEN LIMONITES, DRIED AT 212° F.

	No. 1102. Brown ore Bed A.	No. 1103 Brown ore Bed B.	No. 1104. Brown ore Bed C.	No. 1105. Brown ore Bed D.	No. 1106. Brown ore Bed E.	No. 1107. Honey-comb ore.	No. 1108. Brown ore No. 11.
Oxide of iron	78.000	74.547	76.425	64.433	72.356	64.269	76.880
Alumina	.480	1.080	.440	.880	.450	.580	1.130
Lime	trace.	trace.	trace.	trace.	trace.	trace.	trace.
Magnesia	.407	.479	.441	.446	.443	.479	.795
Brown oxide of manganese	1.084	.280	.380	.180	.480	.680	1.060
Phosphoric acid	.758	1.399	.615	.807	.502	.671	.887
Sulphuric acid	.097	.132	.132	.200	.097	.180	.098
Potash	.424	.251	.143	.135	.328	.251	.502
Soda	.120	.207	.145	.016	.255	.002	.109
Silex and insoluble silicates	9.480	10.680	10.980	23.920	13.480	21.680	6.680
Combined water	10.820	11.100	11.100	9.700	11.300	10.500	11.700
Loss	----	----	----	----	.279	.208	.139
Total	101.670	100.155	100.801	100.717	100.000	100.000	100.000
Percentage of iron	54.622	52.206	53.523	45.123	51.022	44.939	53.840
Moisture, lost at 212° F.	0.700	0.700	0.600	0.600	0.700	1.000	0.900

A comparison of the various Mammoth furnace ores can easily be made in the foregoing table. From the considerable proportion of phosphoric acid and the small amount of alumina present in these, generally, it is probable that the use of pure clay, or other argillaceous material, with the flux, with more lime than is generally employed here, would improve the quality of the iron made at this furnace; by removing some of the phosphoric acid, and thus making the iron purer and more tough.

No. 1108 (*a*)—Limestone. *Labeled "Limestone used as a flux at Mammoth Furnace, Lyon county, Ky."*

A dark-grey, or lead-colored fossiliferous limestone, presenting numerous shining facets of calc. spar. Gives out a bituminous odor when hammered. Powder of a light-grey color.

Dried at 212°, it lost 0.140 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	86.380=54.084 lime.
Carbonate of magnesia	.542
Alumina, and oxides of iron and manganese	1.960
Phosphoric acid	.002
Sulphuric acid	.887
Potash	not estimated.
Soda	not estimated.
Silex and insoluble silicates	8.680
Organic matter and loss	1.549
	100.000

The only objection to the use of this limestone as a flux is in the considerable proportion of sulphuric acid which it contains. This, however, is not likely to leave the limestone, to contaminate the iron with its sulphur, when an excess of lime is present.

No. 1109—Pig Iron. *Labeled "Grey Iron. Foundry Iron, (cold blast,) Mammoth Furnace, &c."*

A moderately fine-grained dark-grey iron. Small fragments extend a little under the hammer; but soon break to pieces. Yields to the file.

No. 1110—Pig Iron. *Labeled "Lively Grey Iron. (Sharp Iron.) Cold blast, Mammoth Furnace, &c."*

Finer-grained; lighter colored, and less tough than the preceding. Yields to the file.

No. 1111—Pig Iron. *Labeled "White Iron, (cold blast,) Mammoth Furnace, &c.; very little made."*

Hard, white: small fragments breaking under the hammer with scarcely any flattening. Homogeneous on the fractured surface; with the appearance of confused radiated bladed crystallization from the lower portion of the pig to the upper surface. Too hard to be filed. Dissolves in acids, and by means of iodine, with great difficulty.

COMPOSITION OF THESE THREE SAMPLES OF PIG IRON.

	No. 1109. Grey iron.	No. 1110. Lively grey iron.	No. 1111. White iron.
Iron	93.096	92.464	93.251
Graphite	2.660	2.800	none.
Combined carbon	1.140	1.500	4.500
Manganese	.421	.233	.276
Silicon	1.681	1.104	.094
Slag	.384	.384	.484
Aluminum	.255	.2[illegible]1	.095
Calcium	a trace.	trace.	trace.
Magnesium	.2[illegible]2	.1[illegible]9	.228
Potassium	.064	.080	.134
Sodium	.070	.145	.135
Phosphorus	.781	1.065	1.346
Sulphur	.080	.080	.080
Total	100.904	100.245	100.623
Total carbon	3.800	4.300	4.500
Specific gravity	6.[illegible]29	7.0376	7.4097

No. 1112—Iron Furnace Slag. *Labeled "Slag from the Grey Iron, Mammoth Furnace, &c."*

A pretty fusible slag; varying from dark, smoky blue, without vesicles, to greyish-green, filled with small air-bubbles.

No. 1113—Iron Furnace Slag. *Labeled "Slag from the Lively Grey Iron, Mammoth Furnace, &c."*

Varying, from *compact*, dark, smoky-blue and bottle-green, to *vesicular*, of light greenish-blue and olive-grey colors. Moderately fusible before the blow-pipe; the bluish into a light bottle-green glass, and the olive-grey into a white vesicular globule.

No. 1114—Iron Furnace Slag. *Labeled "Slag from the White Iron, Mammoth Furnace, &c."*

A grey-green, opake, vesicular slag; involving unburnt charcoal and metalic iron. Moderately fusible.

COMPOSITION OF THESE THREE SLAGS.

	No. 1112. Slag from the grey iron.	No. 1113. Slag from the lively grey iron.	No. 1114. Slag from the white iron.
Silica	64.880	65.080	60.280
Alumina	3.980	8.040	5.800
Lime	22.772	20.190	13.288
Magnesia	1.258	.877	.948
Protoxide of iron	3.358	4.158	16.525
Protoxide of manganese	.446	.541	.651
Phosphoric acid	not estimated.		
Sulphuric acid	.289	.290	.324
Potash	1.854	1.398	1.676
Soda	.375	.365	.397
Loss	.788	----------------	.111
Total	100.000	100.939	100.000
Proportion of the oxygen in the bases to the oxygen in the silica — As	10.108:33.687 or 1:3.332	11.217:33.791 or 1:3.012	11.065:31.299 or 1:2.828

The composition of these slags approaches to that of a *tri-silicate;* that is, the oxygen in the bases, lime, magnesia, alumina, &c., &c., is only about one third of that contained in the silica. The iron would be purer if enough lime and some pure aluminous material were added to make the slag a *bi-silicate.* A great deficiency of lime is to be observed in the slag from the *white iron;* which caused the production of that kind of metal, as well as the loss of more than sixteen per cent. of protoxide of iron in the cinder. With the use of more lime there would be less loss of iron in the slag.

ORE, PIG IRON, SLAG, &c., FROM KELLY & CO.'S IRON WORKS, (SUWANNEE FURNACE,) LYON COUNTY, KY. OBTAINED BY MR. JOHN BARTLETT.

No. 1115—LIMONITE. *Labeled "Iron Ore from Iron Mountain Bank, three miles west of the furnace, Kelly & Co.'s Iron Works, (Suwannee Furnace,) Lyon county, Ky."*

A dense, very dark-brown limonite; not adhering to the tongue. A portion presenting shining mamillary concretions, with a brilliant semi-crystalline fracture. Powder dark, dull Spanish-brown color.

Dried at 212°, it lost 0.90 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Oxide of iron	85.637=59.973 per cent. of iron.
Alumina	.580
Lime	a trace.
Magnesia	.690
Brown oxide of manganese	1.280
Phosphoric acid	1.143
Sulphuric acid	.306
Potash	.463
Soda	.195
Silex and insoluble silicates	4.480
Combined water	5.900
	100.674

This ore contains a little protoxide of iron.

No. 1116—LIMESTONE. *Labeled "Limestone from Baker Spring quarry, two miles from the furnace, used as a flux at Suwannee Furnace, (Kelly & Co.'s,) Lyon county, Ky."*

A dark, umber-grey limestone; showing on the fractured surface shining crystalline facets of calc. spar. Gives a bituminous odor when hammered. Powder of a light-grey color.

Dried at 212° F., it lost 0.200 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	73.580=41.29 per cent. of lime.
Carbonate of magnesia	17.485
Alumina, and oxides of iron and manganese	2.240
Phosphoric acid	.079
Sulphuric acid	.558
Potash }	not estimated.
Soda }	not estimated.
Silex and insoluble silicates	4.880
Loss	1.178
	100.000

No. 1117—SANDSTONE. *"Used for Hearth-stone, at Suwannee Furnace, brought from Caseyville, Union county, Ky."*

A friable, light-grey sandstone. Some yellowish ferruginous bands in parts. Under the lens, it appears made up of small clear rounded quartz grains, with no cement. Some few small black specks, and minute scales of mica in it, and some of the grains are discolored with oxide of iron.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	98.080
Alumina, and oxides of iron and manganese	.440
Lime	a trace.
Magnesia	.466
Phosphoric acid	a trace.
Sulphuric acid	.066
Potash	.328
Soda	.255
Water, expelled at a red heat	.600
	100.235

Quite a refractory sandstone; well suited for hearth-stones.

No. 1118—IRON FURNACE SLAG. *Labeled "Slag from Suwannee Furnace, Lyon county, Ky."*

Varying from bottle-green and bluish, *dense* slag, to *vesicular*, light greenish-grey. Quite fusible before the blow-pipe, into a light bottle-green glass.

COMPOSITION:

Silica	61.180	Containing oxygen 31.766
Alumina	5.380	2.515
Lime	23.333	6.635
Magnesia	1.071	.428
Protoxide of iron	4.410	.978
Protoxide of manganese	.818	.206
Phosphoric acid not estimated, (some present.)		
Sulphuric acid	.269	
Potash	1.661	.281
Soda	.176	.045
		11.088
Loss	1.702	
	100.000	

The oxygen in the bases is to that in the silica, as 11.088 is to 31.766
or as 1. is to 2.866

This slag is very nearly a tri-silicate. By the use of more lime to bring it to the condition of bi-silicate, the quality of the iron would doubtless be improved.

No. 1119—PIG IRON. *Labeled "Very Grey Iron, Suwannee Furnace, Kelly & Co., Lyon county, Ky."*

A very fine-grained grey iron. Small fragments flatten a little under the hammer, but soon break to pieces. Yields to the file.

No. 1120—PIG IRON. *Labeled "Pig Iron, (Grey, No. 2,) from Suwannee Furnace, &c."*

Finer grained than the preceding, (very fine grained,) and a little darker colored. Appears to be a little harder and tougher than that. Yields to the file.

No. 1121—PIG IRON. *Labeled "White Iron, (No. 4,) from Suwannee Furnace, &c. Refined in the Hearth of the Furnace."*

Very hard, brittle, white iron; presenting a confused bladed crystalline appearance on the fractured surface. About the color of impure nickel.

This was refined by *Kelly's method*, in which Bessemer's process for the purification of iron seems to have been measurably anticipated, viz: by dipping the tuyere into the melted metal in the hearth of the furnace and forcing the cold blast through it.

COMPOSITION OF THESE THREE SAMPLES OF PIG IRON.

	No. 1119. Very grey iron.	No. 1120. Grey iron No. 2.	No. 1121. White iron (refined.)
Iron	92.414	92.560	94.338
Graphite	2.644	2.824	.984*
Combined carbon	2.456	1.876	3.000
Manganese	.201	.273	.129
Silicon	1.950	.663	.375
Slag	.384	.484	none.
Aluminum	.224	.131	.095
Calcium	a trace.	trace.	trace.
Magnesium	.258	.419	.325
Potassium	.096	.086	.102
Sodium	.102	.014	.057
Phosphorus	.192	.321	.387
Sulphur	.100	.149	.152
Loss	---------	---------	.056
Total	101.021	100.000	100.000
Total carbon	5.100	4.700	3.984
Specific gravity	6.9892	6.9238	7.6075

MADISON COUNTY.

No. 1122—CLAY. *Labeled "Potters' Clay, near Waco, used for making Stone-ware, Madison county, Ky."*

Of a yellowish-grey color. Portions colored dark yellowish with oxide of iron. Does not darken much in color on burning. Before

* Although stated as *graphite*, this was a brownish carbonaceous material.

the blow-pipe it fuses on the edges. Dried at 212° F., it lost 2.86 per cent. of moisture.

COMPOSITION, DRIED AT 212° F.

Silica	62.580
Alumina	21.980
Oxide of iron	4.780
Lime	a trace.
Magnesia	1.276
Brown oxide of manganese	a trace.
Phosphoric acid	not estimated.
Sulphuric acid	.234
Potash	2.607
Soda	.500
Water expelled at a red heat	6.140
	100.097

Its considerable proportion of oxide of iron communicates its peculiar color to the ware made from this clay.

No. 1123—LIMESTONE. *Labeled "Magnesian Limestone; a good building stone; from Mr. Covington's farm, at Elliston, Madison county, Ky., (where the red-bud soil was collected.")*

A dull, dark, buff-grey, fine-granular rock. Powder light grey-buff color. Specific gravity 2.6912.

Dried at 212° F., it lost 0.20 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	49.320
Carbonate of magnesia	30.729
Alumina, and oxides of iron and manganese	2.960
Phosphoric acid	.271
Sulphuric acid	.509
Potash	.374
Soda	.058
Silex and insoluble silicates	14.180
Loss	1.599
	100.000

This deserves trial as a *hydraulic* limestone; although the proportion of silex which it contains is not as great as is found in the best water lime from the Falls of the Ohio.

No. 1124—SHALE. *Labeled "Black Shale, on the flats of Madison county, Ky., where the soil was collected on the slack lands."*

Shale of a dull dark color, nearly black; irregularly laminated. Does not adhere to the tongue. Easily broken. Powder of a dark mouse-color.

Dried at 212° F., it lost 0.90 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	63.120
Alumina, and oxides of iron and manganese	8.560
Carbonate of lime	11.180
Magnesia	2.034
Phosphoric acid	.143
Sulphuric acid	1.653=0.673 sulphur.
Potash	1.363
Soda	
Bituminous matter and water	12.000
	100.053

No. 1125—SOIL. *Labeled "Virgin Soil derived from the Black Devonian Slate; taken from the level tract of land about half way between Elliston and Richmond, Madison county, Ky."*

Dried soil of a light chocolate grey color. Sifted out of it about one third of its weight of iron gravel, or small ferruginous concretions and fragments of soft ferruginous sandstone. (See next number.)

One thousand grains of the air-dried soil, digested for a month in water charged with carbonic acid, gave up *more than a grain and a half of brownish extract, dried at* 212° *F.*, which had the following

COMPOSITION, VIZ:

Organic and volatile matters	0.617
Alumina, and oxides of iron and manganese and phosphates	.030
Carbonate of lime	.497
Magnesia	.133
Sulphuric acid	.018
Potash	.075
Soda	not estimated.
Silica	.245
Loss	.068
Extract, dried at 212° F.	1.733 grains.

The air-dried soil lost 2.450 per cent. of *moisture* at 400° F., and has the following

COMPOSITION:

Organic and volatile matters	6.125
Alumina	2.215
Oxide of iron	11.015
Carbonate of lime	.095
Magnesia	.385
Brown oxide of manganese	not estimated.
Phosphoric acid	.271
Sulphuric acid	not estimated.
Potash	.121
Soda	.039
Sand and insoluble silicates	79.270
Loss	.464
	100.000

This soil contains a large proportion of oxide of iron; but is not remarkably rich. The *iron gravel* contained in it gave the following results, on analysis, viz:

COMPOSITION.

Alumina, and oxides of iron and manganese	53.240
Carbonate of lime	.080
Magnesia	.400
Phosphoric acid	.253
Sulphuric acid	.025
Potash	.066
Soda	.024
Sand and insoluble silicates	36.300
Water, &c., expelled at a red heat	8.600
Loss	1.012
	100.000

No. 1126—MINERAL WATER. *Labeled "Mineral Water, sent by James H. Spilman, from a bored well eighteen feet deep; used for the steam-engine for ten years; does not fur the boiler. Paint Lick, about twelve miles from Richmond, Madison county, Ky."*

One *thousand parts of the water* was found to contain the following materials, besides free carbonic acid, viz:

COMPOSITION.

Carbonate of lime	0.030	Held in solution by the free carbonic acid.
Carbonate of magnesia	.004	
Carbonate of iron	a trace.	
Phosphate of lime	a trace.	
Chloride of sodium	.456	
Carbonate of soda	279	
Sulphate of lime	.034	
Sulphate of magnesia	.015	
Sulphate of soda	.030	
Sulphate of potash	.074	
Silica	.044	
	0.966	

or less than one tenth of one per cent. of saline matters.

The small amount of saline matter contained in this water, and the presence of a considerable proportion of carbonate of soda, account for the fact that it forms no crusts in the steam-boiler.

No. 1127—SOIL. *Labeled "Virgin, Red-bud Soil, back of Elliston, Madison county, Ky. (New land; produces forty bushels of wheat to the acre.")*

The dried soil is of a dark-umber color. Some fragments of shale were sifted out of it with the coarse seive.

No. 1128—SOIL. *Labeled "Red-bud Soil, from an old field forty years in cultivation; now in oats. Back of Elliston, on the slopes below the junction of the Black Devonian Shale and the Magnesian Limestone, Madison county, Ky."*

The dried soil is of an umber color, slightly lighter than the preceding. Some shot iron ore was removed from it by the coarse seive.

No. 1129—SOIL. *Labeled "Sub-soil from the same old field. Back of Elliston, Madison county, Ky."*

The dried soil is of an umber color, slightly lighter than the preceding.

One thousand grains of each of these soils, thoroughly air-dried, were digested severally for a month in water charged with carbonic acid gas, to which they gave up *soluble extract* in the quantities and of the *composition* stated below, viz:

	No. 1127. Virgin soil.	No. 1128. Old field soil.	No. 1129. Sub-soil.
Organic and volatile matters	2.693	0.550	0.560
Alumina, and oxides of iron and manganese and phosphates	.581	.147	.167
Carbonate of lime	4.287	1.903	1.974
Magnesia	.838	.405	.420
Sulphuric acid	.050	.028	.039
Potash	.208	.033	.035
Soda	.090	.037	.050
Silica	.516	.367	.367
Loss	.287	.130	.131
Soluble extract, dried at 212° F., (grains)	9.550	3.600	3.743

Dried at 400° F., the *composition* of these soils was found to be as follows:

	No. 1127. Virgin soil.	No. 1128. Old field soil.	No. 1129. Sub-soil.
Organic and volatile matters	15.450	9.508	7.584
Alumina	3.565	6.240	5.900
Oxide of iron	5.560	6.835	6.360
Carbonate of lime	1.295	.470	.770
Magnesia	.750	1.041	.960
Brown oxide of manganese	.270	.245	.320
Phosphoric acid	.252	.214	.199
Sulphuric acid	.120	.059	.065
Potash	.753	.796	.705
Soda	.123	.097	.231
Sand and insoluble silicates	71.045	75.620	76.745
Loss	.817	----------	.135
Total	100.000	100.125	100.000
Moisture, expelled at 400° F., (per cent.)	6.150	4.035	4.535

These very rich soils are remarkable for the large proportions of organic matters, lime, potash, phosphoric and sulphuric acids, which they contain, as well as for the large amount of soluble silica which they give up to the carbonated water. It will be seen that the soil of the old field shows the usual signs of deterioration, except in the relative proportion of its potash, whilst it approximates somewhat to the nature of the sub-soil; probably through the influence of the plow. This resemblance may be more particularly noticed in the amount and composition of the *soluble extract* withdrawn by the water charged with carbonic acid; which will be seen to be much less in proportion, from the soil of the old field and from the sub-soil, than from the virgin soil; which latter gives up a remarkably large quantity. These soils, if well drained, ought to be very productive and durable. Doubtless, much of the *organic matter* contained in them, which gives them their dark color, as well as the large proportion of potash, were derived from the black slate from which they originate.

MASON COUNTY.

No. 1130—MARL. *Labeled "Earthy portion, between the D. Lynx beds of the upper blue limestone, edge of Mason and Fleming counties, Ky."*

A fine-grained, dark-greenish-grey rock. Not adhering to the tongue. Dried at 212° F., it lost 0.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	78.180
Alumina, and oxides of iron and manganese	8.020
Carbonate of lime	7.380
Magnesia	3.105
Phosphoric acid	1.040
Sulphuric acid	.592
Potash	.722
Soda	.170
Water and loss	.791
	100.000

Might be used with advantage on exhausted land.

No. 1131—LIMESTONE. *Labeled "Oxidated part, near the surface of the D. Lynx beds of the blue limestone, edge of Mason and Fleming counties, Ky."*

Almost made up of fossil *Delthyris Lynx* and branching *Chaetetes.*

No. 1132—LIMESTONE. *Labeled "Limestone from the Mason county tobacco land, where the soil was collected for analysis."*

A dark, bluish-grey limestone; with buff-grey and brownish oxidated portions; containing shells of *Delthyris Lynx* and *Chaetetes.* Lower Silurian.

No. 1133—LIMESTONE. *Labeled "Delthyris Lynx beds of the upper part of the blue limestone; (Lower Silurian;) near the edge of Mason and Fleming county, Ky.; which give character to the soil of the southern part of Mason and the northern part of Fleming counties, where soils were collected for analysis."*

A dark, olive-grey rock, full of shells of *Delthyris Lynx* and fragments of *Chaetetes*. Appears to be pyritiferous.

The *composition* of these three limestones is as follows, dried at 212° F.:

	No. 1131. D. Lynx limestone.	No. 1132. Tobac.land limestone.	No. 1133. D. Lynx limestone.
Carbonate of lime	75.440	87.980	77.360
Carbonate of magnesia	4.783	1.721	2.307
Alumina and oxides of iron and manganese	3.751	2.200	3.910
Phosphoric acid	.409	.348	.310
Sulphuric acid	.474	.372	*2.433
Potash	.540	.289	.424
Soda	.292	.047	.068
Silex and insoluble silicates	14.440	6.380	13.980
Loss	----------	.663	.666
Total	100.129	100.000	101.458
Moisture, lost at 212° F., per cent.	0.400	0.200	0.300

These limestones are more rich than usual in the mineral elements conducive to vegetable growth.

No. 1134—SOIL. *Labeled "Mason County Virgin Tobacco Soil; from the hill-side near Dover; about one hundred and fifty feet above the Ohio river, in the midst of the Blue Limestone. (Lower Silurian.) Growth, sugar tree, walnut, black and white ash, buckeye, &c."*

Dried soil of a dirty-buff or light-umber color.

No. 1135—SOIL. *Labeled "Soil six or seven years in cultivation: fourth year in tobacco it failed: is exhausted of some ingredient essential to tobacco, but produces fine wheat. Had a top-dressing of nitre two years ago. Langhorne Tabb's land, near foot of hill-side near Dover, Mason county, Ky. What has it lost?"*

Color a shade lighter than that of the preceding.

* Equal to 0.975 per cent. of *sulphur*, in which form it mostly exists in this limestone, combined with iron, as sulphuret of iron, or iron pyrites; and hence the apparent excess in the sum of the analysis.

No. 1136—Soil. *Labeled "Sub-soil from the same field, on Langhorne Tabb's land, near Dover, Mason county, Ky."*

Color of the dried soil lighter than that of the preceding.

One thousand grains of each of these soils, thoroughly air-dried, were digested severally for a month in water charged with carbonic acid gas; to which they gave up soluble matters in quantity and composition as represented in the following table, viz:

	No. 1134. Virgin soil.	No. 1135. Exhausted soil.	No. 1136. Sub-soil.
Organic and volatile matters	1.416	1.030	0.750
Alumina, and oxides of iron and manganese and phosphates	.130	.230	.147
Carbonate of lime	2.163	1.930	1.780
Magnesia	.294	.242	.123
Sulphuric acid	.074	.077	.045
Potash	.106	.077	.081
Soda	.026	.013	trace.
Silex and insoluble silicates	.314	.147	.146
Loss	.047	----------	.265
Soluble extract, dried at 212° F., (grains)	4.570	3.746	3.337

Dried at 400° F., the *composition* of these soils is as follows:

	No. 1134. Virgin soil.	No. 1135. Exhausted soil.	No. 1136. Sub-soil.
Organic and volatile matters	8.462	6.445	5.931
Alumina	4.745	3.730	4.395
Oxide of iron	6.240	4.465	4.090
Carbonate of lime	.836	.476	.497
Magnesia	.798	.807	.618
Brown oxide of manganese	.146	.221	.196
Phosphoric acid	.231	.212	.245
Sulphuric acid	.084	.042	.059
Potash	.558	.418	.475
Soda	.160	.023	.079
Sand and insoluble silicates	78.100	83.330	83.130
Loss	----------	----------	.285
Total	100.360	100.169	100.000
Moisture, lost at 400° F., (per cent.)	4.175	3.265	3.050

Under the head of Bracken county the analyses of other tobacco soils may be seen, and there, as well as in the appendix, may be found remarks on the cultivation of this plant, and its influence on the soil, &c., &c.

This soil does not yield as much *soluble matter*, to water containing carbonic acid, as the virgin soil from Bracken county, and probably failed to produce tobacco profitably, after a few years, not because it was really exhausted, but because it did not yield its nourishment *fast enough* for the rapid growth of that very exacting plant. The soil which is said to be exhausted is yet quite rich in the mineral elements of plants, and could be made to produce tobacco again, by setting it well in clover, and then plowing it in, after having used it for pasture for a year or two. To cut the clover and remove the hay would not answer as good a purpose. It might be still further improved by using stable manure abundantly on the land, especially with lime and plaster of paris and wood ashes, at the time of sowing the clover, or during its early growth. By these means, when, after plowing in the clover, all the vegetable matter has become fully decomposed, a large amount of soluble materials of the proper kind will be present for the nourishment of the tobacco crop.

MEADE COUNTY.

No. 1137—HYDRAULIC LIMESTONE. *Labeled "Limestone from Mitchell's Spring, Meade county, Ky. Cliff about 300 feet above the Ohio river."* (*Analyzed for Mr. James Anderson, of Louisville.*)

Rock of a dull dirty-buff-grey color. Adheres to the tongue.

No. 1138—HYDRAULIC LIMESTONE? (*Sent by the same person for analysis; (from the branch at the foot of cliff near Rock Haven, Meade county, Ky."*

Rock of a dull, dark-grey color; not adhering to the tongue.

COMPOSITION OF THESE TWO LIMESTONES, DRIED AT 212° F.

	No. 1137.	No. 1138.
Carbonate of lime	47.560 (*a*)	28.360 (*b*)
Carbonate of magnesia	26.515 (*c*)	17.771 (*d*)
Alumina, and oxides of iron and manganese and phosphates	2.160	2.680
Sulphuric acid	1.332	2.707
Potash	.126	.115
Soda	.265	.116
Sand and insoluble silicates	19.680	47.980
Loss	2.362	.271
	100.000	100.000

(*a*) Equal to 26.688 per cent. of *lime*
(*b*) Equal to 12.631 per cent. of *magnesia*.
(*c*) Equal to 15.974 per cent. of *lime*.
(*d*) Equal to 8.466 per cent. of *magnesia*.

The first of these, No. 1137, will, very probably, make good hydraulic cement, if properly calcined and managed. The second may possibly contain too much siliceous matter; but is worthy of careful trial.

MERCER COUNTY.

No. 1139—SOIL. *Labeled "Virgin Soil, from woodland, on the farm of James C. McAfee, on the east side of Salt river, four miles north of Harrodsburg, on the base line. Forest growth, sugar-tree, black walnut, oak, black ash, cherry, and hickory. Set in blue-grass: no under-growth. Lower Silurian formation."*

Dried soil of a light chocolate brown color.

No. 1140—SOIL. *Labeled "Sub-soil of the preceding."*

Dried sub-soil of a dirty-buff color.

No. 1141—SOIL. *Labeled "Soil from an old field cultivated in hemp for eight succeeding years, then changed to corn, wheat, rye, corn, and now in barley: the rye was fed down with hogs. Farm of James C. McAfee, Mercer county, Ky."* (*As above*)

Dried soil of a light grey-brown color, lighter than that of the virgin soil. Some shot iron-ore (small rounded ferruginous concretions) were sifted out of it with the coarse seive.

No. 1142—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."* (*These soils were collected by Mr. S. S. Lyon.*)

Dried sub-soil of a dirty buff color. Some shot iron ore was sifted out of it; not as much as from the preceding.

One thousand grains of each of these four specimens of soil, were digested for a month in water charged, under pressure, with carbonic acid. The soluble materials extracted from them severally may be tabulated as follows, viz:

	No. 1139. Virgin soil.	No. 1140. Sub-soil.	No. 1141. Old soil.	No. 1142. Sub-soil.
Organic and volatile matters	3.673	0.333	0.800	0.385
Alumina, and oxides of iron and manganese and phosphates	.147	.063	.163	.080
Carbonate of lime	2.697	.230	1.197	.263
Magnesia	.100	.090	.094	.555
Sulphuric acid	.032	.022	.033	.028
Potash	.069	.012	.090	.061
Soda	.011	.011	.046	.028
Silica	.081	.043	.131	.147
Loss	----------	----------	.096	----------
Soluble extract, dried at 212° F., (grains)	6.810	0.804	2.650	1.547

The *composition* of these four soils, dried at 400° F., was found to be as follows, viz:

	No. 1139. Virgin soil.	No. 1140. Sub-soil.	No. 1141. Old soil.	No. 1142. Sub-soil.
Organic and volatile matters	5.564	3.413	4.805	3.289
Alumina	5.090	6.715	4.595	5.840
Oxide of iron	4.115	4.990	4.740	5.115
Carbonate of lime	.495	.245	.320	.220
Magnesia	.732	.828	.811	.887
Brown oxide of manganese	.120	.120	.120	.220
Phosphoric acid	.323	.243	.288	.345
Sulphuric acid	not estim'd	not estim'd	.042	not estim'd
Potash	.366	.420	.140	.290
Soda	.143	.019	.108	.035
Sand and insoluble silicates	83.295	82.695	83.625	83.945
Loss	----------	.312	.406	----------
Total	100.243	100.000	100.000	100.186
Moisture, lost at 400° F., (per cent.)	4.300	4.000	3.750	3.150

The effect of cultivation may be observed in the composition of the soil of the *old field*, as compared with that of the *virgin soil*, in the reduced proportions of *organic and volatile matters, carbonate of lime, phosphoric acid, potash, and soda*, and in its small quantity of *hygroscopic moisture.* The sub-soil seems to be richer than the surface soil.

No. 1143—LIMESTONE. *Labeled "Limestone from the farm of James C. McAfee, Mercer county, &c. Comes to the surface about three hundred yards from where the samples of Virgin Soil and Sub-soil were collected."* (*Procured by S. S. Lyon, Esq.*)

A compact, light-grey, fossiliferous limestone; weathered surfaces of a dirty-buff color. (*Lower Silurian. Blue Limestone.*)

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	90.720
Carbonate of magnesia	4.615
Alumina, and oxides of iron and manganese	2.700
Phosphoric acid	.146
Sulphuric acid	not estimated
Potash	.328
Soda	.021
Insoluble silicates	1.880
	100.410

No. 1144—SOIL. *Labeled "Virgin Soil from the farm of Mr. Vandevere, three miles west of Harrodsburg, in the oak region of Mercer county, Ky."* (*Collected by S. S. Lyon, Esq.*)

Dried soil of a dirty-grey-buff color.

No. 1145—Soil. *Labeled "Sub-soil of the preceding, &c."*

Dried sub-soil more buff and slightly darker than the preceding.

No. 1146—Soil. *Labeled "Soil from an old field; farm of Mr. Vandevere, Mercer county, &c., &c."*

Dried soil of a dirty-grey-buff color.

No. 1147—Soil. *Labeled "Sub-soil of the old field, &c., &c."*

Dried soil slightly darker and more buff colored than the preceding.

Digested for a month in water charged with carbonic acid, these soils gave *soluble materials* as represented in the following table, viz:

	No. 1144. Virgin soil.	No. 1145. Sub-soil.	No. 1146 Old soil.	No. 1147. Sub-soil.
Organic and volatile matters	1.083	0.960	1.330	0.323
Alumina, and oxides of iron and manganese and phosphates	.281	.147	.213	.140
Carbonate of lime	1.053	.940	.947	.480
Magnesia	.080	.089	.088	.055
Sulphuric acid	.062	.022	.067	.044
Potash	.045	.052	.054	.029
Soda	.103	.133	.070	.276
Silica	.081	.098	.097	.114
Loss	----------	.009	.224	.196
Watery extract, dried at 212° F., (grains)	2.788	2.450	3.090	1.757

The *composition* of these four samples of soils, dried at 400° F., was found, by analysis, to be as follows:

	No. 1144. Virgin soil.	No. 1145. Sub-soil.	No. 1146. Old field.	No. 1147. Sub-soil.
Organic and volatile matters	5.703	5.707	5.049	6.747
Alumina	3.015	5.665	3.240 }	14.360
Oxide of iron	3.210	4.100	3.710 }	
Carbonate of lime	.345	.420	.320	.360
Magnesia	.512	.553	.612	.460
Brown oxide of manganese	.070	.240	.245	----------
Phosphoric acid	.096	.096	.128	.138
Sulphuric acid	.028	.016	.024	.042
Potash	.172	.183	.203	.237
Soda	.068	.015	.108	.057
Sand and insoluble silicates	86.570	82.660	86.145	77.570
Loss	.211	.345	.216	.029
Total	100.000	100.000	100.000	100.000
Moisture, lost at 400° F., (per cent.)	2.600	3.115	2.450	5.525

For some reason, unexplained. the soil of the old field appears to be somewhat richer than the virgin soil. If no mistake has been made in the collection and labeling of these soils, it would appear that there was an original difference in these soils; that which has been cultivated having been the richer.

