GEOLOGICAL REPORT.

During the present year, 1875, Prof. John Collett has made a survey of Vanderburg, Owen and Montgomery counties. He has, also, visited a portion of Clay and Putnam counties, where, especially in the former, new and valuable mining industries have sprung up since the publication of the first report. Prof. W. W. Borden has made a survey of Jennings and Ripley counties.

Dr. G. M. Levette, assisted by Mr. Caleb Cooke, of the Peabody Academy of Science, Salem, Mass., made surveys of a number of lakes situated in the counties of Fulton, Laporte, Kosciusko, Noble and Steuben. This survey embraced a study of the character of the strata and deposits surrounding the lakes, the depth of water and its temperature at different depths, collections of the fishes and mollusks, and samples of the dredgings of ooze or mud, from the deepest water, for microscopic examination.

The very large and interesting collection of fishes made by this survey, among which it is believed a number of new species will be found, has been placed in the hands of Prof. F. W. Putnam, of Peabody Academy, Salem, Mass., for the purpose of having them described and properly named. It is feared, however, that owing to unforseen business relations, Prof. Putnam will not be able to furnish his report on them in time for publication in this volume.

Dr. Moses N. Elrod, of Orleans, and Dr. E. S. McIntire, of Mitchell, Ind., have jointly furnished a report on Orange county. Dr. J. Schneck, of Mt. Carmel, Ill., has very obligingly furnished a catalogue of the flora and sylvia of the Wabash valley below the mouth of White river.

This report is accompanied with highly valuable notes which give among other things, the measurements made of the diameter and hight attained by many of the noble forest trees of that fertile region. The sections furnished by Elrod and McIntire, of the rocks in Orange county, represent the St. Louis limestone as the lowest, and the millstone grit as the highest palæozoic rocks in the county, and the glacial drift as immediately succeeding the latter.

The millstone grit may be traced from Lawrence and Martin counties into Orange county, and is everywhere recognized by being full of quartz pebbles. Though the upper part is a massive conglomerate, the lower beds are in thin layers and sometimes schistose or shaly. While it generally rests upon the upper Chester Archimedes limestone in Lawrence county, there is an intervening bed of workable coal near Shoals, in Martin county; also near Bloomfield, in Greene county, and at many other localities in this part of the coal field. In Spice Valley township, Lawrence county, the Archimedes limestone has locally been removed by chemical action, and its place is occupied by a valuable bed of porcelain clay, "Indianaite"* and hydrated brown-oxide of iron.

A marked variation in the thickness as well as in the mineral character of the rocks representing a geological epoch is not confined to the millstone grit series, but is to be met with in all formations of sedimentary origin.

The millstone grit of Orange county possesses unusual interest because it furnishes the whetstones and grindstones that have a world-wide reputation under the name of "Hindostan" or "French Lick" stones. They received the name of Hindostan stones from the village of Hindostan, which was situated on the bank of East White river, twelve or fifteen miles west of the quarries, and thus became the port from which the stones were shipped down

*See description in Geol. Rep. for 1874, p. 15.

the river to market. But this village, which was once the county seat of Martin county, has long since been deserted and only one log cabin remained to mark its site when I visited the spot in 1870, and the Hindostan stones, though still retaining the name, find their way to the markets of the world through other channels of trade. It may seem strange, but experience has proved that for sharpening special kinds of mechanical tools the whetstones from Orange county are superior to any other known grits, and they are largely shipped to England. It is not from their commercial importance alone that these grit beds are of special interest to the geologist, but they are abundantly filled with the fossil remains of a magnificent flora. Dr. Elrod has made a fine collection of these plants and they have been identified by Prof. Leo Lesquereux as representatives of the carboniferous flora and he gives the names as follows:

Sphenopteris latifolia, Brg't.
Sphenopteris tridactylites, Brg't.
Neuropteris Smithii, Lesq.
Neuropteris Elrodi, *sp. nov.*, closely allied to the former.
Lepidodendron obovatum, Sternb.
Lepidodendron Valtheimianum, Sternb.
Lepidodendron dichotomum, Sternb.
Lepidophlorus, new species?

I enclosed the following section made by Elrod and McIntire to Prof. Lesquereux and he assures me that I have correctly designated the whetstone beds as belonging to the Conglomerate or Millstone grit.

Section at Dishman's quarry.

	ft. in.
Conglomerate with pebbles	45.00
Siliceous iron ore	5.00
Massive sandstone, buff, fine grained, filled with Stigmaria roots which render it unfit for whetstones or other uses	20.00
Shaley sandstone, bluish color	4.00
Whetstone in 2½ feet layers with shale between, filled with ferns, lepidodendrons, etc., 15 feet of good grit	20.00

	ft. in.
Black bituminous shale	.4
Coal, good quality	.10
Under clay	.6
Shaly sandstone	3.00
Massive sandstone, locally white, glass sand	35.00
Upper Chester limestone *Archimedes Wortheni*, *Pentremites robustus*, *P. pyriformis*, *Athyris subtilita* and *Bryozoans*	3.00
Covered and massive sandstone, grindstone grit, *Stigmaria*, *Lepidodendrons*, *Siqiliaria*, but no ferns have yet been found	70.00
Chester limestone (middle member) same fossils as above	12.00
Sandstone alternating with shale, locally good flagging, *stigmaria* and *sigillaria*, middle contains coal 4 inches	25.00
Lower Chester limestone, lithographic, same fossils as above	60 to 90.00
St. Louis limestone, chert, with *lithostrotian*	2.00
Magnesian limestone, fire.stone, lower part concretionary and filled with same fossils as above	50.00
Argillaceous limestone	40.00
Bituminous oil limestone, coal 2 in.	10.00
	435.8

This section, with the exception of the lower part, is seen at F. E. Dishman's quarry, S. 24, T. 3 N., R. 1 W.

The coal, 10 inches thick, is seen in many places in the western part of Orange county as well as in the southeastern part of Martin county, and I believe it to be the equivalent of the sub-conglomerate coal near Shoals in the latter county.

Since it has been assumed by western geologists that the upper Archimedes limestone marks the upper limits of the Chester group, we have in this formation a good guide for establishing the horizon between the upper and lower carboniferous epochs. While the stems and trunks of *Lepidodendron*, *Sigillaria* and *Stigmaria* are found abundant in the Chester sandstone immediately under the upper limestone, they have thus far furnished no remains of filices.

The above reports will be found in their proper places.

In addition to the general management of the survey and increasing duties of the office, I have been able to make a survey of Vigo and Huntington counties. In the office and laboratory work I have been assisted by Dr. G. M. Levette, and a large number of analyses of coals, limestone, iron ores, hydraulic cements and mineral waters have been made.

ANALYSES OF COALS.

Notwithstanding the attention which chemists have given to the analysis of mineral coals, it appears that there is yet much to learn in regard to the nature of the substances formed by its elementary constituents and to the changes which these substances undergo when under the influence of heat and pressure, or the atmosphere at common temperatures. Without discussing in this place the relative merits of proximate and elementary analyses for determining the industrial value of coal, I will proceed to recount the nature of the investigations which have been made in the laboratory during the year for ascertaining the character and calorific intensity of the Indiana coals.

There are almost endless varieties of mineral coals. They differ from one another, not only physically, but in their manner of burning, in the molecular arrangement of their elementary constituents, and in their heat-producing powers. They differ in every coal basin, and in parts of the same field and same seam. We may classify them into anthracite and bituminous coals, and a few other well marked types, yet there are shades of difference which gradually blend them together, so that, as a general rule, the coals at each mine will require a specific study, for they have a distinct industrial value. Coal I, which is usually a non-caking or block coal in the eastern part of the Indiana coal basin, passes into a caking coal a few miles west of Brazil, in Clay county; to the south, at Cannelsburg, Daviess county, the upper part of a correlated seam has four feet of dull-black, close-textured, ringing cannel coal, which gives 5.2 cubic feet of 25 candle gas to the pound.

The cannel coal is firmly united at the base to two feet of glistening, jet-black, caking coal.

Fossil fuel is usually classified as Anthracite, Bituminous, Lignite or Brown Coal, and Peat. Anthracite is a hard coal, black, sub-metallic, sometimes iridescent (peacock colors), and brilliant, fracture usually conchoidal. It yields 85 per cent. of fixed carbon, and after drying, from 3 to 6 per cent. of volatile matter, burns with feeble flame of pale color. Anthracite graduates into bituminous coal, consequently we have semi-anthracite and semi-bituminous, as the fixed carbon approximates nearest to one or the other. Anthracite is not found in the coal measures west of the Appalachians. In 1864 Prof. Richard Owen and myself examined a seam, from four and a half to five feet thick, of good anthracite, iu the Placer Mountains, twenty-seven miles south of Santa Fee, in New Mexico. It was overlaid by a mass of porphyry, and is probably of cretaceous age. For the sake of comparison, I subjoin the proximate analysis which I made of this coal:

Carbon	87.00	per cent.
Ash, red	5.00	"
Gas	4.50	"
Water	3.50	"

In the Jennie Lind Prairie, near Fort Smith, Arkansas, there is a seam, four to five feet thick, of semi-anthracite coal, which belongs to the lower part of the coal measures. It is covered by a few feet of shale and soil, and has to be worked by stripping. A proximate analysis of the top and bottom gave:

	Top.	Bottom.
Fixed carbon	82.25	84.10
Volatile matter	12.35	10.70
Ash, light brown	4.00	1.40
Water	1.40	3.80

Closely allied to anthracite is a native coke, found near Richmond, Va.; it is more compact than artificial coke, but contains some bitumen.

All the coals of the Indiana field belong to the class known as bituminous. The principal varieties may be designated as follows:

Caking coal, long flame, gas and smith coal, fat coal.

Semi-caking coal, long flame.

Block coal, non-caking coal, long flame, dry burning coal, furnace coal.

Semi-block coal, long flame.

Cannel coal, long bright flame, dry burning, gas coal.

Lignite, or brown coal, is not found in Indiana. It differs from the bituminous coals in containing a large per cent. of hygrometric water and oxygen. It burns with considerable flame, without melting or changing form.

Peat is a fossil fuel which is forming, even at the present time, and furnishes striking evidence of the mode of origin of the older beds of coal. It is found in many of the counties in the north part of the State, and will eventually prove of great commercial value to the people of that region, though the present low price of coal, and its great abundance, has thus far caused it to be neglected as fuel. At some of the railway crossings of the Kankakee marsh, peat beds have been probed to the depth of 50 feet.

The following constitute the most marked varieties of bituminous coal:

Caking coal; non-caking or block coal; semi-caking, or semi-block coal; and cannel coal.

The seams of caking coal in Indiana are, locally, not less than fifteen in number, and they vary from a few inches to seven and eight feet in thickness. There are as many as three seams, found over a great portion of the field, that have a united thicknesss of 15 to 20 feet.

Caking coal varies in color, being black, brownish-black, brilliant-black, and iridescent, (peacock coal). Its fracture is cubical, conchoidal, splinty and obsolete laminæ often appear in its structure.

Most of the bituminous coals of America, England, France and Germany are of this variety. They soften and become pasty, or semi-viscid in the fire at a moderate temperature, and give off a large amount of inflammable gas. When, by the prolonged action of heat, all the volatile matter has been driven off, there will remain a grayish black cellular mass called coke. The amount of coke left, or carbon not volatile, varies from 45 to 80 per cent. On account of its melting and running into a mass under the influence of fire, this kind of coal can not be used in its natural state to smelt iron ores, as it would form into a cake and stop the passage of the blast, but when previously charred or converted into coke, the latter constitutes one of the best fuels for the reduction of ores known to the world. The manufacture of coke, however, requires an additional expenditure of labor and involves a loss of at least one-third of the productive heat of the coal.

Block Coal.—In these coals the volatile matter holds about the same relation to the fixed carbon as in the caking coals, but its quality is such that the usual heat produced by burning is not sufficient to render the coal viscid or produce caking, and when the volatile matter is expelled there remains a charred mass of hard, close-textured coke that resembles the original coal in shape and structure; in other words, the coke does not swell and puff up, but retains the laminated structure of the coal. The block coal of Indiana is, therefore, a non-caking, bituminous coal. It has a laminated structure, and contains between the laminæ a soft black substance, that in its fibrous-like structure greatly resembles charcoal. Its composition by proximate analysis is

Carbon	63.00	per cent.
Gas	32.50	per cent.
Ash, white.	1.00	per cent.
Water	3.50	per cent.

An ultimate analysis of the same gave:

Carbon	.8270
Oxygen	.0881
Hydrogen	.0477
Nitrogen	.0174
Sulphur	.0098
Ash	.0100

Block coal may be readily split into sheets or thin slabs in the direction of its bedding lines, but is very difficult to break in the opposite direction. The color is dull-black on the face and glistening or resinous black on the fractured edges. The beds are crossed at right angles, or nearly so, by lines of fracture that appear co-extensive with the field. These fractures also extend from top to bottom of the seam in such a manner that the coal may be readily taken out in great blocks, which gives rise to its name. This severing into blocks, the entire thickness of the seam, leaves the face of the mine notched and not smooth as is usually the case in mines of caking coal. The blocks are very compact and will endure rough handling and stocking without suffering material loss from abrasion. This, in a commercial point of view, gives the block coal great value over and above its other good qualities as a fuel for smelting iron and generating steam.

Cannel coal differs from the other varieties of bituminous coals in its physical appearance as well as in the manner of its burning. It has a more homogeneous structure, rings under the hammer, conchoidal fracture in every direction and does not crock and like the former coal, is usually mined in large blocks. The cannel coal of Daviess county is so hard and enduring that it has been used as a foundation for the engine and mine houses.

Cannel coal kindles readily and burns with a long, bright flame which illuminates the room and does not become viscid. The name is derived from the corruption of the word candle.

It is now universally admitted by all well informed people, that coal is derived from vegetable matter and is the fossil remains of land and water plants such as trees, reeds, ferns and mosses. The change from woody fibre to stone coal having been brought about by chemical action, a species of slow distillation, so to speak, whereby the oxygen, hydrogen and a portion of the carbon of the wood is eliminated in the form of water, carbonic acid and carburetted hydrogen. All the numerous varieties of fossil fuel including asphalts, petroleum, lignites and peat are mainly, if not solely, due to the modified conditions under which this chemical change takes place, such as presence of water, greater or less pressure and heat.

On account of its homogeneous, compact structure some eminent geologists and fossil botanists have been led to conclude that cannel coal is formed from water plants which have a cellular structure, and not from fibrous land plants. While this theory may be true in some degree, it is not sustained by all the facts that may be brought to bear on the subject. The Breckenridge, Kentucky, Cannel coal, which is extremely rich in carbon oils and of a remarkable dense structure, appears to be made up entirely of Stigmaria stems and leaves and Lepidodendron. One seldom splits a block of this cannel coal without finding in it marks of Stigmaria or Lepidodendron well defined by a coating of pyrites. The wash-coal at the bottom of this seam contains Lepidodendron, Calamites and Stigmaria. The roof is formed of a heavy bed of black bituminous shale, containing fragments of ferns and *Lingula umbonata.* I accompanied Prof. Leo Lesqueureux on a visit to the Breckinridge coal in 1857 and his observations on its flora are given in 3d Vol. Ky. Rep., p. 532.

Here then we find one of the best oil producing cannel coals in the country, actually made up of the remains of air breathing plants. But since the roof shales contain the remains of marine brachiopods there is evidence that salt water was close at hand and may have had something to do in forming the character of the coal. Breckenridge cannel coal, according to Dr. Peters' analysis contains:

Moisture	1.30
Volatile matter	54.40
Carbon	32.00
Ash	12.30

The elementary analysis gave:

Carbon	68.128
Hydrogen	6.489
Nitrogen	2.274
Oxygen and loss	5.833
Sulphur	2.476
Ash	14.800

The Daviess county, Indiana, cannel coal, as already stated, is four feet thick and at the base is firmly cemented to a bed of brilliant black caking coal totally unlike the former in chemical composition. No plants have yet been seen associated with either part of the seams yet it is difficult to conceive that the vegetation should have suddenly changed from land to aquatic plants.

