

CLAY COUNTY.

This county is bounded on the north by Parke, on the east by Putnam and Owen, on the south by Greene, and on the West by Sullivan and Vigo counties. Its topography is marked by no very great diversity of surface; the hills are low, and present but few mural precipices where cut by the streams, being for the most part composed of argillaceous and arenaceous shales, rarely flagstones and thick bedded sandstones; they are capped with a thick deposit of glacial clay and gravel, with some boulders. A large portion of the county may be termed level, and from the tenacity with which the clay soil retains water, it is, for a part of the year, inclined to be wet. The principal water-course is Eel river, a branch of the west fork of White river; it crosses the southern part of the county from east to south-west, and thence in a south-east direction in such a manner as to form a large triangular shaped bend; and contains throughout this part of its course a succession of remarkable horseshoe-like crooks; Birch creek and Croy's creek are tributaries of Eel river; the source of the former is near the town of Brazil, and with its tributaries drains the middle part of the county. The latter heads in the northern part of Putnam county, and flows through the north-eastern corner of Clay. The headwaters of north and south Otter creeks flow through the middle and western portions of the northern townships, in a westerly direction, forming, at their junction in Vigo county, Otter creek, a tributary of the Wabash river. Jordan and Six-mile creek are tributaries of Eel river, the former forms its junction at Bowling Green, and the latter at Belleair.

The Wabash and Erie Canal, (now abandoned south of Terre Haute,) passed through the south-west corner of the county. The supply of water for this part of the canal was obtained from the great reservoirs fed by Eel river and Birch creek. Splunge creek reservoir contained four

thousand acres, and the Birch creek reservoir, fourteen hundred.

When these immense reservoirs were constructed, the ground was covered by a dense forest growth, but the stagnant water killed the trees and caused the vegetation to decay, thus loading the air with miasmatic poison to an extent that jeopardized the health of the county for many miles around; therefore, considering themselves aggrieved, and seeing no chance for redress in the courts, the citizens of that part of Clay county bordering on the reservoirs resolved to take the law into their own hands, and, assembling in force, cut the embankments and let out the water. Troops were sent out by the Governor of the State to bring the guilty parties to justice, but resistance on the part of the citizens seemed so determined, and the impracticability of keeping up the canal having become apparent to most persons, it was finally concluded to let the matter rest, and the reservoirs no longer exist except in name, so that we could not even, at this time, find the exact locality of the one fed by Birch creek, in order to mark its original outline on the map.

The Terre Haute & Indianapolis and the Indianapolis & St. Louis railroads cross the "*block coal*" field in the northern part of the county, running nearly parallel with each other, and only about five miles apart. The former is one of the best managed railroads in the West. The track is always kept in the best of order, and the officers furnish every facility in their power to promote the large mining and manufacturing interests along the line of their road. Branch roads or switches have been built to the blast furnaces and to the most important coal mines now opened, both to the north and south of the main line, as shown on the map accompanying this report, making, in the aggregate, about fifteen miles of additional railroad facilities. Four passenger and six regular freight trains run daily each way over this road, and when it is borne in mind that nearly every regular freight train "flags" another, and that fully one-half of this business is derived from a very small part of the

coal lands of this county, some idea may be formed of its vast mineral resources, which are just beginning to be developed.

The Indianapolis & St. Louis railroad is not yet completed, but the work of construction is being rapidly pushed forward, and it is confidently believed that trains will be running through on this road early next summer. As this road also crosses the "block coal" belt in Clay county, some five miles north of the Terre Haute & Indianapolis railroad, there is every reason to believe that it will furnish along its line equal facilities for coal mines and blast furnaces.

Besides these two roads, a charter has been obtained for a railroad to run from Newburg, in Warrick county, on the Ohio river, in a northerly direction to Attica, in Fountain county. This road will run through the central part of Clay county, passing on its way through Bowling Green, Center Point, Brazil, and Carbon. Being located in the heart of the coal field, it will, when completed, afford fine mining facilities from one end of the line to the other. As nearly all the counties through which it will pass have voted liberal donations to aid in its construction, there is, consequently, a fair prospect that it will be built.

GEOLOGY OF CLAY COUNTY.

Clay county is situated on the eastern margin of the Illinois coal field, and contains within its area rocks belonging to the following geological divisions, namely:

Subcarboniferous limestone.

Millstone grit.

Coal measures.

Glacial or drift.