MONTGOMERY COUNTY.

No. 1148—Soil. *Labeled "Soil, first year in cultivation, (in corn,) from the farm of Mr. R. Apperson, Mount Sterling, Montgomery county, Ky. On the Delthyris Lynx beds of the Lower Silurian blue limestone. Forest growth, black walnut, sugar tree, &c. Excellent corn land. Produces hemp, but not well."*

Dried soil of a light yellowish-umber color.

No. 1149—Soil. *Labeled "Same Soil, from an old field, thirty to forty years in cultivation. Mr. R. Apperson's farm, Mt. Sterling, Montgomery county, Ky."*

Dried soil slightly darker colored than the preceding.

No. 1150—Soil. *Labeled "Sub-soil from Mr. Apperson's farm; (garden adjoining the old field,) Mt. Sterling, Montgomery county, Ky."*

Dried sub-soil lighter colored and more yellowish than the preceding.

No. 1151—Soil. *Labeled "Red under-clay of Montgomery county, two miles south of Mt. Sterling."*

Dried clay of a light brick-red color.

(These soils were collected by Dr. D. D. Owen.)

One thousand grains of each of these four soils, thoroughly air-dried, were digested severally in water charged with carbonic acid, for about a month. The quantity of soluble materials extracted is tabulated as follows:

	No. 1148. Virgin soil.	No. 1149. Soil of old field.	No. 1150. Sub-soil.	No. 1151. Under-clay.
Organic and volatile matters	1.733	0.666	0.333	0.266
Alumina, and oxides of iron and manganese and phosphates	.381	.131	.081	.048
Carbonate of lime	1.927	1.113	.580	.263
Magnesia	.227	.178	.106	.042
Sulphuric acid	.054	.0[illegible]8	.046	.022
Potash	.086	.052	.029	.022
Soda	.095	.026	.032	.022
Silica	.200	.200	.200	.214
Loss	.373	.041	----------	----------
Watery extract, dried at 212° F., (grains)	5.076	2.435	1.407	0.899

The *composition* of these four specimens of soil from Montgomery county, was found by analysis to be as follows, viz:

	No. 1148. Virgin soil.	No. 1149. Old field.	No. 1150. Sub-soil.	No. 1151. Under-clay
Organic and volatile matters	6.751	6.172	4.171	4.378
Alumina	4 690	5.440	6.590	7.400
Oxide of iron	5.810	4.710	6.235	11.100
Carbonate of lime	.420	.420	.220	.095
Magnesia	.677	.583	.634	.235
Brown oxide of manganese	.245	.120	.295	.495
Phosphoric acid	.313	.345	.257	.395
Sulphuric acid	.076	.067	.041	.024
Potash	.410	.331	.372	.280
Soda	.245	.133	.139	.104
Sand and insoluble silicates	80.095	81.470	81.370	72.670
Loss	.268	.209	----------	2.824
Total	100.000	100.000	100.324	100.000
Moisture, lost at 400° F, (per cent.)	3.725	3.600	2.900	3.525

These are very good soils; but the under-clay does not prove to be as rich in *potash* as it usually is when found resting on the blue limestone.

No. 1152—CARBONATE OF IRON. *"From James Wells' place, Montgomery county, Ky. (Clinton Group.") (Collected by Messrs. Downie and Lesquereux.)*

Exterior of the irregular nodule coated in part with thin layers of dense dark-brown *limonite;* under which is a softer ochreous-brownish coating. *Interior portion* is dark grey, dense, and fine-grained carbonate of iron. Portion of an encrinital stem in one part.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	46.171	=35.254 per cent. of iron.
Oxide of iron	18.489	
Alumina	2.160	
Carbonate of lime	6.950	
Carbonate of magnesia	4.936	
Carbonate of manganese	1.626	
Phosphoric acid	.630	
Sulphuric acid	.647	
Potash	.366	
Soda	.170	
Silex and insoluble silicates	17.480	
Water and loss	.375	
	100.000	

A good iron ore.

No. 1153—COAL. *Labeled "Bituminous Coal: three miles southeast of Jas. Wells', fifteen miles east of Mt. Sterling, Montgomery county, Ky. Thirty feet under conglomerate. Bed about twenty-two inches thick." (Obtained by Messrs. Downie and Lesquereux.)*

Coal cleaving in thin layers, with soft fibrous coal between; no appearance of pyrites; but the weathered surfaces are soiled with ochreous oxide of iron. Over the spirit lamp it swelled up and agglutinated, leaving a spongy coke. Specific gravity, 1.264.

PROXIMATE ANALYSIS.

Moisture	2.70	Total volatile matters	41.30
Volatile combustible matters	38.60		
Fixed carbon (in the coke)	55.80	Light coke	58.70
Salmon colored ashes	2.90		
	100.00		100.00

The percentage of *sulphur* was found to be 1.072.

The *composition of the ash* is as follows:

Silica	0.884
Alumina, and oxides of iron and manganese	1.720
Lime	.215
Magnesia	.200
Phosphoric acid	trace.
Sulphuric acid	.014
Alkalies	traces
	3.033

No. 1154—COAL. *Labeled "Coal from 'Cabin Bank,' (owned by Jas. Wells,) on the head waters of Hawkins' branch of Slate creek, (Station 800, T. line Eastern div. of Survey,) Montgomery county, Ky. (Under coarse sandstone, like millstone grit.") Obtained by Jos. Lesley, jr.*

A pure, deep pitch-black, shining coal, with some fibrous coal between the layers. Over the spirit lamp it softened and agglutinated somewhat, and swelled into a moderately dense coke. Specific gravity 1.270.

PROXIMATE ANALYSIS.

Moisture	3.60	Total volatile matters	41.60
Volatile combustible matters	38.00		
Fixed carbon in the coke	55.40	Moderately dense coke	58.40
Purplish-grey ashes	3.00		
	100.00		100.00

The percentage of *sulphur* is 1.21.

COMPOSITION OF THE ASH.

Silica	0.884
Alumina, and oxides of iron and manganese	1.380
Lime	trace.
Magnesia	.233
Sulphuric acid, alkalies, and loss	.503
	3.000

This coal remarkably resembles the preceding in composition and properties, and probably is from the same bed.

MORGAN COUNTY.

No. 1155—CARBONATE OF IRON. *Labeled "Carbonate of Iron with Sulphuret of Zinc; in the shale at the base of the coal measures of Caney creek, Morgan county, Ky."*

A rounded nodule. Exterior, reddish-brown; interior portion dark-brown: the fissures infiltrated with zinc blende and a whitish powdery mineral. Powder of a light yellowish-brown color. A mixed portion, without the sulphuret of zinc, taken for analysis.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	48.620	=36.472 per cent. of iron.
Oxide of iron	16.650	
Alumina	1.920	
Carbonate of lime	1.480	
Carbonate of magnesia	6.360	
Carbonate of manganese	.722	
Phosphoric acid	.505	
Sulphuric acid	.517	
Potash	.568	
Soda	.000	
Silex and insoluble silicates	17.580	
Water and loss	5.078	
	100.000	

The air-dried powder lost 1.1 per cent. of *moisture* at 212° F.

The proportion of sulphuret of zinc being variable in different specimens, it was excluded from the analysis. This is a *sufficiently rich ore of iron.*

No. 1156—SOIL. *Labeled "Virgin Soil from the coal measures of Caney creek of Licking river, Morgan county, Ky. Forest growth, white oak, beech, sugar-tree, and black walnut."*

Dried soil of a light yellowish umber color. It contains some minute scales of mica and fragments of soft ferruginous sandstone.

No. 1157—SOIL. *Labeled "Soil from an old field, forty-two years in cultivation, from Judge W. Lykins' farm, head waters of Caney creek. Coal measures. Morgan county, Ky."*

Dried soil resembles the preceding. Contains some fragments of ferruginous sandstone.

(These soils were collected by Dr. Owen.)

One thousand grains of each of these soils, digested for a month in water charged with carbonic acid under pressure, gave up soluble materials as represented below, viz:

	No. 1156. Virgin soil.	No. 1157. Old field.
Organic and volatile matters	1.150	0.400
Alumina, and oxides of iron and manganese and phosphates	.237	.131
Carbonate of lime	1.180	.296
Magnesia	.191	.077
Sulphuric acid	.053	.038
Potash	.069	.083
Soda	.059	trace.
Silica	.047	.047
Loss	.347	.161
Soluble extract, dried at 212° F., (grains)	3.333	1.233

The composition of these two soils, dried at 400° F., was found to be as follows, viz:

	No. 1156. Virgin soil.	No. 1157. Soil of old field.
Organic and volatile matters	7.243	4.881
Alumina	3.590	3.415
Oxide of iron	3.260	2.710
Carbonate of lime	.320	.145
Magnesia	.489	.365
Brown oxide of manganese	.195	.070
Phosphoric acid	.204	.192
Sulphuric acid	.067	.050
Potash	.372	.232
Soda	trace.	.018
Sand and insoluble silicates	84.360	88.595
Total	100.100	100.693
Moisture, lost at 400° F., (per cent.)	2.325	1.550

The usual diminution of the *soluble* and *essential* ingredients of the soil is to be observed in the analysis of that of the old field as compared with the virgin soil.

No. 1158—CARBONATE OF IRON; *from a layer eighteen inches thick on the land of Silas Bishop, on Red River, six miles south of Hazle-green, Morgan county, Ky.* (*Brought by C. C. Moxley.*")

A dense, fine-grained carbonate, of a dark-grey color, sparkling with minute scales of mica. Weathered surface brownish-red and yellow.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	55.382	=28.521 per cent. of iron.
Oxide of iron	2.234	
Alumina	.380	
Carbonate of lime	1.684	
Carbonate of magnesia	2.274	
Carbonate of manganese	1.776	
Phosphoric acid	.335	
Sulphuric acid	.269	
Potash	.232	
Soda	.177	
Silex and insoluble silicates	31.880	
Bituminous matters and loss	3.377	
	100.000	

A good iron ore, rich enough to be profitably smelted.

No. 1159—NATIVE ALUM. *A saline efflorescence labeled "Alum? from micaceous grey-blue shales under bituminous coal. Three and a half miles from West Liberty, on the Hazlegreen road, Morgan county, Ky.*" (*Collected by Messrs. Downie and Lesquereux.*)

A whitish saline matter of an acid astringent taste, mixed with fragments of shale. Soluble with little residue in water. Was found, on testing, to be principally sulphate of alumina with small quantities of chloride, oxide of iron, &c.

If in sufficient quantity, could be employed in the manufacture of alum, by the addition of potash salt, &c., &c.

No. 1160—COAL. *Labeled "Coal, from a bed sixteen inches thick. Casby's bank, a quarter of a mile from his house, on the Little Sandy road, and on the Lick Fork of Elk branch, Morgan county Ky.*") (Station 1741, base line.) Obtained by Joseph Lesley, jr.

A pure deep, pitch-black moderately firm, shining coal; little or no fibrous coal between the layers. Thin scales of bright iron pyrites in some of the joints. Over the spirit lamp it softened a little and left a dense coke. Specific gravity 1.253.

PROXIMATE ANALYSIS.

Moisture	4.40	Total volatile matters	39.20
Volatile combustible matters	34.80		
Fixed carbon in the coke	60.06	Pretty dense coke	60.80
Buff-grey ashes	.74		
	100.00		100.00

The percentage of *sulphur* was found to be 0.672.

No. 1161—COAL. *Labeled "Coal from an opening made some time since, on Big Branch of Lick Fork of Elk branch of Licking river, Morgan county, Ky.* (Station 1690, base line.") Obtained by Jos. Lesley, jr.

A shining deep pitch-black coal: cleaving with irregular shining surfaces: not much fibrous coal. Over the spirit lamp it softens and swells somewhat, leaving a moderately dense coke. Specific gravity 1.250.

PROXIMATE ANALYSIS.

Moisture	3.34	Total volatile matters	44.60
Volatile combustible matters	41.26		
Fixed carbon (in the coke)	54.06	Moderately dense coke	55.40
Light-grey-buff ashes	1.34		
	100.00		100.00

The percentage of *sulphur* was found to be 0.87.

MUHLENBURG COUNTY.

No. 1162—LIMONITE. *Labeled "Hoskins' Ore, lower bed. Muddy River, Muhlenburg county, Ky.* (*Coal measures.*")

A dense, dark-brown limonite, in irregular layers, inclosing cavities lined with ochreous ore. Powder of a yellowish-brown color.

Dried at 212° F., it lost 1.55 per cent. of moisture, and has the following

COMPOSITION:

Oxide of iron	67.340	=47.159 per cent. of iron.
Alumina	1.000	
Carbonate of lime	trace.	
Magnesia	.615	
Brown oxide of manganese	.240	
Phosphoric acid	1.591	
Sulphuric acid	.680	
Potash	.154	
Soda	.106	
Silex and insoluble silicates	16.980	
Combined water	11.300	
	100.006	

Quite a rich iron ore, and but for the considerable proportion of phosphoric acid which it contains, would be unobjectionable. This would tend to diminish the toughness of the iron made from it; which tendency might be diminished, however, by the addition of a pure aluminous material, (pure clay,) with an excess of lime for the flux.

No. 1163—COAL. *Labeled "McNairy's seven feet Coal, working bed. Limestone roof. Elwood, Muhlenburg county, Ky."*

A shining, moderately firm, pitch-black coal; iridescent on the surfaces of the joints. Fibrous coal between some of the layers; others presenting an irregular shining surface. Over the spirit lamp it swelled up and agglutinated into a light, cellular coke, giving out much flame. Specific gravity, 1.287

PROXIMATE ANALYSIS.

Moisture	3.30	Total volatile matters	41.10
Volatile combustible matters	37.80		
Fixed carbon (in the coke)	56.10	Light coke	58.90
Grey ashes	2.80		
	100.00		100.00

The percentage of *sulphur* was found to be 2.711; which is considerable.

No. 1164—COAL. *Labeled "Upper Coal at Airdrie, used for making iron, Muhlenburg county, Ky."*

A deep pitch-black coal, rather brittle; some fibrous coal between the layers, and a thin white incrustation (of sulphate of lime) in some of the joints. Over the spirit lamp it swells up into a moderately dense coke. Specific gravity, 1.593.

PROXIMATE ANALYSIS.

Moisture	7.06	Total volatile matters	37.90
Volatile combustible matters	30.84		
Fixed carbon (in the coke)	58.70	Moderately dense coke	62.10
Light-grey ashes	3.40		
	100.00		100.00

The percentage of *sulphur* was found to be 0.879.

COMPOSITION OF THE ASH.

Silica	2.284
Alumina, and oxides of iron and manganese	.780
Lime	trace.
Magnesia	.233
Sulphuric acid	.063
Potash	.189
Soda	.135
	3.684

NELSON COUNTY.

No. 1165—LIMESTONE. *Labeled "Hydraulic Limestone, Bardstown, Nelson county, Ky."*

A greenish-grey, dull, fine-granular limestone.

No. 1166—LIMESTONE. *Labeled "Magnesian Limestone, Rolling Fork, Nelson county, Ky. Upper Silurian formation."*

A light-grey, dull, fine-granular limestone, with small pores or cavities. Weathered surfaces of a dirty grey-buff color.

No. 1167—LIMESTONE, (*two specimens, a and b.*) *Labeled "Mr. Troutman's Building Stone, Nelson county, Ky. Upper Silurian formation."*

A grey-buff, dull, fine-granular limestone.

COMPOSITION OF THESE FOUR LIMESTONES, DRIED AT 212° F.

	No. 1165. Bardstown.	No. 1166 (a.) Rolling Fork.	No. 1166 (b.) Rolling Fork.	No. 1167. Troutman's
Carbonate of lime	40.480	49.780	48.980	50.480
Carbonate of magnesia	24.267	34.456	34.100	38.154
Alumina, and oxides of iron and manganese	4.493	3.000	2.980	2.100
Phosphoric acid	.207	.246	.118	.118
Sulphuric acid	.819	.475	.366	.289
Potash	.455	.270	not estimated	.258
Soda	.042	.006		.260
Silex and insoluble silicates	29.380	10.780	11.480	8.380
Loss	------------	.987	1.956	------------
	100.143	100.000	100.000	100.039
Moisture, lost at 212° F., (per cent.)	0.44	0.40	0.20	0.20

All of these limestones will most probably be found to make good hydraulic cement when properly calcined and prepared; except perhaps the last one, Troutman's building stone, which does not appear to contain the proper quantity of silicious matter. But even this deserves trial in this relation, as very good water cement has been made of magnesian lime rocks containing as little silex as this. It is probable that a considerable proportion of *potash* aids in the formation of the silicates which are essential to the hydraulic property. These hydraulic porous limestones are not generally good building stones; as was exemplified in the building of the court-house, at Louisville, in which this kind of rock has undergone rapid disintegration, by scaling, under the influence of the atmospheric agencies.

No. 1168—Fossil Coral. *Labeled "Favestella stellata. (Hall.) Junction of Upper and Lower Silurian formations, Bardstown, Nelson county, Ky. (Lower Silurian formation.")*

An irregularly rounded mass of the fossil coral: the cells completely filled with nearly white carbonate of lime.

Dried at 212°, the powder gave off 0.3 per cent. of moisture.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	94.380
Carbonate of magnesia	2.419
Alumina, and oxides of iron and manganese	.660
Phosphoric acid	.117
Sulphuric acid	.338
Potash	.193
Soda	.000
Silex and insoluble silicates	1.980
	100.087

Quite a pure carbonate of lime, which would burn into a very white lime.

No. 1169—Soil. *Labeled "Virgin Soil, from woodland, on the farm of Mr. Felix G. Murphy; on ridge land between the waters of Mill and Stuart's creeks; north side of Beech Fork of Salt river. About forty to forty-five feet below the level of the Black Slate. Forest growth, beech, sugar-tree, large white and yellow poplar, black walnut, hickory, white ash, mulberry, paw-paw, dogwood. Yellow (Upper) Silurian rocks. Nelson county, Ky." (Collected by S. S. Lyon, Esq.)*

Dried soil of a light reddish-brown color.

No. 1170—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil much lighter than the preceding; of a reddish buff-color.

No. 1171—Soil. *Labeled "Soil on Felix G. Murphy's farm, &c., forty feet below the level of the two preceding specimens. Some flints of sub-carboniferous or Devonian origin thrown out of the hole where the specimen was taken, Nelson county, Ky."*

Dried soil of a light reddish-brown color. Some irregular fragments of porous, decayed chert, reddish ferruginous sandstone and shot iron ore were sifted out of this and the succeeding sub-soil with the coarse seive.

No. 1172—Soil. *Labeled "Sub-soil of the next preceding. Felix G. Murphy's farm, &c., &c."*

Dried soil of a lighter reddish-brown color than the preceding.

No. 1173—Soil. *Labeled "Under-clay. Thirty feet below the level of the two preceding specimens: from five feet below the surface, on a root wad. Felix G. Murphy's farm, Nelson county, Ky."*

Fragments of porous, friable, magnesian limestone, full of encrinital stems, &c., were found in this specimen; the analysis of which is given below.

No. 1174—Soil. *Labeled "Soil from an old field, now in pasture; on Felix G. Murphy's farm, Nelson county, Ky."*

Portions of magnesian limestone, (see analysis below,) were found in this and the succeeding sub-soil, with some cherty and ferruginous fragments. Dried soil of a dirty, light reddish-brown color.

No. 1175—Soil. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil a little lighter colored than the soil preceding.

One thousand grains of each of these soils, digested as before described in water charged with carbonic acid, gave up the following materials, viz:

	No. 1169 Soil.	No. 1170. Sub-soil.	No. 1171. Soil.	No. 1172. Sub-soil.	No. 1173. Under-clay.	No. 1174. Old field.	No. 1175. Sub-soil.
Organic & volatile matters	2.300	0.496	1.410	0.380	1.600	0.350	0.300
Alumina, & oxides of iron & manganese & phosphates	.347	.080	.100	.080	.080	.170	.163
Carbonate of lime	1.680	.263	1.680	.913	2.180	.974	.747
Magnesia	.517	.250	.301	.283	.107	.216	.183
Sulphuric acid	.062	.060	.053	.022	.079	.038	.011
Potash	.289	.091	.140	.080	.156	.096	.062
Soda	.045	.026	trace.	.023	.072	.059	.095
Silica	.374	.194	.100	.145	.031	.162	.201
Loss (water & carbonic acid)	.041	....	.756	.173	1.095	.112	.072
Watery extract, dried at 212° F., (grains)	5.655	1.460	4.540	2.100	5.300	2.117	1.833

The *composition* of these seven soils was found, by analysis, to be as follows, dried at 400° F.:

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	No. 1169. Soil.	No. 1170. Sub-soil.	No. 1171. Soil.	No. 1172. Sub-soil	No. 1173. Under-clay.	No. 1174. Old field.	No. 1175. Sub-soil.
Organic & volatile matters	7.351	2.982	7.563	5.812	9.975	4.836	4.665
Alumina	4.990	6.125	4.850	6.640	8.740	4.330	6.990
Oxide of iron	4.015	4.925	5.425	6.415	12.675	3.865	6.415
Carbonate of lime	.171	.045	.411	.311	3.221	.270	.196
Magnesia	.691	.657	.702	.692	2.878	.455	.963
Brown oxide of manganese	.495	.424	.720	.870	.620	.324	.145
Phosphoric acid	.331	.145	.272	.142	.149	.144	.113
Sulphuric acid	.064	.033	.056	.050	.041	.065	.040
Potash	.252	.381	.452	.249	.348	.280	.410
Soda	.017	.032	.040	.049	.297	.062	.159
Sand and insoluble silicates	82.395	83.470	79.295	78.795	61.095	85.695	80.495
Loss		.805	.234				
Total	100.872	100.000	100.000	100.125	100.039	100.526	100.591
Moisture, lost at 400° F., (per cent.)	3.210	2.100	3.610	3.225	4.875	2.300	3.225

These may be classed amongst our best soils. The under-clay does not exhibit as much richness in potash and phosphoric acid as might have been expected; but its proportion of carbonate of lime is large.

The soil of the old field shows a smaller quantity of potash than any of the soils. The sub-soils do not appear to be richer than the surface soils.

No. 1176—LIMESTONE. *Labeled "Porous Magnesian Limestone found in the under-clay, (No. 1173,) on Felix G. Murphy's land, Nelson county, Ky. Upper Silurian."*

A friable dull grey rock; exhibiting numerous fragments of encrinital stems on its degraded surfaces. Powder of a light buff color.

No. 1177—LIMESTONE. *Labeled "Yellow Magnesian Limestone; found in soil No. 1174, on Felix G. Murphy's farm, Nelson county, Ky."* Powder of a light-buff color.

COMPOSITION OF THESE TWO LIMESTONES, DRIED AT 212° F.

	No. 1176. From under-clay.	No. 1177. From soil.
Carbonate of lime	54.080	48.080
Carbonate of magnesia	29.562	29.666
Alumina, and oxides of iron and manganese	2.980	9.780
Phosphoric acid	.054	trace.
Sulphuric acid	.111	trace.
Potash	.231	.534
Soda	.240	.144
Silex and insoluble silicates	.880	10.580
Water and loss	1.862	1.227
	100.000	100.000

The limestone No. 1177 contains a remarkable quantity of potash, and might prove a hydraulic limestone.

No. 1178—LIMESTONE. *Labeled "Limestone from the Turnpike, head of Mill creek, (used in metaling the road,) Nelson county, Ky."* (*Sent by S. S. Lyon, Esq.*)

A fine-grained, compact, light-grey limestone, incrusted with and containing irregular veins of calcareous spar, with a bluish-green (or grass-green) mineral under and mixed with the calc. spar. The *green material* is a calcareo-magnesian mineral, colored with oxide of iron; containing no phosphoric acid.

THE COMPOSITION OF THE LIMESTONE IS AS FOLLOWS:

Carbonate of lime	93.980
Carbonate of magnesia	2.797
Alumina, and oxides of iron and manganese	.264
Phosphoric acid	.054
Sulphuric acid	.338
Potash	.169
Soda	trace.
Silex and insoluble silicates	3.040
	100.662

No. 1179—SOIL. *Labeled "Virgin Soil from the land of Wm. Price. Woodland. Forest growth, poplar, beech, hickory. Geological horizon, black slate. Nelson county, Ky."* (Collected by S. S. Lyon, Esq.)

Dried soil of a grey-chocolate color. Some rounded cherty fragments were sifted out of it with the coarse seive.

No. 1180—SOIL. *Labeled "Sub-soil of the preceding, &c."*

Dried soil lighter colored and more yellowish than the preceding. Some cherty and ferruginous fragments were sifted out of it.

No. 1181—SOIL. *Labeled "Soil taken forty yards distant from the preceding two specimens; same geological horizon; from an old field which has not been cultivated for three years. Nelson county Ky."*

Dried soil resembles the last in color. Contains some cherty and ferruginous fragments.

No. 1182—SOIL. *Labeled "Sub-soil of the preceding, &c."*

Dried soil lighter colored and more yellowish than the preceding. Contains some cherty fragments.

No. 1183—SOIL. *Labeled "Soil of an old field; at the horizon of the Upper Silurian rocks. Nelson county, Ky."* (Collected by S. S. Lyon, Esq.)

Dried soil of a dark grey-buff color. Some iron gravel sifted out of it.

No. 1184—SOIL. *Labeled "Sub-soil of the preceding, &c."*

Sifted out a few fragments of iron gravel.

One thousand grains of each of these soils, (air-dried,) digested in water charged with *carbonic acid*, gave up of soluble *materials* as represented in the following table:

	No. 1179. Virgin soil.	No. 1180. Sub-soil.	No. 1181. Old field.	No. 1182. Sub-soil.	No. 1183. Old field	No. 1184. Sub-soil.
Organic and volatile matters	0.950	0.400	0.350	0.267	0.551	0.407
Alumina, and oxides of iron and manganese and phosphates	.214	.067	.154	.094	.297	.081
Carbonate of lime	1.896	.447	.550	.377	.713	.663
Magnesia	.254	.133	.099	.105	.260	.187
Sulphuric acid	.033	.033	.042	.022	.029	.059
Potash	.083	.050	.040	.018	.045	.045
Soda	trace	.066	.042	.017	.038	.073
Silica	.098	.197	.257	.145	.221	.313
Watery extract, dried at 212° F. (grains)	3.528	1.433	1.564	1.045	2.257	1.619

The *composition* of these soils, dried at 400° F., is given in the following table:

	No. 1179. Virgin soil.	No. 1180. Sub-soil.	No. 1181. Old field.	No. 1182. Sub-soil.	No. 1183. Old field.	No. 1184. Sub-soil.
Organic & vol. matter	9.656	3.809	4.586	3.785	5.149	4.775
Alumina	2.365	3.990	2.990	4.590	2.390	4.715
Oxide of iron	3.285	3.910	4.235	5.060	4.065	5.065
Carbonate of lime	.596	.172	.156	.146	.221	.246
Magnesia	.643	1.529	1.214	1.273	.503	.536
Brown oxide of manganese	.310	.310	.220	.215	.195	.120
Phosphoric acid	.378	.161	.298	.162	.161	.342
Sulphuric acid	.076	.127	.050	.059	.084	.050
Potash	.135	.175	.169	.206	.181	.227
Soda	.046	.038	.045	.046	.047	.061
Sand and insoluble silicates	82.870	86.520	87.045	84.895	85.420	83.495
Loss					1.614	.438
Total	100.160	100.540	100.958	100.407	100.000	100 000
Moisture, lost at 400° F., (per cent.)	3.375	1.950	1.685	2.250	2.300	2.775

In these soils, which present general traits of resemblance, there may be observed the usual differences noticed between the composition of the soil of the old field and that of the virgin soil. With the exception of the potash, all the essential ingredients are in smaller proportion in the former than in the latter. A smaller amount of soluble matter also is extracted by the carbonated water from the cultivated soil.

No. 1185—SOIL. *Labeled "Virgin Soil, from the farm of John Troutman. Woodland. Forest growth, beech, sugar-tree, and poplar. Waste of the Black Slate and Upper Silurian Limestone; (above the horizon of the growth of cedar:) Nelson county, Ky." (Procured by S. S. Lyon, Esq.)*

Dried soil of a light chocolate color. Some ferruginous and cherty particles and a small rounded quartz pebble were sifted out with the coarse seive.

No. 1186—SOIL. *Labeled "Sub-soil of the preceding, &c."*

Dried soil a little lighter colored and more yellowish than the preceding.

No. 1187—SOIL. *Labeled "Soil from the farm of Ralph Cotton, north side of Beech Fork of Salt river, five feet above the base of the Black slate. Containing chert of sub-carboniferous origin, Nelson county, Ky."* (Procured by S. S. Lyon, Esq.)

Dried soil of a light chocolate color. A considerable quantity of fragments of decomposed chert were sifted out with the coarse seive.

No. 1188—SOIL. *Labeled "Sub-soil of the preceding, &c."*

Dried soil somewhat lighter colored and more yellowish than the preceding. Some small ferruginous and cherty particles sifted out.

One thousand grains of each of these soils, digested for a month in water charged with carbonic acid, gave up of *soluble matters* as represented in the following table:

	No. 1185. Virgin soil	No. 1186. Sub-soil.	No. 1187. Soil.	No. 1188. Sub-soil.
Organic and volatile matters	0.783	0.370	0.600	0.793
Alumina, and oxides of iron and manganese and phosphates	.131	.131	.147	.054
Carbonate of lime	.530	.147	1.410	.897
Magnesia	.220	.127	.222	.211
Sulphuric acid	.022	.028	not estim'd	.041
Potash	.065	.016	.096	.064
Soda	.064	.096	.116	.123
Silica	.231	.107	.279	.200
Loss	.071	----------	----------	.084
Watery extract, dried at 212° F., (grains)	2.117	1.022	2.890	2.467

The *composition* of these four soils, dried at 400° F., is given in the following table:

	No. 1185. Virgin soil.	No. 1186. Sub-soil.	No. 1187. Soil.	No. 1188. Sub-soil.
Organic and volatile matters	4.521	2.231	5.326	4.355
Alumina	3.749	4.135	2.490	8.140
Oxide of iron	2.860	3.410	4.570	6.885
Carbonate of lime	.196	.071	.371	.422
Magnesia	.337	.423	.545	.736
Brown oxide of manganese	.195	.160	.170	.170
Phosphoric acid	.031	.096	.247	.216
Sulphuric acid	.067	.041	.067	.050
Potash	.164	.164	.246	.743
Soda	.031	.082	.059	.066
Sand and insoluble silicates	87.570	87.845	85.195	78.170
Loss	.279	1.342	.714	.047
Total	100.000	100.000	100.000	100.000
Moisture, lost at 400° F., (per cent.)	3.225	2.425	3.775	5.275

No. 1189—Marly Clay. *Labeled "White Clay, (or Sub-soil,) near the road on the farm of Mr. Stephen Cambran. South of the 126th mile of Base Line, Nelson county, Ky."* (*Procured by S. S. Lyon, Esq.*)

A greyish-white clay, mottled with yellowish.

No. 1190—Clay. *Labeled "Yellowish Clay, (or Sub-soil,) found immediately under the preceding, &c., &c."*

A brownish-yellow, ferruginous clay, or sub-soil.

COMPOSITION OF THESE CLAYS, DRIED AT 212° F.

	No. 1189. Marly clay.	No 1190. Ferrugin's clay.
Alumina	12.960	15.743
Silica	52.680	54.280
Oxide of iron	6.740	12.940
Carbonate of lime	12.380	1.980
Magnesia	.369	1.216
Brown oxide of manganese	.384	.284
Phosphoric acid	.255	1.068
Sulphuric acid	not estim'd	not estim'd
Potash	2.843	1.371
Soda	not estim'd	.122
Water, expelled at red heat	12.500	11.300
Loss	----------	.071
	101.131	100.000

These clays might probably be used with advantage on soil, in their immediate neighborhood, which has been exhausted by long culture, or which is deficient in lime, alumina, phosphoric acid, or potash.