This is the most remarkable seam of coal of which I have any knowledge, and when taken in connection with the Breckenridge coal, sets at defiance the theory that cannel coal is due to a flora distinct from that which, in general, furnished anthracite and bituminous coals.

The Indiana cannel, like the Breckenridge, is rich in carbon oils and gas. It cotains from 7 to 10½ per cent. of very white ash and is remarkably free from pyrites. The quantity of ash greatly exceeds what we find in the caking and block coals of Indiana, though less than is found in the Breckenridge coal. In every case the ash is in excess of what could be derived from any species of plants known to botanists and in a great measure must have been furnished by water, either turbid or holding in solution mineral matter. If by the latter, as I suspect, then its presence must have had a marked influence in determining the character of the chemical change from wood to coal. If all cannel coals were alike burdened with a large excess of ash we might look to the mineral matter as a prime agent in its production, but while most cannels are in this category with regard to ash, there are some that contain very little. It would appear, therefore, that, so far, scientists have not been able to prove, in a satisfactory manner, that different varieties of coal are in any manner due to distinct species of plants.

In the Geological Report of Indiana, 1873, the results are given of experiments made, by Dr. Levette and myself, to show the effect produced on the fixed carbon of coal when charred under a pressure made by forcing the volatile matter to escape under a column of mercury from 0 to 12 inches high. Since then we have devised an apparatus with a pressure guage attached which indicates the exact pressure, in pounds, under which the gases are confined. With this apparatus we are enabled to distil coals, in 20 gram charges, under a pressure of one atmosphere or 15 pounds per square inch, without leak or danger to the iron retort. A stop-cock was placed in the half inch iron tube which forms the neck of the retort so that the coke may be cooled before coming in contact with the atmosphere.

The most important facts at present deduced from these experiments of coking under pressure are, an increase of fixed carbon obtained from some coals and an increasing tendency to fusibility or viscidity of the fixed carbon so obtained. This is particularly marked in the caking coals of Indiana, but most of all in those of Pennsylvania, such as the Connellsville coal, so celebrated for its dense, crystalline, silvery coke when the volatile matter is expelled in the ordinary coke-oven. And Stone's 2d pool, gas coal which is alike celebrated for its coke, but more especially as a gas coal. The latter coal yields 10,000 cubic feet of gas from a ton of 2,000 pounds, which has an illuminating power of 17 to 18 candles and at the Gas Works at Indianapolis, gives 61.25 per cent. of coke that is dense and crystalline in structure. For the sake of easy reference the results, published in the report for 1873, are here reproduced in table No. 1. The results obtained in 1875 are given in table No. 2, page 18.

TABLE NO. I.

NAME OF MINE OR OWNER.	Platinum crucible. Proximate analysis.	Iron retort. No mercury.	Iron retort. 3 inches mercury.	Iron retort. 6 inches mercury.	Iron retort. 12 inches mercury.
H. K. Wilson, Sullivan Co., Ind..	52.40	59.10	62.00	62.80	59.40
Simonson's, Knox Co., Ind.........	52.50	54.35	54.00	54.30	56.50
Shepard & Haslett's, Knox Co. Ind	55.50	56.10	56.40	57.95	56.15
Woodruff & Fletcher, Clay Co. Ind	57.50	58.85	60.40	58.50	59.25
Barnett's, Clay Co., Ind...............	58.50	62.20	61.75	62.60	63.40
Stone's, Pittsburg, Pa...	57.90	65.05	65.00	65.10	66.10

After recommencing the experiments of testing the effect of coking coals under pressure with the new and more complete apparatus, we soon found that, in order to obtain results strictly comparable with one another, fresh samples of coal should be had from the mines, embracing caking coal, block coal, and cannel coal, and then to begin the investigations at the very start and carry the pressure from 0 to 15 pounds, or more, to the square inch; for the protean hydrocarbon constituents of coal undergo a rapid change, whether exposed to the weather or kept in the house for even a short time.

In the first column of the above table will be found the proximate analyses made in the usual way, that is by charring one gram of the coal in a covered platinum crucible at a bright red heat. The sample of Connellsville coal analysed was sent by my esteemed friend, E. C. Pechin, of Dunbar Furnace, Fayette county, Pa. It is in large lumps, of quadrangular columnar structure, iridescent colors, and slightly coherent. The samples were several months on the road, and then remained some weeks in the laboratory before they were analysed, so we may consider it well seasoned coal. The gain under 15 pounds pressure amounts to 4 per cent. of fixed carbon.

Stone's gas coal, pool No. 2, gave 8.25 per cent. more fixed carbon under 15 pounds pressure than by proximate

TABLE NO. II.

Tabulated exhibit of Coals coked, in 20 gram charges, in iron retort, with safety valve and pressure guage attached.

	Coke from proximate analysis.	Coked without pressure.	Coked at 15 pounds pressure.
Coal from Connellsville, Fayette County, Pennsylvania	71.50	74.50	75 50
Gas Coal, Stone's Pool No. 2, Alleghany County, Pennsylvania	48.50	69.50	70.50
Coal from Arbuckle & Budd, Seelyville, Vigo County, Indiana	53.50	61.20	61.20
Coal from Barnett's Mine, Clay County, Indiana—6 years old	58.50	62.50	63.00
Coal from Niblock's Mine, Clay County, Indiana	52 50	57.00	59.00
Coal from Carbon Block Coal Co., Clay County, Indiana—5 years old	56.75	61.20	66.50
Cannel Coal, Daviess County, Indiana—3 years old	50.50	57.00	57.50
Cannel Coal, Daviess County, Indiana—fresh specimen	48.50	48.50	49.10

analysis. The sample was obtained from the Indianapolis Gas Works, and had been on hand for a considerable but unknown length of time.

Arbuckle & Budd's coal had been in the laboratory about four weeks. It is a bright black, cubical, caking coal. The increase of fixed carbon, made under a pressure of 15 pounds, is 7.70 per cent.

Barnett's coal from Clay county is one of the most complete non-caking coals in the State. The sample analyzed had been on hand six years. By proximate analysis the particles were not nearly so firmly cemented together in coking as those subjected to pressure. It does not swell or puff up and the pieces that are put in the retort adhere together on account of a slight fusing of the edges which serves as a kind of solder.

Niblock & Zimmerman's northern mine is a block coal that contains a few thin layers of caking coal, from one-sixteenth to one-eighth of an inch thick, at intervals in the seam. The sample analyzed was obtained from the office of Niblock, Merrifield & Co., Indianapolis, and had been only a few days out of the mine. It contained 6 per cent. of hygroscopic water. The increase of fixed carbon under 15 pounds pressure amounted to 6.50 per cent. The coke was well cemented together and is good and strong.

Carbon Block Coal Co.'s block coal. This sample had been in the office five years.

The sample of cannel coal, three years old, gained under pressure 7 per cent. of fixed carbon, while the fresh specimen only gained 6 per cent. In these samples the structure of the coal remained unaltered. From the tables it will be seen that though there is a pretty uniform increase in the amount of fixed carbon when the coals are distilled under pressure, each seam of coal furnishes specific differences with reference to the effects of pressure on the fixed carbon. Coals from different seams are also differently affected by exposure for a long time to the influence of the air.

A fresh sample of caking coal taken from Dick's mine in Sullivan county and analyzed in 1870, gave:

Fixed carbon	50.50
Volatile, combustible matter	43.50
Water	4.50
Ash, brown	1.50

The same specimen exposed for six years on a shelf, in a room adjoining the laboratory, gave:

Fixed carbon	55.00
Volatile, combustible matter	40.00
Water	3.50
Ash, brown	1.50

By keeping this coal in the office for six years it has had the effect to change the specific gravity to the extent that a cubic foot has lost 1.19 per cent. of its weight. It has also lost one per cent. of water, 3.5 per cent. of volatile matter, and gained 4.5 of fixed carbon.

If we take 8080 as the heat units of carbon and 11175 as the heat units of the combustion of the combined volatile matter and deduct 2000 units for the heat expended in their expulsion, we have the respective value of fresh and weathered coals.

FRESH COAL.

Carbon .5050x8080	4080
Vol. matter .4350x11175—.4350x2000	3891
Total heat units in fresh coal	7971

Same sample weathered in the office for about six years:

WEATHERED COAL.

Carbon .5500x8080	4444
Vol. matter .4000x11175—.4000x2000	3670
Total heat units in weathered coal	8114

So that instead of losing in caloric value by weathering there is a decided gain of 143 units of heat.

A fresh sample of block coal taken from the Carbon Block Coal Co.'s mines gave:

Carbon	55.25
Volatile matter	39.85
Water	
Ash	

The same sample after weathering in the Geological rooms for five years gave:

Fixed carbon	59.50
Volatile matter	37.00
Water	
Ash	

A cubic foot of this coal lost 6.07 pounds of its weight, 1.9 per cent of hygroscopic water and 2.85 per cent. of volatile matter and gained 4.25 per cent of fixed carbon.

We now proceed to calculate the heating power of this non-caking coal in the same manner as for Dick's caking coal and it will be seen that weathering has the effect to also increase its evaporative value:

FRESH SAMPLE.

Carbon .5525x8080	4464
Vol. matter .3985x11175—.3985x2000	3556
Total units of heat	8020

Same sample five years weathered:

Carbon .5950x8080	4807
Vol. matter .3700x11175—.3700x2000	3394
Total units of heat	8201

The gain in heat power by weathering five years is therefore equal to 181 calories.

The relative value of the above coals as determined by their calculated or theoretical units of heat produced by combustion may be more readily understood by reference to the pounds of water which one pound of the coal will raise from 0° C. (32°F.) to 100° C. (212°F.)

Dicks' coal, fresh, 1 lb. will raise 79.71 water.

Dick's coal, weathered, 1 ℔ will raise 81.14 water.

Carbon Coal Co., fresh, 1 lb. will raise 80.20 water.

Carbon Coal Co., weathered, 1 ℔. will raise 82.01 water.

This investigation is very important from the fact that it is generally believed that coal which is long from the mine deteriorates in value as a fuel and that caking coals part with their caking properties in so great a degree that coals which make good coke when fresh mined will make but indifferent coke after they have been stocked for a period of time.

By the proximate analyses of the above coals no difference could be detected in the caking or fusion of the carbon, and in each case the coke from the respective coals gave evidence of being just as good from the five or six years weathered samples as when fresh from the mines.

In this connection I will mention that it is stated in Dana's System of Mineralogy, article "Mineral coal," p. 754, that "caking coal will loose its caking quality if kept heated for two or three hours at 300° C. (572°F.) and sometimes by mere exposure to the air." This temperature it will be remembered is nearly as great as that of molten lead (617°F.)

The conditions under which the experiment was made, are not given, but with such a temperature and exposed in an open vessel the greater portion of the volatile matter might be so gradually expelled in the time specified that the coal will cease to fuse in the process of coking

A number of experiments have been made in this laboratory to test the effect produced on various kinds of bituminous coals by subjecting them to moderate heat in an air tight vessel arranged somewhat after the form of a digester suggested by Prof. Carmichael for dissolving substances in acid under pressure. The result of these experiments are given in table No. 3, on page 23.

Niblock, Zimmerman & Co. and Woodruff & Fletcher's are block coals; all the other samples, with the exception of the cannel coal from Daviess county, are caking coals. The Connellsville sample was the same used in former experiments and was at least four months from the mine, one month of the time in the dry atmosphere of a room heated with a stove.

This coal heated up to 212° F. for twelve hours in the digester lost .2 per cent. of volatile matter, .5 per cent. of fixed carbon, and in twenty-four hours, at the same temperature, it lost .3 per cent. of vol. matter and 1 per cent. of

TABLE NO. III.

Table showing Loss in certain Coals by exposure in Digester for different periods at 212° F., and the coke from the same.

	One Hour.		Twelve Hours.		Twenty-four Hours.		Forty Hours.		Six Hours at 572° F.	
	Loss in air bath.	Coke from proximate analysis.	Loss in digester.	Coke.	Loss in digester.	Coke.	Loss in digester.	Coke.	Loss in digester.	Coke.
Woodruff & Fletcher, Clay County—3 years old............	3.50	60.50	....	....	5.00	61.00	....	....	....	....
Niblock's Block Coal, Clay County—fresh specimen.........	6.00	52.50	9.00	57.50	....	....	....	....	....	....
McClelland, Clay County—fresh specimen	8.50	59.00	....	....	9.00	61.40	....	....	....	....
Hartford (Wyeth), Clay County—fresh specimen............	2.50	56.50	3.10	57.10	5.20	57.00	6.50	57.00	5.00	57.00
Arbuckle & Budd, Clay County—fresh specimen	3.50	53.50	3.30	55.50	3.30	55.50	1.70	55.50	3.50	57.50
Dick's (top), Sullivan County—5 years old	4.50	62.50	1.20	62.50	3.00	62.50	1.70	62.50	7.50	61.00
Dick's (bottom), Sullivan County—5 years old..................	3.50	61.50	2.00	61.50	3.50	62.00	2.10	62.50	6.20	62.50
Chandler's, Vanderburg County—fresh specimen...	3.50	55.00	3.10	58.00	4.30	57.50	2.80	58.00	7.60	56.00
Connellsville, Pennsylvania—old specimen......................	4.50	71.50	0.70	72.00	0.70	70.00	....	....	....	....
Connellsville, Pennsylvania..	4.50	71.50	0.20	71.00	0.30	70.50	0.30	70.50	1.10	71.50
Monunk, Illinois—fresh specimen...	11.50	53.50	....	....	9.70	56.60	....	....	....	....
Wilmington, Illinois—fresh specimen..................................	10.50	52.50	....	....	9.00	55.00	....	....	....	....
Cannel Coal, Daviess County—4 years old............................	3.50	50.50	0.60	50.50	2.30	50.50	1.80	50.50	3.10	50.50

fixed carbon. Heated forty hours at the same temperature the result was the same as in the last experiment.

Heated for six hours at 572° F. it lost 1.10 per cent. of its weight and gave 71.50 per cent. of coke, the same as obtained from the raw coal. There was no apparent difference in the swelling of the coke from the raw coal and that which had been kept at a temperature of 572° F. for six hours.

The samples of caking coal from Arbuckle & Budd's mine, Seelyville, Vigo county, and Hartford mines, same county, had been in the laboratory about two weeks before analyzed.

Chandler's coal from Vanderburg county was retained in the cellar about a month previous to being analyzed.

The block coal from Niblock, Zimmerman & Co's mine had been on hand about a week in the coal house. These are marked "fresh" in the table.

Arbuckle and Budd's coal heated, respectively, for twelve and twenty-four hours at 212° F. lost 3.30 per cent. in weight, while the fixed carbon gained 2 per cent. in weight. Heated for forty hours at same temperature it lost 1.70 per cent. in weight, while the fixed carbon remained the same. Heated for six hours at 572° F. it lost 3.50 per cent. in weight which corresponds to the whole of the water expelled by drying in the air bath, and gained 4 per cent. in fixed carbon.

The Hartford coal, while it lost 3.10 per cent. in twelve hours, 5.20 per cent in twenty-four hours and 6.50 per cent. in 40 hours, at 212° F., the fixed carbon remained the same in each experiment and was not changed by the temperature of 572° F. to which it was subjected for six hours, though it gained 1 per cent. in weight.

Chandler's coal from Vanderburg county, heated in the air tight digester at 212° F. for twelve hours lost 3.10 per cent. of its weight and gained 3.50 per cent. of fixed carbon; in twenty-four hours at same temperature it lost 4.30 per cent. of weight and gained 3 per cent. of fixed carbon; in forty hours the loss was only 2.80 per cent. while the fixed carbon remained the same as in the twelve hour experiment. Under a temperature of 572° F. for six hours the loss of weight amounted to 7.6 per cent. and the fixed carbon was 2 per cent. less than when heated for twelve hours at 212° F.

The caking coal from Dick's mine and Henry K. Wilson's coal were both from Sullivan county. The former had been in the office five and the latter four years when treated in the digester. Both were analyzed when fresh from the mine and the results are here given for comparison with those after four and five years seasoning.