No. 1191—SOIL. *Labeled "Virgin Soil; from the farm of Hezekiah Mobley. Lick creek; east of Boston, Nelson county, Ky. Ten feet under the level of the Black Slate, and probably derived in part from the Upper Silurian rocks."* (*Obtained by S. S. Lyon, Esq.*)

Dried soil of an umber color. Some fragments of limestone sifted out of it.

No. 1192—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried soil lighter colored and more yellowish than the preceding.

No. 1193—SOIL. *Labeled "Soil from an old field, farm of Hezekiah Mobley. Lick creek; east of Boston, Nelson county, Ky. From the bed of yellowish soil immediately under the Black Devonian Slate. The soil is probably the waste of the upper part of the Yellow (Upper) Silurian rock, and of the slate and shaly beds at the base of the Knob-stone."* (*S. S. Lyon.*)

Dried soil of a light chocolate color, with a tinge of yellowish. Some large cherty and ferruginous particles were sifted out of it.

No. 1194—SOIL. *Labeled "Sub-soil of the preceding, &c., &c."*

Dried sub-soil lighter colored and more yellowish than the preceding.

Some cherty and ferruginous fragments were sifted out of it with the coarse seive.

The quantity of *soluble matters* extracted from a thousand grains of each of these soils, by digestion for a month in water charged with carbonic acid gas, is stated in the following table:

	No. 1191. Virgin soil.	No. 1192. Sub-soil.	No. 1193. Old field.	No. 1194. Sub-soil.
Organic and volatile matters	1.170	0.500	0.673	0.350
Alumina, and oxides of iron and manganese and phosphates	.164	.047	.087	.031
Carbonate of lime	3.913	1.807	.661	.396
Magnesia	.783	.033	.150	.163
Sulphuric acid	.050	.029	.045	.029
Potash	.043	.009	.026	.026
Soda	.043	.041	.022	trace.
Silica	.081	.110	.150	150
Loss	.253			
Watery extract, dried at 212° F., (grains)	6.500	2.577	1.826	1.141

The virgin soil is said by Mr. Lyon to be more immediately derived from the Silurian rocks than the soil of the old field.

The composition of these soils, dried at 400° F., may be seen in the following table:

	No. 1191. Virgin soil	No. 1192. Sub-soil.	No. 1193 Old field	No. 1194. Sub-soil.
Organic and volatile matters	10.425	6.207	3.286	2.564
Alumina	3.490	10.599	1.190	5.893
Oxide of iron	11.385	13.585	3.670	[illegible]
Carbonate of lime	6.146	.770	.172	.229
Magnesia	5.710	1.010	.415	.586
Brown oxide of manganese	.145	.645	.228	.170
Phosphoric acid	.275	.367	.147	.079
Sulphuric acid	.058	.050	.059	.053
Potash	.420	.700	.164	.357
Soda	.099	.083	.024	.042
Sand and insoluble silicates	61.495	61.820	89.045	84.820
Loss	.752	1.173	1.699	.079
Total	100.000	100.000	100.000	100.000
Moisture, lost at 400° F., (per cent.)	7.825	9.375	2.025	3.475

The virgin soil is evidently of a different character from the soil of the old field, and probably was more immediately derived from a limestone stratum. It contains a much greater quantity of alumina and oxide of iron, carbonate of lime, potash, &c., &c., than may be supposed to have originally existed in the old soil. Its proportion of sand, &c., is quite small. If properly drained, it ought to be a very fertile and durable soil.

NELSON COUNTY.

No. 1195—WATER, *sent (October, 21st, 1857) by Dr. J. F. McMillan, of Carlisle, from the only pond in an inclosure, where cattle die of milk-sickness during the dry months, on the farm of B. W. Mathers, near that place. Nicholas county, Ky."*

The water deposited a sediment in the jug on standing which contained silex, (or fine sand.) alumina, oxide of iron, &c., and appeared to be simply fine earth washed from the soil.

The water was carefully examined and submitted to a thorough analysis and testing for the presence of injurious mineral matters, but nothing of the kind which might be supposed to cause disease was found in it.

The quantity of saline matters which it contained was found to be quite small, only 0.049 per cent., which had the following

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	0.02661	} Held in solution by carbonic acid.
Carbonate of magnesia	.00514	}
Sulphate of lime	.00048	
Sulphate of magnesia	.00744	
Sulphate of potash	.00225	
Sulphate of soda	.00487	
Chloride of maguesium	.00037	
Silica	.00184	
Loss	.00100	
	0.04900	

This is in the proportion of rather less than three and a half grains of saline matters to the pound avoirdupois of the water.

No. 1196—SOIL. *Labeled "Virgin Soil, from James M. Turner's land, from woodland pasture. Primitive forest growth, white and red oak, poplar, some black ash, wild cherry, and a good deal of beech. Waters of Stoney creek, Nicholas county, Ky. Lower Silurian formation."*

Dried soil of a yellowish dark grey color.

No. 1197—SOIL. *Labeled "Same Soil as the preceding, from a field which has been more than fifty years in cultivation; lying waste ever since 1852. Jas. M. Turner's land, &c., &c."*

Dried soil, lighter colored and more yellowish than the preceding.

No. 1198—Soil. *Labeled "Sub-soil of the old field (above described.) Jas. M. Turner's land, &c., &c."*

Dried soil of a greyish-buff color.

One thousand grains of each of these three specimens of soils were digested for a month in water charged with carbonic acid; to which they gave up soluble matters in the proportions stated in the following table:

	No. 1196. Virgin soil.	No. 1197. Old field.	No. 1198. Sub-soil.
Organic and volatile matters	0.927	0.550	0.283
Alumina, and oxides of iron and manganese and phosphates	.174	.121	.030
Carbonate of lime	1.830	0.920	.563
Magnesia	.144	.084	.084
Sulphuric acid	.028	.030	.033
Potash	.093	.022	.019
Soda	.082	.025	.021
Silica	.200	.181	.247
Loss	.145		
Watery extract, dried at 212° F., (grains)	3.543	1.933	1.280

The composition of these soils, dried at 400° F., was found to be as follows:

	No. 1196. Virgin soil.	No. 1197. Old field.	No. 1198. Sub-soil.
Organic and volatile matters	7.820	6.339	6.687
Alumina	4.360	6.260	11.235
Oxide of iron	4.465	5.970	7.967
Carbonate of lime	.520	.345	.370
Magnesia	.706	.643	.651
Brown oxide of manganese	.320	.270	.095
Phosphoric acid	.211	.195	.231
Sulphuric acid	.058	.050	.016
Potash	.365	.336	.485
Soda	.131	.071	.078
Sand and insoluble silicates	81.120	79.720	71.870
Loss			.095
Total	100.076	100.199	100.000
Moisture, lost at 400° F., (per cent.)	2.500	2.600	4.150

The soil of the old field does not appear to be as much impoverished as might have been expected; indeed it may be considered still quite fertile; most probably because some of the sub-soil, which is quite rich in the nutritive mineral elements, has become mixed with it in the process of cultivation of the field.

OHIO COUNTY.

No. 1199—COAL. *Labeled "Bull Run Coal, Ohio county, Ky."*

A pure, shining pitch-black coal, which breaks pretty easily, and cleaves into thin layers, with some fibrous coal, like vegetable charcoal, in patches, on the surfaces of the layers; the rest of the surfaces being shining and irregular. Over the spirit lamp it softens and swells up a great deal into a light and spongy coke, giving off much flame. Specific gravity 1.298.

PROXIMATE ANALYSIS.

Moisture	2.60	Total volatile matters	43.80
Volatile combustible matters	41.20		
Fixed carbon (in the coke)	52.66	Light coke	66.20
Purplish-grey ashes	3.54		
	100.00		100.00

The percentage of sulphur was found to be 1.829.

No. 1200—COAL. *Labeled "Crawford's Coal, Ohio county, Ky."*

A rather dull pitch-black coal; rather tough, with an even satiny cross-fracture. No fibrous coal between the layers. Over the spirit lamp it swells a little, gives much smoky flame, and leaves a dense coke. Specific gravity, 1.389.

PROXIMATE ANALYSIS.

Moisture	1.50	Total volatile matters	41.20
Volatile combustible matters	39.70		
Fixed carbon (in the coke)	37.80	Dense coke	58.80
Grey ashes	21.00		
	100.000		100.00

The percentage of sulphur is 3.234.

COMPOSITION OF THE ASH.

Silica	12.084
Alumina, and oxides of iron and manganese	8.280
Lime	.212
Magnesia	.346
Phosphoric acid	a trace.
Sulphuric acid	.132
Potash	.379
Soda	.103
	21.536

The first coal appears to be a good, soft bituminous coal, but the latter contains too much earthy matter and sulphur. The ashes contain more alkaline matter than is generally supposed to be present in coal ash.

OLDHAM COUNTY.

No. 1201—LIMESTONE. *Labeled "Rock from which the white ashy soil was derived.* (See No. 737, in Vol. III, of these Reports;) *one mile northeast of LaGrange, Oldham county, Ky. Upper Silurian formation."*

No. 1202—LIMESTONE. *Labeled "Hydraulic? Limestone, Curry's Fork of Floyd's creek, Oldham county, Ky."*

A fine-granular, dull, greenish-grey rock. Adheres slightly to the tongue.

COMPOSITION OF THESE LIMESTONES, DRIED AT 212° F.

	No. 1201. LaGrange.	No. 1202. Floyd's creek.
Carbonate of lime	41.580	41.980
Carbonate of magnesia	24.050	21.400
Alumina, and oxides of iron and manganese	5.860	6.860
Phosphoric acid	.374	.310
Sulphuric acid	.304	.386
Potash	.455	.370
Soda	.204	.179
Silex and insoluble silicates	23.580	24.680
Water and loss	3.614	3.615
	100.000	100.000

Both of these rocks, which present a striking similarity of composition, would very probably furnish good hydraulic cement, when properly calcined and prepared.

OWEN COUNTY.

No. 1203—MARL. *Labeled "Shale, collected from the spring (now dry) supposed to cause milk-sickness. Waters of Dickey's creek; a mile and a half from Benj. Hayden's, Owen county, Ky."*

A dirty-buff and brownish ferruginous clay-like substance.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	29.247
Alumina, and oxides of iron and manganese	19.940
Carbonate of lime	34.580
Carbonate of magnesia	5.287
Phosphoric acid	.934
Sulphuric acid	.372
Potash	.649
Soda	.000
Water and loss	8.998
	100.000

No. 1204—SOIL. *Labeled "Virgin Soil, from woods, on the first farm after ascending the hill from Harmony to Stamping-Ground. Forest growth, white oak on the top of the ridge, some beech on the sides of the hill. Southern edge of Owen county, Ky. Lower Silurian formation."*

Dried soil of a chocolate-grey color.

No. 1205—SOIL. *Labeled "Same soil, from an old field; on the road from Harmony to Stamping-Ground, &c., &c."*

Dried soil resembles the preceding.

No. 1206—SOIL. *Labeled "Sub-soil of the old field, &c., &c."*

No. 1207—SOIL. *Labeled "Virgin Soil; Weston Jenkins' land, two and a half miles from New Liberty, Owen county, Ky. Forest growth, beech. Lower Silurian formation."*

Dried soil of a chocolate-grey color.

No. 1208—SOIL. *Labeled "Same soil from a cultivated field on Weston Jenkins' farm, &c., &c."*

Dried soil a little darker colored and slightly browner than the preceding

No. 1209—SOIL. *Labeled "Sub-soil from the same cultivated field, &c., &c.*

Dried soil resembles the preceding.

One thousand grains of each of these soils, digested for a month in water charged with carbonic acid gas, gave up of soluble materials as stated in the following table:

	No. 1204. Virgin soil.	No. 1205. Old field.	No. 1206. Sub-soil.	No. 1207. Virgin soil.	No. 1208. Old field.	No. 1209. Sub-soil.
Organic & vol. matters	0.630	0.517	0.333	0.365	0.450	0.333
Alumina, and oxides of iron & manganese & phosphates	.147	.130	.061	.147	.097	.097
Carbonate of lime	.300	1.350	.42[illegible]	.347	.763	.714
Magnesia	.103	[illegible]	.07	[illegible]	.083	.085
Sulphuric acid	.033	.02[illegible]	.0[illegible]6	.033	.031	.023
Potash	.079	.064	.021	.052	.057	.038
Soda	.031	.02[illegible]	.029	.005	.019	------
Silica	.414	.1[illegible]	.21[illegible]	.164	.254	.211
Loss	.043	[illegible]	[illegible]	.0[illegible]	.097	.104
Watery extract, dried at 212° F., (grains)	1.770	2.470	1.217	1.450	1.853	1.630

The *composition* of these six soils is stated in the following table, viz:

	No. 1204. Virgin soil.	No. 1205. Old field.	No. 1206. Sub-soil.	No. 1207. Virgin soil.	No. 1208. Old field.	No. 1209. Sub-soil.
Organic & vol. matters	4.865	6.026	4.319	4.112	5.218	3.890
Alumina	2.695	3.470	5.280	2.545	3.160	3.695
Oxide of iron	2.810	3.935	5.260	2.995	3.360	3.735
Carbonate of lime	traces.	traces.	traces.	.005	.120	.095
Magnesia	.514	.915	1.178	.686	.708	.746
Brown oxide of manganese	.095	.170	.229	.171	.445	.695
Phosphoric acid	.086	.178	.128	.144	.210	.227
Sulphuric acid	.050	.050	.033	.045	.062	.058
Potash	.094	.089	.271	.116	.149	.133
Soda	.035	.040	.098	.022	.049	.042
Sand and insoluble silicates	88.020	84.870	82.820	88.120	85.970	87.295
Loss	.736	.257	.393	1.039	.549	----------
Total	100.000	100.000	100.000	100.000	100.000	100.611
Moisture, lost at 400° F. (per cent.)	2.375	2.925	2.775	2.515	2.750	2.525

These soils, which are much poorer than those based on the *blue limestone* of the Lower Silurian formation, would be benefited by top-dressings of lime or marl. Such a marl as No. 1203, from this county, described above, would answer the purpose admirably.

OWSLEY COUNTY.

No. 1210—CARBONATE OF IRON. *Labeled "Carbonate of Iron incrusted with gypsum, disseminated in the black shales twenty-three feet above coal No. 2, Proctor, Owsley, county, Ky."* (Obtained by Messrs. Downie and Lesquereux.)

A dark-grey, fine-grained carbonate, in flat pieces about an inch thick; surfaces on both sides changed into dark brown peroxide. Powder of a dark dirty buff color. Specific gravity 3.271.

No. 1211—CARBONATE OF IRON. *Labeled "Iron Ore from the north bank of the North Fork of the Kentucky river, forty feet above the river surface; on the land of John G. McGuire, one mile above Proctor, Owsley county, Ky."* (Obtained by Jos. Lesley, jr.) Geological position, *between the main and upper beds of coal.*

Portion of a large nodule of compact, fine-grained, dark-grey carbonate of iron. Exterior surface, and surfaces of the cracks, with a thin coating of yellowish peroxide. Some of the fissures filled with calc. spar. Specific gravity 3.405.

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

	No. 1210. Proctor ore.	No. 1211. Ore, 1 mile above Proctor.
Carbonate of iron	38.321	62.292
Oxide of iron	22.564	7.726
Alumina	.680	.520
Carbonate of lime	.158	1.984
Carbonate of magnesia	8.414	8.885
Carbonate of manganese	1.023	1.324
Phosphoric acid	.759	1.463
Sulphuric acid	.372	.510
Potash	.309	.282
Soda	.200	.347
Silex and insoluble silicates	22.580	11.980
Bituminous matter and loss	4.620	2.687
Total	100.000	100.000
Percentage of metallic iron	34.304	35.400
Moisture, lost at 212° F., (per cent.)	0.70	0.60

Rich enough to be profitably smelted into iron, but containing rather more phosphoric acid than is desirable in iron ore.

No. 1212—SALINE EFFLORESCENCE *called in the neighborhood "nitre;" on the shale with the carbonate of iron. Proctor, Owsley county, Ky.* (Collected by Messrs. Downie and Lesquereux.)

White satiny, acicular, crystalline powder, on and mixed with fragments of shale. The solution in water was neutral. It is pretty pure *sulphate of magnesia, or Epsom salt.*

No. 1213—COAL. *Labeled "Coal from the Big Vein, about three feet to three feet ten inches thick, owned by Philips; on the west side of Mirey branch; about a thousand feet from the river, and one mile from Proctor, Owsley county, Ky. Geological position, under the conglomerate or millstone grit."* (Obtained by Jos. Lesley, jr.)

A pure looking, deep pitch-black coal, with some fibrous coal between the layers. Over the spirit lamp it softened, agglutinated, and swelled into a rather dense coke; with much smoky flame. Specific gravity 1.275.

PROXIMATE ANALYSIS.

Moisture	2.06	Total volatile matters	36.40
Volatile combustible matters	34.34		
Fixed carbon in the coke	56.50	Moderately dense coke	63.60
Light grey ashes	7.10		
	100.00		100.00

The percentage of *sulphur* was found to be 0.796.

Silica	3.984
Alumina, and oxides of iron and manganese	2.460
Lime	.103
Magnesia	.206
Sulphuric acid	not estimated.
Potash	.231
Soda	.175
	7.159

No. 1214—Coal. *Labeled "Coal from McGuire's 'Big Vein,' on Upper Stufflebean creek; half a mile north of Proctor, Owsley county, Ky. Geological position, under the conglomerate."* (Obtained by Joseph Lesley, jr.)

A pure, deep-pitch-black, shining coal. Some fibrous coal between the layers. Over the spirit lamp it softened and agglutinated and swelled into a moderately dense coke. Specific gravity 1.235.

PROXIMATE ANALYSIS.

Moisture	2.30	Total volatile matters	39.60
Volatile combustible matters	37.30		
Fixed carbon (in the coke)	58.90	Moderately dense coke	60.40
Light-tawny ashes	1.50		
	100.00		100.00

The percentage of sulphur was found to be 0.645.

COMPOSITION OF THE ASH.

Silica	0.324
Alumina, and oxides of iron and manganese	.660
Lime	a trace.
Magnesia	.260
Sulphuric acid	.152
Alkalies and loss	.104
	1.500

No. 1031*—Coal. *Labeled "Coal from Beatty's river bank big vein; ninety feet above the river, at its north side, between Lower Stufflebean creek and Miry branch, and nearly opposite to Proctor, Owsley county, Ky."* Geological position, *under the conglomerate or millstone grit."* (Obtained by Jos. Lesley, jr.)

A pure deep-pitch-black, shining coal; with fibrous coal between the layers. Over the spirit lamp it softens and agglutinates, gives much smoky flame, and leaves a moderately dense coke. Specific gravity, 1.338.

* This and the following number, 1031, accidentally omitted in their proper places, are introduced here.

PROXIMATE ANALYSIS.

Moisture	1.50	Total volatile matters	38.26
Volatile combustible matters	36.76		
Fixed carbon (in the coke)	55.14	Moderately dense coke	61.74
Grey-purple ash	6.60		
	100.00		100.00

The percentage of sulphur is 4.074.

COMPOSITION OF THE ASH.

Silica	1.284
Alumina, and oxides of iron and manganese	4.380
Lime	a trace.
Magnesia	.266
Sulphuric acid, alkalies, and loss	.670
	6.600

POWELL COUNTY.

No. 1032—CARBONATE OF IRON. *Labeled "Knob Iron Ore, above Stanton, Powell county, Ky."*

A fine-grained, dark-grey ore; weathered surfaces dull reddish-brown and yellowish. Powder yellowish grey. Specific gravity 3.3571.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	51.062	=32.021 per cent. of iron.
Oxide of iron	10.500	
Alumina	2.480	
Carbonate of lime	5.780	
Carbonate of magnesia	10.048	
Carbonate of manganese	4.034	
Phosphoric acid	1.088	
Sulphuric acid	.235	
Potash	.527	
Soda	.267	
Silex and insoluble silicates	14.040	
	100.081	

No. 1215—SOIL. *Labeled "Virgin Soil, from Moses S. Conner's farm, near Red river, Powell county, Ky. Principal forest growth, small white oak, also some hickories of small size. This soil is chiefly derived from the Black Devonian shale."*

Dried soil of a dark umber-grey color. A considerable quantity of fragments of dark grey and soft red ferruginous slaty sandstone was sifted out of this soil with the coarse seive.

No. 1216—SOIL. *Labeled "Same Soil, from an old field, fifteen to twenty years in cultivation. Moses S. Conner's farm, &c., &c."*

Dried soil of a buff-grey color. Contains fragments of red ferruginous slaty sandstone, but not so much as the preceding.

o. 1217—SOIL. *Labeled "Sub-soil, from the same old field. Moses S. Conner's farm, &c., &c."*

Dried sub-soil of a light, greyish-buff color. Contains fragments of ferruginous sandstone, like the preceding. These were sifted out with the coarse seive before proceeding to the analysis.

One thousand grains of each of these soils were digested for a month in water charged with carbonic acid gas, to which they gave up soluble materials as represented in the following table:

	No. 1215.	No. 1216.	No. 1217.
	Virgin soil.	Soil of old field.	Sub-soil.
Organic and volatile matters	1.617	0.566	0.460
Alumina, and oxides of iron and manganese and phosphates	.714	.314	.181
Carbonate of lime	.280	.517	.147
Magnesia	.098	.118	.223
Sulphuric acid	.033	.019	.045
Potash	.114	.087	.049
Soda	.037	.037	.021
Silica	.200	.200	.200
Loss	.042	.045	----------
Watery extract, dried at 212° F., (grains)	3.135	1.903	1.326

The *composition* of these soils, dried at 400° F., was found to be as follows, viz:

	No. 1215.	No. 1216.	No. 1217.
	Virgin soil.	Soil of old field.	Sub-soil.
Organic and volatile matters	8.033	5.102	3.625
Alumina	3.215	4.300	4.690
Oxide of iron	4.885	5.285	5.885
Carbonate of lime	.095	.070	.020
Magnesia	.581	.420	.540
Brown oxide of manganese	.130	.220	.145
Phosphoric acid	.278	.174	.143
Sulphuric acid	.278	.110	.067
Potash	.579	.290	.350
Soda	.031	.187	.067
Sand and insoluble silicates	81.795	83.820	83.940
Loss	.100	.022	.528
Total	100.000	100.000	100.000
Moisture, lost at 400° F., (per cent.)	2.90	2.00	1.815

The large proportion of potash in these soils shows their origin from the black slate. They ought to be fertile and durable soils. The only deficiency observed in their composition is in the *lime*, which can easily be supplied in top-dressing, and which will, no doubt, much increase their productiveness.

PULASKI COUNTY.

No. 1218—CARBONATE OF IRON; *from the coal mines of the Cumberland Coal Company; near the Falls of the Cumberland river, Pulaski county, Ky.*" (Sent by Gov. R. P. Letcher.)

A dark-grey, or mouse-colored, fine-grained, compact, carbonate of iron. Weathered surfaces reddish and yellowish. The specimen is apparently from a layer about three and a half inches thick.

COMPOSITION, DRIED AT 212° F.

Carbonate of iron	79.781	=39.638 per cent. of iron.
Oxide of iron	1.561	
Alumina	1.060	
Carbonate of lime	1.580	
Carbonate of magnesia	3.094	
Carbonate of manganese	.120	
Phosphoric acid	.758	
Sulphuric acid	.269	=0.108 per cent. sulphur.
Potash	.212	
Soda	.034	
Bituminous matter	.820	
Silex and insoluble silicates	8.780	
Loss	1.931	
	100.000	

Quite a rich carbonate of iron.

ROCKCASTLE COUNTY.

No. 1219—COAL, *from Wm. Dyre's bank; on McClure branch of West Fork of Skegg's creek; about eight miles east of south from Mount Vernon, Rockcastle county, Ky. Bed only stripped; three feet disclosed, but is about forty inches thick, with about a three feet head of black slate roofing.*" (Obtained by Joseph Lesley, jr.)

Rather a dull-looking coal; pretty tough; not much fibrous coal between the layers. Exterior stained with ochreous oxide of iron. Over the spirit lamp it swelled up into a spongy coke. Specific gravity 1.249.

PROXIMATE ANALYSIS.

Moisture	1.66	Total volatile matters	39.40
Volatile combustible matters	37.74		
Fixed carbon (in the coke)	58.26	Spongy coke	60.60
Buff-grey ashes	2.34		
	100.00		100.00

The percentage of *sulphur* is 0.818.

No. 1220—Coal. *"From Henry Mullin's bank; in a ridge which divides Roundstone from Skegg's creek waters; one mile southwest of his house, and five miles southeast of Mt. Vernon, Rockcastle county, Ky. Bed forty inches thick, with a capping of three feet of very hard, bluish, slaty shale; and above it six feet of blue shale." (Obtained by Jos. Lesley, jr.)*

Resembles the preceding. Over the spirit lamp it behaved like that. Specific gravity, 1.259.

PROXIMATE ANALYSIS.

Moisture	1.70	Total volatile matters	38.00
Volatile combustible matters	36.30		
Fixed carbon (in the coke)	59.80	Moderately dense spongy coke	62.00
Light-grey ashes	2.20		
	100.00		100.00

The percentage of *sulphur* was found to be 0.685.

COMPOSITION OF THE ASH.

Silica	0.784
Alumina, and oxides of iron and manganese	.580
Carbonate of lime	.084
Magnesia	.366
Sulphuric acid	.111
Potash	.046
Soda	.343
	2.314

ROWAN COUNTY.

No. 1221—Sandstone. *Labeled "Knob Building Stone; mouth of Triplett creek, edge of Rowan county, Ky."*

A fine-grained, grey sandstone. Adheres to the tongue. Powder nearly white. Specific gravity, 2.539.

Dried at 212°, its powder lost 0.40 per cent. of *moisture.*

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	90.240
Alumina, and oxides of iron and manganese	3.965
Carbonate of lime	1.480
Magnesia	.932
Phosphoric acid	.117
Sulphuric acid	.269
Potash	.336
Soda	.089
Water, expelled at a red heat	2.900
	100.328

The fact that this sandstone adheres to the moist tongue indicates that it will absorb moisture; and, consequently, be liable to disintegration under the influence of frost.

No. 1222—SOIL. *Labeled "Virgin Soil, near Morehead, Rowan county, Ky. Forest growth, white oak, chestnut, hickory, beech; some sugar-tree and black walnut."*

Dried soil of a dirty, greyish-buff color. Some fragments of soft sandstone were sifted out of it with the coarse seive.

No. 1223—SOIL. *Labeled "Soil from a farm in Morehead, Rowan county, Ky., fifty or sixty years in cultivation. Knob formation."*

Dried soil of a greyish-buff color, lighter colored than the preceding.

One thousand grains of each of these soils, digested for a month in water charged with carbonic acid, gave up of *soluble materials* as follows, viz:

	No. 1222. Virgin soil.	No. 1223. Old field.
Organic and volatile matters	1.266	0.507
Alumina, and oxides of iron and manganese and phosphates	.214	.124
Carbonate of lime	.347	.730
Magnesia	.127	.366
Sulphuric acid	.028	.022
Potash	.069	.045
Soda	.029	.020
Silica	.081	.114
Watery extract, dried at 212° F., (grains)	2.161	1.928

The composition of these two soils, dried at 400° F., is as follows:

	No. 1222. Virgin soil.	No. 1223. Old field.
Organic and volatile matters	5.461	3.797
Alumina	3.490	3.165
Oxide of iron	3.085	1.885
Carbonate of lime	.220	.195
Magnesia	.311	.279
Brown oxide of manganese	.195	.060
Phosphoric acid	.078	.095
Sulphuric acid	.110	.028
Potash	.400	.191
Soda	.022	.025
Sand and insoluble silicates	86.520	90.420
Loss	.108	----------
Total	100.000	100.140
Moisture, lost at 400° F.	1.850	1.250

The only deficiency observed in the composition of the virgin soil of this locality, is in the proportion of *phosphoric acid*. The addition of ground bones, or of super-phosphate of lime, or guano, would doubtless make it quite productive. The soil of the old field exhibits the usual signs of partial exhaustion: it may be improved by the same means, just indicated, with the addition of wood ashes.

SCOTT COUNTY.

No. 1224—"SHALE, *from milk-sick district. Floyd's Fork of Big Eagle, Scott county, Ky.*"

A friable, dirty-grey-buff shale. Powder of a light buff color.

No. 1225—"MUDSTONE, *from milk-sick district. Floyd's Fork of Big Eagle, Scott county, Ky.*" (*From near a sheep farm where the disease was more prevalent than ordinary.*)

A friable, dirty-buff, shaly rock. Adheres to the tongue.

COMPOSITION OF THESE ROCKS, DRIED AT 212° F.

	No. 1224. Shale.	No. 1225. Mudstone.
Sand and insoluble silicates	75.920	77.840
Alumina, and oxides of iron and manganese	11.660	9.140
Carbonate of lime	1.460	3.784
Carbonate of magnesia and loss	6.220	3.401
Phosphoric acid	.482	.566
Sulphuric acid	.338	.303
Potash	not estim'd	.579
Soda	not estim'd	.047
Water, expelled at a red heat	3.900	4.340
	100.000	100.000

These shales were fully tested for traces of the poisonous metals, but nothing was found in them which might be supposed to occasion the endemic disease.

TRIGG COUNTY.

No. 1226—LIMONITE. *Labeled "Pot Ore from D. Hillman's Empire Furnace, Trigg county, Ky."*

A curved, irregular layer of dense, dark colored limonite, inclosing a large cavity, through the walls of which project some remains of coralloid bodies, (probably cyathophylli.) Exterior, soft ochreous ore, of red, yellow, and brown colors. Powder of a handsome Spanish-brown color.

No. 1227—LIMONITE. *Labeled "Brown Ore, Empire Furnace, &c."*

A dense, dark-brown limonite; in pretty thick irregularly curved layers, incrusted with bright red, yellow, and brown soft ochreous ore. Powder of a brownish-yellow color.

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

	No. 1226. Pot ore.	No. 1227. Brown ore.
Oxide of iron	86.540	68.540
Alumina	.580	.480
Carbonate of lime	a trace.	trace.
Magnesia	.289	.854
Brown oxide of manganese	.184	.384
Phosphoric acid	.374	.156
Sulphuric acid	.166	.122
Potash	.193	.502
Soda	.076	.129
Silex and insoluble silicates	7.080	17.100
Combined water	5.560	11.180
Loss	----------	.553
Total	101.042	100.000
Moisture, expelled at 212° F.	1.400	1.600
Percentage of metallic iron	60.605	48.009

The "pot ore" is the richer, but the "brown ore" will doubtless yield the tougher iron of the two.

No. 1228—LIMESTONE. *Labeled "Grey Limestone used as a flux at Empire Furnace, Trigg county, Ky."*

A moderately coarse-grained dark-grey limestone, containing fossils and presenting shining crystalline facets.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	93.040	=52.21 per cent. of lime.
Carbonate of magnesia	1.259	
Alumina, and oxides of iron and manganese	2.980	
Phosphoric acid	none	
Sulphuric acid	.242	
Potash	.193	
Soda	.179	
Silex and insoluble silicates	1.980	
Loss	.127	
	100.000	

Well suited for the use to which it is applied; especially as it contains no *phosphoric acid.* It would be still better did it contain less *sulphuric acid.*

No. 1229—Iron Furnace Slag. *Labeled "Slag from Empire Furnace, Trigg county, Ky."*

A dense, smoky-blue and grey-blue slag; mottled with dark (carbonaceous?) matter; opalescent; translucent on the thin edges; containing a few air-bubbles. Before the blow-pipe it easily fuses into a light bottle-green glass.

COMPOSITION.

Silica	64.480	Containing oxygen=	33.485
Alumina	5.280	2.468	
Lime	19.317	5.493	
Magnesia	1.304	.421	
Protoxide of iron	6.462	1.434	
Protoxide of manganese	.911	.204	
Phosphoric acid	trace.		
Sulphuric acid	trace.		
Potash	1.953	.312	
Soda	.319	.082	
	100.026	10.514	33.485

The oxygen in the bases is to that in the silica, as	10.514 is to 33.485
or as	1 is to 3.204

This slag approaches very nearly, in composition, to what is called a *tri-silicate;* and the large proportion of protoxide of iron in it (6.462 per cent.) shows that the addition of more limestone to the flux would be beneficial. By reference to the former volumes of the Report, it will be seen that most of the charcoal furnaces in the northern portion of the State use limestone enough to produce a *bi-silicate* slag; and doubtless the larger quantity of lime tends to remove sulphur and other impurities injurious to the iron. The addition of some aluminous material, (free from phosphoric acid,) to the flux of the Empire furnace, might also be an improvement.