Dick's coal, top part, when fresh	52.00
Dick's coal, top part, after five years seasoning	62.00
Gain of fixed carbon in five years	10.00
Dick's coal, bottom part, when fresh	54.50
Dick's coal, bottom part, after five years seasoning	61.50
Gain of fixed carbon in five years	7.00
H. K. Wilson's coal,* when fresh	52.40
H. K. Wilson's coal, treated in digester after five years seasoning	69.00
Gain of fixed carbon	16.60

The Daviess county cannel coal when nearly fresh from the mine contained:

Fresh coal, - -	Water 2.50	Coke 48.50
After three years,	" 3.50	" 50 50
Gain of fixed carbon		2.00

As shown in table No 3, p. 23, heating in the air tight digester even up to 572° F. for six hours made no change in the yield of fixed carbon.

We had no old sample of Niblock's block coal for comparison. A fresh specimen heated for twelve hours in the digester at 212° F. lost 9 per cent. in weight and gained 5 per cent in fixed carbon.

The following statement will show the change which

*On account of losing the only sample we had of this interesting coal the amount of coke it yields after five years exposure can not be given.

Woodruff & Fletcher's block coal underwent during two years exposure in this office, and under the influence of 212° F. in the digester for twenty four hours.

Fresh coal yielded water	4.50	Coke	53.50
Old coal yielded "	4.00	"	60.50
Gain of fixed carbon in two years			7.00
Two year old coal gave coke			60.50
Same after exposure in digester 24 hours			61.00
Gain of fixed carbon			.50

The deductions to be drawn from the foregoing experiments are:

1st. That the volatile hydrocarbon constituents of bituminous coals undergo a decided change by exposure to the air at common temperatures. The effect of this change is to render non-volatile or to fix a portion of their carbon element whereby the percentage of coke is increased and that of the volatile matter diminished. The excess of carbon is greater in some coals than in others, most in caking coals and least in cannel coals. The maximum amount of change when under shelter, may be reached by some coals in less than five years.

2d. That the same result may be brought about by subjecting the coal to a temperature of 212° F. for a period of twelve to forty hours in an air tight digester.

3d. That while the volatile matter diminishes in quantity and may be less valuable for manufacturing illuminating gas, as a fuel, the coal is increased in calorific power and becomes more valuable with age, owing to the unstable nature of the volatile matter in coals.

It becomes a question of very great importance to the analyst to know what length of time and at what temperature coals should be exposed in order to expel the hygrometric water which they contain. Prof. S. Heinrichs has given some very valuable results on this point, in the Iowa Geological Report for 1868, deduced from the analyses of Iowa coals. He found these coals when powdered and exposed for one hour to a temperature of 115° C. (240° F.)

lost their maximum weight or hygrometric water, after which time they began to increase in weight. This increase he believes is due to the oxidation of bitumen. Since the publication of Prof. Heinrichs' analyses his views have, in the main, been adopted by chemists, and thirty to sixty minutes have been generally taken as the proper length of time, and 212° to 250° F. as the best temperature for expelling the moisture without changing the weight of the coal by decomposing some of its hydrocarbon constituents.

In order to determine the effect of prolonged drying on Indiana coals, a sample of caking coal, containing only 1.5 per cent. of ash, from Dick's mine, Sullivan county, and a block coal from Barnett's mine, clay county, containing 1.5 per cent. white ash, were pulverized and a centigram of each was weighed in platinum capsules and then placed in a copper air bath with thermometer attached and maintained at a temperature of 212° F. Two samples of Pennsylvania caking coals, one from Connellsville, the other, Stone's gas coal from Fayette county, were subsequently treated in the same manner and the results are given in Table 4, on page 28.

It will be seen in this table that the maximum amount of loss was reached by all the coals in two and a half hours. At three and a half hours they began to increase in weight and this increase continued to the end of seven hours, which closed the day's work, and Dick's and Barnett's were left over night exposed to the atmosphere of the laboratory. The next morning, after a lapse of twelve hours, Dick's coal only showed a loss of 0.5 per cent. and Barnett's had completely regained its original weight of a decigram. As the air bath would only hold two samples at a time, these coals were now thrown away and their place given to the two Pennsylvania coals, which were left in the air bath for sixty two hours to test the point of maximum increase of weight.

At the end of fourteen hours Stone's coal had increased .0025 or 2.5 per cent; and the Connellsville .0029 or 2.9 per cent. They were returned to the hot air bath and

TABLE NO. IV.

SHOWING THE EFFECT OF CONTINUED HEATING OF COALS IN AIR BATH AT 212° FAHRENHEIT.

	Dick's Coal, Sullivan Co., Indiana.	Barnett's Coal, Clay Co., Indiana.	Stone's Gas Coal, Pennsylvania.	Connellsville Coking Coal, Pennsylvania.
After ½ hours exposure it lost........	3.2	2.6	1.0	0.8
After 1 hours exposure it lost.........	3.4	2.7	1.1	0.85
After 1½ hours exposure it lost.... ..	3.5	2.7	1.1	0.85
After 2 hours exposure it lost........	3.6	2.8	1.1	0.9
After 2½ hours exposure it lost.......	3.65	2.8	1.15	1.0
After 3½ hours exposure it lost.......	3.6	2.7	1.1	1.0
After 4 hours exposure it lost.........	3.55	2.5	1.1	0.95
After 4½ hours exposure it lost.......	3.4	2.5	1.05	0.9
After 5 hours exposure it lost........	3.3	2.4	1.0	0.9
After 5½ hours exposure it lost.......	3.3	2 35	0·95	0.8
After 6 hours exposure it lost.......	3.2	2.3	0.9	0.8
After 6½ hours exposure it lost.......	3.2	2.3	0.9	0.75
After 7 hours exposure it lost.	3.15	2.25	0.85	0.7
After 7½ hours exposure it lost.......			0.8	0.65
After 14 hours exposure it gained...			2.5	2.9
After 22 hours exposure it gained...			2.5	3.8
After 62 hours exposure it gained...			6.0	8.3
After 90 hours exposure it gained...			5.8	4.75
After 140 hours exposure it gained.			5.8	

weighed again at the end of eight hours additional exposure; Stone's showed no change in weight but the Connellsville had increased to .0038 or 3.8 per cent. After a continued exposure of forty hours longer Stone's had increased to .006 or 6.0 per cent. and Connellsville .0083 or 8.3 per cent.

Total hours in hot air bath 60
Maximum gain of Connellsville.... .... 8.3 per cent.
Maximum gain of Stone's.......................... 6.0 per cent.

It is difficult to account for so great a gain in the weight of these coals by exposure to the moderate temperature of 212° F. for sixty-two hours.

Fresh portions of the same coals after a lapse of one week, during which time they had been exposed to the dry atmosphere of the laboratory, were again placed in the hot air bath, and kept at a temperature of 212° F. for ninety hours. Connellsville gained in weight .00475 or 4.75 per cent. It was then charred or coked in the usual way and gave 76.03 per cent of coke which was incoherent and poured from the crucible like so much black sand.

Stone's gas coal gained in ninety hours, 5.8 per cent. It was returned to the air bath for fifty hours longer and no change in weight was apparent. It was then charred and gave 71.92 per cent. of coke which presented the same appearance as that from the Connellsville coal.

By referring to the proximate analyses of these coals we find that the unheated coals gave:

Connellsville	70.50 per cent.
Ninety hours at 212°	76.03 per cent.
Showing an increase in fixed carbon of..	5.53 per cent.
Coke from Stone's coal, fresh	64.50 per cent.
Coke from Stone's coal, after 90 hours at 212°	71.92 per cent.
Showing an increase in fixed carbon of..	7.42 per cent.

I can not agree with Prof. Heinrichs that the increase in weight given to bituminous coals by a prolonged exposure at a moderate temperature in the hot air bath is due to the oxidation of carbon, but rather to the oxidation of hydrogen, since the oxidation of carbon will result in its expulsion as C. O. or $C. O_2$ and thus reduce instead of promote the increase of weight and the fixed carbon shown by the above experiments. It is my opinion therefore, that the change which takes place is due to the oxidation of the hydrogen of the marsh gas, $C. H_4$, to form $C\ H_2 + H_2\ O. = C. + 2\ H_2\ O.$

A portion of the increased weight is also due, in cases where sulphide of iron ($Fe S$) present in the coal, to the oxidation of the sulphur into proto-sulphate of iron ($Fe O, S O_3 + H_2 O$).

It is of course difficult in the absence of a knowledge of the elements of the coal determined under the various conditions to which it has been subjected, to indicate the precise nature of the change which has taken place in its constituents, in order to produce so remarkable a difference in its composition as we see brought about by weathering or by the application of moderate heat, either while exposed to the influence of the atmosphere or in a closed vessel.

In addition to hygrometric water, mineral coal encloses a large volume of gas similar in composition to those known to occur in mines, that is, carbonic acid, oxygen, nitrogen and marsh gas. E. Meyer has examined coals from several coal fields in Germany and from the New Castle and Durham districts in England, and found in both fresh raised samples and samples that had been weathered from one to five years, a ready flow of enclosed gases .Some Durham coals enclosed as much as three times their own volume of gases. The quantity was less in the weathered coal and contained but little or no marsh gas ($C. H_4$), but a considerable per cent. of heavy carburetted hydrogen ($C_2 H_6$). Meyer considers the absence of marsh gas in the weathered specimens due to its great diffusibility. Samples of the same coal containing marsh gas, when heated to a temperature of 45° C. (113° F.) for two days lost all trace of this gas, but there was developed in its place heavy carburetted hydrogen ($C_2 H_6$).

Another coal heated to 50° C. (122° F.) gave similar results $C.H_4$ disappeared and $C_2 H_6$ made its appearance.

In every case the volume of enclosed gas is lessened by weathering at ordinary temperatures, or by subjecting the coal to moderate heat. The important question suggested by these interesting experiments by Meyer is: whence comes the $C_2 H_6$? His analyses indicate that the hydrogen was oxydised by the oxygen of the coal and not by that contained in the atmosphere. May it not be possible then that C_2 H_4 is formed by the oxidation of one equivalent of hydrogen from the marsh gas ($C.H_4$) leaving $C.H_3 = C_2$ H_6. Since the oxidation of hydrogen will alone account for an increase of carbon in the enclosed gases it may also account for the conversion of volatile hydrocarbon into solid carbon, as shown by weathering and also by subjecting the coal to a temperature of 212° F. in the air tight digester. But it will not account for the increase of weight under prolonged heating in the air bath after all water and enclosed gases have been expelled, for this requires the addition and not the subtraction of matter, and the latter must be obtained from the atmospheric oxygen.

If moderate heat and pressure have the effect to increase the per cent. of carbon in bituminous coals, then it is not necessary to look for any extraordinary physical phenomena to explain the formation of beds of anthracite, since these causes are sufficient to account for their containing so little volatile combustible matter.

M. L. Gruner in his very able treatise on the classification and heating power of coals* endeavors to show that the industrial value of coal is more accurately obtained by proximate than by elementary analysis since the greater the amount of carbon and the less the volatile matter a coal contains the greater will be its heating power, or in other words, the heating power of a coal depends upon the amount of coke which it yields. While I am ready to admit that proximate analysis will teach us very much in regard to the physical peculiarities of coal, it can not justly be claimed as conveying to the consumer its real industrial value. The rapid change which the relative proportion of fixed carbon undergoes by weathering and the variations which are made in its determination by rapid and slow distillation or by increasing or diminishing the heat, all admonish us of the impossibility of drawing accurate conclnsions by a comparison of the proximate analyses of coals made at different times by different analysts and under unknown conditions of the sample analysed. Nor

*Engineering and Mining Journal, 18th July 1874. Translated by R. P. Rothwell, M E.

will it do to refer to the American experiments by Walter R. Johnson, or to those made by the English admiralty for the evaporative value of coals as the touch-stone by which to compare the value of more modern results, since they are imperfect in modes and totally without value for comparison.

By an elementary analysis we find the total amount of carbon and hydrogen, and since these elements, singly or combined, represent all that is combustible in coal or capable of producing heat, no matter whether the sample be fresh or weathered, provided the results are rendered from coal that has been previously dried for one hour in a hot-air bath at a temperature not less than 212° F, therefore, if we wish to make a perfect study of coal, I can not see how it is possible to dispense with its teachings. Not only does it furnish the carbon and hydrogen, but those elements which, by their expulsion, act as absorbents of heat.

But I am free to admit that by using proper care in making proximate analyses of coals, such as paying strict attention to see that the specimens after leaving the mines are kept similarly exposed to meteorological changes, then dried and charred at similar temperatures, that such results are comparable with one another and we may very fairly arrive at their heat units by Dulong's formula and using the accurate determination of Favre and Silberman of the heat units of carbon burning to carbonic acid, $C. O_2$ and those of the volatile combustibles of coal burning to form water and carbonic acid, and of hydrogen burning to form water, *i. e.*, one grain of carbon burning to carbonic acid will raise 8080 grains of water from 0° C. (32°F.) to 1° C. (33.4° F,) one grain of hydrogen burning to form water, (H_2 O.) will raise 34462 grains of water from 0° C. to 1° C. The constituents of coal gas by weight and their heat units are:

Hydrogen	5 x 34462=	172310 heat units.
Marsh gas	61 x 13061=	797843 heat units.
Olefiant gas............................	10 x 11858=	118580 heat units.
Carbonic oxide........................	12 x 2403=	28836 heat units.
Carbonic acid, nitrogen, etc........	nil.	nil.
		1117569

1117569 ÷ 100 = 11175 heat units for the combustion of coal gas. That is, one grain of volatile combustible matter of coal when burned will raise 11175 grains of water from 0° C. to 1° C.

If now, we use Dulong's formula for calculating the calorific value of coal by the heat units of its combustible constituents and deduct 2000 heat units for every unit of volatile matter in the dry coal, as heat lost in their expulsion, and then compare the results deduced from the proximate analysis with those obtained from the elementary analysis of the same coal, they will be found to agree so closely that it will be quite safe under the conditions already stated, to adopt this mode of calculating the relative evaporative power of coals by means of a knowledge of their proximate constituents alone.

In the Gas Works,* at Indianapolis, it is found that it requires about 16 pounds of coke to expel the volatile matter from 100 pounds of coal. I have therefore assumed, upon the basis given by Mr. Bell, 2000 as the number of heat units required to expel one unit of volatile matter, instead of 1895, and have taken the determination of carbon heat units, as established by Faver and Silberman, and the exact figures given by Bunsen for the heat units of the volatile combustible matter of coal.

The following examples will serve to illustrate the two modes of making the calculation.

The sample taken, block coal from the Star mines, Clay

*Mr. I. Lowthian Bell ascertained that, at the New Castle Gas Works, 15 pounds of coke were used to expel the gas from 100 pounds of coal. The 15 pounds of coke contained eight-tenths of a pound of ash and a deduction of one-third was made, from the heat units, for radiation and waste by the chimney:

15 coke = C 14.2 x 8000 =	113600
Less one-third for waste	37800
Net calories evolved by burning 100 pounds of coal	75800

Admitting the general correctness of this estimate, each unit of volatile matter requires 1895 heat units. "Chemical Phenomena of the Blast Furnace," p. 306.

county, Indiana, being one of the few coals which were simultaneously analysed, ultimately and proximately.

Ultimate analysis gave:

Ash	.0100
Carbon	.8270
Hydrogen	.0477
Oxygen	.0881
Nitrogen	.0174
Sulphur	.0098
	1.0000

The combustion of the carbon will give: C. 8270 x 8080 = 6682 carbon calories.

Hydrogen, after deducting the amount which combines with the oxygen, gives: H. 0389 x 34462 = 1340 hydrogen calories. Throwing off the fractions in each instance, we have 6682 + 1340 = 8020 coal heat units.

The same coal, by proximate analysis, gave:

Ash, white	.010
Carbon	.630
Gas	.325
Water	.035
	1.000

Heat of combustion calculated as before; Carbon .630 x 8080 = 5090 carbon calories. Volatile combustibles .325 x 11175 = 3611 units, but this will require .325 x 2000 = .650 units of heat to expel it, then 3611—650 = 2961 calories available for heat, then:

Carbon	5090 heat units.
Volatile matter	2961 heat units.
Gives	8051 total coal calories.

We may therefore, with very great propriety, adopt this rule for estimating the evaporative power of coal.

Manner of conducting the analysis of coal:

It is a matter of no little difficulty to select from a mine a proper sample for analysis, at least such a sample as will represent the average commercial value of the seam.

The best way, therefore, is to take samples from the top, middle and bottom parts of the seam. These should be carefully labeled, wrapped in paper and sent to the laboratory as soon thereafter as practicable. On arriving at the laboratory, they should be taken in hand at once. About a pound of each sample should be pulverised fine enough to be passed through a porcelain colander with one-tenth inch perforations. Then transferred to bottles with good cork stoppers. Each bottle should be labeled, showing the date of mining, when bottled, name of mine, etc. These bottles serve as stocks from which the different quantities are to be taken that serve for analysis. It is not a good plan to mix the portions taken from different parts of the seam and consider the mixture an average sample so that one set of analyses may serve; for though it might furnish a fair statement of the commercial value of the seam, it would leave us in ignorance of much useful information in regard to the true character of the seam.

PROXIMATE ANALYSIS.

One gram. is charred in a covered platinum crucible of about one fluid ounce capacity. The heat is derived from a three-jet Bunsen gas burner and the crucible is kept at a bright red heat until the escaping gas ceases to burn and the condensed carbon disappears from the cover. The weight of the charred mass gives the coke, and the volatile matter is estimated by the loss. To determine the hygroscopic water, one decigram of pulverised coal is weighed in a small, shallow, platinum capsule and placed in a hot air bath where it remains at a temperature of 100° to 105° C. for one hour, the loss gives the water. The capsule, with the dry coal, is then placed over the strong flame of a Bunsen burner until it is consumed to ash.

The weight of the ash is deducted from the coke to find the fixed carbon and the weight of the water is deducted from the total volatile matter to find the per cent. of combustible gas.

All this appears very simple but it requires great care and attention in order to obtain reliable results. The temperature of 100° C. (212° F.) is recommended, since it is believed that a higher temperature is no more effective and is more liable to produce decomposition of the volatile constituents.

ELEMENTARY ANALYSIS.

The combustion is best performed in a hard glass tube, twenty inches long and three-quarters of an inch in diameter. Twelve inches of the posterior end is filled with a tightly rolled coil of fine copper gauze. This is oxidised by drawing air through the red hot tube with an aspirator. The usual appliances are used to dry the oxygen and free it from carbonic acid and other impurities, and also arrest the hydrogen, sulphur and carbonic acid.

Previous to commencing the combustion a current of pure oxygen is passed through the heated tube to complete the oxidation of the copper and expel the last trace of moisture. Two decigrams of pulverized coal are now placed in a platinum boat and inserted in the anterior part of the tube about three inches from the copper. The heat of the gas furnace is applied with due precaution and the combustion is completed when the coal has been burnt to ash and oxygen bubbles pass freely through the potash apparatus. When the hydrogen, sulphur, potash apparatus and potash U tube have been weighed, another analysis may be proceeded with and in this way as many as four combustions may be made in a day. A good tube will serve for ten or twenty combustions. The potash apparatus should be renewed after every third combustion in order to insure a proper absorption of the carbonic acid.

The advantages to be derived from this mode of conducting the analyses, are: You are enabled to watch the combustion of the coal and see when it is completed; the ash may be determined at the same time and the tube is at once ready for the reception of another sample of coal; nitrogen is determined by Varrentrapp and Will's method, *i. e.*, by conversion into ammonia. The ammonia is received in a measured quantity of standard oxalic acid, and the amount of free acid remaining is determined by neutralizing with a standard solution of soda. The quantity of acid saturated by ammonia is then found from the difference.

DETERMINATION OF SULPHUR AND PHOSPHORUS.

There is, generally speaking, less reliance to be placed in the published statements of the amount of sulphur and phosphorus in coals than in any one of its other elementary constituents. The results are, as is well known, generally under rather than over the actual amount of sulphur present in a coal. The loss is due to a portion of the sulphur being converted into sulphuretted hydrogen, and the phosphorous into phosphoretted hydrogen, which escapes during the process of dissolving the coal. In order to avoid this loss, five decigrams of coal are fused with eight grains caustic potash and two grains nitrate of potash in a silver crucible.

Both the caustic potash and nitrate of potash should be tested for sulphur and the per cent. marked upon the bottle.

The half gram powdered coal is placed in the crucible and moistened with alcohol, eight grams potash is then put in with the coal and placed over a moderate heat until the potash is melted, after which two grams nitrate of potash is added, the whole is kept at a gentle heat for about two hours or until all the moisture is expelled; the heat is then increased until all ebullition ceases. The coal should dissolve without deflagration from ignition. After cooling, the contents of the crucible are dissolved out with water and neutralized with hydrochloric acid, evaporated to dryness, moistened with hydrochloric acid and re-dissolved with water. Filter out the silicic acid, heat the filtrate and precipitate the iron and alumina with ammonia and determine the sulphuric acid in the filtrate with chloride of barium.

The phosphoric acid is precipitated with the iron, and to separate it, the precipitate is dissolved from the filter with a weak solution of hydrochloric acid, and then evaporated to dryness to separate the last trace of silicic acid. Moisten with nitric acid, dissolve in water, filter and precipitate the phosphoric acid with molybdate of ammonia. Wash the precipitate as directed by Fresenius, dissolve with ammonia and precipitate phosphoric acid with sulphate of magnesia. In order to determine the per cent. of iron and alumina, it is better to take another half gram of coal and fuse as before. The iron and alumina are then precipitated from the hot solution with ammonia and the alumina is separated by digesting the precipitate with hydrate of potassa in a silver crucible.

This mode of determining the sulphur, phosphorous, iron and alumina in coal, is simple, expeditious and accurate. It has been adopted after repeated trials of all other known processes and leaves nothing to be desired. Owing to want of time these deleterious ingredients have not been determined in the following coals, but the proximate analyses have been determined with great care. This deficiency will be supplied in future reports as well as other important investigations to render their commercial value more definitely understood; for after years of experience in the study of coal analyses, it is only within the last year I have hit upon modes that can be relied upon as furnishing the necessary information regarding the physical and chemical constitution of this mineral.

REVIEW OF THE GEOLOGICAL WORK ACCOMPLISHED DURING THE YEAR.

Professor John Collett has made a classification of the coal seams and their accompanying rock strata in Vanderburg and Owen counties, as well as some additional investigations in the south and southwestern part of Clay county where there has been very important mining operations instituted since the report of 1869. Also, a detailed survey of Montgomery county.

Professor Borden finds in his survey of Ripley and Jennings counties the most westerly crop of the Cincinnati rocks in the northeastern part of the latter county and the most easterly crop of the Niagara and Clinton along the waters of Laughery creek in Ripley county. The Cincinnati rocks in the latter county have an aggregate thickness of 190 feet. The Niagara 42 feet. There is a hiatus in the chronology of the strata from the Niagara to the Quaternary beds. The latter period is represented by glacial drift and Champlain 35 feet, and from 2 to 25 feet of alluvial clays and soil. The geological section of Jennings contains a thin crop of Cincinnati rocks which are 32 feet thick in the northeast part of the county, 40 feet of Niagara, 74 feet of Devonian strata, Corniferous 18 feet; building stone, equivalent of the hydraulic cement beds of Clarke county, 11 feet; Gennessee shale of New York reports, "New Albany black shale," 45 feet.

The lower carboniferous and coal measures are entirely absent, and we come next in the ascending order to the Quaternary, which appears in about the same force as in Jennings county. The Hamilton beds in this county furnish some of the best building stones in the State. For a detailed account of the various formations and the economical value of their minerals the reader is referred to Prof. Borden's Report in another place in this volume.

The survey of the inland lakes, in the northern part of the State, conducted by Dr. G. M. Levette, assisted by Caleb Cooke, of Peabody Academy, Salem, Massachusetts, was productive of many important results as will be seen by reference to the report. Up to the time of this survey it was currently believed that many of these beautiful lakes had a very great depth of water, some indeed were commonly called "bottomless lakes." The greatest depth of water found in any examined did not exceed 52 feet while some of the so called "bottomless lakes" had a depth of only 9.5 feet. The temperature of the water was taken with one of Green's deep sea thermometers and carefully noted at different depths, which showed a uniform decrease in the temperature from the surface to the bottom. Pine Lake, in Laporte county, had a surface temperature of 68° F. and at the bottom 52 feet the temperature was 55° F. An apparent exception to the rule of a gradual decrease in the temperature toward the bottom was met with in Stone's Lake, Laporte county, where the thermometer fell from 66° at 28 feet to 56° at 30 feet, a difference of 10° in two feet. This rapid change of temperature is no doubt properly attributed to the presence of springs of cold water which rise from the bottom. The water of these lakes is remarkably clear and free from mineral matter. An analysis was made of the water from Lake James in Steuben county. It is clear and has a pleasant taste and is neutral to litmus paper.

An imperial gallon (10 pounds) contains 10.5 grains of solid mineral matter, composed of

Bicarbonate of lime	7.00 grains.
Iron, alumina and silica	2.10 grains.
Magnesia and undetermined	1.40 grains.
	10.50

It contains no more mineral matter than is commonly present in river water and is not only a potable water in a most eminent degree, and may be drawn from the bottom with a temperature of 50° which is refreshingly cool without the addition of ice, but is likewise well suited for laundry purposes and for those branches of manufactures which require large quantities of water, such as the manufacture of fine writing paper, printing paper, etc.

The ancient shores of many of these lakes, for it appears that their water area has been constantly diminishing, are composed of chalk (carbonate of lime) of creamy tint almost white. This tint is due to organic matter since it only contains a trace of oxide of iron and the discoloration disappears when it is burnt. This chalk was at one time in common use for the manufacture of quick-lime, for which purpose it answers very well, but does not compare favorably in quality with the lime from Huntington, Peru and Delphi, nor can it be mined and burnt as cheaply as at the latter localities where the best of limestone is quarried at the surface crop. Samples of this fresh water chalk were collected from various localities, two of which were analysed. One from the shore of a small lake on the farm of G. W. Slocum, Sec. 3, T. 37, R. 13, Steuben county. This sample contained in 100 parts:

Water at 212° F	8.00 per cent.
Carbonic acid and combined water	41.50 per cent.
Insoluble silicates	.30 per cent.
Oxide of iron	a trace
Alumina	1.50 per cent.
Lime	45.36 per cent.
Magnesia	3.42 per cent.
Sulphuric acid	.10 per cent.
Phosphoric acid	.38 per cent.
	100.56

The other sample analysed was taken from a bluff one mile north of Rome City, Noble county, that formed the border of a lake which has filled up by vegetation and formed a peat bog.

Composition in 100 parts:

Water at 212° F	3.00 per cent.
Carbonic acid and combined water	41.00 per cent.
Insoluble silicates	.70 per cent.
Oxide of iron	a trace.
Alumina	1.00 per cent.
Lime	49.84 per cent.
Magnesia	4.10 per cent.
Sulphuric acid	.03 per cent.
Phosphoric acid	.52 per cent.
	100.19

These chalks show a remarkable degree of purity, the insoluble matter in each case is less than one per cent., and they contain only a trace of iron. The discoloration is removed by ignition; it is pulverulent when dry and soft like mortar when first taken from the bank, and may be pressed into pencils and will mark like the common English chalk.

The deposits bordering some of the lakes, and which occupied the ancient bed of the lake, have a thickness, where penetrated by wells, of from twenty to thirty feet.

Specimens of this fresh water chalk were sent to Prof. Edwin Bicknell, of Cambridge University, and Dr. J. Gardner, of Bedford, Indiana, and to Dr. W. W. Butterfield, of this city, for microscopic inspection, and not one of these able microscopists could find in it either diatoms or the globigerina so characteristic of the marine chalk, nor any other forms of foraminifera. We are therefore brought to conclude, notwithstanding that the percentage of bicarbonate of lime is not greater than is commonly found in river water, that these great chalk beds are formed by chemical precipitation of the lime and magnesia from the water, brought about by the agency of the atmosphere and aquatic plants. In the absence of accurate knowledge regarding the annual rate at which this deposit takes place we may with reason assume that it progressed at the rate of one-tenth of an inch a year and at this rate the deposit of thirty feet required a period of 3,600 years for their accumulation. Long as this period may appear to many, it is plain to see, independent of other striking geological evidence, that it does not by any means represent the age of the lakes; since it is known that the deposition accumulates with far greater rapidity along the shores where the water is shallow and more under the influence of the sun's rays to elevate its temperature and dissipate the carbonic acid that held the lime in solution, so that the estimate should include a horizontal as well as verticle measurement of the accumulated chalk. By this means too the circumference of the lakes have been very greatly contracted and the chalk deposit may, in some instances, be followed inland for several hundred yards. Indeed in this way some lakes have been almost entirely filled up and the central portion formed into peat bogs.

While this chalk is available for the manufacture of quick lime it is far more valuable as a fertilizer. It will be found especially well suited when dried and pulverized to promote the growth of cereals and grasses on sand and clay lands. About two tons prepared in this way should be sown broadcast over an acre and then plowed in. It will have a tendency to *warm* the soil and furnish lime, magnesia and phosphoric acid, being richer in the latter substance than most productive soils.

In addition to the investigations for temperature of the water of these inland lakes at serial depths, Dr. Levette was directed to take the temperature of the deep wells bored for artesian water at Fort Wayne, Allen county, and at Wabash, Wabash county. The well at Fort Wayne, at the time of his visit, was 2,635 feet deep, but has since reached a depth of 3,000 feet, where the work is suspended without having found water that rises to a greater hight than eight feet below the surface. The mouth of the bore, which is situated in the public square, is about thirty feet above the bed of the Maumee river, 228 feet above the level of Lake Erie and 793 feet above tide-water of the Gulf of Mexico. The first eighty-eight feet went through glacial drift where it struck the first rock, which is a light colored limestone belonging to the Niagara epoch and continues through limestone and calcareous shale to the depth of 2,500 feet; thence in soft calcareous rock to the bottom which is still in the Lower Silurian. The temperature of the air in the house covering the well and the machinery used in boring, was 70° F. The temperature of the water in the well was taken at 90 feet down, at 100 feet, at 1,000 feet, at 1,500 feet and at the bottom, 2,635 feet, and in each instance the thermometer registered 51½° F.

The well at Wabash was commenced in the Court House square, 85 feet above Wabash river, 186 feet above Lake Erie, and 751 feet above tide water in the Gulf. This bore started in the Niagara limestone, which shows itself in the street cut close by, and continued in limestone and calcareous shales to the depth of 2,270 feet without finding artesian water. Water was reached at 85 feet and it is believed by the parties who were employed to make the bore that several other seams of water were encountered. The temperature of the air at the surface was 85° F. and uniformly 50½° F. at 100 feet, 500 feet, 1,000 feet and 2,270 feet down.

The results obtained above were so different from what was expected, that special precautions were taken to prevent any possible error from derangement of the thermometer, which is one made expressly for the purpose by James Green, of New York, it was therefore subjected to the temperature of melting ice and found to be in perfect working order. The inference to be drawn from the uniform temperature of these wells, is, that they are filled with water that comes from an upper stratum and the temperature which it receives at that horizon is by means of the greater specific gravity of cold water carried down to the bottom. This constant supply of cold water from above counteracts the influence of internal heat. In this respect the deep wells correspond with the results obtained by the "Challenger" in the sheltered basins of the deep sea lying in the neighborhood of the Australian continent. These basins correspond to wells of large diameter and the temperature of the water within the rim was found to be the same from top to bottom.

The level of the water in the Wabash well stands on a level with that of Wabash river, since it is known to rise and fall with that stream and is topographically 96 feet below the surface of the water in the Fort Wayne well. But on the other hand the seam of water supply of the latter well lies some nearer to the surface of the earth.