No. 1230—Pig Iron. *Labeled "Sharp Iron, Empire Furnace, &c."*

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

No. 1231—Pig Iron. *Labeled "Foundry Iron, Empire Furnace, &c., &c."*

Rather a fine-grained, dark-grey iron. Yields easily to the file; in small fragments breaks readily under the hammer.

No. 1232—PIG IRON. *Labeled "White Iron, Empire Furnace, &c., &c."*

Very hard and brittle; quite light colored: presenting a confused, bladed, semi-crystalline appearance on the fractured surfaces. Dissolves with difficulty, in dilute acids, and by means of iodine in warm water.

COMPOSITION OF THESE THREE SPECIMENS OF PIG IRON.

	No 1230. Sharp iron.	No. 1231. Foundry iron.	No. 1232. White iron.
Iron	92.984	93.686	95.747
Graphite	2.700	3.200	trace.
Combined carbon	2.060	1.360	2.400
Manganese	.132	.133	.334
Silicon	1.104	1.536	.373
Slag	.284	.136	.104
Aluminum	.177	.307	.149
Calcium	trace.	trace.	trace.
Magnesium	.226	.264	.224
Potassium	.052	.104	.157
Sodium	trace.	trace.	trace.
Phosphorus	.249	.389	.333
Sulphur	.094	.226	.080
Loss	----------	----------	.099
Total	100.062	101.341	100.000
Total carbon	4.760	4.560	2.400
Specific gravity	7.0629	7.4872	7.6095

For the analysis of the hearth sandstone used at this furnace, see *Union county.*

The specimens from the Trigg county furnaces were collected by Mr. Jno. Bartlett.

No. 1233—LIMONITE. *Labeled "'Pot Ore,' from the ore beds of Centre Furnace, two and a half miles back of Empire Furnace, Trigg county, Ky."*

A geode formed of a layer of dense, dark-brown limonite, about half an inch in thickness, forming the walls of an irregular cavity, three to four inches in diameter. Exterior of the geode composed of soft ochreous ore. Interior surface generally hard, and sometimes beautifully iridescent, sometimes smooth and polished, mammillary, or botryoidal. Occasionally the cavity of the geode contains clay, casts of fossil shells, or crystals of sulphate of lime; almost always they are filled with water and mud, the analyses of some specimens of which are given below.

These geodes of limonite, called by the furnace men "pots," are frequently found of very great size. The powdered ore is of a reddish-brown color.

No. 1234—LIMONITE. *Labeled "Brown Ore, Centre Furnace Ore Bed, Trigg county, Ky."*

A dense, dark-brown limonite, in thick irregular layers coated with red, ochreous ore. Powder brownish-yellow.

No. 1235—LIMONITE. *Labeled "Brown Ore from a bed close to Centre Furnace, Trigg county, Ky. Too near to the furnace to be worked; considered superior ore by the manager."*

A dense, dark-brown limonite; containing several small cavities lined with small quartz crystals, and a silicious incrustation. Powder of a yellowish-brown color.

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

	No. 1233. Pot ore.	No. 1234. Brown ore.	No. 1235. Brown ore near furnace.
Oxide of iron	78.840	73.540	73.340
Alumina	1.380	1.380	.921
Carbonate of lime	trace.	trace.	trace.
Magnesia	.873	.500	.527
Brown oxide of manganese	.980	.640	.444
Phosphoric acid	.483	.220	.159
Sulphuric acid	.441	.097	.475
Potash	.270	.359	.269
Soda	.197	.123	.043
Silex and insoluble silicates	11.580	9.740	15.380
Combined water	3.720	11.320	9.460
Loss	1.236	2.081	------------
Total	100.000	100.000	101.038
Percentage of metallic iron	47.230	51.511	51.361
Moisture, expelled at 212° F.	0.600	0.340	0.400

No. 1236—LIMESTONE. *Labeled "Limestone, used as flux at Centre Furnace, Trigg county, Ky. Found in the neighborhood."*

A grey, fossiliferous limestone; glistening with small crystalline facets of calcareous spar.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	94.940 = 53.276 per cent. of lime.
Carbonate of magnesia	1.958
Alumina, and oxides of iron and manganese	.280
Phosphoric acid	.156
Sulphuric acid	not estimated.
Potash	.181
Soda	.166
Silex and insoluble silicates	2.840
	100.521

No. 1237—IRON FURNACE SLAG. *Labeled "Slag from the Grey Iron, Centre Furnace, &c."*

Translucent, purplish-blue, marbled with opalescent grey-blue. Before the blow-pipe fuses readily into a clear glass, which becomes filled with air-bubbles on continuing the heat in the oxidating flame.

No. 1238—IRON FURNACE SLAG. *Labeled "Slag from the Lively-Grey Iron, Centre Furnace, &c."*

Olive-green, translucent on the edges; containing many large air-bubbles, as well as numerous minute ones. Before the blow-pipe it is not so fusible as the preceding: melting into an olive-green glass.

COMPOSITION OF THESE SLAGS.

	No. 1237.			No. 1238.		
	Slag (grey iron.)		Oxygen.	Slag (Lively-grey.)		Oxygen.
Silica	65.140	=	33.822	63.680	=	33.064
Alumina	7.580	=	3.543	8.880	=	4.150
Lime	22.715	=	6.761	21.088	=	6.002
Magnesia	.826	=	.330	.965	=	.385
Protoxide of iron	1.404	=	.310	2.502	=	.555
Protoxide of manganese	.171	=	.038	.632	=	.142
Phosphoric acid	marked traces.			marked traces.		
Sulphuric acid	not estimated.			.269		
Potash	1.564	=	.265	1.630	=	.276
Soda	.228	=	.058	.180	=	.056
Loss	.372		--------	.174		
Total	100.000		11.305	100.000		11.566
The oxygen in the bases is to that in the silica as	11.305 to 33.822			11.566 to 33.064		
or as	1 to 2.991			1 to 2.859		

These approach very nearly to the composition of *tri-silicates*.

No. 1239—PIG IRON. *Labeled "Grey, or Foundry Iron, Centre Furnace, &c."*

A dark-grey iron, moderately coarse grained, specular; the flat granules being quite brilliant. Yields easily to the file. Small fragments easily crushed under the hammer.

No. 1240—PIG IRON. *Labeled "Lively Grey Iron, (forging,) Centre Furnace, &c.*

A fine-grained, light-grey iron; quite hard; yields with difficulty to the file. Extends very little under the hammer; small fragments soon break to pieces when hammered.

COMPOSITION OF THESE TWO SPECIMENS OF PIG IRON.

	No. 1239. Grey iron.	No. 1240. Lively grey iron.
Iron	94.796	96.212
Graphite	2.500	2.000
Combined carbon	1.700	1.000
Manganese	.133	.133
Silicon	1.345	.624
Slag	.184	.184
Aluminum	.177	.177
Calcium	trace.	trace.
Magnesium	.285	.333
Potassium	.048	.070
Sodium	.042	.065
Phosphorus	.080	.108
Sulphur	.122	.152
Total	101.402	101.058
Total carbon	4.200	3.000
Specific gravity	7.1256	7.4108

By the kindness of Mr. S. S. Goodrich, of Centre furnace, I was supplied with two specimens of the water contained in the cavities of the 'pot ore' of this region, and was thus enabled to submit it to analysis, as follows:

No. 1241—WATER FROM INTERIOR OF POT ORE, *Centre Furnace, Trigg, county, Ky., labeled "Liquid from interior of Pot Ore.* The walls of the 'pot' were solid and compact, and from one to three inches thick. This 'pot' was surrounded by, or a part of, a lump of ore that would have weighed six tons (!) and it was taken from near the middle."

The liquid, which was sent to me in a bottle, (marked No. 1,) contained a large proportion of tenacious dark-brown mud. (See below for analysis of this sediment.) The cork of the bottle was sensibly darkened, as by the action of a salt of iron.

Evaporated to dryness at 212°, the filtered liquid left only 0.405 per cent. of *saline matters;* which was principally composed of *sulphates of magnesia, lime,* and *manganese,* with a little *sulphate of iron,* and a small proportion of *chlorides.*

No. 1242—WATER FROM THE INTERIOR OF POT ORE, *Centre Furnace, &c.,* labeled "Liquid from a large 'pot' embedded in clay. It was rolled out and broken, and found to contain nearly three quarts of the liquid. The shell was from one to four inches thick." (Sent by S. S. Goodrich, Esq.) *Bottle No.* 2.

There was a small quantity of brownish sediment in the bottle. The cork was only slightly deepened in color. Specific gravity 1.0065.

Evaporated to dryness, it left 0.84 per cent. of *saline matters,* dried at 212° F., which was of the following

COMPOSITION:

Sulphate of manganese	0.308	
Sulphate of magnesia	.265	
Sulphate of potash	.009	
Sulphate of lime	.136	
Chloride of sodium	.037	
Carbonates of lime, magnesia and iron and loss	.085	
Saline matters, dried at 212°	0.840	per cent.

No. 1243—"*Sediment from the water inclosed in the Pot Ore, Centre Furnace, Trigg county, Ky.*"

An umber colored earthy material, in soft friable lumps.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	88.380
Alumina, and oxides of iron and manganese	3.580
Lime	a trace.
Magnesia	.700
Phosphoric acid	.092
Sulphuric acid	not estimated.
Potash	.722
Soda	.296
Carbonaceous matter	3.000
Water, expelled at red heat	3.240
	100.010

The presence of the above described saline solution in the interior of the "pot ore," where it has probably existed for ages, is a singular fact; which may throw some light on the character of the chalybeate water from which the hydrated oxide of iron (limonite) was originally deposited. The sediment examined is an earthy matter, or dried mud, of the nature of common soil.

No. 1244—LIMONITE. *Labeled "Pot Ore, from Fulton Furnace; two and a half miles northwest of Empire Furnace, Trigg county, Ky."*

A dense, dark brown layer, incrusted with cinnamon colored ochreous limonite, and including an irregular cavity. Powder yellowish-brown.

No. 1245—LIMONITE. *Labeled "Brown Ore, from Fulton Furnace, &c, &c."*

A dense, dark brown limonite; not adhering to the tongue; covered with brownish-yellow ochreous ore. Powder yellowish-brown.

COMPOSITION OF THESE TWO LIMONITES, DRIED AT 212° F.

	No. 1244. Pot ore.	No. 1245. Brown ore.
Oxide of iron	77.070	73.680
Alumina	.480	.380
Lime	a trace.	trace.
Magnesia	.773	.649
Brown oxide of manganese	.580	.380
Phosphoric acid	.438	.886
Sulphuric acid	.097	.097
Potash	.308	.231
Soda	.270	.021
Silex and insoluble silicates	9.480	13.230
Combined water	11.100	10.800
Total	100.596	100.354
Percentage of metallic iron	53.973	51.599
Moisture, expelled at 212° F.,	0.800	0.900

The "brown ore" contains more phosphoric acid than the "pot ore," and hence the iron made from it may not be so tough as that from the latter.

No. 1246—LIMESTONE. *Labeled "Grey Limestone used as a flux at Fulton Furnace. Found near the Furnace."*

A grey, fossiliferous, fine-grained limestone; glimmering with small facets of calc. spar.

No. 1247—LIMESTONE. *Labeled "Black Limestone, sometimes used as a flux at Fulton Furnace; but the grey is considered the best, and is now used."*

A dark-umber colored limestone, (nearly black.) Bituminous and fossiliferous. Fine granular with small facets of calc. spar.

Powder of a buff-grey color.

COMPOSITION OF THESE TWO LIMESTONES, DRIED AT 212° F.

	No. 1246. Grey limestone.	No. 1247. Black limestone
Carbonate of lime	88.180	69.080
Carbonate of magnesia	4.335	2.168
Alumina, and oxides of iron and manganese	.280	2.480
Phosphoric acid	trace.	.335
Sulphuric acid	.180	.532
Potash	.251	.355
Soda	.054	.232
Silex and insoluble silicates	9.520	21.840
Loss and bituminous matters	------------	2.978
Total	102.800	100.000
Moisture, expelled at a red heat	0.200	0.200
Percentage of pure lime	.487	38.764

The *grey* is obviously a better limestone for the flux for the iron furnace than the black, containing more *lime* and being more free from injurious impurities. The black limestone is the best for agricultural purposes, for spreading on land to increase its productiveness; for which it is very well adapted by its large proportions of phosphoric and sulphuric acids and the alkalies.

No. 1248—IRON FURNACE SLAG. *Labeled "Slag from the Fulton Furnace, Trigg county, Ky."*

A dense, greyish light blue, translucent, and bluish-grey opake and opalescent slag. Before the blow-pipe, it fuses without difficulty into a clear light bottle-green glass.

COMPOSITION.

Silica	64.880	Containing oxygen=33.667	
Alumina	8.980	4.197	
Lime	21.200	6.028	
Magnesia	1.087	.434	
Protoxide of manganese	.540	.121	
Protoxide of iron	2.660	.590	
Potash	1.533	.260	
Soda	.358	.092	
	101.238 oxygen as	11.722	to 33.687
Oxygen in the bases is to that in the silica, as		1 is	to 2.874

This slag was found to contain phosphoric acid also, but its quantity was not estimated. This slag approaches in composition to what is called a *tri-silicate*. More limestone in the flux could be advantageously employed at this furnace.

No. 1249—PIG IRON. *Labeled "Sharp Iron, (lively grey,) for forging, Fulton Furnace, Trigg county, Ky."*

A fine grained, dark-grey iron. Yields easily to the file. Small fragments extend a little under the hammer, but soon break to pieces.

No. 1250—PIG IRON. *Labeled "Grey Iron, used for foundry purposes, Fulton Furnace, &c, &c."*

A moderately coarse-grained iron, with brilliant flattened grains, (specular?) Yields easily to the file. In small fragments it crushes easily under the hammer, and does not extend much.

	No. 1249. Sharp iron.	No. 1250. Grey iron.
Iron	93.546	93.204
Graphite	3.360	2.500
Combined carbon	1.640	1.800
Manganese	.276	.276
Silicon	1.008	1.008
Slag	.184	.884
Aluminum	.069	.095
Calcium	trace.	trace.
Magnesium	.264	.311
Potassium	.064	.064
Sodium	.070	.070
Phosphorus	.192	.252
Sulphur	trace.	.053
Total	100.673	100.517
Total carbon	5.000	4.300
Specific gravity	7.1440	6.918

The "sharp iron" is quite a pure specimen, and ought to produce tough malleable iron.

TRIMBLE COUNTY.

No. 1251—FOSSIL SHELLS. *Labeled "Murchisonia sp? Trimble county, Ky. What composition?"*

Detached specimens of fossil shells of the genus Murchisonia, with their cavities filled with calc. spar and limestone.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	94.880
Carbonate of magnesia	1.119
Alumina, and oxides of iron and manganese	.680
Phosphoric acid	.059
Sulphuric acid	.200
Potash	.193
Soda	.082
Silex and insoluble silicates	2.460
Loss	.307
	100.000

They do not differ much in composition from the limestone in which they are found.

UNION COUNTY.

No. 1252—IMPURE BITUMINOUS LIMONITE. *Labeled "Black Band Iron Ore. Over the first coal at Curlew Mines, Union county, Ky."*

A dull, almost black, shaly ore; very full of small particles of yellow iron pyrites, and covered with effloresced sulphate of iron. Powder nearly black.

COMPOSITION, DRIED AT 212° F.

Oxide of iron	38.240	
Alumina	.778	
Carbonate of lime	.580	
Magnesia	.615	
Brown oxide of manganese	.580	
Phosphoric acid	.502	
Sulphuric acid	1.426	=1.775 sulphur.
Potash	.328	
Soda	.201	
Silex and insoluble silicates	11.300	
Bituminous matters	37.800	
Combined water	5.100	
	100.450	

Dried at 212° F., it lost as much as 7.60 per cent. of moisture. Too impure to be used as an ore of iron.

No. 1253—SANDSTONE. *Labeled "Hearth-stone used at Empire Furnace, (Trigg county,) brought from Caseyville, Union county, Ky."*

A friable sandstone, made up of clear rounded grains of quartz; some parts without any appearance of cement; in other parts brown from the presence of oxide of iron, &c. Powder of a light buff color.

COMPOSITION, DRIED AT 212° F.

Sand and insoluble silicates	94.080
Alumina, and oxides of iron and manganese	2.660
Lime	trace.
Magnesia	.733
Phosphoric acid	.092
Sulphuric acid	.097
Potash	.250
Soda	.103
Water, expelled at red heat	1.700
Loss	.285
	100.000

Dried at 212° F., it lost 0.30 per cent. of *moisture.*

A similar sandstone from this county, used for hearth-stone at Suwannee furnace, is described under the head of Lyon county.

No. 1254—COAL, (*cannel.*) *Labeled "Upper part of Payne and Berry's Coal, Union county, Ky."*

General color dull black, with irregular blotches of shining pitch black, and numerous patches of yellow pyrites; in some parts imperfect casts of bi-valve shells and a fragment of vegetable charcoal. Generally scarcely soiling the hands. Over the spirit lamp it decrepitated somewhat, but did not swell up nor agglutinate.

No. 1255—COAL. *Labeled "Lower part of Payne and Berry's Coal, &c., &c."*

A bright pitch-black, pure coal; breaking easily. Fibrous coal, like the charred remains of reed leaves, between some of the layers; but the cleavage surfaces are generally glossy and irregular, with an approach to the bird-eye structure. No appearance of pyrites.

PROXIMATE ANALYSIS OF THESE TWO SPECIMENS.

	No. 1254. Upper part.
Moisture	2.00
Volatile combustible matters	35.40
Fixed carbon	37.30
Purplish-brown ashes	25.30
	100.000
Total volatile matters	37.40
Dense coke	62.60
Percentage of sulphur	16.142
Specific gravity	1.823

	No. 1255. Lower part.
Moisture	4.50
Volatile combustible matters	37.10
Fixed carbon	55.10
Dark purplish-grey ashes	3.30
	100.00
Total volatile matters	41.60
Light coke	58.40
Percentage of sulphur	3.262
Specific gravity	1.274

A marked difference will be seen in the composition and purity of these two samples.

COMPOSITION OF THE ASH OF NO. 1255, (LOWER PART.)

Silica	1.044
Alumina, and oxides of iron and manganese	2.080
Lime	.103
Magnesia	.133
Sulphuric acid	.066
	3.426

Traces of alkalies and phosphoric acid were present.

No. 1256—COAL. *Labeled "Cannel Coal, upper part, at Casey's mines, Union county, Ky."*

"A half inch layer of cannel coal with a quarter of an inch of pyritous bituminous shale above it, and bituminous coal under."

A dull black, tough, satiny looking coal. Over the spirit lamp, fragments swell very little, and do not agglutinate. Specific gravity 1.282.

PROXIMATE ANALYSIS.

Moisture	0.40	Total volatile matters	35.90
Volatile combustible matters	35.50		
Fixed carbon	48.20	Pretty dense coke	64.10
Light-grey ashes	15.90		
	100.00		100.00

The percentage of *sulphur* was found to be 1.017.

COMPOSITION OF THE ASH.

Silica	10.444
Alumina, and oxides of iron and manganese	4.138
Lime	trace.
Magnesia	.399
Phosphoric acid	.182
Sulphuric acid	.060
Alkalies and loss	.677
	15.900

The ash of this impure coal contains notable proportions of phosphoric acid and the alkalies.

No. 1257—COAL. *Labeled "Bird's-eye Coal, No. 10, or first coal at Curlew mines, Union county, Ky."*

A dull-black, tough cannel coal; with a curled-maple-like structure. The surface of the specimen, especially on the lines of cleavage, had become covered with effloresced sulphate of iron, although it had been kept in a comparatively dry room, warmed with a constant fire. Over the spirit lamp it softened and swelled very little; burnt with much smoky flame, leaving a pretty dense coke. Specific gravity 1.328.

PROXIMATE ANALYSIS.

Moisture	1.00	Total volatile matters	41.30
Volatile combustible matters	40.30		
Fixed carbon (in the coke)	44.30	Pretty dense coke	58.70
Grey-purple ashes	14.40		
	100.00		100.00

The percentage of *sulphur* was found to be 9.639.

COMPOSITION OF THE ASH.

Silica	2.784
Alumina, and oxides of iron and manganese	11.320
Lime	trace.
Magnesia	.299
Sulphuric acid	.201
Alkalies	not estimated.
	14.504

Submitted to destructive distillation for the production of oil, &c., it yielded the following products, viz:

Crude oil	190.0
Ammoniacal water	56.0
Coke	608.5
Combustible gases and loss	145.5
	1000.0

The gases from a thousand grains measured seven hundred and five cubic inches, and were not remarkable for illuminating powers. The remaining coke was porous and aggregated into a single mass. If the specimen tried is a fair sample of this coal, it does not promise much for the manufacture of coal oil. It, moreover, contains much more sulphur than the average.

No. 1258—COAL. *Labeled "Equivalent of Bell's Coal. Coal Company bank, town of Mulford, Union county, Ky."*

A deep pitch-black, somewhat brittle, shining, coal, cleaving into thin layers, with irregular shining surfaces, and little or no fibrous coal or pyrites. Exterior covered with orange colored, ochreous, oxide of iron. Over the spirit lamp it softened and agglutinated into a spongy coke. Specific gravity 1.295.

PROXIMATE ANALYSIS.

Moisture	1.34	Total combustible matters	37.30
Volatile combustible matters	35.96		
Fixed carbon (in the coke)	59.10	Spongy coke	62.70
Purplish-grey ashes	3.60		
	100.00		100.00

The percentage of *sulphur* was found to be 1.609.

COMPOSITION OF THE ASH.

Silica	1.384
Alumina, and oxides of iron and manganese	2.080
Lime	.271
Magnesia	.099
Alkalies and sulphuric acid	not estimated.
	3.834

A very good bituminous coal.

No. 1259—"FERRUGINOUS LIMESTONE, *fifteen to twenty inches thick, over the "Well" Coal, at Mulford's, Union county, Ky. How much iron?"*

A dull, greyish-black, fine-grained rock. Not adhering to the tongue. Powder mouse-colored. Specific gravity 2.686.

COMPOSITION, DRIED AT 212° F.

Carbonate of lime	47.380
Carbonate of magnesia	19.601
Carbonate of iron	13.556
Carbonate of manganese	.722
Alumina	4.000
Phosphoric acid	.848
Sulphuric acid	.222
Potash	.291
Soda	.160
Silex and insoluble silicates	7.280
Bituminous matters	6.160
	100.220

Contains too small a quantity of oxide of iron to be used as an ore for the production of that metal.

WOODFORD COUNTY.

No. 1260—"MINERAL WATER. *From a bored well, eighty-six feet deep, on the farm of Mr. Jno. H. Williams, three miles northeast of Versailles, Woodford county, Ky.*"

The water has a strong bituminous smell; and when evaporated to dryness at 212° F., left 3.555 per cent. of *saline matters;* the *composition* of which is as follows:

Carbonates of lime and magnesia	traces, not estimated
Chloride of sodium, (common salt)	2.340
Chloride of potassium	.014
Chloride of calcium	.325
Chloride of magnesium	.280
Sulphuric acid, Bromine, Alumina, silica, and loss	.596
	3.555

No. 1261—MINERAL WATER. "*From a bored well sixty feet deep, at Judge R. C. Grave's farm, Woodford county, Ky.*"

The recent water contains a little sulphuretted hydrogen; it contains a flocculent whitish sediment, which is composed of *sulphur*, mixed with *organic matter*, a little *carbonate of lime*, and a trace of oxide of iron.

When the water is boiled, it forms a considerable whitish deposit, composed of carbonate of lime, with some carbonate of magnesia. The remaining saline solution is *alkaline*, and contains carbonate of soda, with a little sulphate, and some chloride of sodium, with chloride of magnesium and a little chloride of calcium. The total saline matters amount only to 0.0285 per cent.

TABLE I. (B.) SOILS, SUB-SOILS, UNDER-CLAYS, AND MARLS. (*Coal Measures Formation.*)

Number in the report.	County.	Extracted from 1,000 grains by water charged with carb. acid.	Moisture expelled at 400 deg. F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
963	Estill	1.600	1.125	2.680	3.220	1.485	0.021	0.297	0.110	0.128	trace.	0.166	0.064	92.095	On millstone grit soil.
1025	Hancock	4.317	1.300	3.865	3.465	1.970	.170	.393	.233	.143	0.042	.150	.100	90.520	Ohio bottom soil.
1026	Hancock	1.590	0.923	2.019	3.390	2.690	.021	.439	.095	.190	.042	.181	.057	90.720	Ohio bottom sub-soil.
1027	Hancock	6.752	2.400	6.071	3.465	3.710	.346	.544	.095	.187	.050	.367	.077	84.945	Old field soil.
1028	Hancock	1.196	2.525	4.129	5.440	5.725	.246	.797	.170	.145	.047	.391	.349	82.745	Sub-soil.
1029	Hancock	4.751	2.200	4.422	3.215	3.285	.171	.446	.241	.161	.059	.205	.040	88.130	Virgin soil, (woods.)
1030	Hancock	1.159	2.125	3.678	4.890	5.135	.071	.799	.120	.152	.016	.328	.051	84.720	Sub-soil.
1033	Hancock	3.250	1.475	4.729	2.115	1.900	.196	.408	.070	.185	.042	.212	.062	91.170	Soil.
1034	Hancock	1.800	1.850	3.642	5.390	6.400	.071	.585	.095	.151	not est.	.413	.131	83.320	Sub-soil.
1044	Hardin	1.538	1.475	3.197	2.015	2.035	.130	.472	.170	.072	.021	.164	.021	91.345	Old field, } On oolitic limestone in mill. grit.
1045	Hardin	1.044	1.525	2.615	2.015	2.865	.095	.411	.080	.072	.021	.169	.049	89.770	Sub-soil, }
1051	Hopkins	7.133	2.600	6.263	3.390	2.700	.445	.491	.295	.148	.076	.158	.034	85.970	Soil.
1052	Hopkins	2.983	1.900	4.295	4.845	2.910	.160	.507	.370	.078	.059	.330	.113	86.070	Sub-soil.
1053	Hopkins	1.777	1.775	3.843	4.165	2.985	.095	.393	.280	.118	.025	.225	.090	87.945	Soil.
1054	Hopkins	0.850	2.150	3.756	5.890	4.700	.070	.584	.120	.096	.016	.323	.047	84.445	Sub-soil.
1055	Hopkins	2.570	1.300	2.887	3.415	2.385	.220	.344	.095	.173	.016	.198	.073	90.745	Soil.
1056	Hopkins	0.796	1.915	3.629	6.590	4.600	.045	.656	.170	.053	.033	.331	.067	84.445	Sub-soil, } Top of the millstone grit.
1058	Jackson	2.450	1.915	4.998	5.560	2.970	.011	.444	.120	.126	.042	.243	.074	85.860	Virgin soil. }
1059	Jackson	2.483	1.115	3.390	3.035	1.860	.031	.298	.045	.062	trace.	.232	.012	91.160	Old field soil. }
1060	Jackson	1.500	0.965	2.433	5.583 (alumina and oxide of iron)		.011	.117	------	.142	.016	.238	.078	90.995	Sub-soil. }
1061	Jackson	3.833	1.850	4.737	9.210 (alumina and oxide of iron)		.080	.306	------	.176	.050	.373	.085	84.620	Virgin soil. } Slopes of the shales and sandstone.
1062	Jackson	4.750	2.500	6.425	6.320	3.360	.110	.529	.270	.194	.045	.306	.070	82.870	Old field soil. }
1063	Jackson	2.283	2.035	4.812	6.870	3.710	.180	.456	.120	.160	.050	.521	.083	83.270	Sub-soil. }
1156	Morgan	3.333	2.325	7.243	3.590	3.260	.320	.480	.195	.204	.067	.372	trace.	84.360	Virgin soil.
1157	Morgan	1.233	1.550	4.881	3.415	2.710	.145	.385	.070	.192	.050	.232	.018	88.595	Old field soil.

TABLE I. (C.) SOILS, SUB-SOILS, UNDER-CLAYS, &C., OF THE SUB-CARBONIFEROUS GROUP.

Number in the report.	County.	Extracted from 1,000 grains by water charged with carb. acid.	Moisture expelled at 400° F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
		(Grains.)													
812	Bath	3.077	1.425	4.251	1.515	2.210	0.195	0.329	0.130	0.095	0.033	0.130	0.050	91.095	Virgin soil. } Sub-carboniferous sandstone.
813	Bath	1.757	0.975	3.105	1.340	3.710	.095	.295	.110	.127	.033	.110	.040	89.920	Old field.
814	Bath	1.483	0.650	2.164	1.415	4.435	.080	.362	.170	.095	.028	.164	.018	92.270	Sub-soil.
815	Bath	4.935	3.025	8.198	5.490	3.360	.220	.488	.220	.179	.076	.210	.018	82.745	Old field soil.
816	Bath	1.339	1.750	5.038	6.927 (alumina and oxide of iron)		.070	.500	------	.144	.033	.171	.119	86.995	Sub-soil.
817	Bath	5.733	3.350	10.527	4.240	2.210	.645	.405	.295	.223	.050	.212	.046	81.295	Sub-carb. limestone soil.
818	Bath	1.637	1.550	4.418	4.540	2.660	.160	.398	.415	.144	.025	.085	.181	87.720	Sub-soil of same.
837	Breckinr'ge	7.015	6.250	1.839	2.510 (alumina and oxide of iron)		60.050	.101	------	.030	.084	.217	.061	34.580	Disintegrated limestone.
839	Breckinr'ge	6.823	4.000	8.411	5.240	4.838	1.880	.830	.345	.130	.076	.414	.099	77.495	Virgin soil.
840	Breckinr'ge	1.300	3.000	4.407	6.590	4.460	.570	.559	.120	.152	.016	.378	.178	82.270	Sub-soil.
841	Breckinr'ge	2.350	1.775	5.141	2.315	2.535	.420	.366	.120	.160	.059	.118	.032	88.120	Virgin soil.
842	Breckinr'ge	1.117	1.975	3.513	3.740	3.970	.195	.474	.195	.094	.033	.198	.078	87.120	Sub-soil.
843	Breckinr'ge	1.466	1.425	2.942	3.215	2.335	.145	.488	.095	.085	.028	.183	.050	90.930	Old field soil.
844	Breckinr'ge	1.149	2.825	3.678	5.165	5.085	.220	.542	.070	.095	.033	.347	.113	83.720	Sub-soil.
845	Breckinr'ge	2.700	2.650	5.136	2.615	2.935	.170	.345	.195	.095	.055	.119	.033	87.645	Soil.
846	Breckinr'ge	0.823	2.350	3.609	5.315	4.010	.110	.392	.170	.095	.041	.327	.041	85.220	Sub-soil.
848	Bullitt	2.684	2.075	5.159	3.540	3.875	.210	.416	.071	.209	.059	.256	.037	86.070	Virgin soil.
849	Bullitt	2.803	1.800	5.142	3.515	3.125	.271	.431	.121	.150	.065	.217	.062	87.345	Old garden soil.
850	Bullitt	1.105	2.550	3.591	6.440	4.840	.170	.562	.070	.127	.033	.278	.005	84.110	Sub-soil.
851	Bullitt	5.370	2.465	7.033	3.840	5.840	1.621	1.643	.110	.281	.050	.211	.170	80.220	Virgin soil (bottom.)
852	Bullitt	2.725	2.725	3.675	2.390	3.290	a trace	.451	.145	.129	not est.	.125	.040	88.745	Virgin soil (hill top.)
853	Bullitt	2.830	3.525	5.827	4.065	4.165	.395	.828	.145	.159	not est.	.082	.132	84.395	Old field soil.
854	Bullitt	0.776	3.100	3.261	6.290	5.390	a trace	.569	.195	.094	not est.	.477	.081	83.395	Sub soil soil.
960	Estill	4.066	3.510	8.483	6.750	3.210	.030	.460	.460	.318	.055	.408	.068	79.695	Virgin soil.
961	Estill	4.077	2.100	4.617	4.535	2.270	.181	.451	.310	.274	.033	.296	.085	86.610	Old field soil.
962	Estill	1.533	1.615	2.957	5.110	2.910	.096	.417	.180	.192	.016	.316	.093	87.970	Sub-soil.
1040	Hardin	2.823	2.100	5.207	2.990	2.235	.370	.392	.320	.183	.040	.169	.042	88.130	Virgin soil.
1041	Hardin	0.850	1.750	2.865	3.540	3.260	.245	.483	.245	.078	.057	.183	.063	87.570	Sub-soil.

TABLE I. (C.) SOILS, &c., &c.—Continued.

Number in the report.	County.	Extracted from 1,000 grains by water charged with carb. acid.	Moisture expelled at 400° F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
1042	Hardin.....	1.917	1.265	3.378	3.020	2.260	0.245	0.321	0.120	0.137	0.041	0.121	0.040	90.926	Old field soil.
1043	Hardin.....	1.078	1.425	2.561	2.990	2.5 5	.170	.315	.195	.119	.028	.101	trace.	90.495	Sub-soil.
1222	Rowan.....	2.161	1.850	5.461	3.490	3.085	.220	.311	.195	.078	.110	.400	.022	86.520	Virgin soil. } Knob formation.
1223	Rowan.....	1.928	1.250	3.797	3.165	1.885	.195	.279	.060	.095	.028	.191	.025	90.420	Old field soil } Knob formation.

TABLE I. (D.) SOILS, SUB-SOILS, UNDER-CLAYS, AND MARLS. (*Devonian Formation.*)

Number in the report.	County.	Dissolved from 1,000 grains by water charged with carb. acid.	Moisture expelled at 400° F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
884	Clarke	3.777	3.750	7.195	5.615	6.635	0.120	0.948	0.220	0 346	0.050	0.580	0.409	78.470	Virgin soil (Indian old fields.)
885	Clarke	5.790	5.000	6.842	5.690	9.535	.820	.772	.145	.384	.127	.265	.122	75.170	Old field soil (Ind. old fields.)
886	Clarke	1.893	5.275	9.263	6.815	12.310	.345	.855	.170	.217	.067	.463	.088	69.220	Sub-soil (Indian old fields.)
958	Estill	3.057	4.275	10.942	3.290	6.635	.420	.392	.145	.347	.578	.697	.309	74.895	Cultivated field.
1125	Madison	1.733	2.450	6.125	2.215	11.015	.095	.385	not est.	.271	not est.	.121	.039	79.270	Virgin soil (on Dev'n slate.)
1127	Madison	9.550	6.150	15.450	3.565	5.560	1.295	.750	.270	.252	.120	.753	.123	71.045	Virgin "Red Bud" soil.
1128	Madison	3.600	4.035	8.508	6.240	6.835	.470	1.041	.215	.214	.059	.796	.097	75.620	Old field "Red Bud" soil.
1129	Madison	3.743	4.535	7.584	5.900	6.360	.770	.960	.320	.199	.085	.705	.231	76.745	Sub-soil "Red Bud."
1179	Nelson	3.528	3.375	9.656	2.365	3.285	.396	.643	.310	.378	.076	.135	.046	82.870	Virgin soil.
1180	Nelson	1.433	1.950	3.809	3.990	3.910	.172	1.328	.310	.161	.127	.175	.038	86.520	Sub-soil.
1181	Nelson	1.564	1.885	4.586	2.990	4.235	.196	1.214	.220	.208	.050	.169	.045	87.045	Old field soil.
1182	Nelson	1.045	2.250	3.785	4.590	5.000	.146	1.273	.245	.162	.059	.206	.046	84.895	Sub-soil.
1183	Nelson	2.257	2.350	5.149	2.390	4.035	.221	.503	.195	.161	.084	.181	.047	85.840	Old field soil.
1184	Nelson	1.819	2.775	4.705	4.715	5.035	.246	.536	.120	.342	.050	.227	.061	83.495	Sub-soil.
1185	Nelson	2.117	3.225	4.521	3.749	2.860	.196	.337	.195	.031	.067	.164	.031	87.570	Virgin soil.
1186	Nelson	1.022	2.425	2.231	4.135	3.410	.071	.423	.160	.096	.041	.164	.082	87.845	Sub-soil.
1187	Nelson	2.890	3.775	5.326	2.490	4.570	.371	.545	.170	.247	.067	.246	.059	85.195	Soil.
1188	Nelson	2.467	5.275	4.355	8.140	6.885	.492	.736	.170	.216	.050	.743	.066	78.170	Sub-soil.
1189	Nelson	....	....	......	12.960	6.740	12.380	.389	.384	.253	not est.	2.843	not est.	52.680	White under-clay (marl.)
1190	Nelson	....	....	......	15.348	12.940	1.980	1.216	.284	1.088	not est.	1.371	.122	54.280	Ferruginous under-clay.
1191	Nelson	6.500	7.825	10.425	3.490	11.385	6.146	5.710	.145	.275	.058	.420	.099	61.495	Virgin soil. } Partly from
1192	Nelson	2.577	9.375	6.207	10.590	13.585	.770	1.010	.645	.367	.050	.700	.083	64.820	Sub-soil. } *Upper Silurian.*
1193	Nelson	1.826	2.625	3.286	1.190	3.670	.172	.415	.228	.047	.050	.164	.034	89.045	Old field soil.
1194	Nelson	1.144	3.475	2.564	5.890	5.135	.220	.584	.170	.079	.058	.357	.042	84.820	Sub-soil.
1215	Powell	3.135	2.900	8.033	3.215	4.885	.095	.581	.130	.278	.278	.579	.031	81.795	Virgin soil. } From
1216	Powell	1.903	2.000	5.120	4.300	5.285	.070	.420	.220	.174	.110	.290	.187	83.820	Old field soil } the black
1217	Powell	1.326	1.815	3.625	4.690	5.885	.020	.540	.115	.145	.067	.350	.067	83.940	Sub-soil. } shale.

TABLE I. (E.) SOILS, SUB-SOILS, UNDER-CLAYS, AND MARLS. (*Upper Silurian Formation.*)

Number in the report.	County.	Dissolved from 1,000 grains by water charged with carb. acid.	Moisture expelled at 400° F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
805	Bath	3.050	3.650	8.165	4.565	6.960	0.570	0.710	not est.	0.174	not est.	0.290	0.059	79.145	Virgin (Clinton group) soil.
806	Bath	2.717	3.450	7.639	5.390	7.885	.420	.615	not est.	.216	not est.	.249	.073	78.270	Old field (Clinton group) soil.
807	Bath	2.103	2.475	5.024	3.535	3.535	.095	.385	0.220	.118	0.041	.246	.100	86.980	Virgin (Clinton group) soil.
808	Bath	2.552	2.600	5.118	5.115	5.150	.170	.523	.220	.284	.058	.210	.048	83.320	Old field (Clinton group) soil.
1069	Jefferson	....	....	2.196	7.260		26.880	1.687	......	.694	.406	.965	.012	59.900	Marl (Chenowith creek.)
1070	Jefferson	2.783	2.100	5.173	2.900	3.085	.370	.719	.395	.203	.076	.208	.154	86.370	Virgin soil (Beargrass.)
1071	Jefferson	1.480	1.650	3.417	3.665	3.410	.270	.621	.270	.127	.042	.212	.077	87.995	Sub-soil of same.
1072	Jefferson	3.066	1.975	5.457	2.365	2.510	.370	.467	.320	.160	.059	.167	.072	87.170	Old field soil (Beargrass.)
1073	Jefferson	1.500	1.650	3.406	3.365	3.410	.290	.576	.220	.127	.025	.257	.127	87.795	Sub-soil of same.
1074	Jefferson	2.120	1.685	4.389	2.890	2.985	.270	.484	.245	.258	.067	.253	.026	87.345	70 years old field (Beargrass.)
1075	Jefferson	1.055	1.775	3.105	4.115	3.320	.245	.513	.220	.176	.041	.275	.047	87.870	Sub-soil of same.
1076	Jefferson	7.766	....	8.284	19.310		2.595	.071	......	.260	.062	.874	.090	68.820	Marl in the lime-rock.
1087	Lewis	1.833	2.065	4.809	2.595	4.485	.221	.542	.220	.112	.045	.338	.050	86.495	Yellow mag. limestone soil.
1088	Lewis	2.650	2.125	5.915	1.865	2.340	.245	.426	.045	.144	.050	.159	.005	88.295	Virgin soil mag. limestone.
1089	Lewis	2.936	1.850	4.613	1.990	3.510	.195	.426	.120	.118	.042	.130	.063	87.470	Old field soil mag. limestone.
1090	Lewis	1.695	1.825	4.403	4.640	3.585	.230	.475	.045	.062	.011	.195	.127	87.120	Sub soil of same.
1169	Nelson	5.655	3.210	7.351	4.990	4.015	.171	.691	.495	.331	.064	.352	.017	82.395	Soil.
1170	Nelson	1.460	2.100	2.982	6.125	4.925	.045	.637	.420	.145	.033	.381	.032	83.470	Sub-soil.
1171	Nelson	4.540	3.610	7.563	4.850	5.425	.411	.702	.720	.272	.036	.452	.040	79.295	Soil.
1172	Nelson	2.100	3.225	5.812	6.640	6.414	.311	.692	.870	.142	.050	.349	.049	78.795	Sub-soil.
1173	Nelson	5.300	4.875	9.975	8.740	12.675	3.221	2.878	.620	.149	.041	.348	.297	61.095	Under-clay.
1174	Nelson	2.117	2.300	4.836	4.330	3.865	.270	.455	.324	.144	.065	.280	.062	85.895	Old field soil.
1175	Nelson	1.833	3.225	4.665	6.990	6.415	.196	.982	.145	.113	.040	.410	.139	80.495	Sub-soil.

TABLE I. (F) SOILS, SUB-SOILS, UNDER-CLAYS, AND MARLS. (*Lower Silurian Formation.*)

Number in the report.	County.	Dissolved from 1,000 grains by water charged with carb acid.	Moisture expelled at 400° F.	Organic and volatile matters.	Alumina.	Oxide of iron.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Sand and silicates.	Remarks.
804	Bath	5.150	4.500	9.527	3.990	4.275	0.620	0.700	not est.	0.415	not est.	0.290	0.054	80.120	Best hemp soil of Bath co.
809	Bath	6.400	4.200	8.376	5.115	2.185	.580	.460	0.195	.565	0.084	.372	.124	82.595	Virgin soil.
810	Bath	3.694	3.[illegible]00	6.708	5.265	4.235	.445	.617	.295	.295	.067	.280	.044	82.[illegible]70	Old field soil.
811	Bath	1.881	2.650	4.108	5.490	4.245	.370	.619	.295	.512	.055	.767	.037	84.920	Sub-soil.
826	Bracken	9.861	6.975	7.981	6.645	6.825	1.586	1.354	.296	.342	.110	.758	.047	72.920	Virgin tobacco soil.
827	Bracken	1.454	2.950	4.853	3.680	5.540	.396	.844	.146	.179	.031	.458	not est.	83.310	Sub soil.
828	Bracken	3.333	2.525	5.489	4.080	3.215	.471	.762	.196	.260	.042	.265	.029	85.300	Exhausted tobacco soil.
829	Bracken	4.780	3.675	7.412	5.990	6.975	.871	1.621	.260	.289	.033	1.164	.058	74.895	Vineyard soil.
830	Bracken	3.670	1.635	3.497	3.360	4.095	.495	.593	.145	.225	.045	.319	.029	86.970	Under-clay (contains bones.)
831	Bracken	2.017	2.200	5.931	4.115	3.435	.170	.886	not est.	.254	not est.	.190	.034	84.695	Virgin soil.
832	Bracken	1.390	2.525	3.795	3.465	3.210	.220	.869	not est.	.227	not est.	.237	.080	87.070	Old field soil.
878	Clarke	5.633	4.750	9.028	6.565	5.600	.545	.687	.545	.366	.084	.475	.124	76.070	Virgin soil
879	Clarke	3.600	3.125	6.879	4.240	4.960	.695	.563	.320	.211	.084	.296	.056	81.920	Old field soil.
880	Clarke	2.490	3.400	5.797	7.165	5.460	.320	.859	.370	.228	.050	.583	.053	79.620	Sub-soil.
881	Clarke	2.633	4.050	7.764	6.790	5.860	.345	.883	.380	.306	.092	.589	.005	76.820	Virgin soil.
882	Clarke	1.917	3.350	5.985	6.240	5.785	.195	.719	.320	.245	.067	.296	.034	79.945	Old field soil.
883	Clarke	2.194	3.350	5.923	6.290	5.885	.195	1.133	.395	.296	.076	.507	.065	79.970	Sub-soil.
971	Fayette	....	....	*5.676	21.656		2.480	†3.276	......	.182	......	6.655	.195	56.880	Marly clay (Brink's branch.)
972	Fleming	....	1.200	*14.900	10.401	10.760	16.880	‡6.385	1.084	.079	.338	1.147	not est.	39.780	Marl (junc. Upper Silurian.)
975	Fleming	4.259	5.525	11.315	5.060	11.675	.420	.874	.290	.251	.084	.349	.224	69.145	Virgin soil. } Junction of
976	Fleming	2.521	4.225	7.395	4.190	11.210	.395	.679	.395	.181	.042	.202	.014	75.645	Old field soil } Upper and
977	Fleming	2.082	6.650	7.675	10.335	14.930	.470	.868	.370	.216	.059	.439	.050	64.995	Sub-soil. } Low'r Silur'n.
978	Fleming	4.566	4.675	8.521	6.840	5.760	.870	.798	.170	.224	.075	.526	.128	76.445	Virgin soil (blue limestone.)
979	Fleming	2.850	3.100	5.211	5.275	5.510	.370	.736	.270	.409	.091	.468	.043	80.945	Old field soil.
980	Fleming	2.079	2.875	4.195	6.265	6.035	.395	.580	.095	.223	.058	.700	.168	80.745	Sub soil.
982	Franklin	2.076	2.700	6.372	4.185	4.310	.320	.563	.320	.[illegible]50	.076	.222	.052	82.270	Virgin soil.
983	Frank'in	2.896	2.490	6.147	5.435	4.560	.320	.801	.445	.270	.076	.288	.058	81.470	Old field soil.
984	Franklin	2.054	2.125	4.281	5.035	4.785	.520	.526	.095	.553	.050	.290	.073	83.445	Sub-soil.

986	Garrard	1.400	2.400	4.200	3.790	3.310	0.170	0.506	0.295	0.243	0.096	0.135	0.092	87.670	Woodland soil.	On the bird's-eye limestone.
987	Garrard	1.133	2.460	2.988	4.840	3.970	.120	.540	.245	.260	.024	.257	.026	86.645	Sub-soil.	
988	Garrard	2.383	2.725	5.294	5.090	3.910	.110	.973	.245	.244	.050	.190	.026	82.945	Old field soil.	
989	Garrard	1.974	2.525	3.411	13.635		2.470	.325	......	.249	.059	.347	.092	79.960	Sub-soil.	
990	Grant	......	......	......	16.250		4.980	†3.285	......	.310	1.197	.988	.178	71.280	Marl, in blue limestone.	
1130	Mason	......	......	......	8.020		7.380	3.105	......	1.040	.592	.722	.172	78.180	Marl, in blue limestone.	
1134	Mason	4.570	4.175	8.462	4.745	6.240	.836	.798	.146	.231	.084	.558	.160	78.100	Virgin tobacco soil.	
1135	Mason	3.746	3.265	6.445	3.730	4.465	.476	.807	.221	.212	.042	.418	.023	83.330	Old field soil.	
1136	Mason	3.357	3.050	5.9[illegible]1	4.390	4.090	.497	.618	.196	.245	.059	.475	.079	83.130	Sub-soil.	
1139	Mercer	6.810	4.300	5.564	5.090	4.115	.495	.732	.120	.[illegible]23	not est.	.[illegible]66	.143	83.295	Virgin soil.	
1140	Mercer	0.804	4.000	3.413	6.715	4.990	.245	.828	.120	.243	not est.	.421	.019	82.695	Sub soil.	
1141	Mercer	2.650	3.750	4.805	4.595	4.740	.320	.811	.120	.288	.042	.140	.108	83.625	Old field soil.	
1142	Mercer	1.547	3.150	3.289	5.840	5.115	.220	.887	.220	.345	not est.	.290	.035	83.945	Sub soil.	
1144	Mercer	2.788	2.600	5.703	3.015	3.210	.345	.512	.070	.096	.028	.172	.068	86.570	Virgin soil.	Oak region of Mercer county.
1145	Mercer	2.450	3.115	5.707	5.665	4.100	.420	.553	.240	.096	.016	.183	.015	82.660	Sub-soil.	
1146	Mercer	3.090	2.450	5.049	3.240	3.710	.320	.612	.245	.128	.024	.203	.108	86.145	Old field soil.	
1147	Mercer	1.757	5.525	6.747	14.[illegible]60		.360	.460	......	.138	.042	.237	.057	77.570	Sub-soil.	
1148	Montgomery	5.076	3.725	6.751	4.690	5.810	.420	.677	.245	.513	.076	.410	.245	80.095	Virgin soil.	
1149	Montgomery	2.4[illegible]5	3.600	6.172	5.440	4.710	.420	.583	.120	.345	.067	.331	.133	81.470	Old field soil.	
1150	Montgomery	1.4[illegible]7	2.900	4.171	6.590	6.235	.220	.634	.295	.257	.041	.372	.139	81.370	Sub-soil.	
1151	Montgomery	0.899	3.525	4.378	7.400	11.100	.095	.9[illegible]5	.495	.[illegible]95	.024	.280	.104	72.670	Under-clay.	
1196	Nicholas	3.543	2.500	7.820	4.360	4.465	.520	.706	.320	.211	.058	.365	.131	81.120	Virgin soil.	
1197	Nicholas	1.933	2.600	6.339	6.260	5.970	.345	.643	.270	.195	.050	.336	.071	79.720	Old field soil.	
1198	Nicholas	1.280	4.150	6.687	11.235	7.987	.370	.851	.095	.231	.016	.485	.078	71.870	Sub-soil.	
1203	Owen	......	......	‡8.998	19.940		34.580	†5.287	......	.934	.372	.649	......	29.240	Marl from milk-sick district.	
1204	Owen	1.770	2.375	4.865	2.695	2.810	trace.	.514	.095	.086	.050	.094	.035	88.020	Virgin soil.	White oak and beech land on the silicious mud-stone.
1205	Owen	2.470	2.925	6.026	3.470	3.935	trace.	.915	.170	.178	.050	.089	.040	84.870	Old field soil.	
1206	Owen	1.217	2.775	4.319	5.280	5.260	trace.	1.178	.220	.128	.033	.271	.098	82.820	Sub-soil.	
1207	Owen	1.450	2.515	4.112	2.545	2.995	.005	.686	.171	.144	.045	.116	.022	88.120	Virgin soil.	
1208	Owen	1.853	2.750	5.218	3.160	3.565	.120	.708	.445	.210	.062	.149	.049	85.970	Old field soil.	
1209	Owen	1.630	2.525	3.890	3.695	3.735	.095	.746	.695	.227	.058	.133	.042	87.295	Sub-soil.	

* Water. † Carbonate. ‡ Magnesia.

Table II. Limestones.

Number in the report.	County.	Specific gravity.	Carbonate of lime.	Carbonate of magnesia.	Carbonate of iron.	Carbonate of manganese.	Alumina.	Oxide of iron.	Oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Silica, &c.	Lime.	Magnesia.	Remarks.
796	Bath	2.704	53.210	18.531	......	......	0.620	8.020	0.380	0.117	0.033	0.444	0.212	17.540	29.877	8.828	Hydraulic.
797	Bath	......	51.540	28.770	3.095	0.752	.290	10.627	......	.502	.235	.209	trace.	1.980	28.580	13.700	Clinton group.
822	Bourbon	......	75.980	15.595	......	......		4.080		.822	.427	.165	.042	2.640	43.637	7.426	Lower Silurian.
825	Bracken	......	91.040	3.678	......	......		1.660		.182	.209	.200	.148	2.880	51.064	....	Lower Silurian.
828	Breckinridge	......	80.080	1.473	......	......		1.580		trace.	.166	.398	.080	15.580	....	....	Sub-carboniferous.
850	Bullitt	......	50.980	37.747	......	......		2.700		trace.	not est.	.463	.228	6.380	....	....	Upper Silurian.
857	Bullitt	......	52.880	37.577	......	......		1.640		trace.	.067	.270	.198	5.980	....	....	Upper Silurian.
858	Bullitt	......	93.600	3.314	......	......		.780		trace.	not est.	.297	.000	1.980	....	....	Sub-carboniferous.
868	Carter	2.782	50.780	3.220	......	......	0.880	3.060	30.000	.950	.475	.132	.067	1.880	....	....	Star Furnace.
876	Clarke	2.735	60.640	32.500	......	......		0.580		.207	.194	.374	.250	3.520	34.028	15.040	Lower Silurian.
877	Clarke	......	85.560	3.507	......	......		3.280		.118	.474	.422	.402	5.920	48.017	....	Lower Silurian.
884	Clarke	......	40.280	15.903	......	......		0.480		....	1.025	.436	.164	23.180	....	....	Devonian (hydraulic?)
897	Crittenden	2.710	52.880	25.858	......	......		1.460		.008	.003	.304	.255	18.880	....	....	Crittenden Furnace.
898	Crittenden	2.723	35.280	20.246	......	......		1.323		.117	trace.	.344	.056	14.280	....	....	Crittenden Furnace.
915	Crittenden	......	70.780	8.408	......	......		2.580		trace.	.587	.353	.233	7.580	30.158	....	Hurricane Furnace.
930	Daviess	......	37.000	16.005	......	......		10.440		.207	3.155	.368	.063	28.320	....	....	Sub-carboniferous (hydraulic?)
939	Estill	2.682	92.020	.029	......	......		1.120		.310	.166	.193	.083	4.580	50.515	....	Sub-carboniferous.
947	Estill	......	41.380	30.010	4.321	......	0.806	2.360	0.480	.374	1.471	.482	.019	18.680	23.221	....	Upper Silurian (hydraulic?)
949	Estill	2.716	27.080	10.022	......	......		9.060		.246	.544	.618	.298	38.480	....	....	Hydraulic.
950	Estill	......	37.480	22.927	......	......		6.100		.182	1.368	.085	.372	28.580	....	....	Hydraulic.
951	Estill	......	36.580	19.792	......	......		0.200		.070	1.561	.482	.231	28.240	....	....	Hydraulic.
965	Fayette	......	92.640	3.099	......	......		.440		trace.	.441	not es	not es	2.480	....	....	Lower Silurian.
967	Fayette	......	77.460	15.498	......	......		1.280		.246	.160	.103	.363	2.980	....	....	Lower Silurian (Raven creek.)
968	Fayette	......	95.680	2.044	......	......		.380		.182	.166	.103	.048	1.380	....	....	Lower Silurian (Bird's-eye marb.)
9	Fayette	......	92.080	23.070	......	......		6.080		.246	.441	.102	.182	5.280	....	....	Lower Silurian (Ky. marble.)
970	Fayette	......	91.480	1.044	......	......		3.880		.848	.317	.232	.338	2.380	....	....	Lower Silurian (coarse grained.)
	Fleming	......	42.080	25.358	5.155	.421	1.080	11.073	......	.848	.324	.290	.033	10.880	23.951	....	Clinton group (hydraulic?)
974	Fleming	......	71.700	9.931	......	......		12.240		.630	.337	.341	.139	2.880	....	....	Clinton group.
981	Franklin	......	93.580	3.663	......	......		.880		.117	.441	.057	.165	.380	52.663	....	Lower Silurian.
985	Garrard	......	34.780	21.470	......	......		5.200		.310	.866	.471	.130	35.180	....	....	Upper Silurian (hydraulic?)
992	Grayson	......	85.080	2.503	......	......		2.500		.182	.839	.350	trace.	7.480	....	....	Sub-carboniferous.
1000	Greenup	2.700	94.980	1.583	......	......		.580		trace.	.317	.212	.140	2.080	53.298	....	Sub-carboniferous (Kenton Fur.)

1013	Greenup......	2.630	65.280	4.346	28.841	......	0.280	......	0.380	trace.	1.196	0.027	0.191	.380	......	......	Ferruginous (Steam Furnace.)
1037	Hardin	......	79.180	11.469	......	......		0.880		.156	.338	.173	.008	0.080	......	......	Sub-carboniferous.
1038	Hardin	......	82.280	7.300	......	......		.660		.182	.417	.390	.000	9.220	......	......	Sub-carboniferous.
1039	Hardin	......	98.540	.629	......	......		.460		.125	.274	.154	.022	.380	......	......	Sub-carboniferous ("Oolitic.")
1046	Henderson....	......	86.380	3.678	......	......		1.700		.248	.168	.289	.068	3.280	......	......	Coal Measures.
1065	Jefferson	......	52.080	31.473	......	......		4.473		.208	.303	.606	.307	10.480	......	......	Upper Silurian.
1066	Jefferson	......	42.980	21.819	......	......		6.560		.214	1.284	.223	.372	23.080	24.118	10.305	Upper Silurian (hydraulic
1067	Jefferson	......	*50.280	....	......	......		10.460		.156	not est.	.214	.072	17.720	28.280	10.095	Old hydraulic cement.
1068	Jefferson	......	45.880	22.911	......	......		5.760		.220	.200	.347	.372	21.523	25.746	10.014	Madison, Indiana.
1068a		......	....	....	......	......		14.000		not est.	not est.	not es	not es	29.040	38.718	15.337	Same after calcination.
1077	Jefferson	......	89.080	6.783	......	......		1.480		.310	.475	.154	.163	2.680	......	......	Upper Silurian or Devonian.
1078	Jefferson	......	92.560	4.615	......	......		.480		trace.	.168	.100	.074	2.580	......	......	Upper Silurian or Devonian.
1079	Jefferson	......	82.080	14.014	......	......		.880		.182	.272	.013	.212	.880	......	......	Upper Silurian or Devonian.
1080	Jefferson	......	88.080	7.483	......	......		.208		.060	.647	.252	not es	1.080	......	......	Upper Silurian or Devonian.
1081	Jefferson	......	86.260	2.567	......	......		.580		trace.	.132	.115	.116	9.580	......	......	Upper Silurian or Devonian.
1084	Lewis	2.687	42.480	15.225	10.032	0.371	1.341	0.446	......	.182	.132	.560	.326	23.380	......	......	Concretion in shale.
1085	Lewis	......	55.240	27.820	......	......		12.280		.207	.152	.167	.126	2.580	......	......	Upper Silurian.
1094	Livingston ...	......	91.680	3.168	......	......		.284		trace.	.372	.224	.024	4.280	51.447	......	Sub-carboniferous?
1108	Lyon	......	86.380	.542	......	......		1.960		.002	.867	not es	not es	8.620	54.084	......	Mammoth Furnace.
1116	Lyon	......	73.580	17.485	......	......		2.240		.070	.538	not es	not es	4.880	41.290	......	Suwanee Furnace.
1123	Madison......	......	49.320	30.729	......	......		2.060		.271	.509	.374	.058	14.180	......	......	Upper Silurian (hydraulic?)
1131	Mason	......	75.440	4.783	......	......		3.751		.409	.474	.540	.292	14.440	......	......	Lower Silurian.
1132	Mason	......	87.080	1.721	......	......		2.200		.348	.372	.280	.047	6.380	......	......	Lower Silurian.
1133	Mason	......	77.980	2.307	......	......		3.910		.310	2.433	.424	.068	13.980	......	......	Lower Silurian.
1137	Meade	......	47.560	28.515	......	......		2.160		....	1.332	.126	.005	19.680	26.688	12.631	Hydraulic.
1138	Meade	......	28.360	17.771	......	......		2.680		....	2.707	.115	.116	47.080	15.974	8.460	Hydraulic.
1143	Mercer........	......	90.720	4.615	......	......		2.700		.146	not est.	.228	.021	1.880	......	......	Lower Silurian.
1165	Nelson........	......	40.480	24.267	......	......		4.493		.207	.810	.455	.042	29.280	......	......	Upper Silurian (hydraulic?)
1166a	Nelson........	......	49.780	34.456	......	......		3.000		.246	.475	.270	.006	10.780	......	......	Upper Silurian (hydraulic?)
1166b	Nelson........	......	48.980	34.100	......	......		2.080		.118	.380	not es	not es	11.480	......	......	Upper Silurian (hydraulic?)
1167	Nelson........	......	50.480	32.154	......	......		2.100		.118	.289	.258	.260	8.380	......	......	Upper Silurian (hydraulic?)
1168	Nelson........	......	94.380	2.419	......	......		.060		.117	.338	.103	......	1.980	......	......	Upper Silurian (fossil coral.)
1176	Nelson........	......	54.080	30.562	......	......		2.080		.054	.111	.231	.240	.880	......	......	Upper Silurian.
1177	Nelson........	......	48.080	29.060	......	......		0.780		trace.	trace.	.533	.134	10.580	......	......	Upper Silurian.
1178	Nelson........	......	93.080	2.707	......	......		.204		.054	.338	.189	trace.	3.040	......	......	Upper Silurian.
1201	Oldham	......	41.580	24.030	......	......		5.800		.374	.303	.455	.204	23.580	......	......	Upper Silurian (hydraulic?)
1202	Oldham	......	41.980	21.400	......	......		6.860		.310	.386	.370	.379	24.680	......	......	Upper Silurian (hydraulic?)
1228	Trigg	......	93.040	1.259	......	......		2.080		none.	.242	.103	.179	1.080	52.210	......	Empire Furnace.
1230	Trigg	......	94.040	1.058	......	......		.280		.156	not est.	.181	.166	2.840	53.27	......	Centre Furnace.
1246	Trigg	......	88.180	4.335	......	......		.280		trace.	.180	.251	.054	0.520	40.487	......	Fulton Furnace (grey.)
1247	Trigg	......	69.080	2.108	......	......		2.480		.335	.532	.365	.232	21.840	38.764	......	Fulton Furnace (black.)
1251	Trimble......	......	94.880	1.119	......	......		.080		.059	.200	.103	.082	2.480	......	......	Fossil Murchisonia.
1259	Union	2.689	47.380	19.609	13.556	0.722	4.000			.848	.222	.291	.160	7.280	Bit. &c. =0160.		Mulford's.

* Carbonic acid=22.140. Combined water=10.340.

TABLE III. (A.) IRON ORES. (*Limonites.*)

Number in the report.	County.	Oxide of iron.	Alumina.	Carbonate of lime.	Magnesia.	Brown oxide of manganese	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Combined water.	Silex, &c.	Percentage of iron.	Remarks.
777	Bath	76.680	0.440	none.	0.665	0.580	0.886	0.235	0.358	0.197	11.200	8.080	53.400	Slate Furnace ore.
778	Bath	76.774	.880	none.	1.018	.680	1.206	.221	.258	.202	11.760	7.280	53.766	Slate Furnace ore.
779	Bath	52.660	2.642	trace.	.781	.580	.438	.235	.509	.230	9.300	32.780	36.878	Slate Furnace ore.
780	Bath	80.520	3.482	none.	.558	.220	.758	.201	.386	.132	10.900	3.280	56.369	From Wickliffe bank.
782	Bath	82.120	.820	trace.	1.010	1.340	.220	.386	.193	.180	5.420	8.980	57.510	Clear Creek Furnace.
783	Bath	70.935	.900	trace.	1.129	1.780	.505	.290	.291	.180	5.400	18.640	49.677	Clear Creek Furnace.
784	Bath	72.886	.980	trace.	.551	.380	.694	.283	.521	.048	12.200	11.880	51.043	Clear Creek Furnace.
785	Bath	68.140	2.733	trace.	1.171	1.680	.247	.336	.413	.132	9.040	16.080	47.719	Clear Creek Fur. (Jones' bank.)
786	Bath	64.306	3.080	trace.	1.003	2.440	.374	.290	.703	.312	6.[illegible]00	21.407	45.054	Clear Creek Furnace.
790	Bath	86.268	.480	trace.	.840	3.580	.272	.303	.220	.124	6.000	2.120	60.415	Clear Creek Furnace.
791	Bath	65.400	4.[illegible]66	trace.	.932	.580	1.014	.234	.656	.245	12.100	15.080	45.800	Clear Creek Furnace.
792	Bath	77.580	1.600	trace.	.504	.580	.720	.2[illegible]4	.386	.260	11.500	7.040	54.330	Clear Creek Furnace.
793	Bath	69.940	3.297	6.504	2.556	1.580	1.783	.267	.328	.202	6.200	7.980	48.980	Clear Creek Furnace.
794	Bath	38.000	3.265	1.284	1.565	.780	1.015	.853	.583	.147	7.900	44.880	26.612	Clear Creek Furnace.
859	Campbell ..	16.6[illegible]0	6.920	.980	2.396	3.480	.950	.269	.596	.003	6.500	61.280	....	Yeton Farm bog iron ore.
860	Carter	69.740	1.680	trace.	1.114	1.780	.335	.272	.270	trace.	12.800	11.680	48.840	Star Furnace (Red Kidney Ore.)
861	Carter	43.780	1.380	17.680	3.022	1.880	2.293	.460	.374	.025	9.726	19.380	30.666	Star Furnace (Lim. Ore No. 5.)
862	Carter	39.440	.280	1.800	.836	39.677	2.101	not est.	.270	.039	14.300	1.380	27.620	Star Furnace (Block Ore.)
863	Carter	70.872	.720	trace	.999	1.280	1.268	.647	.386	.132	10.500	12.980	49.633	Star Furnace (Yel. Kidney Ore.)
864	Carter	68.880	.980	6.880	2.444	.380	1.140	.681	.231	.057	6.700	10.840	48.238	Star Furnace (Lim. Ore No. 8.)
887	Clarke	66.060		.084	.266	......	1.015	.132	.349	.181	12.873	19.040	....	Iron Gravel (Indian old fields.)
891	Crittenden .	78.140	.580	trace.	.680	.580	.502	.133	.328	.014	11.000	7.780	54.722	Crittenden Furnace "Pipe Ore."
892	Crittenden .	80.940	.580	trace.	.474	.380	.502	.201	.328	.202	5.300	11.520	56.684	Crittenden Furnace "Pot Ore."
893	Crittenden .	81.000	.580	trace.	.796	.180	.886	trace.	.320	.150	10.900	5.180	56.725	Crittenden Furnace "Block Ore."
894	Crittenden .	72.140	.480	trace.	.308	.880	.438	.166	.417	.180	10.200	16.980	5[illegible].521	Crittenden Furnace "Brown Ore."
895	Crittenden .	81.340	1.340	trace.	.503	.360	1.204	.132	.181	.064	11.140	4.380	56.954	Critt. Fur. "Honey-comb Ore."
909	Crittenden .	80.940	.420	trace.	.713	.280	.438	.200	.200	trace.	10.000	7.380	56.684	Hurricane Furnace "Block Ore."
910	Crittenden .	56.840	8.980	trace.	.916	.320	.591	.040	.301	trace.	11.600	20.880	[illegible]9.806	Hurricane Fur. Honey comb Ore."
911	Crittenden .	82.540	.580	trace.	.541	.240	.502	.083	.162	.076	10.560	5.380	58.014	Hurricane Furnace "Pipe Ore."