Having determined the temperature of these wells, where the water does not reach the top, it was deemed important to make a test of some artesian well. Several wells had been bored at Terre Haute, in Vigo county, for petroleum, but owing to the moderate yield of oil and its low price in the market they have been abandoned and we only found one of the three wells that could be tested for temperature in any manner. This is a well owned by J. S. Miller and is situated in the edge of the city and on the bank of Wabash river, 93 feet below lake Erie, and 472 feet above tide water of the Gulf of Mexico. The drill commenced in the glacial drift, passed through the coal measures, Devonian and in my opinion stopped in the Niagara at the depth of

1923 feet and 4 inches. According to the record of the bore, it went through five seams of coal. The first seam at the depth of 164½ feet which is 6.2 feet thick; at 183 feet, coal 3 feet thick; at 216 feet, coal 9 inches thick; at 224 feet, salt water with gas; at 262 feet, coal 2 feet 3 inches thick; 308 feet, coal 3 feet 3 inches; sulphur water first appeared at a depth of 980 feet but the present flow, it is believed, comes from the bottom of the well and if piped so as to confine the water it will rise to the hight of 30 feet above the surface. The water belongs to the class known as saline sulphuret. At out-flow the water has a temperature of 81° F. and continued the same to the depth of 100 feet where the thermometer was stopped by some obstruction that prevented its further descent. There can be no question but the temperature of 81° will be found persistant to the bottom. This well fully confirms the conclusions which had already been reached, that the temperature of these bores is dependent upon the temperature of the water which fills them, and the latter is determined by the horizon from which it is derived. It is now generally admitted that the earth was once in a state of liquid incandescence and that it has been gradually cooling. In this way the outer surface became a solid crust and finally so much reduced in temperature as to render it the fit abode of plants and animals.

Physicists have determined by observations on the manner in which the earth attracts the moon and by experiments made with the pendulum that the earth can not be an empty sphere. And by observations on the precessional motion of the pole of the earth, Mr. Hopkins undertakes to show that the solid crust can not be less than from 800 to 1,000 miles, but, as Lyell remarks, "this does not preclude us from imagining that great lakes and seas of melted matter may be distributed through a shell of 800 miles thick." Though the thermal condition of the central part of the globe is a subject which has long elicited the attention of mathematicians and philosophers, the solution appears to be still far from being definitely settled. By the study of deep mines and deep bores certain facts have been attained which go to show that under varying conditions there is a regular increment in temperature of the earth's crust as you descend below the external stratum. According to Bishoff the heat increases more rapidly in schists than in granite, still more rapidly in metallic veins and more in lodes of copper than in those of tin, and most of all in beds of coal. From the irregularity found to exist in the temperature of artesian wells they have not proved to be a reliable means of determining the true rate of increase in the temperature of the earth's strata.

In an artesian well in Wurtemburg the temperature increases 1° F. for every 19 feet of descent. In two wells, one in Durham the other in Manchester, each 2,000 feet deep, Mr. Phillips found the temperature to increase 1° for every 65 to 70 feet in depth. In the silver and lead mines of Saxony the increase was found to be 1° for every 65 feet. While in other mines in the country it was found necessary to descend three or four times as far for one degree of heat. In Cornwall, England, at a depth of 1,380 feet the mean temperature was found to be 68° F. which gives one degree for every 75 feet. The experimental well bored at Grenelle, near Paris, is 1,800 feet, or nearly the same as the Terre Haute well, gave an increase of 1° for every 60 feet. But the artesian well at the Royal Palace in Naples, is 1460 feet deep and has a temperature of only 68° and after deducting for the mean temperature at the surface, this gives a rate equal to one degree in 208 feet. Another well in the same city, only 900 feet deep, shows an increase of one degree in every 83 feet of depth. The difference in the rate of increase in these two wells may be due to an influx of cold water in the upper part of the well at Grenelle. These examples are given for the purpose of comparison with the results obtained from the well at Terre Haute, and if we may assume the mean temperature of the surface to be 50° F. at Terre Haute, we then have an increase of one degree for every 62 feet of depth which agrees very closely with the observations made on the Durham and Manchester wells in England.

In estimating the temperature of the earth by observations on the temperature of artesian wells and mines, it is not only necessary to know the mean temperature at the surface, but the elevation above the sea should also be taken in consideration. In my opinion the most reliable way to arrive at the mean temperature of a locality is to adopt for it the temperature of well water where the depth is not less than 20 to 40 feet. For I have found that the temperature of well water at such depths represents very fairly the mean temperature of the surface and at all events furnishes a constant standard by which to calculate the rate of increment in deep bores. The deepest as well as one of the most instructive artesian bores of which I have any knowledge, is the one situated about 25 miles south of Berlin and bored by the Prussian government. For a depth of 291 feet it passed through gypsum and from thence it encountered salt for a distance of 3,881 feet without reaching the bottom of the mass. The total depth being 4,172 feet.

Professor Mohr, of Bonn, reports the temperature of this well to be as follows:

Depth.	Degrees F.	Increase per 100 feet.
700	67.22	......
900	72.16	2.47
1100	76.87	2.36
1300	81.37	2.25
1500	85.62	2.13
1700	89.65	2.02
1900	93.46	1.91
2100	97.03	1.79
3390	114.70	......

These observations show that the rate of increase of heat diminishes with the depth, and Prof. Mohr believes that at a depth of 5,170 feet a zone of invariable temperature will be reached.

Estimating according to the rate of increase shown by the investigations of Mohr, the temperature of the earth at the bottom of the Fort Wayne well will be about

108.88° F. but calculated by the assumption of one degree of increase for every 62 feet of depth, as furnished by the experiments on the Terre Haute well, it would give a temperature of $3000 \div 62 + 50 = 98.4°$ F.

The temperature found in the Prussian well is 93.46° at the depth of 1900 feet which is 12.46° higher than the water which issues from the Terre Haute well, and goes to show that the latter water is mixed with colder streams from above, or is from a horizon about 1500 feet below the surface, since the actual difference of temperature between the Prussian well and the Terre Haute and Fort Wayne wells at the respective depths given above, are about the same.

ANALYSES OF COALS.

One hundred and thirty-three samples of coal, representing sixty-nine different mines or out-crops, have been analysed during the year and the results are given on the following pages and in the tables of analyses in another part of the report.

CLAY COUNTY COALS.

Elias Cooprider's coal L on section 31, township 10, range 6, near Middletown, Clay county. This is a compact jet-black, slightly laminate, caking coal with some evidence of pyrites in the lower part.

	Top.		Middle.		Bottom.
Fixed carbon	44.00		45.00		50.50
Gas	47.50		44.00		42.50
Water	4.00		2.50		3.00
Ash ... pink	4.50	brown,	8.50	yellow,	4 00
Coke, per cent	48.50		53 50		54.50
Heat units	7924.		7673.		7980.
Specific gravity	1.280		1.533		1.211
Weight of 1 cubic foot	80.00		95.81		75.68

Coke: vitreous, puffed, amorphous.

John Cooprider's coal K on section 31, town 10, range 6 near Middlebury, Clay county. Coal L, 8 feet thick. A, jet-black, compact, caking coal, breaks into irregular cubes and has some pyrites in the vertical seams.

	Middle.	Bottom.
Fixed carbon	44.50	41.50
Gas	47.00	47.50
Water	3.00	3.50
Ash, purple	5.50	7.50
Coke, per cent	50.00	49.00
Heat units	7808.	7711.
Specific gravity	1.271	1.274
Weight of 1 cubic foot	79.44	79.62

Coke: lustreless, puffed, amorphous.

Kennedy's coal near Centre Point, Clay county. Coal I, 4 feet thick. This is a dry, laminate, dull black, block coal, breaking into irregular fragments; shows charcoal partings and pyrites in the vertical seams. The bottom of the seam runs into caking coal with white clay in the seams.

	Top.	Middle.	Bottom.
Fixed carbon	46.50	49.50	52.00
Gas	35.00	39.00	40.50
Water	3.00	2.50	3.00
Ash	brown, 15.50	white, 9.00	white, 4.50
Coke	62.00	58.00	56.50
Heat units	6968.	7575.	7917.
Specific gravity	1.354	1.204	1.188
Weight of 1 cubic foot	84.62	75.25	74.25

Coke: not puffed, vitreous, laminate, the bottom part showing a tendency to cake.

Knickerbocker Coal Company's shaft near Salem, Clay county. Coal I, 3 feet 2 inches thick. This is a dull black, block coal in thin laminæ with charcoal partings, breaks into irregular forms and is very strong across the lines of bedding.

	Top.	Middle.	Bottom.
Fixed carbon	55.00	52.50	50.50
Gas	37.00	39.50	40.00
Water	2.50	2.00	3.00
Ash	buff, 5.50	white, 6.00	white, 6.50
Coke	60.50	58.50	57.00
Heat units	7838.	7774.	7750.
Specific gravity	1.167	1.184	1.241
Weight of 1 cubic foot	72.93	74.00	77.56

Coke: laminate, vitreous, not swollen.

W. R. Kress' coal I, on section 6, township 9, range 6, near Middlebury, Clay county. A dull black, slaty, block coal, running into caking coal at the bottom of the seam, has charcoal partings, is much stained with iron and shows pyrites at the bottom of the seam.

	Top.	Middle.	Bottom.
Fixed carbon	44.00	40.50	38.50
Gas	39.50	44.50	44.50
Water	3.50	4.50	4.00
Ash	red, 13.00	brown, 10.50	gray, 13.00
Coke	57.00	51.00	51.50
Heat units	7179.	7355.	7194.
Specific gravity	1.318	1.287	1.432
Weight of 1 cubic foot	82.37	80.43	89.40

Coke: from top and middle laminate, vitreous, not puffed; from bottom, puffed, lustreless, amorphous.

Limited Liability Coal Co.'s coal, near Ashboro, Clay county. Coal I, 3 feet 10 inches thick. This is a typical block coal, in thin laminæ, separated by charcoal markings, very strong across the bedding and free from sulphur.

Fixed carbon	57.00
Gas	37.00
Water	3.00
Ash, white	3.00
Coke	60.00
Heat units	8000.
Specific gravity	1.231
Weight of 1 cubic foot	76.93

Coke: not puffed, lustreless, laminate.

Coal at Lodi, Clay county, 30 inches thick. A glossy, jet-black, caking coal, with pyrites in the partings.

Fixed carbon	43.00
Gas	40.50
Water	3.00
Ash, red	13.50
Coke	56.50
Heat units	7190.
Weight of one cubic foot	81.43
Specific gravity	1.303

Coke: puffed, lustreless, amorphous.

Markland Coal Co.'s coal, near Clay city, Clay county. Coal I, 3 feet 4 inches thick. This is a bright black, laminate, block coal with very distinct charcoal partings. Four inches of the middle of this seam is a glossy, jet black, caking coal, with only one-half per cent. of ash; it bears a close resemblance to the mineral Albertite from Nova Scotia. On exposure to the air, it breaks into small irregular fragments, and burns like a pine knot when once ignited. Underlying the bottom are 3 or 4 inches of bone coal, containing considerable pyrites, analysis not given.

	Top.	Middle.	Bottom.
Fixed carbon	58.00	63.50	59.00
Gas	36.00	33.50	36.00
Water	2.00	2.50	2.50
Ash, white	4.00	.50	2.50
Coke	62.00	64.00	61.50
Heat units	7989.	8205.	8070.
Specific gravity	1.202	1.145	1.221
Weight of 1 cubic foot	75.12	71.56	76.31

Coke from top slightly puffed, laminate, vitreous; from middle very much puffed, amorphous, vitreous; from bottom slightly puffed, amorphous, vitreous.

McClellan & Zeller's coal, north of Brazil, Clay county. This is a typical block coal, a dull, lustreless black, in thin laminæ, separated by fibrous charcoal partings, very strong across the bedding lines, free from pyrites and calcite and is highly esteemed for blast and puddling furnace use. The specimen analysed was fresh from the mine and held a large excess of water which on exposure to the air of the laboratory for a few weeks would reduce to about 3.5 per cent.

Fixed carbon	56.50
Gas	32.50
Water	8.50
Ash, white	2.50
Coke	59.00
Heat units, wet coal	7549
Heat units, dry coal	8000.
Specific gravity	1.285
Weight of 1 cubic foot	80.31

Coke: laminate, not swollen, lustreless.

John McCrea's coal near Hoosiertown, Clay county. Coal I. This is a dull black, semi-block coal in moderately thin laminæ, running into caking coal at the bottom of the seam; no pyrites visible.

	Top.	Middle.	Bottom.
Fixed carbon	56.50	56.00	58.00
Gas	39.50	36.00	37.00
Water	2.00	2.50	2.50
Ash, white	2.00	5.50	2.50
Coke,	58.50	61.50	60.50
Heat units	8189.	7828.	8080.
Specific gravity	1.196	1.229	1.227
Weight of 1 cubic foot	74.75	76.81	76.06

Coke: slightly puffed, laminate, vitreous.

Morrison's shaft coal, on J. B. Moss' land, section 8, township 11, range 6, near Centre Point, Clay county. Coal I, 3 feet 11 inches thick. This is a compact, strong, dull black, block coal in moderately thin laminæ, breaks into irregular cubic fragments; is slightly iron stained in the vertical seams.

	Top.	Middle.	Bottom.
Fixed Carbon	52.50	58.50	57.00
Gas,	37.00	34.00	36.00
Water	3.50	3.00	3.50
Ash ....flesh,	7.00	white, 4.50	flesh, 3.50
Coke	59.50	63.00	60.50
Heat units	7637.	7846.	7909.
Specific gravity	1.233	1.253	1.209
Weight of 1 cubic foot	77.06	78.31	75.56

Coke: from top and middle, laminate, vitreous, not puffed; from bottom, slightly puffed, amorphous, vitreous.

Muir & Free's coal, on section 27, township 9, range 7, in Clay county. Coal I, 3 feet 3 inches thick. This is a dull black, block coal with charcoal partings in moderately thin laminæ, breaks into irregular cubic forms and is glossy on the cross fracture.

	Top.	Middle.
Fixed Carbon	52.00	48.50
Gas	42.50	41.50
Water	2.50	4.00
Ash, white	3.00	6.00
Coke	55.00	54.50

Heat units	8101.	7727.
Specific gravity	1.269	1.167
Weight of 1 cubic foot	79.31	72.93

Coke: slightly puffed, laminate, lustreless.

Ward & Perry's coal, "Oakland Slope," on section 19, township 12, range 6, Clay county. Coal I, 4 feet thick. The top part of this coal is a dead black, compact, bony, cannel-like coal, with pyrites in the vertical seams. The remainder of the seam is a dull black, distinctly laminate, block coal with no appearance of pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	57.00	58.50	58.00
Gas	36.50	36.00	34.50
Water	3.00	2.50	2.50
Ash	red, 3.50	white, 3.00	white, 5.00
Coke	60.50	61.50	63.00
Heat units	7955.	8030.	7851.
Specific gravity	1.165	1.162	1.222
Weight of 1 cubic foot.	72.81	72.62	76.37

Coke: from top, not puffed, amorphous, brilliant; from middle and bottom, slightly puffed, laminate, vitreous.

Ambrose Phipp's coal, on section 30, township 10, range 6, near Middlebury, Clay county. Coal K, 3 feet thick. This is a brilliant black, semi-block coal in moderately thick laminæ, with charcoal partings, running into a caking coal at bottom of the seam, with pyrites. The whole is much iron-stained.

	Top.	Middle.	Bottom.
Fixed carbon	52.00	48.50	40.00
Gas	39.50	44.50	47.00
Water	3.00	2.50	2.50
Ash	brown, 5.50	pink, 4.50	red, 10.50
Coke	57.50	53.00	50.50
Heat units	7826.	8002.	7544.
Specific gravity	1.303	1.266	1.333
Weight of 1 cubic foot..	81.43	79.15	83.31

Coke: slightly puffed, lustreless, laminate.

Jacob Rousch's coal, on section 4, township 9, range 6, near Middlebury, Clay county. Coal K, 17 inches thick. This is a lustreless, black, slaty, block coal, in thin and easily separated laminæ; stained with iron in the vertical seams.