912	Crittenden	83.060	.480	trace.	.513	.240	trace.	.218	.135	.104	11.600	4.080	58.168	Hurricane Furnace "Pot Ore."
913	Crittenden	84.640	.580	trace.	.471	.680	.464	.097	.143	.115	10.800	2.920	59.275	Hurricane Furnace "Slate Ore."
914	Crittenden	25.940	.588	trace.	.654	.180	trace.	.132	.189	trace.	3.400	68.180	18.166	Hurricane Furnace "Sand Ore."
931	Edmonson	37.240	2.057	1.180	.419	.680	2.423	.544	.201	.066	9.670	45.670	26.039	Nolin Furnace (Fossil Nautilus.)
932	Estill	60.800	3.060	trace.	.642	2.360	.800	.107	.413	.185	10.540	21.360	42.635	Cottage Furnace (Block Ore.)
933	Estill	66.140	1.460	trace.	.803	1.140	.310	.213	.405	.053	7.560	22.360	46.303	Cottage Furnace (Speckled Ore.)
934	Estill	52.454	.660	trace.	.852	2.480	.740	.107	.366	.167	8.900	33.980	36.755	Cottage Furnace (Rough Ore)
935	Estill	45.540	3.496	trace.	1.028	.980	.925	.145	.434	.190	8.700	39.080	31.891	Cottage Furnace (Kidney Ore.)
936	Estill	62.200	.440	trace.	2.742	1.620	.502	.135	.508	.192	10.760	21.080	43.559	Cottage Fur. (Buzzard Bank Ore.)
944	Estill	71.600	.520	.680	1.408	1.680	.822	.303	.492	.202	11.280	11.120	50.042	Old Furnace ore banks.
945	Estill	62.480	3.349	trace.	.513	.920	.591	.372	.714	.143	10.800	20.580	43.756	Old Furnace ore banks.
993	Greenup	46.640	2.440	.380	1.902	1.380	.412	.255	.656	.192	9.300	36.240	32.662	Kenton Fur. (Blue. Lim. Ore.)
996	Greenup	33.540	4.887	trace.	1.635	.280	.733	.290	.502	.265	8.860	49.480	23.480	Kenton Furnace (Block Ore.)
997	Greenup	78.840	.980	trace.	.471	2.264	.541	.166	.127	.319	11.960	3.980	55.213	Kenton F. (ore with S. C. Lim'st.)
998	Greenup	82.240	.580	trace.	1.041	5.984	.310	.269	.224	.093	7.240	1.920	57.595	Kenton Fur. (John Conley Ore.)
999	Greenup	44.980	2.580	trace.	.891	.080	.694	.372	.135	.260	8.400	41.680	31.500	Ken. Fur. (Rough Big Block Ore.)
1000	Greenup	51.400	3.720	trace.	1.343	.880	2.462	.386	.440	trace.	10.600	28.520	35.996	Kenton Fur. (Little Block Ore.)
1001	Greenup	49.740	3.000	trace.	.603	.480	1.742	.269	.166	.179	8.600	35.180	26.594	Kenton Furnace (Marl Ore)
1002	Greenup	59.680	5.120	trace.	.763	1.080	2.037	.303	.251	.264	7.160	23.560	33.000	Kenton Fur. (Flat Kidney Ore.)
1003	Greenup	21.740	19.160	trace.	.628	.080	trace.	.990	.165	.119	10.300	47.480	15.225	Kenton Fur. (near Pink Clay Ore.)
1004	Greenup	83.880	.280	trace.	.543	5.380	.822	.236	.252	trace.	7.760	1.680	58.742	Kenton Furnace (Dogstone Ore)
1005	Greenup	46.540	3.148	trace.	.919	1.080	1.232	.303	.618	.015	9.310	37.320	39.396	Kenton Furnace (Fossiliferous.)
1017	Greenup	71.740	.980	trace.	1.180*	1.629*	.758	.544	.242	.144	12.828	6.984	52.342	Bellefonte Fur. (Rejected Ore.)
1019	Greenup	43.280	1.580	33.180	2.337*	1.180	.508	.338	.374	.120	3.919	13.184	30.309	Raccoon Fur. exterior of Co. ore.
1020	Greenup	45.070	.730	trace.	.808	.355	1.056	.165	.337	.114	7.800	44.720	31.563	Rac. Fur. Ferrug's Conglomerate.
1022	Greenup	61.640	1.200	14.580	1.818	.380	1.591	.067	.324	.205	7.640	10.800	43.167	Pennsylvania Fur. (New Bank).
1023	Hancock	33.649	2.980	.580	10.695*	.784	.374	.612	.421	.249	5.484	44.180	23.658	Ferruginous Conglomerate.
1092	Livingston	78.310	.780	trace.	.850	.684	.630	.166	.154	.242	11.800	6.480	54.840	Ozeoro Furnace (Brown Ore.)
1093	Livingston	76.340	.180	trace.	.850	.884	.438	trace.	.126	trace.	11.900	8.780	53.462	Ozeoro Furnace (Pot Ore.)
1102	Lyon	78.000	.480	trace.	.107	1.084	.758	.097	.424	.120	10.820	9.480	54.622	Mammoth Fur. (Brown Ore, A.)
1103	Lyon	74.547	1.080	trace.	.479	.280	1.399	.132	.251	.207	11.100	10.680	52.206	Mammoth Fur. Brown Ore, B.
1104	Lyon	76.425	.440	trace.	.441	.380	.615	.132	.143	.145	11.100	10.980	53.522	Mammoth Fur. (Brown Ore, C.)
1105	Lyon	64.433	1.880	trace.	.446	.180	.807	.200	.135	.016	9.708	23.920	45.123	Mammoth Fur. (Brown Ore, D.)
1106	Lyon	72.356	.480	trace.	.443	.480	.502	.097	.328	.255	11.300	13.480	51.022	Mammoth Fur. (Brown Ore, E.)
1107	Lyon	64.269	.580	trace.	.479	.680	.871	.180	.251	.002	10.500	21.880	44.939	Mam. Fur. (Honey-comb Ore.)
1108	Lyon	76.880	1.130	trace.	.795	1.080	.887	.098	.502	.109	11.700	6.680	53.840	Mam. Fur. (Brown Ore, No. 11.)
1115	Lyon	85.637	.580	trace.	.690	1.280	1.143	.306	.463	.195	5.900	4.480	59.973	Suwannee Fur. (Iron Mount. Ore.)
1162	Muhlenburg	67.340	1.000	trace	.615	.240	1.591	.680	.154	.106	11.300	16.980	47.159	Hoskins' Ore, I'r bed, Muddy riv.
1226	Trigg	86.540	.580	trace.	.289	.184	.374	.166	.193	.076	5.560	7.080	60.605	Empire Furnace "Pot Ore."
1227	Trigg	68.540	.480	trace.	.854	.384	.156	.122	.502	.129	11.180	17.100	48.009	Empire Furnace "Brown Ore."
1233	Trigg	78.840	1.380	trace.	.873	.980	.483	.441	.270	.197	3.720	11.580	47.230	Centre Furnace "Pot Ore."
1234	Trigg	73.54	1.380	trace.	.500	.640	.220	.097	.359	.123	11.320	9.740	51.511	Centre Furnace "Brown Ore."

(TABLE III. (A.) IRON ORES. *Limonites*—Continued.)

Number in the report.	County.	Oxide of iron.	Alumina.	Carbonate of lime.	Magnesia.	Brown oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Combined water.	Silica, &c.	Percentage of iron.	Remarks.
1235	Trigg ------	73.340	0.921	trace.	0.527	0.440	0.159	0.475	0.289	0.043	9.460	15.380	51.361	Centre Fur. Brown Ore near fur.
1244	Trigg ------	77.070	.480	trace.	.773	.580	.418	.097	.308	.270	11.100	9.440	53.973	Fulton Furnace "Pot Ore"
1245	Trigg ------	73.680	.380	trace.	.649	.380	.886	.097	.231	.021	10.800	13.230	51.599	Fulton Furnace "Brown Ore."
1252	Union -----	38.240	.778	0.580	.615	.580	.502	4.426	.328	.301	5.100	11.300	--------	Bitumen, &c., = 57.800; Curlew Black Band.

* Carbonates.

TABLE III. (B.) IRON ORES. (*Carbonate of Iron.*)

Number in the report.	County.	Specific gravity.	Carbonate of iron.	Oxide of iron.	Alumina.	Carbonate of lime.	Carbonate of magnesia.	Carbonate of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Bituminous matter.	Silex and silicates.	Water.	Percentage of iron.	Remarks.
787	Bath	3.33	47.330	11.880	4.180	5.490	7.754	1.987	0.886	0.473	0.174	0.171	......	19.580	......	31.192	Clear Creek Furnace.
788	Bath	....	44.575	7.121	3.320	5.290	7.187	.722	1.120	.338	.788	.247	......	17.380	......	26.020	Clear Creek Furnace.
789	Bath	....	43.716	3.937	1.881	1.184	5.903	.873	.489	.303	.255	.286	......	40.880	......	23.838	Clear Creek Furnace.
865	Carter	....	20.190	51.310	.380	.880	2.926	1.475	[illegible]	.441	.374	.010	......	11.780	0.412	45.028	Star Furnace.
866	Carter	....	87.527	.778	.084	trace.	1.954	1.324	.267	.613	.181	trace.	......	[illegible]	......	42.167	Star Furnace.
867	Carter	....	60.134	4.775	.480	1.080	5.105	1.987	.510	[illegible]	.193	.153	......	21.480	......	32.395	Star Furnace.
896	Crittenden ...	3.353	64.191	2.948	.480	2.124	13.205	1.324	.852	.301	.704	.270	......	12.[illegible]0	......	32.043	Crittenden Furnace.
897	Estill	3.5[illegible]6	78.086	1.030	2.463	1.880	4.508	3.492	.438	[illegible]	.231	.198	......	8.[illegible]0	......	39.[illegible]1	Cottage Furnace.
934	Estill	....	54.147	16.197	1.160	6.190	3.885	2.090	.438	.303	.250	.321	......	13.190	......	37.495	Cottage Furnace.
948	Estill	....	64.210	4.543	.580	1.120	9.335	2.077	.464	.300	.424	.281	......	13.180	2.7	34.203	Station Camp creek.
1004	Greenup	2.985	41.290	4.700	1.580	1.880	5.981	2.990	.774	[illegible]	.571	.140	......	[illegible].000	......	22.788	Kenton Furnace.
1005	Greenup	3.275	5[illegible].267	3.882	5.980	4.980	3.626	.873	2.[illegible]	.730	.257	.186	8......	20.680	......	29.024	Kenton Furnace.
1012	Greenup	....	59.130	....	2.200	1.980	4.375	1.445	.482	.612	not est.	not est.	......	57.980	......	24.100	Little Sandy river.
1014	Greenup	3.440	47.024	5.088	.780	17.690	4.123	1.650	1.[illegible]3	.[illegible]	.380	.302	......	.320	......	36.234	Caroline Furnace.
1016	Greenup	....	81.448	1.493	.940	2.580	2.581	1.126	.371	1.[illegible]7	.298	.011	......	7.924	......	0.646	Bellefonte Furnace.
1018	Greenup	3.128	17.703	21.286	.920	37.580	2.901	1.475	[illegible]0	1.370	.270	.166	......	8.480	7 [illegible]	23.488	Raccoon Furnace.
1024	Hancock	3.518	73.026	5.752	1.400	1.380	7.020	.374	.094	.298	.201	.172	......	9.080	......	31.593	Lewisport.
1092	Laurel	....	72.900	....	1.980	3.180	4.751	1.304	1.[illegible]8	.444	not est.	not est.	......	13.520	......	35.284	On Gillis' branch.
1152	Montgomery	....	46.171	18.489	2.100	6.95	4.136	1.026	.070	.[illegible]7	.336	.170	......	17.48[illegible]	......	35.254	Wall [illegible] (Clinton group.)
1155	Morgan	....	48.020	16.651	1.980	1.480	6.380	.722	.505	.517	.558	......	......	17.550	.473	36.572	In coal shale.
1159	Morgan	....	55.782	9.334	.380	1.084	2.274	1.776	.235	.339	.032	.177	3.377	21.880	......	28.571	On Red river.
1210	Owsley	3.251	38.381	22.514	.920	.151	8.414	1.083	.780	.372	.300	.200	4.020	22.500	......	34.504	In the coal shales.
1211	Owsley	3.435	62.292	7.726	.550	1.98	8.885	1.284	1.413	.390	.292	.247	2.887	11.9[illegible]	......	[illegible]	On J. G. McGuire's land.
1232	Powell	[illegible]57	51.082	10.580	2.440	5.780	10.048	4.034	1.[illegible]	.235	.337	.227	......	14.040	......	32.021	Knob iron ores.
1218	Pulaski	....	79.781	1.551	1.080	1.580	3.024	.180	.778	[illegible]	.212	.421	.820	8.780	......	39.038	Cumberland Coal Co. mines.

TABLE IV. COALS.

Number in the report.	County.	Specific gravity.	Moisture.	Volatile combustible matters.	Carbon in the coke.	Ashes.	Total volatile matters.	Coke.	Sulphur.	Crude oil from 1000 grains.	Remarks.
819	Bath	1.288	2.90	37.30	56.50	3.30	40.20	59.80	0.806	----------	Flower hill bank, on Indian creek.
820	Bath	1.288	5.30	35.84	55.80	3.06	41.14	58.86	0.672	----------	Cox and McCormick's, on Beaver creek.
821	Bath	1.268	2.30	40.10	53.86	3.74	42.40	57.60	2.522	----------	"Big Bank," on Indian creek.
834	Breathitt	1.278	0.70	44.00	39.90	15.40	44.70	55.30	0.452	273 grains.	Cannel coal, Quicksand creek.
835	Breathitt	1.219	0.30	56.70	38.10	4.90	57.00	43.00	1.513	364 grains.	Cannel coal, from South's bank.
870	Carter	1.266	7.70	36.50	53.80	2.00	44.20	55.80	1.267	----------	Star Furnace.
871	Carter	1.200	.60	66.30	28.30	4.80	66.90	33.10	1.320	436 grains.	Cannel coal, Stinson bank.
872	Carter	------	1.26	39.64	49.40	9.70	40.90	59.10	0.694	----------	Carter's hill, (upper 18 inches.)
873	Carter	1.298	4.40	35.00	52.70	7.90	39.40	60.60	3.261	----------	Carter's hill, (under 18 inches.)
874	Carter	1.299	4.26	35.94	55.30	6.50	40.20	59.80	2.339	----------	Tar Kiln branch of Stinson's cr'k, (upper part) (bituminous.)
875	Carter	1.145	0.90	64.16	27.04	7.90	65.06	34.94	2.843	411 grains.	Tar Kiln branch of Stinson's cr'k, (under part) (cannel)
929	Crittenden	1.297	1.00	36.50	51.90	10.60	37.50	62.50	0.686	----------	Sneed's mines, (cannel coal portion.)
964	Estill	1.336	2.90	37.76	50.84	8.50	40.66	59.34	4.350	----------	Billy's Fork of Miller's creek, (Townsend's.)
1021	Greenup	1.271	4.70	40.20	52.40	2.70	44.90	55.10	0.837	209 grains.	Bradford's ——— on Fulton Forge farm.
1035	Hancock	1.359	4.30	37.20	42.60	15.90	41.50	58.50	1.306	----------	Upper part of Mayo's coal, Hawesville.
1036	Hancock	1.268	5.46	41.14	48.80	4.60	46.60	53.40	3.661	----------	Boyd's coal, Hawesville.
1057	Hopkins	1.274	4.06	37.44	54.80	3.70	41.50	58.50	2.796	----------	Arnold's coal.
1064	Jackson	1.290	1.10	38.20	50.80	9.90	39.30	60.70	0.962	----------	Mr. Isaac's coal.
1153	Montgomery	1.264	2.70	38.60	55.80	2.90	41.30	58.70	1.072	----------	30 feet under the conglomerate.
1054	Montgomery	1.270	3.60	38.00	55.40	3.00	41.60	58.40	1.210	----------	"Cabin bank," Hawkins' branch of Slate creek.
1160	Morgan	1.253	4.40	34.80	60.06	0.74	39.20	60.80	0.672	----------	"Casby's bank," Elk Fork of Elk branch.
1161	Morgan	1.250	3.34	41.26	54.06	1.34	44.60	55.40	0.870	----------	On big branch of Lick Fork of Elk branch.
1163	Muhlenburg	1.287	3.30	37.80	56.10	2.80	41.10	58.90	2.711	----------	McNairy's, seven feet coal.
1164	Muhlenburg	1.593	7.06	30.84	58.70	3.40	37.90	62.10	0.879	----------	Upper coal at Airdrie.
1199	Ohio	1.298	2.60	41.20	52.66	3.54	43.80	66.20	1.829	----------	Bull Run coal.
1200	Ohio	1.389	1.50	39.70	37.80	21.00	41.20	58.80	3.234	----------	Crawford's coal.
1213	Owsley	1.275	2.06	34.34	56.50	7.10	36.40	63.60	0.796	----------	Big Vein, (Philips'.)
1214	Owsley	1.235	2.30	37.30	58.90	1.50	39.60	60.40	.645	----------	Big Vein, (McGuire's.)
1219	Owsley	1.338	1.50	36.70	55.14	6.60	38.26	61.75	4.074	----------	Big Vein, Beatty's river bank.
	Rockcastle	1.419	1.66	37.74	58.26	2.34	39.40	60.60	.808	----------	Wm. Dyre's bank, Skeggs' creek.

TABLE IV. COALS—Continued.

Number in the report.	County.	Specific gravity.	Moisture.	V[illegible]tile ombustible matters.	Carbon in the coke.	Ashes.	Total volatile matters.	Coke.	Sulphur.	Crude oil from 1000 grains.	Remarks.
1220	Rockcastle	1.259	1.70	36.30	59.80	2.20	38.00	62.00	0.685	----------	Henry Mullins' bank, Skeggs' creek.
1254	Union	1.423	2.00	35.40	37.30	25.30	37.40	62.60	16.142	----------	Payne & Berry's coal, (upper part.)
1255	Union	1.274	4.50	37.10	55.10	3.30	41.60	58.40	3.262	----------	Payne & Berry's coal, (lower part.)
1256	U. ion	1.282	0.40	35.50	48.20	15.90	35.90	64.10	1.017	----------	Casey's mines, (cannel, upper part.)
1257	Ut.ion	1.328	1.00	40.30	44.30	14.40	41.30	58.70	9.639	190 grains.	Curlew mines, (bird's-eye coal.)
1258	Union	1.295	1.34	35.96	59.10	3.60	37.30	62.70	1.609	----------	Mulford Coal Company bank.

TABLE V. SANDSTONES, SHALES, CLAYS, &c.

Number in the report.	County.	Sand and silicates.	[illegible]nate of lime.	Magnesia.	Alumina.	Oxide of iron.	Oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Water expelled at a red heat.	Bituminous matters.	Lime.	Remarks.
824	Bracken	88.580	0.920	0.899		6.460		0.438	0.200	0.560	0.166	1.900	......	.....	Lower Silurian mudstone.
836	Breckinr'ge	98.340	trace.	.266		.580		trace.	.042	trace.	trace.	.772	......	.....	White sandstone.
847	Bullitt	90.380	trace.	.800		5.660		.118	.231	.463	.142	2.206	......	.....	Knob building stone.
855	Bullitt	69.420	......	......		12.725		.216	3.830	1.271	.217	12.040		1.458	Black (Devonian) shale.
899	Crittenden	99.080	trace	.360		.080		trace.	.064	.386	.121	.300	......	.....	Crittenden Furnace (hearthstone.)
900	Crittenden	98.680	trace.	.400		.380		trace.	trace.	.464	.058	.500	......	.....	Crittenden Furnace (hearthstone.)
916	Crittenden	97.430	trace	.566		.980		trace.	trace	.213	.156	.685	......	.....	Hurricane Furnace (hearthstone.)
917	Crittenden	98.580	trace.	.666		.640		trace.	trace	.241	.124	.240	......	.....	Hurricane Furnace (hearthstone.)
918	Crittenden	98.640	trace.	.266		.580		trace	trace.	.212	.028	.400	......	.....	Hurricane Furnace (hearthstone.)
927	Crittenden	62.280	*.325	1.815	18.880	3.560	......	.115	......	3.558	trace.	9.067	......	.....	Hurricane Furnace (fire clay.)
923	Crittenden	96.980	trace.	.599		.680		not est.	.058	.162	.129	1.392	......	.....	Hur. Furnace (silicious concretion.)
946	Estill	71.780	none.	.547	17.580	2.420	......	not est.	.112	2.271	.322	4.410	......	.....	Potters' clay.
959	Estill	82.280	.244	.433		6.860		.310	.132	1.101	.349	8.300		.....	Black Devonian shale.
991	Grant	78.480	2.780	1.491		12.340		.640	.338	.957	trace.	3.074	......	.....	Shale (Lower Silurian.)
1006	Greenup	44.020	trace	.373	32.81	7.88	......	.310	.....	.146	1.121	13.360	......	.....	Kenton Furnace.
1007	Greenup	42.920	trace.	.215	37.44	4.94	.....	.207	......	.155	.205	13.700	......	.....	Kenton Furnace. } Ferruginous clay-stones.
1008	Greenup	47.780	trace.	.291		41.000		.216	......	.193	.856	13.360	......	.....	Kenton Furnace.
1049	Henry	80.380	.789	.933		11.650		.310	.304	.490	.257	4.896	......	.....	Mastodon bed clay.
1050	Henry	46.480	trace.	.566		40.172		3.128	.461	.463	.141	8.746	......	.....	Ditto (ferruginous.)
1046	Lewis	90.920	trace.	.732		5.800		.118	.300	trace.	trace.	2.400	......	.....	Soft yellow sandstone.
1095	Livingston	94.280	trace.	.513		3.560		trace.	.152	.193	.050	2.100	......	.....	Hearthstone Ozcora Furnace.
1117	Lyon	98.080	trace.	.466		.440		trace.	.066	.728	.255	.600	......	.....	Do Suwannee Furnace, Union co.
1122	Madison	62.580	trace.	1.276	21.980	4.78	trace.	not est.	.234	2.607	.500	6.140	......	.....	Potters' clay.
1124	Madison	63.120	11.180	2.034		8.560		.143	1.053	1.363	......	12.000		.....	Black shale.

TABLE V. SANDSTONES, SHALES, CLAYS, &c.—Continued.

Number in the report.	County.	Sand and silicates.	Carbonate of lime.	Magnesia.	Alumina.	Oxide of iron.	Oxide of manganese.	Phosphoric acid.	Sulphuric acid.	Potash.	Soda.	Water expelled at a red heat.	Bituminous matters.	Lime.	Remarks.
1221	Rowan	90.240	1.480	0.932		3.965		0.117	0.269	0.336	0.059	2.900	------	-----	Sandstone. Knob building stone.
1224	Scott	75.920	1.480	†6.220		11.660		.482	.338	not est.	not est.	3.900	------	-----	Shale, milk-sickness district.
1225	Scott	77.840	3.784	†3.401		9.140		.566	.303	.579	.047	4.349	------	-----	Mudstone, milk-sickness district.
1253	Union	94.080	trace.	.733		2.660		.092	.097	.250	.103	1.700	------	-----	Hearth sandstone, Emp. Furnace.

* Lime. † Carbonate.

TABLE VI. IRON FURNACE SLAGS.

Number in the report.	County.	Silica.	Alumina.	Lime.	Magnesia.	Protoxide of iron.	Protoxide of manganese.	Phosphoric acid.	Sulphuric acid or sulphur.	Potash.	Soda.	Oxygen in the bases.	Oxygen in the silica.	Proportion of the oxygen in the bases to the oxygen in the silica.	Furnace.
905	Crittenden	59.580	7.980	23.164	1.358	4.464	0.260	not est.	(Sulphur) 0.135	1.425	0.130	12.258	30.050	as 1 : 2.451	Crittenden fur.
906	Crittenden	61.980	9.080	24.623	1.538	.963	.446	not est.	(Sulphur) .052	1.317	.275	12.495	32.182	as 1 : 2.575	Crittenden fur.
907	Crittenden	64.880	7.480	15.847	1.287	7.164	.781	not est.	(Sulphur) .080	2.047	.271	10.692	33.688	as 1 : 3.150	Crittenden fur.
908	Crittenden	65.520	8.280	22.155	1.645	1.584	.353	not est.	(Sulphur) .149	1.892	.162	11.599	34.021	as 1 : 2.941	Crittenden fur.
923	Crittenden	55.380	14.440	25.578	3.304	1.494	trace.	not est.	not est.	1.815	.173	16.017	28.755	as 1 : 1.798	Hurricane fur.
924	Crittenden	55.580	13.380	25.241	3.660	1.854	trace.	not est.	not est.	1.495	.199	15.611	28.859	as 1 : 1.848	Hurricane fur.
925	Crittenden	56.980	13.280	16.936	2.845	10.495	trace.	not est.	not est.	1.398	.016	14.729	29.585	as 1 : 2.008	Hurricane fur.
926	Crittenden	59.980	11.880	21.066	3.566	4.014	trace.	not est.	not est.	1.151	.388	14.154	31.143	as 1 : 2.200	Hurricane fur.
940	Estill	56.300	16.100	21.414	1.845	1.170	.595	0.654	not est.	1.757	.190	15.070	29.232	as 1 : 1.930	Cottage fur.
941	Estill	58.040	12.360	18.058	1.333	6.122	1.060	.117	not est.	1.970	.309	12.496	30.136	as 1 : 2.331	Cottage fur.
1015	Greenup	52.580	11.280	16.905	2.141	10.783	2.121	trace.	not est.	3.121	.265	14.397	27.301	as 1 : 1.896	Clinton furnace
1099	Livingston	62.580	7.380	25.465	1.244	.882	.539	trace.	not est.	1.313	.905	11.959	32.493	as 1 : 2.717	Ozeoro furnace.
1100	Livingston	63.380	8.960	20.751	1.462	3.456	.450	trace.	not est.	1.649	.207	11.881	32.909	as 1 : 2.790	Ozeoro furnace.
1101	Livingston	63.380	9.560	19.461	2.543	2.914	.487	trace.	not est.	1.680	.202	12.074	32.909	as 1 : 2.725	Ozeoro furnace.
1112	Lyon	64.880	3.980	22.772	1.358	3.258	.446	not est.	.289	1.854	.375	10.108	33.687	as 1 : 3.332	Mammoth fur.
1113	Lyon	65.080	8.040	20.190	.877	4.158	.541	not est.	.290	1.398	.365	11.217	33.791	as 1 : 3.012	Mammoth fur.
1114	Lyon	60.280	5.800	13.288	.948	16.525	.651	not est.	.324	1.676	.397	11.065	31.209	as 1 : 2.828	Mammoth fur.
1118	Lyon	61.180	5.380	23.333	1.071	4.410	.818	not est.	.269	1.661	.176	11.088	31.766	as 1 : 2.866	Suwannee fur.
1229	Trigg	64.480	5.280	19.317	1.304	6.462	.911	not est.	not est.	1.953	.319	10.514	33.485	as 1 : 3.204	Empire furnace.
1237	*Trigg	65.140	7.580	22.715	.826	1.404	.171	not est.	not est.	1.564	.228	11.305	33.822	as 1 : 2.991	Centre furnace.
1238	Trigg	63.680	8.880	21.088	.965	2.505	.632	not est.	not est.	1.630	.180	11.566	33.064	as 1 : 2.859	Centre furnace.
1948	Trigg	64.880	8.980	21.200	1.087	2.660	.540	not est.	not est.	1.533	.358	11.722	33.687	as 1 : 2.874	Fulton furnace.

TABLE VII. PIG IRON.

Number in the report.	County.	Specific gravity.	Iron.	Graphite.	Combined carbon.	Total carbon.	Manganese.	Silicon.	Slag.	Aluminum.	Calcium.	Magnesium.	Potassium.	Sodium.	Phosphorus.	Sulphur.	Furnace, &c.
781	Bath	7.069	94.542	1.700	none.	1.700	0.692	1.067	0.080	0.309	trace.	0.169	0.142	0.050	0.084	0.135	Slate F.
795	Bath	6.912	97.060	.400	none.	.400	.634	.471	none.	.255	trace.	.220	.177	.140	.108	.166	Clear cr. F. Sal.
869	Carter	7.093	90.606	2.100	1.520	3.620	1.507	2.181	.284	.301	trace.	.303	.073	trace.	1.404	.135	Star Furnace.
901	Crittenden	6.983	90.733	1.884	1.716	3.600	.129	3.490	.664	.084	trace.	.271	.102	.065	.864	.127	Crittenden F.
902	Crittenden	6.990	91.094	2.024	.340	2.364	.633	3.777	.724	.202	trace.	.414	.080	.097	.443	.052	Crittenden F.
903	Crittenden	6.603	91.111	2.224	.420	2.642	.417	3.508	.984	.202	trace.	.417	.054	.077	.320	.052	Crittenden F.
904	Crittenden	7.399	93.879	.384	4.500	4.884	.344	.623	.084	.202	trace.	.451	.080	.097	.451	.127	Crittenden F.
919	Crittenden	7.065	91.871	2.040	2.284	4.321	.172	2.180	.184	.202	trace.	.368	.064	.054	.727	.066	Hurricane F.
920	Crittenden	7.106	92.143	2.624	1.560	4.184	.433	2.065	.284	.170	trace	.348	.048	.082	.540	.066	Hurricane F.
921	Crittenden	7.926	92.263	.984	5.360	6.344	.417	.142	.184	.262	trace.	.328	.105	.177	.464	.108	Hurricane F.
922	Crittenden	7.278	92.336	2.224	2.860	5.084	.345	.624	.084	.149	trace.	.220	.089	.012	.446	not est.	Hurricane F.
942	Estill	7.112	93.689	3.150	.610	3.760	.689	.989	.320	.047	trace.	.258	.068	.098	.344	.060	Cottage F.
943	Estill	7.121	93.793	3.220	.550	3.770	.548	.793	.260	.055	trace.	.225	not est.	not est.	.474	.120	Cottage F.
910	Greenup	6.861	94.162	2.120	.180	2.300	.078	1.085	.284	.255	trace.	.675	.112	.049	1.050	.232	Kenton F.
1011	Greenup		94.057	1.556	.914	2.470	.345	.507	.284	.149	trace.	.179	.640	.109	.823	.259	Kenton F.
1096	Livingston	7.029	91.714	2.624	1.700	4.324	.634	1.796	.244	.063	trace.	.263	.089	.012	.755	.053	Ozeoro F.
1097	Livingston	7.082	92.548	2.524	1.380	3.904	.417	1.853	.384	.095	trace.	.222	.092	trace.	.671	.061	Ozeoro F.
1098	Livingston	7.295	93.459	1.984	2.360	4.344	.201	.892	.184	.202	trace.	.165	.096	.006	.502	.071	Ozeoro F.
1109	Lyon	6.853	93.086	2.660	1.140	3.800	.421	1.681	.384	.255	trace.	.282	.064	.070	.781	.080	Mammoth F.
1110	Lyon	7.038	92.464	2.800	1.500	4.300	.233	1.104	.384	.201	trace.	.189	.080	.145	1.065	.080	Mammoth F.
1111	Lyon	7.410	93.251	none.	4.500	4.500	.276	.094	.484	.095	trace.	.228	.134	.135	1.346	.080	Mammoth F.
1119	Lyon	6.989	92.414	2.641	2.456	5.100	.201	1.950	.384	.224	trace.	.258	.096	.102	.192	.100	Suwannee F.
1120	Lyon	6.924	92.560	2.824	1.876	4.700	.273	.863	.484	.131	trace.	.419	.086	.014	.321	.149	Suwannee F.
1121	Lyon	7.607	94.338	.984*	3.000	3.984	.129	.375	none.	.095	trace.	.325	.102	.057	.387	.152	Suwannee F.
1230	Trigg	7.063	92.984	2.700	2.060	4.760	.132	1.104	.284	.177	trace.	.226	.052	trace.	.219	.094	Empire F.
1231	Trigg	7.487	93.686	3.200	1.360	4.560	.133	1.536	.136	.307	trace.	.264	.104	trace.	.389	.226	Empire F.
1232	Trigg	7.609	95.747	trace.	2.400	2.400	.334	.373	.104	.149	trace.	.224	.157	trace.	.333	.080	Empire F.
1239	Trigg	7.126	94.786	2.500	1.700	4.200	.133	1.345	.184	.177	trace.	.285	.048	.042	.080	.122	Centre F.
1240	Trigg	7.411	96.912	2.000	1.000	3.000	.133	.624	.184	.177	trace.	.333	.070	.065	.108	.152	Centre F.
1249	Trigg	7.144	93.546	3.360	1.640	5.000	.276	1.008	.184	.069	trace.	.264	.164	.070	.192	trace.	Fulton F.
1250	Trigg	6.918	93.201	2.500	1.800	4.300	.276	1.008	.884	.095	trace.	.311	.064	.070	.252	.053	Fulton F.