Fixed carbon	49.50
Gas	40.00
Water	3.50
Ash, flesh	7.00
Coke	56.50
Heat units	7670.
Specific gravity	1.239
Weight of 1 cubic foot	77.42

Coke: not puffed, lustreless, laminate.

Stedman's coal, near Centre Point, Clay county. Coal I, 3 feet 10 inches thick. A dull black, laminate, block coal, breaks into rectangular forms and shows some pyrites in the seams.

	Top.	Middle.	Bottom.
Fixed carbon	57.50	50.50	60.00
Gas	35.50	39.50	32.00
Water	3.00	2.00	3.00
Ash, white	4.00	8.00	5.00
Coke	61.50	58.50	65.00
Heat units	7903.	7904.	7784.
Specific gravity	1.208	1.216	1.220
Weight of 1 cubic foot.	75.50	76.00	76.25

Coke: from top and middle, not puffed, laminate, lustreless; bottom, puffed, vitreous, amorphous.

John Storm's coal, on section 6, township 9, range 6, near Middlebury, Clay county. Coal B? 3 feet 6 inches thick. The upper part is a laminate, shaly, iron-stained, block coal; the middle and lower parts run into bright caking coal with white clay in the seams and breaks into irregular fragments.

	Top.	Middle.	Bottom.
Fixed carbon	52.50	59.00	55.50
Gas	38.00	36.00	35.50
Water	2.50	2.50	2.00
Ash, white	7.00	2.50	7.00
Coke	59.50	61.50	62.50
Heat units	7728.	8070.	7731.
Specific gravity	1.204	1.257	1.230
Weight of 1 cubic foot.	75.25	78,56	76,87

Coke: from top not puffed, laminate, vitreous; from middle and bottom puffed, vitreous, amorphous.

Wagstaff's coal, near Coal City, Clay county. Coal B? 3 feet 6 inches thick. The top and bottom parts of this seam are lustreless, shaly, block coals, while the middle portion is a bright, glossy black, caking coal; the top portion contains considerable pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	61.00	59.00	54.50
Gas	33.50	36.00	40.50
Water	2.50	2.50	2.50
Ash, red	3.00	2.50	2.50
Coke	64.00	61.50	57.00
Heat units	8003.	8070.	8120.
Specific gravity	1.319	1.231	1.214
Weight of 1 cubic foot	82.43	76.93	75.87

Coke: from top and bottom, not puffed, laminate, lustreless; from middle, puffed, amorphous, brilliant.

Woodruff & Fletcher's coal near Hoosiertown, Clay county. Coal I, 4 feet thick. This is a dull black, laminate, block coal, with charcoal partings, breaks into rhomboidal blocks, no visible pyrites.

	Top.	Middle.	Bottom.
Fixed carbon	55.50	59.00	58.00
Gas	36.00	35.50	38.50
Water	2.00	2.00	2.00
Ash	white, 6.50	flesh, 3.50	white, 1.50
Coke	62.00	62.50	59.50
Heat units	7787.	8024.	8218.
Specific gravity	1.221	1.216	1.188
Weight of 1 cubic foot	76.31	76.00	74.12

Coke: puffed, vitreous, amorphous.

OWEN COUNTY COALS.

Arney's coal, near Middletown, Owen county. Seam 3 feet 8 inches thick. This is a dull black, caking coal, breaking into irregular blocks, except a few inches of the middle of the seam, which has a conchoidal fracture, slightly iridescent and indistinctly laminate. In the upper and lower parts of the seam the laminæ are well marked and calcite appears in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	49.50	49.50	51.50
Gas	45.00	45.00	40.50

Water	3.00	3.50	3.00
Ash ... white,	2.50	white, 2.00	red, 5.00
Coke	52.00	51.50	56.50
Heat units	8129.	8129.	7877.
Specific gravity	1.212	1.206	1.271
Weight of 1 cubic foot	75.75	75.37	79.44

Coke: from top and middle, puffed, vitreous, amorphous; from bottom, not puffed, laminate, lustreless.

Reuben Barton's coal, on section 14, township 9, range 5, near Patricksburg, Owen county. Seam 17 inches thick. A glossy, black, caking coal, with pyrites in the partings; breaks into irregular cubes.

Fixed carbon	44.00
Gas	49.00
Water	2.50
Ash, red	4.50
Coke	48.50
Heat units	8051.
Specific gravity	1.267
Weight of 1 cubic foot	79.18

Coke: puffed, amorphous, brilliant.

James Beamen's coal, on section 3, township 11, range 4, near Cataract, Owen county. Coal A, 2 feet thick. This is a dull black, dry, block coal, in very thin laminæ; no signs of pyrites or calcite.

Fixed carbon	52.50
Gas	41.00
Water	3.50
Ash, red	3.00
Coke	55.50
Heat units	8004.
Specific gravity	1.240
Weight of 1 cubic foot	77.50

Coke: unaltered, laminate, vitreous.

Joseph Brammer's coal, on section 1, township 10, range 5, near Patricksburg, Owen county. Seam 32 inches thick. This is a dull black, semi-cannel coal with a slightly conchoidal fracture, the bottom of the seam running into slaty, block coal with pyrites in the partings; the whole showing iron stains.

	Top.		Middle.		Bottom.
Fixed carbon	46.00		53.50		46.00
Gas	48.50		41.00		47.00
Water	4.00		2.00		2.50
Ash ... yellow,	1.50	red,	3.50	pink,	4.50
Coke	47.50		57.00		50.50
Heat units	8167.		8085.		8029.
Specific gravity	1.192		1.204		1.277
Weight of 1 cubic foot	74.50		75.25		79.81

Coke: from the cannel portion of the seam, shriveled, laminate, lustreless; that from the middle and bottom, slightly puffed, laminate, lustreless.

Tice Burger's coal, on section 26, township 10, range 6, near Marion, Owen county. This is a dull black, lustreless, block coal in thin laminæ with charcoal partings; pyrites occur in the vertical seams.

	Middle.	Bottom.
Fixed carbon	54.00	58.00
Gas	42.50	35.00
Water	2.00	3.50
Ash, white	1.50	3.50
Coke	55.50	61.50
Heat units	8262.	7897.
Specific gravity	1.191	1.223
Weight of 1 cubic foot	75.68	76.44

Coke: from middle part, not puffed, laminate, vitreous; from bottom, slightly puffed, vitreous, amorphous.

Chambers' coal, on section 3, township 10, range 5, near Patricksburg, Owen county. This is a jet black, brittle, caking coal in the top and middle portions of the seam, while the bottom part is slaty with considerable pyrites. The whole more or less stained with iron in the vertical seams.

	Top.		Middle.		Bottom.
Fixed carbon	49.00		56.50		50.00
Gas	45.50		39.00		39.00
Water	2.50		2.50		2.50
Ash ... brown,	3.00	white,	2.00	brown,	8.50
Coke	52.00		58.50		58.50
Heat units	8134.		8143.		7618.
Specific gravity	1.230		1.237		1.248
Weight of 1 cubic foot	76.87		77.31		78.00

Coke: from top, slightly puffed, laminate, lustreless; from middle and bottom, unchanged, laminate, vitreous.

D. C. Cress' coal, near Vandalia, Owen county. Coal A, 2 feet 3 inches thick. This is a dull black, slaty, caking coal, with pyrites in the partings.

Fixed carbon	55.00
Gas	39.50
Water	3.00
Ash, yellow	2.50
Coke	57.50
Heat units	8068.
Specific gravity	1.248
Weight of 1 cubic foot	78.00

Coke: slightly puffed, vitreous, laminate.

G. Croft's coal, on section 23, township 10, range 6, near Marion, Owen county. Coal I, 3 feet thick. This is a dry, laminate, block coal, with charcoal partings, no pyrites visible.

	Middle.	Bottom.
Fixed carbon	57.50	57.00
Gas	38.50	36.00
Water	2.00	2.50
Ash, white	2.00	4.50
Coke	59.50	61.50
Heat units	8178.	7909.
Specific gravity	1.214	1.250
Weight of 1 cubic foot	75.87	78.12

Coke: slightly puffed, laminate, vitreous.

Joel Dillon's coal, on section 21, township 9, range 5, Owen county. Coal M, 18 inches thick. This is a slaty, dull black, block coal, stained with iron.

Fixed carbon	53.00
Gas	39.50
Water	3.00
Ash, white	4.50
Coke	57.50
Heat units	7906.
Specific gravity	1.243
Weight of 1 cubic foot	77.68

Coke: slightly puffed, laminate, vitreous.

Aaron Fiscus' coal, on section 26, township 9, range 5, in Owen county. Coal 14 inches thick. This is a compact, slaty, dull black, cannel coal with pyrites and plant impressions in the partings.

Fixed carbon	45.00
Gas	33.00
Water	2.50
Ash, gray	19.50
Coke	64.50
Heat units	6664.
Specific gravity	1.362
Weight of 1 cubic foot	85.12

Coke: unchanged, laminate, vitreous.

Calvin Fletcher's coal, on section 10, township 10, range 5, near Patricksburg, Owen county. Coal I, 5 feet 6 inches thick. This is a dull black, laminate, block coal with charcoal partings, no visible pyrites, though stained with iron in vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	60.00	58.00	44.00
Gas	35.00	37.50	45.50
Water	2.00	2.00	2.00
Ash	white, 3.00	white, 2.50	red, 8.50
Coke	63.00	60.50	52.50
Heat units	8059.	8126.	7638.
Specific gravity	1.219	1.206	1.241
Weight of 1 cubic foot	76.18	75.37	77.56

Coke : slightly puffed, laminate, lustreless.

Louisa Hester's coal, on section 26, township 9, range 5, in Owen county. Coal 14 inches thick. A compact, slaty, dull black, cannel coal, with pyrites in the partings.

Fixed carbon	47.00
Gas	36.00
Water	4.50
Ash, gray	12.50
Coke	59.50
Heat units	7101.
Specific gravity	1.333
Weight of 1 cubic foot	83.31

Coke: unchanged, laminate, vitreous.

Jackson James' coal, near Arcola, Owen county. Coal A, 8 inches thick. This is a compact, lustreless, deep black, cannel coal.

Fixed carbon	32.50
Gas	54.00
Water	4.00
Ash, pink	9.50
Coke	42.00
Heat units	7580.
Specific gravity	1.222
Weight of 1 cubic foot	76.31

Coke: shrivelled, laminate, lustreless.

McCreary's coal, Owen county. Coal A, 1 foot 2 inches thick. This is a dull black, laminate, somewhat slaty, semi-block coal, with iron stains and pyrites in the vertical seams.

	Top.	Bottom.
Fixed carbon	53.50	51.00
Gas	38.00	42.00
Water	3.00	2.50
Ash	brown, 5.50	red, 4.50
Coke	59.00	59.50
Heat units	7809.	7974.
Specific gravity	1.280	1.276
Weight of 1 cubic foot	80.00	79.76

Coke : slightly puffed, laminate, lustreless.

W. S. Norris' coal, near Patricksburg, Owen county. Coal B, 2 feet 6 inches thick. This is a dull black, shaly, caking coal, with pyrites in the partings.

Fixed carbon	45.00
Gas	48.00
Water	2.00
Ash, red	5.00
Coke	50.00
Heat units	8040.
Specific gravity	1.282
Weight of 1 cubic foot	80.12

Coke: puffed, vitreous, amorphous.

Overholtzer's coal near Patricksburg, Owen county. Coal I, 4 to 6 feet thick. This is a dry, laminate, dull black, block coal, with charcoal partings, vertical seams stained with iron.

	Middle.	Bottom.
Fixed carbon	57.00	53.00
Gas	35.00	34.50
Water	3.50	3.00

Ash	yellow, 4.50	white,	9.50
Coke	61.50		62.50
Heat units	7817.		7447.
Specific gravity	1.242		1.292
Weight of 1 cubic foot	76.65		80.75

Coke: not puffed, laminate, lustreless.

Jesse Reagan's coal, near Stockton, Owen county. Seam 3 feet 6 inches thick. This is a dull black, dry, shaly, laminate, block coal, running into caking coal at bottom of seam; charcoal partings between the laminæ; vertical seams stained with iron.

	Top.	Middle.	Bottom.
Fixed carbon	52.50	52.00	52.50
Gas	37.00	40.50	39.50
Water	3.00	2.50	2.50
Ash, white	7.50	5.00	5.50
Coke	60.00	57.00	58.00
Heat units	7555.	7918.	7866.
Specific gravity	1.261	1.230	1.250
Weight of 1 cubic foot	78.81	76.87	78.12

Coke: slightly puffed, laminate, vitreous.

Jesse Rowe's coal, on section 11, township 10, range 6, near Marion, Owen county. Coal I, 3 feet 2 inches thick.

This is a dull black, slaty, laminate, semi-block coal, with pyrites in the partings.

	Middle.	Bottom.
Fixed carbon	56.00	53.50
Gas	36.00	39.00
Water	3.00	3.00
Ash, white	5.00	4.50
Coke	61.00	58.00
Heat units	7828.	7901.
Specific gravity	1.235	1.213
Weight of 1 cubic foot	77.18	75.81

Coke: not puffed, laminate, lustreless.

William Royer's coal, on section 11, township 10, range 5, near Patricksburg, Owen county. Coal I, 6 feet thick. This is a deep black, laminate, block coal, with charcoal in the partings. Some pyrites in the lower part of the seam.

	Top.	Middle.	Bottom.
Fixed carbon	55.50	55.00	51.50
Gas	38.00	39.00	41.50
Water	2.50	3.00	3.00

Ash .... white,	4.00	pink, 3.00	white, 4.00
Coke........................	59.50	58.00	55.50
Heat units.................	7970.	8022.	7969.
Specific gravity...........	1.260	1.193	1.219
Weight of 1 cubic foot	78.75	74.56	76.18

Coke: from top and middle, not puffed, amorphous, lustreless; from bottom, slightly puffed, amorphous, vitreous.

John C. Stahl's coal, on section 19, township 10, range 5, near Patricksburg, Owen county. Coal I, 4 feet 6 inches thick. This is a deep black, laminate, block coal, breaking in regular cubic forms, has charcoal partings, and the vertical seams are stained with iron.

Fixed carbon	58.00
Gas	36.00
Water	3.00
Ash, white..	3.00
Coke	61.00
Heat units..	7989.
Specific gravity..................................	1.203
Weight of one cubic foot.....................	75.18

Coke: not swollen, laminate, vitreous.

Mrs. R. White's coal, one mile south of Coal City, Owen county. Seam 2 feet 6 inches thick. A bright, black, laminate, semi-block coal, with iron stains and pyrites in the partings.

Fixed carbon..	55.50
Gas	39.00
Water..	3.00
Ash, pink..	2.50
Coke	58.00
Heat units	8062.
Specific gravity	1.216
Weight of one cubic foot.....................	76.00

Coke: not puffed, laminate, lustreless.

GREENE COUNTY.

B. Schweitzer's coal, on section 14, township 8, range 5, in Greene county. Coal A, 2 feet 6 inches thick. A bright black, caking coal, in indistinct laminæ, breaks into regular cubes and has pyrites and iron stains in the vertical seams.

	Top.	Bottom.
Fixed carbon	47.00	50.00
Gas	44.50	44.00
Water	2.50	2.50
Ash, red	6.00	3.50
Coke	53.00	53.50
Heat units	7881.	8077.
Specfic gravity	1 317	1,302
Weight of 1 cubic foot	82.31	81.37

Coke: puffed, lustreless, amorphous.

FOUNTAIN COUNTY.

Barker's Mine, Fountain county. Block coal in thin, alternating, vitreous and lustreless laminæ, with charcoal partings, very hard and difficult to break across the bedding lines.

Fixed carbon	54.50
Gas	36.00
Water	5.00
Ash, white	4.50
Coke	59.00
Heat units	7707.
Specific gravity	1.195
Weight of 1 cubic foot	74.68

Coke: laminate, compact, lustreless.

Judge Coate's mine, Fountain county. A brilliant, glossy black, caking coal, indistinctly laminate, breaks with somewhat conchoidal fracture and contains pyrites in the partings.