* A brown carbonaceous material, not true graphite.

APPENDIX.

For the sake of comparison with the soils of Kentucky, a number of soils from the States of Illinois, Indiana, Iowa, Minnesota, and Wisconsin, mostly prairie soils, collected by Dr. D. D. Owen, during his northwestern explorations, were submitted to analysis. The results are given below.

No. 1262—Soil. *Labeled "Illinois Virgin Prairie Soil. Surface soil, at the junction of the Illinois Central, and the Ohio and Mississippi railroads, Odin, Marion county, Illinois. (Collected by W. A. Gunn, Esq.")*

The dried soil is of a mouse color.

No. 1263—Soil. *Labeled "Upland Soil, (sec. 16, T. 27, N. R. 15 W. of 4th P. M.) L'Eau Gallee, Wisconsin. On the confines of the lower sandstone and lower magnesian limestone, of the Lower Silurian formation." (Collected by Dr. Owen.)*

Dried soil of a mouse color, containing a large proportion of vegetable remains, and some small rounded clear grains of sand.

No. 1264—Soil. *Labeled "Soil from the White Earth Prairie: six miles above Traverse des Sioux. Minnesota or St. Peters river." (Collected by Dr. D. D. Owen.)*

Dried soil of a dark umber color, nearly black; exhibiting much silicious sand, in the form of rounded transparent and reddish and milky grains. A fragment of dark-brown oxide of iron sifted out of it.

No. 1265—Soil. *Labeled "Virgin Soil, collected near the cliffs of the sub-carboniferous magnesian limestone; three or four miles below the falls of the Iowa river, Iowa." (Collected by Dr. D. D. Owen.)*

Dried soil of a dark mouse color, containing small rounded grains of hyaline and milky quartz sand; and an irregular fragment of yellowish magnesian limestone.

No. 1266—SOIL. *Labeled "Upland Soil, in the woods near Ballard's Coal Bank, Iowa river."* (*Collected by Dr. Owen.*)

Dried soil of a dark slate-grey color.

No. 1267—SOIL. *Labeled "Soil near the plaster bed, near correction line. Upper Des Moines river, below Lizard Fork, Iowa."* (*Collected by Dr. D. D. Owen.*)

Dried soil of an umber grey or light umber color; contains small rounded grains of clear and reddish quartz sand, and some small rounded quartz pebbles and shot iron ore.

No. 1268—SOIL. *Labeled "Soil on the sub-carboniferous limestone on the Iowa river, (section 1, Township 82, Range 15,) below Toledo, Iowa."* (Collected by Dr. D. D. Owen.)

Dried soil of a dark mouse color; it contains small rounded grains of clear quartz sand.

One thousand grains of each of these soils, air-dried, were digested, severally, for a month, in water charged with carbonic acid. The soluble materials extracted are stated in the following table, viz:

	No. 1262.	No. 1263.	No. 1264.	No. 1265.	No. 1266.	No. 1267.	No. 1268.
	Illinois.	Wis'n.	Minn'a.	Iowa.	Iowa.	Iowa.	Iowa.
Organic and volatile matters	0.633	8.523	4.100	3.000	1.060	0.444	2.433
Alumina, and oxides of iron and manganese and phosphates	.097	1.187	2.030	1.203	.830	.213	.896
Carbonate of lime	.497	6.430	3.847	10.053	5.707	.863	2.173
Magnesia	.101	.050	.610	.443	.393	.199	.405
Sulphuric acid	.045	.067	.033	.039	.033	.050	.039
Potash	.035	.240	.201	.061	.154	.091	.064
Soda	.057	.129	.532	.051	.055	.057	.114
Silica	.264	.564	.414	1.347	.464	.447	.264
Loss	.021	....	.016	.220	.921	.079	....
Soluble extract, dried at 212° F., (grains)	1.750	17.190	11.783	16.417	9.617	2.443	2.388

The large amount of soluble matter in most of these soils is remarkable. It will also be observed that most of them give up a greater quantity of *silica* in its soluble condition than any of the Kentucky soils; which is no doubt due to the very large amount of the decomposed remains of grasses which they contain; most of these soils, except the one from "near Ballard's, in the woods," being prairie soils, on which for an unknown time the grasses have annually grown up and decayed; leaving in their remains not only a large amount of soluble matter in general but also a large proportion of soluble silica.

The composition of these seven soils, dried at 400° F., is as follows:

	No. 1162. Illinois.	No. 1263. Wiscon-sin.	No. 1264. Minneso-ta.	No. 1265. Iowa.	No. 1266. Iowa.	No. 1267. Iowa.	No. 1268. Iowa.
Organic & volatile matters	5.082	19.201	*10.949	14.985	5.530	2.606	7.150
Alumina	3.200	1.150	3.675	1.565	1.560	2.285	6.035
Oxide of iron	2.410	1.869	5.160	2.785	2.420	2.110	4.310
Carbonate of lime	.245	1.945	.945	38.395	1.370	.445	.871
Magnesia	.598	.815	.701	1.782	.580	.561	.891
Brown oxide of manganese	.115	.395	.295	.195	.120	.071	.290
Phosphoric acid	.152	.218	.275	.229	.118	.062	.164
Sulphuric acid	.072	.175	.110	.119	.059	.058	.067
Potash	.222	.270	.406	.191	.290	.323	.463
Soda	.039	.092	.177	.057	.038	.063	.075
Sand and insoluble silicates	87.895	74.045	78.045	40.620	87.845	91.595	79.280
Loss	.090	----	----	----	.070	----	.404
Total	100.000	100.166	100.748	100.843	100.000	100.179	100.000
Moisture, expelled at 400° F.	2.40	6.125	4.475	3.725	1.900	1.200	4.525

These soils may be considered amongst the most fertile of the northwest; in the virgin or uncultivated condition. They are generally remarkable for the large proportion of *organic materials* which they contain, and consequently for their great amount of *soluble matter*. Mostly the proportions of alumina and oxide of iron are moderate, even below the average; whilst in the mineral elements which enter into the composition of vegetables and animals* they are generally rich; but they do not in this respect excel, and several do not equal, the rich lands of Kentucky based on the soft beds of the blue limestone of the Lower Silurian formation. Soil No. 1265, from near the cliffs of the sub-carboniferous limestone, &c., Iowa, contains an extraordinary quantity of carbonate of lime.

CHEMICAL INVESTIGATION INTO THE COMPOSITION OF THE ASHES OF KENTUCKY TOBACCO.

In view of the importance of the tobacco crop in Kentucky, and of the rapidity with which this plant exhausts the soil on which it is grown, it was thought advisable to endeavor, by the analysis of the ashes of a variety of samples from different parts of the country, as well as by

* Viz: Potash, soda, lime, magnesia, phosphoric and sulphuric acids, &c.

the analysis of the virgin soil and that which had been exhausted by this crop, to ascertain the amount and nature of the mineral ingredients necessary to this plant, as compared with wheat, corn, &c, and thus to find out the best means of preserving or restoring the fertility of the land employed in this kind of culture.

By the kindness of Robert W. Scott, Esq., a number of *premium specimens* of the best leaf tobacco of the State was obtained for this purpose, from the rooms of the State Agricultural Society, at Frankfort. I was also indebted to the politeness of Mr. Spratt, of Pickett's tobacco warehouse, Louisville, who sent, at my request, a large number of samples from many counties of the State, amongst which were several premium specimens. To make the comparison as complete as possible, some of the best Cuba and Florida cigar leaf tobacco were obtained from Mr. Meyer, cigar manufacturer of this city, who had imported them; and who also obliged me by classifying the various samples which I had collected.

Out of all the specimens on hand, thirty were selected from regions representing as many different geological formations as possible; a second object in the investigation being to endeavor to verify the statement made by Liebig in his Agricultural Chemistry, on the authority of Pelouze, that the quality of tobacco is affected by the nature and composition of the soil on which it is grown. The statement referred to is as follows: "A most striking proof of the influence of potash upon vegetation has been furnished by the 'administration' in Paris. For many accurate analyses of the ashes of various sorts of tobacco have been executed, by the orders of the 'administration;' and it has been found, as the result of these, that the value of the tobacco stands in a certain relation to the quantity of potash contained in the ashes. By this means a mode was furnished of distinguishing the different soils upon which the tobacco under examination had been cultivated, as well as the class to which it belonged. Another striking fact was also disclosed through these analyses. Certain celebrated kinds of American tobacco were found gradually to yield a smaller quantity of ashes, and their value diminished in the same proportion. For this information I am indebted to M. Pelouze, Professor of the Polytechnic School in Paris."

The most extended examination of the chemical composition of the ashes of tobacco, of which I can find any account in the books within my reach, were made by M. Barral, and reported to French Academy; a notice of which I find in the *Comptes Rendus des Sceances de l'Acad. des Sc.*, 22d Dec., 1845, p. 1374. M. Barral seems to have examined a number of samples of tobacco, from various soils and different parts of the world. He found the proportion of the ash to vary in the different parts of the plant, as follows:

In the leaves, it amounted to	23. per cent.
In the midribs of the leaves to	22. per cent.
In the stems to	10. per cent.
In the roots to	7. per cent.
In the seeds to	4. per cent.

In this *notice*, I find the following remarks: "The several kinds of tobacco examined, being from soils naturally very different, gave ashes, the composition of which is very various. But in the midst of this variety a fact presents itself, of which the constancy is worthy of remark. M. Liebig has announced this principle; that, in the same plant, according to circumstances, one base may replace an equivalent proportion of another analogous base. This principle has never before been verified by a suite of experiments made on a plant brought from so many different countries. It results from the figures contained in my *memoire* that, (with exception of the roots,) the quantity of *oxygen* contained in the bases of the ashes of the *stalks, midribs,* and *leaves,* of all kinds of tobacco, is, on an average, 13 *per cent.*" M. Barral adds, that the tobacco is the plant which contains the largest quantity of ashes, and the largest amount of *nitrogen,* in its composition, of all plants.

For the benefit of the non-chemical reader, we will state, that a *base* is a substance, which forms salts with acids; for instance, potash, soda, lime, magnesia, oxide of iron, &c., are all *bases;* and as the *saturating* or *combining* power of the bases is always strictly in proportion to the *oxygen* they contain, the comparison of the amount of oxygen in the various bases is an exact mode of comparing their *equivalent proportion,* or *saturating power.*

The present occasion was taken to endeavor to verify this statement of Liebig, in regard to the equivalency of the bases contained in the ashes of tobacco; and it will be seen, that with some exceptional cases, in which, generally, a very large quantity of magnesia and lime or soda were present, and in some others where the tobacco, grown on poor soil, had but a small percentage of ashes, there is a remarkable regularity in this respect, notwithstanding the considerable variety in percentage of the ashes. The proportion of *oxygen* in the bases does not vary much from 15 per cent. in the air-dried leaves and midribs alone; whilst the *proportion of ash* varies, in the same samples, from a little more than 12 per cent. to more than 22 per cent.! It is probable, that were the irregular quantity excluded, represented by "carbonic acid and loss," in the tables, the approximation would be greater yet. Thus, it would appear, that within certain limits, although one base may be replaced by another analogous base, in the mineral constituents of vegetables; as, for instance, soda for potash, magnesia for lime, and vice versa, yet they tend to replace each other in *definite proportions*, (or equal saturating quantities,) as in ordinary chemical combinations. M. Barral's calculation giving 13 per cent. as the quantity of oxygen contained in the ash, included that of the *stalks* as well as of the *leaves* and *midribs;* ours giving about 15 per cent. in the ashes of the leaves and midribs alone.

Not having been able to see the original memoir of M. Barral, and finding but very few analyses of tobacco ash recorded, in the works to which I have access, I am unable to compare the following analysis with any considerable number of others; if, indeed, many such analyses have been published, which is doubtful: but in the few which are to be found in the journals of science, the proportion of the ash to the air-dried plant is generally over stated, because the *fine sand*, derived from the dust of the soil which has adhered to the viscid leaves, has not been excluded in the analysis; hence the proportion of *silica* has been stated as high as 12 per. cent. in an analysis quoted by Sprengel, and in that by Merz, quoted at the end of the Chemical Report in the 2d Vol. of these Reports on the Geology of Kentucky, it is stated at more than four and a half per cent. In the thirty analyses given below, the average proportion of the silica is about the third of one per cent. only, and it rarely is found to exceed one and a half per cent.

The fresh leaf of the tobacco is always covered with a viscid secretion, which causes dust, &c., to adhere firmly to the surface, sometimes in considerable quantity. In these analyses the *fine sand*, from the dust of the soil adhering to the leaves, was excluded, by digesting the residual *silicious matters* in a dilute alkaline solution, and rejecting all that was not dissolved in that menstruum, which easily takes up the silica which had entered into the composition of the vegetable, and leaves the *sand* undissolved. In treating the Cuba tobacco ash in this way, it was interesting to see the sand, thus excluded, of a marked red color, showing that the plant had grown on the celebrated red soil of that island.

In ten analyses of tobacco ashes by Fresenius and Will, published in the *Journal fur Praktische Chemie*, XXXVIII, 31, June, 1846, the proportion of silica given is from 3.59 to 14.16 per cent.! although they attempted to exclude the *sand* by the use of a caustic alkaline solution. Doubtless they boiled it in too strong a solution, and thus dissolved some of the fine sand itself. They do not give the relative weight of the ash to the dried leaf, and their analyses are so much the less valuable in an agricultural sense. The proportions of *potash*, in their different specimens, vary from 23.33 to 6.01 per cent. of the ashes In Table VII (*a*,) which we have appended, giving the proportions of the several ingredients in one hundred parts of the ashes of the thirty samples analyzed for this Report, the quantity of *potash* varies from 35.38 to 20.54 per cent. In only two specimens does the *silica* appear as high as 10.66 and 9.20 per cent.; and in these, which were the first analyzed, the error mentioned above was committed.

Recently, a report of four analyses of the ashes of tobacco *leaves*, and of three of the ashes of the *stalks*, by Dr. Chas. T. Jackson, of Boston, Mass., together with the analyses of four tobacco soils and four sub-soils, have appeared in the Patent Office Report (AGRICULTURE) for 1858, p. 290. The soil and plants were from Massachusetts and Maryland. In these tobacco leaf analyses the quantity of "*silica and silicious dust*" is from 8.60 to 29.40 per cent. of the ashes! No effort having been made to exclude the *silicious sand* from the silica which entered into the composition of the leaf. The proportion of *ashes* to the air-dried leaf, with this great irregularity in the silicious dust included, varies from 14.53 to 20.20 per cent., and the quantity of *potash*, from 15.20 to 20.40 per cent. of the ash. We have appended the report of these four analyses as well as of the three of the ashes of the tobacco stalk, for reference and comparison. It will be seen that the percentage of ash to the dried stalk is from 8.72 to 10.72; the proportion of *potash* in the ashes of the stalk is from 27.48 to 40.12 per cent.; that of *lime* from 11.84 to 23.88 per cent., and that of *phosphoric acid* from 10.28 to 12.52 per cent.; provided the figures are correctly printed; for, it will be seen, there is such a remarkable *identity* of the figures (in the columns

No. 1 *a* and No. 3 *a*,) representing the proportions of the potash, soda, lime, magnesia, phosphoric acid, sulphuric acid, and chlorine, even to the smallest decimal fraction, (except in the lime,) that it is very probable some error in copying has occurred. The probability that two similar analyses should give so exactly the same figures in the results, in seven different ingredients, being quite small.

METHOD OF ANALYSIS OF THE TOBACCO ASH.

The method of analysis followed may be thus described: The various samples of tobacco, in the original small bundles of leaves, or "hands," were freely exposed, in a dry room where a fire was kept daily, until they were all thoroughly air-dried. It was found that when thus equally exposed they differed much in their apparent dryness; some samples being crisp and brittle, whilst others remained permanently soft and flexible; especially those which contained much chlorides. An average leaf* was now cut into small pieces, midrib and all, and weighed before and after exposure, for a day or more, to the temperature of boiling water in the water-bath. The loss of weight observed indicated the *moisture* of the air-dried leaf.

The dried leaf was then carefully burnt to ashes, with the lowest possible heat, in a large platinum capsule, over a spirit lamp; and the *ash*, cooled over sulphuric acid, was weighed.

The ash, not always perfectly white, was now digested in pure diluted nitric acid at a moderate heat, and, after a sufficient time, the undissolved residue, separated, washed, and dried, was weighed. This residue consists of *sand*, *silica*, and unburnt *carbon*. The amount of the latter was ascertained by burning, and was excluded from the weight of the ash, as was also the *sand*, by the process mentioned above.

The clear acid solution was now carefully divided into five equal parts by means of a pipette. One portion was evaporated to dryness, for the estimation of the dissolved *silica;* which was added to that which was left undissolved by the diluted nitric acid. Another portion was used for the estimation of the *sulphuric acid*, by nitrate of baryta, &c.

The third portion was employed for the estimation of the *phosphoric acid*, by the use of molybdate of ammonia, &c. In the fourth portion the *chlorine* was estimated, in the usual way.

* Of the small samples two or three leaves were taken.

The fifth portion was used for the *general analysis;* pretty much in the manner described in the third volume of these Reports, under the head of soil analysis; with this difference, that the first precipitate, produced by the addition of ammonia, containing the *phosphates*,* &c., after being dried and weighed, was dissolved in the smallest quantity of hydrochloric acid, and then sulphuric acid and alcohol were added to separate the *lime* as *sulphate*, by which means the amount of *phosphate of lime* (tri-basic) was calculated. The acid, alcoholic, filtrate, evaporated nearly to dryness, was now super-saturated with ammonia, which gave a precipitate of phosphates of magnesia and iron, &c. This mixed precipitate was dissolved in a small quantity of hydrochloric acid, and the *oxides of iron and manganese* separated from the *magnesia*, &c.

A separate estimation of the phosphoric acid was made by the use of the ammoniacal-sulphate of magnesia to the appropriate filtrates.

The results of these thirty analyses are as follows; given in the tabular form, and arranged, as nearly as possible, according to the geological formation in which the tobacco was grown. Beginning, however, with Cuba and Florida tobacco, which have been placed in the first table for comparison.

TABLE I (*a.*) *Composition of the ashes of Cuba and Florida Leaf Tobacco. In 100 parts of the air-dried leaf.*

	No. 1. Cuba	No. 2. Florida.	Average.
Potash	4.5249	5.9015	5.2132
Soda	.3782	.1222	.2502
Lime	5.6258	2.9889	4.3073
Magnesia	1.3590	2.1581	1.7585
Oxides of iron and manganese	.3024	.0401	.1712
Phosphoric acid	1.0788	.4240	.7512
Sulphuric acid	.2676	.4565	.3620
Chlorine	1.3748	.8212	1.0980
Silica	.3508	.2024	.2766
Carbonic acid and loss	5.4952	3.8178	4.6569
Per cent. of ash in the air-dried leaf	20.7575	16.9327	18.8451
Per cent. of moisture in the air-dried leaf	11.2111	11.1764	----------
Per cent. of phosphate of lime in the air-dried leaf	1.2063	.2087	----------
Per. cent. of phosphate of magnesia in the air-dried leaf	.2202	.2445	----------

* In consequence of the large quantity of lime and magnesia in tobacco ash, they contain all the phosphoric acid.

No. 1. Cuba Leaf Tobacco, imported by Mr. Meyer, cigar manufacturer, Lexington. Leaves quite small; of a light greenish-brown color. Flavor said to be exceedingly good in smoking.

No. 2. Florida Leaf Tobacco, also imported by Mr. Meyer; leaves very small, smaller than those of the Cuba, and of greenish-brown color, with numerous small, rounded, light-colored spots upon them. Flavor very mild and pleasant when smoked.

The leaves of both these specimens were much smaller and thinner than those of most kinds of Kentucky tobacco, and were not gummy on their surfaces.

It will be observed that the Florida tobacco leaf contains but a small proportion of *lime*, but more than makes up its proportion of alkaline earths by its large quantity of magnesia. Although the percentage of its ash is small, it contains more *potash* than any other tobacco examined.

TABLE II (a.) TOBACCO PRODUCED ON SOIL BASED ON THE LOWER SILURIAN FORMATION.

	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.	Average.
Potash	3.7811	4.9197	6.0155	4.6008	5.4248	5.1309	5.1726	5.9134	6.1241	4.8926	5.1170
Soda	1.1531	.2436	trace.	1.6448	.0244	.4025	.0828	.1810	.3701	.3404	.4267
Lime	5.6612	3.9417	5.7572	7.8798	3.6613	5.3580	4.6630	4.5119	3.8658	4.1672	4.6335
Magnesia	.7266	.4498	.4560	1.1372	.5905	.7991	.6112	.4221	.6808	.7445	.6981
Oxides of iron and manganese	.0369	.0457	.0480	.0434	.0375	.0635	not est.	.0596	.1645	.0223	.0335
Phosphoric acid	.5701	.6809	1.0090	.5395	.4797	.5164	.6130	.4512	.6441	.4063	.5089
Sulphuric acid	.6802	.5268	1.0382	.6359	.5539	.5756	.5799	.5217	.5941	.4499	.5415
Chlorine	.0609	.0750	.0828	.0749	.2557	.0324	.0733	.0723	.0154	.0340	.0583
Silica	1.6724	.1453	.7168	.1622	.2297	.1456	.3074	.5029	.0442	.1372	.2868
Carbonic acid and loss	3.8401	4.7691	5.3052	5.6785	4.5818	6.1976	4.9856	4.0867	5.6414	6.1518	5.4493
Per cent. of ash in the air-dried leaf	18.1826	15.7976	20.4287	22.3970	15.8393	19.2246	17.1068	16.7138	18.1445	17.3452	17.7736
Per cent. of moisture in the air-dried leaf	11.8820	11.5801	9.0311	9.1357	10.6180	9.5169	10.0082	10.4393	11.9069	11.5773	....
Per cent. of phosphate of lime in the air-dried leaf	.9725	.9692	2.1964	1.0197	.6149	.7812	1.0522	.7756	1.2421	1.0519	....
Per cent. of phosphate of magnesia in the air-dried leaf	.0813	not est.	.0208	not est.	not est.	.0404	not est.	no est.	.0673	.4212	....

No. 3. Mason County Cigar Leaf Tobacco; which received the premium from the Kentucky State Agricultural Society in 1856. Obtained by R. W. Scott, Esq., from the State Agricultural Society rooms at Frankfort; from whence were procured all the specimens included in this table, except Nos. 11 and 12, which were obtained, by the kindness of Mr. Spratt, from Pickett's Tobacco Warehouse, Louisville.

No. 4. "Maryland Bay Cigar Tobacco," raised in Bracken county by Dr. J. Bradford.

No. 5. "Leaf Tobacco," raised on bottom land, in Mason county. Presented to Kentucky State Agricultural Society by Hon. L. J. Bradford.

No. 6. "Leaf Tobacco," raised on hill land in Mason county. Presented as above.

No. 7. "Mason County Shipping Tobacco." Premium from Kentucky State Agricultural Society in 1857.

No. 8. "Mason County Leaf Sample." Premium from Kentucky State Agricultural Society in 1856.

No. 9. "Mason County Cigar Tobacco," raised by L. J. and J. T. Bradford, in Bracken county, Ky.

No. 10. "Bracken County Tobacco," raised by Hon. L. J. Bradford.

No. 11. Premium Cigar Tobacco. Mason county. From Pickett's Warehouse, No. 9981.

No. 12. Trimble County Cigar Tobacco. From Pickett's Warehouse, No. 9976.

These were very fine samples of the best leaf tobacco of Mason, Bracken, and Trimble counties. Some of them having received premiums on public exhibition. The leaf is generally much larger than those of the Cuba and Florida tobaccos, but usually quite thin, silky, and free from gummy matter; and of a rich brown or bright yellowish brown color.

TABLE III (*a*.) *Tobacco produced on soil based on the silicious mudstone beds of the Lower Silurian formation.*

	No. 13.	No. 14.	Average.
Potash	4.2725	3.1155	3.6940
Soda	.1818	.1582	.1700
Lime	2.1154	3.7693	2.9423
Magnesia	1.0909	1.3037	1.1973
Oxides of iron and manganese	.0418	.0920	.0669
Phosphoric acid	.6363	.4247	.5305
Sulphuric acid	.8481	.4716	.6598
Chlorine	.5518	.0460	.2989
Silica	.1291	.2464	.1878
Carbonic acid and loss	2.8008	4.0865	3.4337
Per cent. of ash in the air-dried leaf	12.6685	13.7139	13.1812
Per cent. of moisture in the air-dried leaf	9.8950	12.5434	----------
Per cent. of phosphate of lime in the air dried leaf	.8990	.4745	----------
Per cent. of phosphate of magnesia in the air-dried leaf	.3600	.1400	----------

No. 13. Owen County Tobacco. (Manufacturing.) From Pickett's Warehouse, No. 9,998. A very strong tobacco; leaves large; dark-brown; quite gummy.

No. 14. Gallatin County Tobacco. (Cutting tobacco ?) From Pickett's Warehouse, No. 347. Leaves of moderate size; brown and flexible. A strong tobacco of pleasant flavor, when smoked.

TABLE IV (a.) TOBACCO, GROWN PRINCIPALLY ON SOILS BASED ON SUB-CARBONIFEROUS STRATA.

	No. 15.	No. 16.	No. 17.	No. 18.	No. 19.	No. 20.	No. 21.	No. 22.	No. 23.	Average.
Potash	4.4602	4.1870	3.6110	3.9633	3.6406	4.9107	4.7302	3.9242	3.2261	4.0726
Soda	.3292	.2436	trace.	trace.	.0605	.3736	.1661	.0768	.1263	.1951
Lime	3.6075	4.5594	3.3243	4.7605	5.3667	4.8124	3.9402	5.2749	4.8724	4.5052
Magnesia	.6382	.6218	.5949	.9356	.2178	.5700	.5988	.6006	.5402	.5909
Oxides of iron and manganese	.0223	.0793	.0204	.0538	.0227	.0224	.0199	.0256	.0403	.0384
Phosphoric acid	.8814	.7730	.4170	.3725	.4245	.5892	.2791	.3466	.5358	.5175
Sulphuric acid	.1805	.7119	.4520	.3778	.3998	.3268	.3888	.2916	.4395	.3967
Chlorine	.0186	.0900	.1720	.2233	.0396	.1345	.0397	.0248	.3161	.1175
Silica	.4354	.2816	.2133	.3231	.4070	.2957	.1816	.2288	.4999	.3207
Carbonic acid and loss	3.7844	4.6643	3.6324	5.7843	6.5421	6.1074	5.6904	6.1672	4.5808	5.1696
Per cent. of ash in dried leaf	14.3577	16.2119	12.4573	16.8232	17.1213	18.1437	16.0248	17.0011	15.1774	15.9242
Per cent. of moisture in dried leaf	11.7665	11.4956	12.7819	4.8813	12.8754	12.4794	14.0732	11.9501	11.2481	....
Per cent. of phosphate of lime in dried leaf	1.5072	1.1603	.5783	.4590	.6079	.8914	.4531	.5329	.9806	....
Per cent. of phosphate of magnesia in dried leaf	.0527	.1429	.1234	.2101	.1086	.1025	.1381	.0999	.0805	....

No. 15. "*Barren County Tobacco;*" from the State Agricultural rooms at Frankfort. A bright colored tobacco: tough and flexible; leaves of a moderate size. A strong, pungent tobacco, when smoked.

No. 16. "*Hart County Premium Manufacturing Tobacco.*" No. 9934, Pickett's Warehouse, Louisville. Moderate sized leaf; mottled brownish and yellowish. Very strong tobacco.

No. 17. "*Green County Tobacco.*" No. 10,000, Pickett's Warehouse. A bright-yellowish-brown flexible leaf; suitable for cigars. ("Probably from Spanish seed.") A pretty mild tobacco.

No. 18. "*Meade County Tobacco.*" No. 9,953, Pickett's Warehouse. Of a rich yellowish-brown color; "very mild, but not of a very pleasant taste," when smoked. Cigar tobacco?

No. 19. "*Simpson County Tobacco.*" No. 42, Pickett's Warehouse. Rather a large leaf, flexible; of a yellowish-brown color; "when smoked, of a very strong and unpleasant taste." *Shipping tobacco?*

No. 20. "*Taylor County Tobacco.*" No. 312, Pickett's Warehouse. Quite a small leaf; not very tough; of a light yellowish-brown and greenish color. Very mild and pleasant when smoked. *Cutting tobacco?*

No. 21. *Larue County Tobacco.* No. 310, Pickett's Warehouse. O bright, very light yellowish brown, or brownish yellow color. Leaves of moderate size, quite flexible. Very mild when smoked. A cigar tobacco?

No. 22. "*Hardin County Tobacco.*" No. 9994, Pickett's Warehouse. Leaves of a good size; yellowish-brown and greenish; not very flexible. Strong and pungent when smoked. *Manufacturing tobacco.*

No. 23. "*Christian County Premium Shipping Tobacco.*" No. 10,008, Pickett's Warehouse. Leaves of moderate size; dark brown. "Moderately strong; rather pleasant for smoking."

TABLE V (a.) TOBACCO GROWN PRINCIPALLY ON QUARTERNARY SOIL; GENERALLY WITH COAL MEASURES SUB-STRATA.

	No. 24.	No. 25.	No. 26.	No. 27.	No. 28.	No. 29.	No. 30.	Average.
Potash	3.2494	3.6006	3.4350	3.5515	3.2636	3.6845	2.6889	3.3534
Soda	.7476	.0527	.0958	.2074	.1247	.0853	.0612	.1540
Lime	3.8650	4.2502	3.0001	4.3399	4.2558	3.8001	2.9179	3.7756
Magnesia	.5259	.7374	1.4985	1.9703	1.0888	1.0886	1.0075	1.1310
Oxides of iron and manganese	.0967	.1219	.0158	.0284	.0269	.1435	.0171	.0643
Phosphoric acid	.7503	.6726	.5649	.3431	.5518	.6815	.4321	.5710
Sulphuric acid	.4050	.4825	.3155	.3000	.6076	.3542	.5716	.4336
Chlorine	.1894	.4158	2.4085	.0831	.6381	.1435	.2494	.5897
Silica	1.6232	.5090	.2661	.2794	.1194	.4409	.1623	.4800
Carbonic acid and loss	3.7717	3.4255	1.8050	3.1475	3.5034	2.7131	4.0363	3.0231
Per cent. of ash in air-dried leaf	15.2242	14.2682	13.4052	14.2106	14.1801	13.1352	12.1473	13.5758
Per cent. of moisture in air-dried leaf	7.8086	11.5883	12.3912	10.8037	12.0412	10.9696	12.8832	----------
Per cent. of phosphate of lime in air-dried leaf	1.0638	1.2708	.7334	.6080	1.0976	.5665	.6473	----------
Per cent. of phosphate of magnesia in the air-dried leaf	.3168	.1995	.0088	.3061	.6381	.2624	.0742	----------

No. 24. "*Henderson County Manufacturing Tobacco. Premium from Kentucky State Agricultural Society*, 1856." Leaves of a moderate size; brown. "A mild tobacco, but not very pleasant when smoked."