Fixed carbon	47.50
Gas	44.00
Water	5.50
Ash, white	3.00
Coke	50.50
Heat units	7875.
Specific gravity	1.230
Weight of 1 cubic foot	76.25

Coke: puffed, glossy, amorphous.

Kirtland's mine, three miles north of Veedersburg, Fountain county. The top of the seam is a vitreous, compact, caking coal, cubical fracture, distinctly laminate. The bottom of the seam is a dull, lustreless, cannel coal, breaks with a splinty fracture and contains pyrites and calcite in the vertical seams.

	Top.		Bottom.
Fixed carbon	47.50		39.00
Gas	46.00		53.00
Water	4.00		3.50
Ash, red,	2.50	brown,	4.50
Coke	50.00		43.50
Heat units	8058.		8014.
Specific gravity	1.203		1.211
Weight of 1 cubic foot	75.18		75.68

Coke: from top coal, slightly altered, compact, vitreous; from bottom coal, unaltered, lustreless.

James W. McKee's coal, Fountain county. A compact, dull black, block coal, with occasional quarter-inch strata of brilliant, cubical, caking coal, separated by thin laminæ, and they in turn by fibrous charcoal markings, vertical seams slightly stained with iron.

	Top.	Bottom.
Fixed carbon	55.00	47.50
Gas	35.00	41.50
Water	6.00	5.50
Ash, white	4.00	5.50
Coke	59.00	53.00
Heat units	7655.	7644.
Specific gravity	1.205	1.225
Weight of 1 cubic foot	75.31	76.56

Coke: compact, unaltered, laminate, vitreous.

Stedman Thompson's coal, Fountain county. This is a deep black, lustreless, compact, block coal, in thin laminæ, very strong, and free from pyrites.

	Top.		Bottom.
Fixed carbon	52.50		51.50
Gas	37.50		41.50
Water	5.50		3.00
Ash, white,	4.50	flesh,	4.00
Coke	57.00		55.50
Heat units	7682.		7969.
Specific gravity	1.239		1.207
Weight of 1 cubic foot	77.43		75.43

Coke: unchanged, compact, vitreous, laminate.

VANDERBURG COUNTY.

Ingleside mine, near Evansville. Coal M, 4 feet 2 inches thick. This is a glossy black, caking coal, irregular fracture, with calcite in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	44.00	48.50	46.00
Gas	39.50	42.00	39.50
Water	3.00	3.50	3.50
Ash, white	13.50	6.00	11.00
Coke	57.50	54.50	57.50
Heat units	7179.	7772.	7341.
Specific gravity	1.273	1.275	1.336
Weight of 1 cubic foot	79.56	79.68	83.50

Coke: puffed, amorphous, brilliant.

Ingleside mine, John Engle's heirs, near Evansville, Vanderburg county. Lower coal L, 1 foot 3 inches thick. This is a dull black, caking coal, with charcoal markings between the laminæ; pyrites and calcite are seen in the vertical seams, which are more or less stained with iron.

Fixed carbon	53.50
Gas	39.00
Water	3.50
Ash, red	4.00
Coke	57.50
Heat units	7901.
Specific gravity	1.275
Weight of 1 cubic foot	79.68

Coke: puffed, lustreless, amorphous.

WARRICK COUNTY.

Chandler's coal, 12 miles east of Evansville, in Warrick county. Coal M, 4 feet 2 inches thick. This is a jet black, semi-block coal, with charcoal markings between the laminæ; breaks into cubic forms and shows some pyrites and considerable calcite in the vertical seams.

	Top.	Middle.	Bottom.
Fixed carbon	47.50	49.50	45.00
Gas	40.00	41.50	34.50
Water	3.50	3.50	4.00
Ash, white	9.00	5.50	16.50

Coke	56.50	55.00	61.00
Heat units	7508.	7808.	6801.
Specific gravity	1.274	1.282	1.283
Weight of 1 cubic foot	79.62	80.12	80.18

Coke: from top and middle, slightly puffed, laminate, lustreless; from bottom, less puffed, lustreless, amorphous.

Millersburg coal, Warrick county. Coal N, 3 feet 6 inches thick. A dense, glossy black, caking coal, conchoidal fracture, with occasional iridescence, no pyrites visible.

	Middle.		Bottom.
Fixed carbon	53.00		49.00
Gas	41.50		45.50
Water	3.00		3.50
Ash ... blue,	2.50	brown,	2.00
Coke	55.50		51.00
Heat units	8090.		8042.
Specific gravity	1.242		1.243
Weight of 1 cubic foot	77.62		77.68

Coke: slightly puffed, lustreless, amorphous.

POSEY COUNTY.

George Heldferl's coal, near St. Wendells, Posey county. Seam 18 inches thick. This is a dull black, slaty, caking coal, stained with iron in the seams.

Fixed carbon	51.00
Gas	39.50
Water	4.00
Ash, brown	5.50
Coke	56.50
Heat units	7745.
Specific gravity	1.327
Weight of 1 cubic foot	82.93

Coke: not puffed, laminate, lustreless.

SULLIVAN COUNTY.

Dick's mine, on section 30, township 9, range 8, Sullivan county. Coal M. Upper part of seam, collected by Prof. Collett in 1870. A brilliant, glossy black, caking coal, irregular fracture, no visible laminæ, has the appearance of bitumen after being melted and cooled; contains very little earthy matter. The first column gives the analysis made in

December, 1870. The second column, the analysis after the specimen had been kept in the laboratory five years.

	Analysis of 1870.	Analysis of 1875.
Fixed carbon	50.50	55.00
Gas	43.50	40.00
Water	4.50	3.50
Ash, white	1.50	1.50
Coke	52.00	56.50
Heat units	8071.	8114.
Specific gravity	1.239	1.258
Weight of 1 cubic foot	77.43	78.62

Coke: in both cases, has a metallic lustre, slightly puffed, amorphous, compact.

DAVIESS COUNTY.

James S. Morgan's coal, on the Ohio and Mississippi railroad in Daviess county. No. 1 is the top and No. 2 the bottom of the top seam of coal 30 feet from the surface. The top of the seam is a deep black, distinctly laminate, block coal with charcoal partings, breaks into irregular cubes and shows pyrites in the seams. The bottom of the seam is a bright, deep black, semi-block coal with no traces of pyrites. No. 3, is a lower seam, 63 feet from the surface, 3 feet 4 inches thick, a glossy, jet black, caking coal, conchoidal fracture, laminæ not distinct, no pyrites visible.

	No. 1.	No. 2.	No. 3.
Fixed carbon	56.00	53.50	53.00
Gas	32.50	36.00	39.50
Water	6.00	5.50	5.00
Ash	red, 5.50	white, 5.00	white, 2 50
Coke	61.50	58.50	55.50
Heat units	7507.	7626.	7906.
Specific gravity	1.277	1.252	1.239
Weight of 1 cubic foot.	79.81	78.25	77.44

Coke: from No's. 1 and 2, slightly puffed, laminate, lustreless; from No. 3, much puffed, vitreous, amorphous.

VERMILLION COUNTY.

Charles Moore's coal, near State line, on Indianapolis, Decatur & Springfield Railroad, in Vermillion county. Seam 4 feet 6 inches thick, 130 feet from the surface.

This is a deep black, caking coal, distinct laminæ, breaks into large cubical blocks and has some pyrites and calcite in the vertical seams.

Fixed carbon	46.00
Gas	44.00
Water	5.50
Ash, flesh	4.50
Coke	50.50
Heat units	7754.
Specific gravity	1.258
Weight of 1 cubic foot	78.62

Coke: puffed, amorphous, lustreless.

PARKE COUNTY.

Hargrave's mine, north side of Sugar creek, near Moore's Mill, Parke county. A glossy, deep black, caking coal, upper part shaly, with pyrites in the seams.

Fixed carbon	46.50
Gas	46.00
Water	4.00
Ash, brown	3.50
Coke	50.50
Heat units	7977.
Specific gravity	1.228
Weight of 1 cubic foot	76.75

Coke: puffed, amorphous, brilliant.

MONTGOMERY COUNTY.

Berryman Clover's coal, four miles south of Waveland, Montgomery county. Coal A, 1 foot thick. A dull black, caking coal in indistinct laminæ, stained with iron and has considerable pyrites in the partings.

Fixed carbon	52.00
Gas	41.50
Water	3.00
Ash, white	3.50
Coke	55.50
Heat units	8010.
Specific gravity	1.254
Weight of 1 cubic foot	78.37

Coke: slightly puffed, laminate, lustreless.

Hannah S. Burford's coal, three and a half miles northwest of Waveland, Montgomery county. Coal A, 7 inches thick. A dull black, caking coal, in thin laminæ, with pyrites in the partings.

Fixed carbon	49.00
Gas	43.50
Water	2.50
Ash, white	5.00
Coke	54.00
Heat units	7950.
Specific gravity	1.202
Weight of 1 cubic foot	75.12

Coke: puffed, laminate, lustreless.

EXTRA-LIMITAL COALS.

Connellsville coal, Fayette county, Pennsylvania. Sent by E. C. Pechin, of Dunbar Furnace, in the autumn of 1875. From this coal the celebrated foundry coke is made. The specimen received would measure about one-half a cubic foot; every part of it displayed prismatic colors; it has a columnar structure, inclined to be granular and easily broken into small fragments.

Fixed carbon	65.00
Gas	24.00
Water	4.50
Ash, white	6.50
Coke	71.50
Heat units	7454.
Specific gravity	1.280
Weight of 1 cubic foot	80.00

Coke: of steel gray color, columnar, very strong, dense, slightly puffed on the surface.

Stone's Gas coal, Fayette county, Pennsylvania. This coal is in common use in many cities in the western states for the manufacture of illuminating gas. The specimen analysed was obtained at the Indianapolis Gas Works, and said by the Superintendent to be "first-class."

Fixed carbon	58.00
Gas	34.00
Water	3.00

Ash, white	5.00
Coke	63.00
Heat units	7805.
Specific gravity	1.292
Weight of 1 cubic foot	80.75

Coke: slightly puffed, amorphous, lustreless, and is much esteemed by our citizens as a grate and stove fuel.

Coal from Sardrie, Mud river, Mecklenburg county, Kentucky. Coal N, (No. 11, of D. D. Owen), 3 feet 6 inches thick. This is a dull black, vitreous, caking coal, with irregular, resinous fracture, laminæ indistinct, no visible pyrites.

	Sardrie.	Mud river.
Fixed carbon	51.00	57.00
Gas	42.50	37.00
Water	2.00	3.50
Ash, white	4.50	2.50
Coke	55.50	59.50
Heat units	8020.	8000.
Specific gravity	1.325	1.280
Weight of 1 cubic foot	82.81	80.00

Coke: puffed, lustreless, amorphous.

Wilmington coal, Illinois. A brilliant, jet black, caking coal, cubical fracture, with pyrites and calcite in the seams.

Fixed carbon	46.00
Gas	37.00
Water	10.50
Ash, red	6.50
Coke	52.50
Heat units	7111.
Specific gravity	1.248
Weight of 1 cubic foot	78.00

Coke: puffed, amorphous, brilliant.

Monunk coal, Illinois. A campact, deep black, caking coal, laminæ very indistinct, breaks into irregular cubes, and contains some pyrites.

Fixed carbon	48.00
Gas	35.00
Water	11.50
Ash, brown	5.50
Coke	53.50

Heat units	7089.
Specific gravity	1.232
Weight of 1 cubic foot	77.00

Coke: puffed, lustreless, amorphous.

Lignite—Brown coal, from Robertson county, Texas. Seam 10 feet thick, specimen presented by Levi Pennington. This is a lustreless, dull brown coal with irregular fracture, and much inclined to shrink, crack and fall to pieces on exposure to the air.

Fixed carbon	45,00
Gas	39.50
Wâter	11.00
Ash, white	4.50
Coke	49.50
Heat units	7260.
Specific gravity	1.232
Weight of 1 cubič foot	77.00

Coke: slightly shrunken, lustreless, and bears a close resemblance to wood charcoal.

ANALYSES OF COALS—CLAY COUNTY.

COUNTY.	NAME OF MINE OR OWNER.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Clay	Elias Cooprider, Middlebury, top..................	1,280	80.00	44,00	4,50	48,50	47,50	4,00	51.50	7924,	Pink,
Clay	Elias Cooprider, Middlebury, middle	1.533	95.81	45,00	8,50	53,50	44,00	2.50	46,50	7673.	Brown,
Clay	Elias Cooprider, Middlebury, bottom	1,211	75.68	50,50	4.00	54,50	42,50	3,00	45.50	7980.	Yellow.
Clay	John Cooprider, Middlebury, middle,............	1,271	79,44	44.50	5,50	50.00	47.00	3.00	50.00	7808,	Purple.
Clay	John Cooprider, Middlebury, bottom............	1.274	79,62	41,50	7.50	49.00	47,50	3.50	51,00	7711.	Purple.
Clay	Kennedy, Centre Point, top	1.354	84.62	46,50	15,50	62.00	35,00	3,00	38,00	6968,	Brown,
Clay	Kennedy, Centre Point, middle	1,204	75,25	49.50	9.00	58.50	39,00	2.50	41,50	7575,	White,
Clay	Kennedy, Centre Point, bottom........................	1,188	74,25	52,00	4,50	56,50	40,50	3,00	43,50	7917.	White,
Clay	Knickerbocker Coal Co., Salem, top	1.167	72.93	55.00	5,50	60.50	37,00	2.50	39.50	7838,	Buff.
Clay	Knickerbocker Coal Co., Salem, middle..........	1,184	74.00	52.50	6,00	58.50	39,50	2,00	41,50	7774,	White,
Clay	Knickerbocker Coal Co., Salem, bottom.........	1,241	77.56	50.50	6.50	57,00	40,00	3,00	43.00	7750.	White.
Clay	W. R. Kress, Middlebury, top............................	1,318	82,37	44,00	13,00	57,00	39,50	3.50	43,00	7179.	Red,
Clay	W. R. Kress, Middlebury, middle	1,287	80.43	40.50	10.50	51,00	44.50	4.50	49.00	7855.	Brown.
Clay	W. R. Kress, Middlebury, bottom.....................	1.432	89,40	38.50	13.00	51.50	44,50	4.00	48.50	7194,	Gray,
Clay	Lim. Liability Coal Co., Ashville	1,231	76,93	57,00	3,00	60.00	37,00	3,00	40,00	8000,	White.
Clay	Coal from Lodi..	1.303	81,43	43.00	13,50	56,50	40,50	3.00	43,50	7190.	Red,
Clay	Markland Coal Co., Clay City, top..................	1,202	75,12	58,00	4 00	62.00	36,00	2,00	38,00	7989,	White,
Clay	Markland Coal Co., Clay City, middle	1,145	71,56	63.50	0.50	64.00	33,50	2.50	36.00	8205,	White.
Clay	Markland Coal Co., Clay City, bottom..........	1.221	76.31	59,00	2.50	61,50	36,00	2.50	38,50	8070,	White.
Clay	Morrison's shaft, Centre Point, top	1,233	77,06	52,50	7,00	59,50	37,00	3,50	40,50	7637.	Flesh.
Clay	Morrison's shaft, Centre Point, middle	1.253	78.31	58.50	4.50	63.00	34,00	3.00	37,00	7846,	White.
Clay	Morrison's shaft, Centre Point, bottom	1.209	75.56	57.00	3.50	60,50	36,00	3,50	39,50	7909.	Flesh.

ANALYSES OF COALS—CLAY COUNTY.

County.	Name of Mine or Owner.	Specific Gravity	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water	Total Volatile Matter.	Heat Units.	Color of Ash.
Clay	Muir & Free, top	1.269	79.31	52.00	3.00	55.00	42.50	2.50	45.00	8101.	White.
Clay	Muir & Free, middle	1.167	72.93	48.50	6.00	54.50	41.50	4.00	45.50	7727.	White.
Clay	McClelland & Zeller	1.285	80.31	56.50	2.50	59.00	32.50	8.50	41.00	8005.	White.
Clay	John McCrea, Hoosiertown, top	1.196	74.75	56.50	2.00	58.50	39.50	2.00	41.50	8189.	White.
Clay	John McCrea, Hoosiertown, middle	1.229	76.81	56.00	5.50	61.50	36.00	2.50	38.50	7828.	White.
Clay	John McCrea, Hoosiertown, bottom	1.227	76.06	58.00	2.50	60.50	37.00	2.50	39.50	8080.	White.
Clay	Niblock & Co.'s "Chicago Mine,"	1.251	78.19	50.50	2.00	52.50	41.50	6.00	47.50	7888.	White.
Clay	A. Phipps, Middlebury, top	1.303	81.43	52.00	5.50	57.50	39.50	3.00	42.50	7826.	Brown.
Clay	A. Phipps, Middlebury, middle	1.266	79.15	48.50	4.50	53.00	44.50	2.50	47.00	8002.	Pink.
Clay	A. Phipps, Middlebury, bottom	1.333	83.31	40.00	10.50	50.50	47.00	2.50	49.50	7544.	Red.
Clay	Jacob Roush, Middlebury	1.239	77.42	49.50	7.00	56.50	40.00	3.50	43.50	7670.	Flesh.
Clay	Stedman's, Centre Point, top	1.208	75.50	57.50	4.00	61.50	35.50	3.00	38.50	7903.	White.
Clay	Stedman's, Centre Point, middle	1.216	76.00	50.50	8.00	58.50	39.50	2.00	41.50	7904.	White.
Clay	Stedman's, Centre Point, bottom	1.220	76.25	60.00	5.00	65.00	32.00	3.00	35.00	7784.	White.
Clay	J. Storm, Middlebury, top	1.204	75.25	52 50	7.00	59.50	38.00	2.50	40.50	7728.	White.
Clay	J. Storm, Middlebury, middle	1.257	78.56	59.00	2.50	61.50	36.00	2.50	38.50	8070.	White.
Clay	J. Storm, Middlebury, bottom	1.230	76.87	55.50	7.00	62.50	35.50	2.00	37.50	7731.	White.
Clay	Wagstaff, Clay City, top	1.319	82.43	61.00	3.00	64.00	33.50	2.50	36.00	8003.	Red.
Clay	Wagstaff, Clay City, middle	1.231	76.93	59.00	2.50	61.50	36.00	2.50	38.50	8070.	Pink.
Clay	Wagstaff, Clay City, bottom	1.214	75.87	54.50	2.50	57.00	40.50	2.50	43.00	8120.	Pink.
Clay	Ward & Perry, Oakland Slope, top	1.165	72.81	57.00	3.50	60.50	36.50	3.00	39.50	7955.	Red.
Clay	Ward & Perry, Oakland Slope, middle	1.162	72.62	58.50	3.00	61.50	36.00	2.50	38.50	8030.	White.
Clay	Ward & Perry, Oakland Slope, bottom	1.222	76.37	58.00	5.00	63.00	34.50	2.50	37.00	7851.	White.

ANALYSES OF COALS—CLAY AND OWEN COUNTIES.

COUNTY.	NAME OF MINE OR OWNER.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total volatile matter.	Heat units.	Color of Ash.
Clay	Woodruff & Fletcher, Hoosiertown, top	1.221	76.31	55.50	6.50	62.00	36.00	2.00	38.00	7787.	White.
Clay	Woodruff & Fletcher, Hoosiertown, middle	1.216	76.00	59.00	3.50	62.50	35.50	2.00	37.50	8024.	Flesh.
Clay	Woodruff & Fletcher, Hoosiertown, bottom	1.188	74.12	58.00	1.50	59.50	38.50	2.00	40.50	8218.	White.
Clay	Woodruff & Fletcher, near Brazil, old	1.142	71.87	59.00	1.50	60.50	35.50	4.00	39.50	8024.	White.
Owen	Arney's, top	1.212	75.75	49.50	2.50	52.00	45.00	3.00	48.00	8129.	White.
Owen	Arney's middle	1.206	75.37	49.50	2.00	51.50	45.00	3.50	48 50	8129.	White.
Owen	Arney's bottom	1.271	79.44	51.50	5.00	56.50	40.50	3.00	43.50	7877.	Red.
Owen	Reuben Barton	1.267	79 18	44.00	4.50	48.50	49.00	2.50	51.50	8051.	Red.
Owen	James Beaman	1.240	77.50	52.50	3.00	55.50	41.00	3.50	44.50	8004.	Red.
Owen	James Brammer, Patricksburg, top	1.192	74.50	46.00	1.50	47.50	48.50	4.00	52.50	8167.	Yellow.
Owen	James Brammer, Patricksburg, middle	1.204	75.25	53.50	3.50	57.00	41.00	2.00	43.00	8085.	Red.
Owen	James Brammer, Patricksburg, bottom	1.277	79.81	46.00	4.50	50.50	47.00	2.50	49.50	8029.	Pink.
Owen	Tice Bunger, middle	1.191	75.68	54.00	1.50	55.50	42.50	2.00	44.50	8262.	White.
Owen	Tice Bunger, bottom	1.223	76.44	58.00	3.50	61.50	35.00	3.50	38.50	7897.	White.
Owen	Chambers, top	1.230	76.87	49.00	3.00	52.00	45.50	2.50	48 00	8134.	Brown.
Owen	Chambers, middle	1.237	77.31	56.50	2.00	58.50	39.00	2.50	41.50	8143.	White.
Owen	Chambers, bottom	1.248	78.00	50.00	8.50	58.50	39.00	2.50	41.50	7618.	Brown.
Owen	D. C. Cress	1.248	78.00	55.00	2.50	57.50	39.50	3.00	42.50	8068.	Yellow.
Owen	G. Croft, middle	1.214	75.87	57.50	2.00	59.50	38.50	2.00	40.50	8178.	White.
Owen	G. Croft, bottom	1.250	78.12	57.00	4.50	61.50	36.00	2 50	38.50	7909.	White.
Owen	Joel Dillon	1.243	77.68	53.00	4.50	57.50	39.50	3.00	42.50	7906.	White.
Owen	A. Fiscus	1.362	85.12	45.00	19.50	64.50	33.00	2 50	35.50	6664.	Gray.

ANALYSES OF COALS—OWEN AND GREENE COUNTIES.

County.	Name of Mine or Owner.	Specific Gravity	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Owen	Calvin Fletcher, top	1.219	76.18	60.00	3.00	63.00	35.00	2.00	37.00	8059.	White.
Owen	Calvin Fletcher, middle	1.206	75.37	58.00	2.50	60.50	37.50	2.00	39.50	8126.	White.
Owen	Calvin Fletcher, bottom	1.241	77.56	44.00	8.50	52.50	45.50	2.00	47.50	7638.	Red.
Owen	Louisa Hester, cannel slate	1.333	83.31	47.00	12.50	59.50	36.00	4.50	40.50	7101.	Gray.
Owen	Jackson James	1.222	76.31	32.50	9.50	42.00	54.00	4.00	58.00	7580.	Pink.
Owen	McCreary, top	1.280	80.00	53.50	5.50	59.00	38.00	3.00	41.00	7809.	Brown.
Owen	McCreary, bottom	1.276	79.76	51.00	4.50	55.50	42.00	2.50	44.50	7974.	Red.
Owen	W. S. Norris	1.282	80.12	45.00	5.00	50.00	48.00	2.00	50.00	8040.	Red.
Owen	Oberholtzer, middle	1.242	77.62	57.00	4.50	61.50	35.00	3.50	38.50	7817.	Yellow.
Owen	Oberholtzer, bottom	1.292	80.75	53.00	9.50	62.50	34.50	3.00	37.50	7447.	White.
Owen	Jesse Reagan, top	1.261	78.81	52.50	7.50	60.00	37.00	3.00	40.00	7555.	White.
Owen	Jesse Reagan, middle	1.230	76.87	52.00	5.00	57.00	40.50	2.50	43.00	7918.	White.
Owen	Jesse Reagan, bottom	1.250	78.12	52.50	5.50	58.00	39.50	2.50	42.00	7866.	White.
Owen	J. Rowe, middle	1.235	77.18	56.00	5.00	61.00	36.00	3.00	39.00	7828.	White.
Owen	J. Rowe, bottom	1.213	75.81	53.50	4.50	58.00	39.00	3.00	42.00	7901.	White.
Owen	William Royer, top	1.260	78.75	55.50	4.00	59.50	38.00	2.50	40.50	7970.	White.
Owen	William Royer, middle	1.193	74.56	55.00	3.00	58.00	39.00	3.00	42.00	8022.	Pink.
Owen	William Royer, bottom	1.219	76.18	51.50	4.00	55 50	41.50	3.00	44.50	7969.	White.
Owen	J. C. Stall	1.203	75.18	58.00	3.00	61.00	36.00	3.00	39.00	7989.	White.
Owen	White	1.216	76.00	55.50	2.50	58.00	39.00	3.00	42.00	8062.	Pink.
Greene	B. Schweitzer, top	1.317	82.31	47.00	6.00	53.00	44.50	2.50	47.00	7881.	Red.
Greene	B. Schweitzer, bottom	1.302	81.37	50.00	3.50	53.50	44.00	2.50	46.50	8077.	Red.
Robertson	Brown coal, Texas	1.232	77.00	45.00	4.50	49.50	39.50	11.00	50.50	7260.	White.

ANALYSES OF COALS—VIGO AND FOUNTAIN COUNTIES.

County.	Name of Mine or Owner.	Specific gravity.	Weight of one cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water	Total volatile matter.	Heat units.	Color of Ash.
Vigo	Arbuckle & Budd, Seelyville, top	1.211	75.68	48.00	3.50	51.50	45.00	3.50	48.50	8007.	White.
Vigo	Arbuckle & Budd, Seelyville, bottom	1.250	78.12	50.00	3.50	53.50	43.50	3.00	46.50	8031.	White.
Vigo	Barrick & Sons	1.192	74.50	48.20	4.30	52.50	44.50	3.00	47.50	8000.	Red.
Vigo	Henry Brayton, Grant	1.216	76.00	44.00	8.50	52.50	44.00	3.50	47.50	7592.	Red.
Vigo	Foote's bore	1.217	76.06	50.10	1.80	51.90	44.40	3.70	48.10	8123.	Brown.
Vigo	P. H. Holloman	1.242	77.62	42.00	12.50	54.50	42.00	3.50	45.50	7247.	White.
Vigo	G. W. Mooreland	1.195	74.70	47.50	4.50	52.00	43.50	4.50	48.00	7829.	Red.
Vigo	A. McPherson	1.239	77.43	56.50	4.00	60.50	37.00	2 50	39.50	7959.	White.
Vigo	McQuilkins	1.210	75.62	47.50	3 50	51.00	44.50	4.50	49.00	7921.	White.
Vigo	F. Bhyan	1.226	76.62	48.50	6.00	54.50	43.50	2.00	45.50	7910.	Flesh.
Vigo	Somerset Coal Company	1.210	75.62	51.00	1.50	52.50	43.00	4.50	47.50	8066.	White.
Vigo	Webster & Bramwell, top	1.197	74.81	48.00	3.00	51.00	46.00	3.00	49.00	8098.	Purple.
Vigo	Webster & Bramwell, bottom	1.210	75.62	47.50	4.00	51.50	45.50	3.00	48.50	8013.	Red.
Vigo	J. S. Wyeth, Hartford, top	1.237	77.31	49.00	7.50	56.50	41.00	2.50	43.50	7721.	White.
Vigo	J. S. Wyeth, Hartford, bottom	1.216	76.00	51.00	4.50	55 50	42.00	2.50	44.50	7974.	White.
Fountain	Barker's	1.195	74.68	54.50	4.50	59.00	36.00	5.00	41.00	7707.	White.
Fountain	Judge Coates'	1.230	76.25	47.50	3.00	50 50	44.00	5.50	49.50	7875.	White.
Fountain	Kirtland, top	1.203	75.18	47.50	2.50	50.00	46.00	4.00	50.00	8058.	Red.
Fountain	Kirtland, bottom	1.211	75.68	39 00	4.50	43.50	53.00	3.50	56.50	8014.	Brown.
Fountain	J. W. McKee, top	1.205	75.31	55.00	4.00	59.00	35.00	6.00	41.00	7655.	White.
Fountain	J. W. McKee, bottom	1.225	76.56	47.50	5.50	53.00	41.50	5 50	47.00	7646.	White.
Fountain	Steadman Thompson, top	1.239	77.43	52.50	4.50	57.00	37.50	5.50	43.00	7682.	White.
Fountain	Steadman Thompson, bottom	1.207	75.43	51.50	4.00	55.50	41.50	3.00	44.50	7969.	Flesh.

ANALYSES OF COALS.

COUNTY.	NAME OF MINE OR OWNER.	Specific Gravity	Weight of one Cubic foot.	Fixed Carbon.	Ash.	Coke.	Gas.	Water.	Total Volatile Matter.	Heat Units.	Color of Ash.
Vanderburg	Ingleside, (L)	1.275	79.68	53.50	4.00	57.50	39.00	3.50	42.50	7901.	Red.
Vanderburg	Ingleside, (M), top	1.273	79.56	44.00	13.50	57.50	39.50	3.00	42 50	7179.	White.
Vanderburg	Ingleside, (M), middle	1.275	79.68	48.50	6.00	54.50	42.00	3.50	45.50	7772.	White.
Vanderburg	Insleside, (M), bottom	1.336	83.50	46.00	11.00	57.00	39.50	3.50	43.00	7341.	White.
Warrick	Chandler's, (M), top	1.274	79.62	47.50	9.00	56.50	40.60	3.50	43.80	7508.	White.
Warrick	Chandler's, (M), middle	1.282	80.12	49.50	5.50	55.00	41.50	3.50	45.00	7808.	White.
Warrick	Chandler's, (M), bottom	1.283	80.18	45.00	16.50	61.50	34 50	4.00	38.50	6801.	White.
Warrick	Millersburg, (N) middle	1.242	77.62	53.00	2.50	55.50	41.50	3.00	44.50	8090.	Blue.
Warrick	Millersburg, (N), bottom	1.243	77.68	49.00	2.00	51.00	45.50	3.50	49.00	8042.	Brown.
Posey	G. Heldferl's, St. Wendell's	1.327	82.93	51.00	5.50	56.50	39.50	4.00	43.50	7745.	Brown.
Montgomery	B. Clover, near Waveland	1.254	78.37	52 00	3.50	55.50	41.50	3.00	44.50	8010.	White.
Montgomery	H. S. Burford, near Waveland	1.202	75.12	49.00	5.00	54.00	43.50	2.50	46.00	7950.	White.
Parke	Moore's Mill, on Sugar Creek	1 228	76.75	46.50	3.50	50.00	46.00	4.00	50.00	7977.	Brown.
Vermillion	Charles Moore's mine	1.258	78.62	46.00	4.50	50.50	44.00	5.50	49.50	7751.	Flesh.
Sullivan	Dick's, 5 years old	1.239	77.43	55.00	1.50	56.50	40.00	3.50	43.50	8114.	White.
Sullivan	Dick's, fresh from mine	1.258	78.62	50.50	1.50	52.00	43.50	4.50	48.00	8071.	White.
Daviess	J. S. Morgan, top, No. 1	1.277	79.81	56.00	5.50	61.50	32.50	6.00	38.50	7507.	Red.
Davioss	J. S. Morgan, bottom, No. 2	1.252	78.25	53.50	5.00	58.50	36.00	5.50	41.50	7626.	White.
Daviess	J S. Morgan, lower seam, No. 3	1.239	17.44	53 00	2.50	55.50	39.50	5.00	44.50	7906.	White.
	Connellsvilla, Pennsylvania	1.280	80.00	65.00	6.50	71.50	24.00	4.50	28.50	7454.	White.
	Stone's Gas coal, Pennsylvania	1.292	80.75	58.00	5.00	63.00	34.00	3.00	37.00	7805.	White.
	Mud River, Kentucky	1.280	80.00	57.00	2.50	59.50	37.00	3.50	40.50	8000.	White.
	Sardrie, Kentucky	1.325	82.81	51.00	4.50	55.50	42.50	2.00	44.50	8020.	White.