No. 25. "*Henderson County Leaf Sample. Premium to W. S. Elam, by Kentucky State Agricultural Society.*" Leaves large, dark brown; tough. "A strong tobacco when smoked."

No. 26. "*Henderson County Leaf Cigar Tobacco. Premium to W. S. Elam, by the State Agricultural Society*, 1857." Leaves large; brighter colored than the preceding; quite flexible and tough. "A very pleasant and mild smoking tobacco."

No. 27. "*Henderson County Leaf Manufacturing Tobacco. Premium to T. J. Lockett by Kentucky State Agricultural Society.*" Leaves large; of a rich yellowish-brown color; somewhat flexible. "A weak tobacco when smoked."

No. 28. *Henderson County Shipping Tobacco. Premium to W. S. Elam, from Kentucky State Agricultural Society.*" Leaves large; of a handsome yellowish-brown color; somewhat flexible. "Very strong when smoked."

No. 29. *Daviess County Premium Cutting Tobacco. Pickett's Warehouse, No.* 10,010." Leaf of a moderate size; dark brown and greenish; not very flexible. "A very strong and pungent tobacco when smoked."

No. 30. "*Graves County Cutting Tobacco. Pickett's Warehouse, No.* 285." Leaves quite large and heavy; dark-brown; quite flexible, and somewhat gummy. "Moderately strong, but quite sweet and pleasant when smoked."

TABLE VI (*a.*) *Average Composition of the Ash of the whole thirty samples of Tobacco.*

Potash	4.2960
Soda	.2392
Lime	4.0328
Magnesia	1.0752
Oxides of iron and manganese	.0549
Phosphoric acid	.5753
Sulphuric acid	.4787
Chlorine	.4325
Silica	.3104
Carbonic acid and loss	4.3645
Percentage of ash in the air-dried leaf	15.86[illegible]

TABLE VII (a.) COMPOSITION IN 100 PARTS, AND PROPORTIONS OF OXYGEN IN THE BASES, OF THE THIRTY TOBACCO ASHES.

No.	COUNTY, &c.	Potash.	Soda.	Lime.	Magnesia.	Oxid's of iron and manganes .	Phosphoric acid.	Sulphuric acid.	Chlorine.	Silica.	Carbonic acid and loss.	Oxygen in the bases.
1	Cuba tobacco	21.90	1.82	27.10	6.55	1.46	5.20	1.29	6.62	1.69	26.47	14.93
2	Florida tobacco	34.84	.72	17.65	12.75	.24	2.50	2.70	4.85	1.19	22.55	16.28
3	Mason county tobacco	20.79	6.34	31.14	4.00	.20	3.14	3.74	.33	9.2	21.12	15.67
4	Bracken county tobacco	31.14	1.54	24.94	2.85	.29	4.31	3.34	.47	.92	31.19	14.10
5	Mason county tobacco	29.44	trace.	28.18	2.23	.24	4.94	5.08	.41	3.51	25.97	14.01
6	Mason county tobacco	20.54	7.34	35.18	5.08	.19	2.41	2.84	.33	.73	25.36	17.44
7	Mason county tobacco	34.25	.15	23.12	3.71	.24	3.03	3.49	1.61	1.45	28.93	13.96
8	Mason county tobacco	26.69	2.09	27.87	4.16	.33	2.69	3.01	.17	.76	32.23	14.73
9	Mason county tobacco	30.24	.48	27.26	3.57		3.58	3.49	.43	1.80	29.14	14.43
10	Bracken county tobacco	35.38	1.08	26.99	2.53	.36	2.70	3.07	.43	3.00	24.45	15.07
11	Mason county tobacco	33.75	2.14	21.31	3.75	.91	3.75	3.27	.08	.24	31.10	13.69
12	Trimble county tobacco	28.21	1.96	24.03	4.29	.13	2.34	2.59	.19	.79	35.47	13.86
13	Owen county tobacco	33.72	1.44	16.70	8.61	.33	5.02	6.69	4.36	1.02	22.11	14.68
14	Gallatin county tobacco	22.72	1.15	27.49	9.51	.67	3.10	3.44	.33	1.79	29.80	15.96
15	Barren county tobacco	31.06	2.29	25.13	4.45	.16	6.14	1.26	1.30	3.03	26.36	14.80
16	Hart county tobacco	25.83	1.50	28.13	3.84	.49	4.76	4.39	.55	1.74	28.77	14.45
17	Green county tobacco	28.99	trace.	26.68	4.78	.16	3.35	3.63	1.38	1.87	29.16	13.62
18	Meade county tobacco	23.56	trace.	24.47	5.56	.32	2.22	2.25	1.33	1.92	34.38	13.28
19	Simpson county tobacco	21.26	.35	31.75	1.27	.13	2.48	2.34	.23	2.38	38.21	13.16
20	Taylor county tobacco	27.07	2.06	26.52	3.14	.12	3.24	1.81	.74	1.63	33.67	14.31
21	Larue county tobacco	29.52	.96	24.59	3.74	.13	1.74	2.43	.25	1.13	35.50	13.78
22	Hardin county tobacco	23.08	.45	31.03	3.53	.15	2.27	1.72	.15	1.34	36.28	14.31
23	Christian county tobacco	21.26	.83	32.10	3.56	.26	3.53	2.90	2.08	3.29	30.19	14.43
24	Henderson county tobacco	21.34	4.91	25.39	3.45	.64	4.93	2.67	1.24	10.66	24.77	15.17
25	Henderson county tobacco	25.24	.37	29.79	5.17	.85	4.71	3.38	2.92	3.57	24.00	14.93
26	Henderson county tobacco	25.63	.71	22.38	11.18	.12	4.21	2.35	17.92	1.98	13.47	15.40
27	Henderson county tobacco	24.99	1.46	30.54	13.87	.20	2.41	2.11	.59	1.68	22.15	17.90
28	Henderson county tobacco	21.01	.88	30.01	7.68	.19	3.89	4.29	4.50	.84	24.71	15.79
29	Daviess county tobacco	28.05	.65	28.93	8.29	1.09	5.19	2.70	1.09	3.36	20.65	16.79
30	Graves county tobacco	22.14	.53	24.02	8.29	.14	3.56	4.71	2.05	1 34	33.22	14.08
	Average proportion of oxygen in the bases of the thirty samples											14.83

(See under Bracken and Mason counties for remarks on tobacco soil, culture, &c., &c.)

For the sake of comparison I append a summary of the analyses of *tobacco ashes* by Dr. Chas. T. Jackson, reported in Patent Office Reports, 1858, (*Agriculture*,) viz: four of the ash of the *leaves* and three of the ash of the *stalk* of the tobacco, as follows :

No. 1. "*Locality, Massachusetts ; Hatfield, Connecticut river. Farm of W. H. Dickinson. Sample from the best soil.*" (Ash of the leaves.)

No. 2. "*Locality, Massachusetts. Town of Whatley, Connecticut river, farm of J. Allis. Tolerably good soil.*." (Ashes of the leaves.)

No. 3. "*Locality, Maryland. Prince George's county. Richest soil.*" (Ashes of leaves.)

No. 4. "*Locality, Maryland. Prince George's county. Much worn soil.*" (Ashes of leaves.)

No. 1 (*a*.) *Ashes of the stalk of sample No.* 1.

No. 3 (*a*.) *Ashes of the stalk of sample No.* 3.

No. 4 (*a*.) *Ashes of the stalk of sample No.* 4.

	No. 1. Leaf.	No. 2. Leaf.	No. 3. Leaf.	No. 4. Leaf.	No. 1 (*a*.) Stalk.	No. 3 (*a*.) Stalk.	No. 4 (*a*.) Stalk.
Potash	20.40	15.20	17.60	20.32	40.12	40.12	27.48
Soda	6.03	2.52	1.40	4.36	9.20	9.20	7.28
Lime	25.75	26.99	22.66	25.85	11.84	11.48	23.88
Magnesia	1.60	.60	8.00	2.00	.80	.80	.40
Oxides of iron and manganese	1.20	1.60	2.80	1.20	2.00	1.40	1.30
Phosphoric acid	7.60	9.65	8.50	7.15	12.52	12.52	10.28
Sulphuric acid	2.75	2.72	8.00	1.52	2.04	2.04	4.48
Chlorine	1.68	.72	3.76	.92	2.96	2.96	3.12
Silica and silicious sand	9.60	29.40	8.60	21.20	.40	2.40	3.20
Carbonic acid and loss	23.59	9.20	18.68	15.48	16.12	17.08	18.58
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Per cent. of ash in dried leaf or stalk	18.92	20.20	14.53	14.76	10.72	9.20	8.72

Such a close and extraordinary resemblance appears in the two columns of figures under Nos. 1 (*a*) and 3 (*a*,) that it is probable some errors of copying have occurred.

CHEMICAL EXAMINATION OF NATIVE WINES, MADE FROM CATAWBA AND HERBEMONT GRAPES.

One sample of the Catawba wine analyzed was made by myself, in the autumn of 1857, from grapes grown by Mr. Foley, Fayette county, Ky., which, in consequence of a severe drought, had not filled and ripened well. The juice was fermented in a glass bottle, air having been entirely excluded during the process, by a tight cork, sealed, through which was inserted a syphon-like bent glass tube, with its outer end immersed in water in a vial, to allow the carbonic acid to escape which was produced in the fermentation. The specific gravity of the fresh juice was not taken; but that of some from Catawba grapes grown in my garden in 1855 was found to be 1.070.

The wine obtained was almost colorless; having only a very light reddish tint. The juice having been immediately separated from the skins and seeds of the grapes in moderately pressing them. The taste of the wine is quite acid, but pleasant; and the *bouquet* is remarkably fine.

The other specimen of Catawba wine examined was procured for me, by the kindness of Jos. M. Locke, M. D., of Cincinnati, from the cellars of Mr. N. L. Longworth. This is apparently an old wine, quite sound, and of a pale sherry color.

The *Herbemont wine* analyzed was also obtained from Mr. Longworth by Dr. Locke. Its color is yellowish, like that of cider. The *bouquet* is not as pleasant as that of the Catawba wine; but somewhat like that of some kinds of Rhine wine. It contains a little *aldehyde*, the result of a commencement of acetification, and was found to yield a small quantity of *acetic acid* on analysis. It was evidently beginning to turn to vinegar.

The results of the examinations of these three samples of wine may be tabulated as follows:

	My Catawba. wine.	Longworth's Catawba.	Longworth's Herbemont.	Nierstein wein. 1842.
Specific gravity	0.995	----------	----------	0.995
Per cent. of alcohol	8.500	10.660	10.660	11.300
Per cent. of solid extract	1.748	1.830	1.380	1.900
Per cent. of ash	.145	.130	.140	.130
Quantity of caustic soda to neutralize 100 parts of wine	.404	.371	.364	.270

For comparison I have placed in the above table the results, given by **Diez, (quoted by Mulder, "*Die Chemie des Weins*," f. 188,) of his exami-**

nation of the *Nierstein wine*, which, amongst the Rhine wines he analyzed, most nearly resembles our Catawba in composition. Our wine will be seen, however, to contain a little less alcohol, and much more acid than that. The free acid in the first sample of Catawba above, amounts to about one per cent., and is not disguised in the wine by any remains of sugar; as the most delicate tests could not detect the smallest quantity of that substance in it. A small amount of sweetish substance is, however, contained in what is called the *extractive matter*, which, no doubt, has been sometimes mistaken for sugar, and which, according to the recent observations of M. Pasteur, communicated to the French Academy, is *glycerine*, always produced in the vinous fermentation in company with a small quantity of succinic acid. The percentage of free acid in the Rhine wines is less than this, in the best kinds; it being, according to Schubert, (Mulder, *Chem. des Weins*, f. 190,) generally from 0.8 to 0.9 per cent., and mollified by the presence of a larger proportion of *extractive matters*, containing a small quantity, less than one per cent., of sugar or glycerine.

The quantity of grape-sugar in the fresh juice which furnished these three specimens of native wine must have been from about 17. to 22. per cent. We are told by Mulder, from the best authorities, that the average amount of grape-sugar in grape juice, from all the various wine countries, varies from 13 to 30 per cent. According to Fontenelle, the juice of the grapes in the south of France contains from 18 to 30 per cent. of sugar; whilst according to Chaptal it varies from 15 to 20 per cent. in the more northern vineyards. On the Rhine it varies from 13 to 25 per cent. When we understand that all the *alcohol* of the wine is derived from the *sugar;* of which it produces about half its weight by complete fermentation; it is easy to see that the more sugar is contained in the unfermented juice, within certain limits, the stronger the wine will be. At or above 40 per cent. of sugar, however, the fermentation proceeds very slowly; and the large quantity of alcohol resulting puts an end to the process before all the sugar is decomposed.

The stronger varieties of wine, as Madeira, Port, and Sherry, which contain 20 per cent. and upwards, of alcohol, have usually been strengthened, after the fermentation is over, by the addition of brandy. The weaker varieties of wine, as certain kinds of German, French, and Dutch wines, contain only from about 6 to 10 per cent. of alcohol.

When the percentage falls below 8 per cent., it is very difficult to prevent acetification; and the finest kinds of these wines contain from 9 to 13 per cent. of alcohol; produced from a proportionate amount of sugar in the grape juice. Understanding these facts, the French have learned to equalize the quality of their wines, by adding *grape-sugar*, made from potato starch, to the acid juice of the imperfectly ripened grapes of unfavorable seasons.

This could very properly be done in the manufacture of our Catawba wine; although a prejudice exists against the addition of sugar to the grape juice; based, probably, on the idea that ordinary *cane* sugar and the natural sugar of the grape, (*grape-sugar* or *glucose*,) are different substances. But the *cane-sugar* changes speedily into *grape-sugar* under the influence of the *acid* of the grape juice; and it is not known that the products of its fermentation are at all different from those of the sugar naturally contained in the grape. If, then, *brown* sugar, or any other kind which has a *peculiar flavor*, be avoided; or if the pains be taken to manufacture pure *grape-sugar* from starch, as is done in France, the addition of the *pure* sugar, in proper quantity, to the too acid juice of bad seasons, would greatly improve the wine, and not be liable to any objections. This means could also very properly be employed to manufacture *stronger* wines than can be produced from the native grape juice alone.

The solid materials and the acids of the above wines were found to be in the following proportions in 100 parts of the wine, viz:

	My Catawba.	Longworth's Catawba.	Longworth's Herbemont.
Tartaric acid and racemic acids	0.5749	0.5120	0.2756
Malic acid	.2169	.2427	.2253
Citric and tannic acids	traces	traces.	traces.
Extractive matters	.0600	not estim'd.	not estimated.
Gum	.0060		
Albumen, coloring, and fatty matters	not estimated.	not estimated.	not estimated.
Acetic acid	none.	traces.	.2869
Sugar	none.	none.	none.

Some loss of the acids occurred in the processes for their separation, judging from the quantity of caustic soda required to neutralize the wine. It is believed that they contain notable quantities of *racemic acid*, replacing an equal amount of the tartaric acid usually found in grape juice.

The *ash* obtained on thoroughly burning the *solid extract* left by the evaporation of the wine, was also analyzed, in these three samples; and the results are as follows:

COMPOSITION OF THE ASH OF WINE.

	My Catawba.	Longworth's Catawba.	Longworth's Herbemont.
Potash	0.0357	0.0439	.0320
Soda	.0160	.0060	.0100
Lime	.0045	.0024	.0029
Magnesia	.0117	.0106	.0150
Oxide of iron	trace.	trace.	trace.
Phosphoric acid	.0095	.0015	.0035
Sulphuric acid	.0219	.0105	.0120
Chlorine	.0003	.0024	.0029
Silica	.0 21	not estimated.	not estimated.
Carbonic acid and loss	.0433	.0529	.0617
Ash of 100 parts of the wine	0.1450	0.1300	0.1400

The quantity of *mineral matters* derived, from the soil, which is retained in the wine, when it has become completely clear after perfect fermentation, is quite small; amounting only to about one seventh of one per cent.!

A great deal of the *potash, lime, magnesia, &c.*, originally contained in the grape juice, separates as *lees*, as the fermentation progresses, and finally settles to the bottom of the wine cask: forming the *crude tartar;* from which we obtain all the tartaric acid and cream of tartar of commerce. If these lees, as well as the leaves and shoots of the vine removed in pruning, &c., and the husks, stems, and seeds, be restored to the soil, and nothing carried away but the wine, vine culture would prove much less exhausting to the soil than any other kind of *hoed* crop. Some comparative calculations on this subject will be given at the end of this appendix.

According to Boussingault, (Ann. de Chem. et de Phys., 3me Serie, Tome 30, p. 369,) the quantities of mineral materials in the ashes of the unfermented juice of the grape, from his own vineyard, in Alsace, are as follows, in the hundred parts of the juice, viz:

Potash	0.842
Lime	.092
Magnesia	.172
Phosphoric acid	.412
Sulphuric acid	.096
Chlorine	trace.
Silica	.006
Carbonic acid	.250
	1.870

Amounting, in all, to nearly two per cent. of the weight of the juice.

The *stalks and branches of the vine* contain considerable proportions of potash, lime, and phosphoric acid, yielding from above *two* to more than *three per cent. of their weight of ashes.* The following is about an average account of the *composition of the ash,* according to Bruchauer:

Potash	34.1
Soda	7.6
Lime	32.2
Magnesia	4.7
Oxide of iron	.2
Phosphoric acid	16.4
Sulphuric acid	2.7
Chloride of sodium	.8
Silica	1.5

The leaves contain a large percentage of mineral matters, derived from the soil. But both leaves and prunings should be left to decay on the soil, for which, according to experience in Europe, they are the best manure in the cultivation of the vine.

BLEEDINGS OF THE GRAPE-VINE.

In the spring of 1860, the writer caused to be collected a quantity of the "bleedings" of a *Lenoir* grape-vine, from a branch which had been cut off for the purpose; with a view to ascertain by analysis, whether any notable quantity of the essential materials of the soil, &c., was contained in it. The result was as follows:

One hundred parts of the clear colorless fluid evaporated to dryness at 212° F., left 0.286 per cent. of *extract* which was of a light-chestnut color, and contained a vegetable substance resembling gum. This, when incinerated, left 0.084 per cent. of *ashes,* so that the amount of the *organic matters* was 0.202 per cent. The *composition of the ashes* was found to be as follows:

Carbonate of lime	0.0419
Magnesia	.0057
Phosphoric acid	trace.
Sulphuric acid	.0027
Potash	.0240
Soda	.0004
Silica	.0048
Loss	.0045
	0.0840

So that, as might have been expected, this sap of the vine contains a portion of those mineral materials which are essential to vegetable nourishment.

CHEMICAL INVESTIGATION INTO THE COMPOSITION OF THE ASHSE OF THE GRAIN AND COB OF INDIAN CORN, AND THE PROPORTION OF OIL CONTAINED IN THE GRAIN.

This examination was commenced with a view to ascertain whether any difference in the quantity or composition of the *mineral constituents* of the grain, or, in the proportion of the *fatty matter*, could be observed in the corn grown on very poor land, as compared with that raised in the rich blue limestone region of central Kentucky. It being well known that the food produced on these rich lands is peculiarly conducive to the nourishment and fattening of animals, and that those of this favored region, like the vegetables on which they feed, appear of a larger growth, more fully developed, and in better condition, generally, than those produced on the poorer lands of the State. This may be supposed to be owing to the greater abundance of food in the rich land; the vegetable growth being stimulated by the greater quantity of the nutritive mineral elements which are present in the soluble condition in the soil; but, on the other hand, investigations into the composition of the ashes of the tobacco plant have demonstrated that there may be a marked difference in the *quantity* as well as in *composition* of the mineral ingredients of the same plant grown on different soils.

The specimens obtained for this comparative examination are described as follows:

No. 1 (*c.*) "*Indian Corn, grown on the farm of Richard Collins, on an old worn out and very poor field. 'Old Scott place,' two miles east of Hardinsburg, Breckinridge county, Kentucky. Soil, the waste of the second sandstone above the base of the millstone grit; the surface of the field being well covered with small fragments of that bed.*"

Average length of the ears about seven inches. The corn from six and a half ears weighed two pounds six ounces avoirdupois. The produce was about eight to twelve bushels per acre; the season having been unfavorable. This is a yellowish-red corn, said to be more productive on poor land than the white varieties. This specimen was procured at my request, for this especial purpose, by the able Topographical Assistant, S. S. Lyon, Esq., who was desired to select corn from the poorest field he met with in his extensive perambulations of the State.

No. 2 (*c.*) "*Indian Corn from the farm of Christopher Keiser, six miles from Lexington, on the Henry's Mill turnpike, Fayette county, Ky. Grown on the rich land of the Blue Limestone of the Lower Silurian formation.*"

•Produce about seventy-five bushels to the acre, the season having been unfavorable. Average length of the ears about seven and a half inches. Weight of the corn on five ears, three pounds and a half, avoirdupois: weight of the cob about one sixth that of the corn; the ears being well dried. A white dent corn.

A quantity of each of these two specimens was ground to meal in a hand mill; a portion of each carefully incinerated for the purpose of the ash analyses; and another, larger, portion treated with ether, in a displacement apparatus, for the separation and estimation of the fatty matter, or oil.

The results obtained were as follows:

IN 100 PARTS OF THE THOROUGHLY AIR-DRIED CORN.

	No. 1 (*c.*)	No. 2 (*c.*)
Yellowish oil	4.600	5.260
In the ashes—		
Potash	0.2840	0.2878
Soda	.0854	.2204
Lime	.0052	.0076
Magnesia	.0713	.1287
Oxides of iron and manganese	not est.	not est.
Phosphoric acid	.3513	.4230
Sulphuric acid	.0165	trace.
Chlorine	not est.	not est.
Silica	.0150	.0250
Carbonic acid and loss	.1513	.3195
Total ash in 100 parts of the dried corn	0.9800	1.4120
Proportion of phosphate of lime	0.0093	0.0139
Proportion of phosphate of magnesia	0.1984	0.3584
Proportion of phosphoric acid combined with the alkaline	0.1428	0.1870

Of course no *positively certain* conclusion can be attained by means of a single pair of analyses alone; but as far as these go, they show the superior nourishing and fattening qualities of the corn grown on the rich ground, as compared, *in equal weights of the corn*, with that raised on poorer land; and thus give a new motive to farmers to keep their ground in good condition. In short, the corn from Fayette county, not only gives a larger proportion of oil, and of mineral substances in the form of ash, but the potash, lime, magnesia, phosphoric acid, and silica, are all in larger amount in this; and only in the single ingredient, the sulphuric acid, does the corn from the poor ground exceed this in its quantity of essential mineral matter.

Some of the difference observed may possibly be due to the *different varieties* of corn; how much cannot be determined without careful chemical analysis of corn of these two kinds grown on the same ground. But the reddish yellow corn is generally considered, by farmers, richer in oil and stronger as food for animals, than the white corn; and the probability is that the difference of composition, shown above, is due more to the soil than the variety of corn grown on it.* In corroboration of this view, I may refer to three analyses by Emmons and Salisbury, (Natural History of New York, (Agriculture,) Part V, Vol. II, p. 249,) of the ashes of the same variety of corn, (eight-rowed yellow,) grown on different soils, in Lewis county, (New York,) 1847.

The corn grown on a clay loam yielded 1.452 per cent. of ash; that raised on a sandy plain, with a top-dressing of manure, yielded 1.710 per cent. of ash; that grown on an intervale, without manure, 1.748 per cent; and the proportions of potash, soda, lime, phosphoric acid, &c., vary considerably in the three analyses.

When the writer first read Boussingault's statement of the very small proportion of lime which is found in the ashes of the grain of Indian corn of Europe, (see Rural Economy: edition of Appleton & Co., 1845, p. 414,) he was persuaded that the corn of our rich limestone region would not exhibit the same deficiency in its ash; but the above analyses, as well as several by Emmons and Salisbury, Sprengel, and others, show that lime enters in very small proportion into the composition of the *mineral* portion of this grain. In which respect it resembles wheat, but contains still less lime than that grain, and differs widely from the tobacco plant, the ashes of which always contain much lime. Phosphates of magnesia and of the alkalies are found in the corn in much larger proportion than the phosphate of lime; and, like all the grains, the *phosphates* make up the greater proportion of the weight of the ash. The case is different in regard to the leaves, stems, husks, cob, &c., which

* Quoted from an article, by the writer, in the Kentucky Farmer.

generally contain a larger amount of potash, lime, soda, magnesia, &c., and a smaller proportion of phosphoric acid.

Some of the cobs from the corn, (No. 2 *c*,) grown in Fayette county, were incinerated, and the ash obtained submitted to analysis, with the following results:

COMPOSITION OF THE ASHES OF THE COB OF INDIAN CORN. IN 100 PARTS OF THE COB OF CORN, (NO. 2 *c*,) THOROUGHLY DRIED.

Potash	0.3588
Soda	.0065
Lime	.0024
Magnesia	.0355
Oxides of iron and manganese	not estimated
Phosphoric acid	.0274
Sulphuric acid	.0007
Chlorine	not estimated.
Silica	.1742
Carbonic acid and loss	.3655
Total ash in 100 parts of dried cob	0.9710

From the above analyses it will be easy for any one to calculate the quantity of essential mineral matters removed from an acre of land by a crop of corn, in the grain and cobs only. Thus, in the crop of seventy-five bushels, raised on Mr. Keiser's farm; as one hundred pounds of the dried corn gave more than one pound and four tenths of a pound (1.412) of ash, the whole seventy-five bushels, each of fifty-six pounds, weighing in all four thousand two hundred (4,200 lbs.) pounds of corn, would take more than fifty-nine pounds (59.304 lbs.) of essential mineral matters from the soil in the grain alone; and the *cobs*, calculating their weight as one fifth that of the corn, would rob it of more than eight pounds (8.156 lbs.) more of these valuable ingredients.

Many analyses have been made of the ashes of the various vegetable products of the farm and of the garden in Europe, and some in this country. For instance, a very full examination of the various parts of the Indian corn plant, at different stages of its growth, &c., as well as the analyses of several other grains, grasses, and garden and field vegetables, may be found detailed in the Reports of the Geological, Agricultural, &c., Survey of New York: (Natural History of New York, part Agriculture:) made by Emmons and Salisbury, and published by that State.

It is desirable that such examinations should be multiplied in this country; that the relationships of our various crops to the soil may be clearly ascertained.

In the above analyses of the Indian corn, the proportion of oil stated does not probably represent the whole contained in the grain; the examination was rather *comparative* than exhaustive; both specimens, ground alike, were digested for an equal time in equal quantities of ether, and the oil washed out by displacement. If the corn had been reduced to a finer powder, or brought to a pulp by boiling with water, before digesting it in ether, it is probable a somewhat larger quantity of oil would have been separated. For the corn contains quite a considerable quantity of yellow oil, to which it owes its great fattening property. Boussingault found from 7.8 to 9 per cent. of oil in corn. Poggiole found 6.7 per cent. Charles T. Jackson, (Patent Office Report, 1857, Agriculture,) from 2.9 to 4.2 per cent., and Polson 4.4 to 4.5 per cent. (*Liebig and Kopp's Jahresbericht fur* 1855, *p.* 889, *and* 1856, *p.* 809.)

See the end of this Appendix for a comparative table of the ashes of corn, wheat, tobacco, &c.

CHEMICAL EXAMINATION OF THE ASHES OF WHITE WHEAT, GROWN ON KENTUCKY SOIL, &c., &c.

The specimen of prime white wheat selected for the examination was obtained, March 23d, 1859, from Messrs. J. L. Elbert & Co., of Lexington; grown by Dr. Latham in that vicinity, on rich blue limestone land. It had been in the warehouse, where there was no fire, about six weeks—the weather having been rather warm for the season. Before incineration, experiments were made as to the relative amount of *moisture* it would give out on exposure at various temperatures; which resulted as follows, viz:

1. Exposed for thirty days to the dry air of the laboratory, daily heated by the furnace stove to the temperature of about 75° F., *it lost* 4.398 *per cent. in weight by the escape of moisture.*

2. Another quantity of the same wheat, kept in the water-bath, where it was exposed to boiling water heat, for two successive days, *lost in all* 12.710 *per cent. of moisture.*

3. A third quantity, heated for five hours in the oil-bath, to the temperature of 400° F., *lost as much as* 17.540 *per cent. of its weight.* The sample which had been dried in the water-bath was crisp, slightly deepened in color, and as though cooked; the gluten having been partly altered by the heat, so that the quantity of elastic paste which it would make with water was diminished.

That dried in the oil-bath, at 400° F., was completely parched and browned, and the germs, of such grains as had begun to sprout, were completely blackened, so that the loss of weight in this experiment was greater than that of mere *hygroscopic moisture.*

Air-dried, or dried at or below the boiling temperature, the wheat proved quite hygroscopic; giving up moisture and losing weight in a dry atmosphere, or when heated, and absorbing moisture and regaining weight when exposed to moist air, at a lower temperature.

There is probably a greater change in weight, in wheat, under these circumstances, than persons generally suppose. I have no doubt that wheat, taken from a moist "pen," and dried in a warm warehouse or mill, may lose from 4 to 6 per cent., by weight, of *moisture*, in a few days or weeks.

Some of this white wheat, thoroughly air-dried, was carefully reduced to ashes and these analyzed, with the following result:

COMPOSITION OF THE ASHES OF WHITE WHEAT.

	In 100 parts.	In a bushel.
Potash	0.454	0.27 4 lbs.
Soda	.011	.00 6 lbs.
Lime	.136	.08 6 lbs.
Magnesia	.202	.12 2 lbs.
Oxides of iron and manganese	traces.	traces.
Phosphoric acid	.760	.45 0 lbs.
Sulphuric acid	.007	.00 2 lbs.
Chlorine	.029	.01 4 lbs.
Silica	.024	.02 4 lbs.
Carbonic acid and loss	.081	.04 6 lbs.
Total ash	1.714	1.02 4 lbs.
Proportion of phosphate of lime	0.246	0.14 3 lbs.
Proportion of phosphate of magnesia	0.562	0.33 2 lbs.
Proportion of phosphoric acid in the alkaline phosphates	0.295	0.17 6 lbs.

It will be seen that the ash of wheat is quite rich in phosphates, especially phosphates of magnesia and lime, taking more of these from the soil than the Indian corn, in equal weights of the grains; and we can readily understand how even a rich soil may, after successive wheat crops, refuse to produce it in a healthy and profitable manner, because of the resulting deficiency of phosphates in the soil; and why the English farmers find it so advantageous to employ bone-dust, or super-phosphates on their wheat lands, that they actually import bones from distant foreign countries, and even glean the battle-fields of their ghastly relics.

To give a comparative view of the amount of the various *essential mineral elements of the soil*, which is removed *from an acre of ground*, in a crop of wheat, corn, tobacco, or wine, I append the following table. In which I estimate only the grain of the corn and wheat, without the stalks, leaves, husks, cobs, &c., and only the pure fermented wine; supposing the leaves and cuttings of the vine and the lees of the wine, deposited during and after fermentation, to be returned to the soil.

TABLE SHOWING THE MINERAL MATTERS REMOVED FROM THE SOIL.

	In a wheat crop of 20 bushels.	In a corn crop of 50 bushels.	In a tobacco crop of 1000 lbs. and stalks.	In 500 gallons of Catawba wine.
Potash	5.45 lbs.	8.06 lbs.	69.73 lbs.	1.428 lbs.
Soda	.13 lbs.	6.22 lbs.	6.80 lbs.	.640 lbs.
Lime	1.63 lbs.	.22 lbs.	68.00 lbs.	.180 lbs.
Magnesia	2.43 lbs.	3.61 lbs.	8.67 lbs.	.468 lbs.
Phosphoric acid	9.12 lbs.	11.85 lbs.	8.13 lbs.	.320 lbs.
Sulphuric acid	.08 lbs.	not estimated.	8.40 lbs.	.876 lbs.
Chlorine	.35 lbs.	not estimated.	1.06 lbs.	.012 lbs.
Soluble silica	.41 lbs.	.71 lbs.	5.86 lbs.	.084 lbs.
Total mineral matters from an acre of land	19.60 lbs.	30.67 lbs.	176.65 lbs.	4.068 lbs.

This table clearly exhibits the relative exhausting influence of these several crops. It will be seen that the tobacco consumes the most, of all the essential ingredients of the soil, but especially of potash and lime. The wheat and corn crops require *phosphates* in larger quantity than any other materials; and the quantity taken in the wine appears remarkably small. It is to be recollected, however, that all *hoed crops* cause a much greater deterioration in a given time than those which bind and cover the soil during their growth, as the small grains, clover, &c.; more of the soluble materials being decomposed and washed out by the atmospheric agents in the latter case than in the former.