The subcarboniferous limestone formation embraces the oldest stratified rocks found in the county. The only outcrop of this limestone, which I saw, is exposed in the bank of Jordan creek, where it cuts through a ridge, one and a quarter miles northwest of Bowling Green, in the northeast quarter of section eighteen, town eleven, range five

west. At this point of exposure it is about ten feet thick, and contains characteristic fossils. *Productus cora*, *Pentramites pyraformis*, Say. *Sprifer incrassatus*, *Athyris subtilita*, and some fragments of unrecognized shells were seen. Above the limestone, at this locality, there is about thirty feet of arenaceous shale, with a considerable quantity of hydrated brown oxide of iron. This ore occupies the same geological horizon as the heavy deposits of iron ore found to the south, in Greene county, and being on the "line of strike," or outcrop, from the latter locality, it may prove to be extensive and valuable; at least the indications are sufficiently favorable to warrant me in recommending further search by sinking a few shallow shafts along its out-crop. The millstone grit epoch follows immediately above this limestone in regular sequence, and is very variable in its lithological character, and carries two or more coal beds. It is sometimes represented by a massive, coarse-grained rock, sixty to seventy feet thick, specked with peroxide of iron, and is usually separated into two beds by a parting of shale, with six to twelve inches of coal. At other points the massive rock is entirely replaced by a great depth of arenaceous shales, containing no coal. This massive rock is quite soft when first quarried from the bank, but soon becomes very hard on being exposed to the influence of the air. It varies in color from light buff to brownish red, and can be quarried in blocks of large dimensions. At most quarries it presents the character of a fair building stone.

Around Bowling Green the millstone grit is largely composed of arenaceous shales, with here and there a layer of very good building stone, specimens of which may be seen in the jail, which is built of sandstone, quarried a short distance south of the town. On the opposite side of the ridge in which the sub-carboniferous limestone is exposed, and in the same section, town, and range, the following section is seen, the lower coal of which belongs, apparently, just above the shales over the limestone. The connected section for the locality of Bowling Green is therefore:

Drift, gravel, and clay,	20 ft.
Shale and schistose sandstone,	15 ft.
Coal B.,	1 ft.
Fine potter's clay,	3 ft; 6 in.
Bluish-black argillaceous shale and rash-coal, 7 to 8 ft.	
Coal A. ("block coal,")	1 ft. 3 in.
Fire clay with stigmaria,	? ft.
Arenaceous shale,	30 ft.
Subcarboniferous limestone,	10 ft.
Low water of Jordan creek,	0 ft.
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	88 ft. 9 in.

Coals A. and B. were opened and worked to a small extent, for neighborhood use, by Esquire Elkins, of Bowling Green. The quality of the coal is good, but the seams are too thin to prove remunerative. The fire clay under B. is light colored and very plastic, and is adapted for the manufacture of stoneware. The shales above A. are filled with beautiful coal plants, that are difficult to preserve, on account of the friable nature of the shale. *Neuropteris Loschii*, *N. hirsuta*, *Sphenophyllum Schlotheimii*, and *Pecopteris arborescence*; large fruit, flattened trunks of *Sigillaria*, *Lepidodendron*, and *Calamites*.

Descending the hill on the east side of Bowling Green, the road cut exposes the following section:

Soil and drift,	30 ft.
Whitish-gray flagstones (place building stone,) 20 ft.	
Coal B.,	1 ft.
Fire clay,	2 ft.
Silicious shale,	13 ft.
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	66 ft.

A quarter of a mile beyond, in a ravine, there is to be seen below this section three feet of coal-rash, resting on hard, arenaceous fire clay. On going up this ravine, the

coal-rash rises rapidly with the hill, and before reaching the top, it is united with the thin coal B., which is here overlaid by a thin, schistose, rough weathering sandstone, with marks of false bedding in places. Here, in the coal-rash, we also find an abundance of compressed trunks of coal-measure trees belonging to the same genera above noted.

Near Eel river, in the north edge of the town of Bowling Green, some time before my visit to the place, a shallow bore was made, which passed through a thin coal, (probably B.,) and the coal-rash of the above section. I was unable to learn any further particulars regarding the strata passed through in this bore, or the depth of it, but it is generally conceded that it is of but little depth. Sixty or seventy feet would surely have reached the subcarboniferous limestone, making a reasonable allowance for the thickening of the siliceous rocks to the westward of the exposure of this limestone on Jordan creek, in section eighteen, town ten, range five west. The ridge of millstone grit on which Bowling Green is situated, bears away to the south, touching Eel river just below Belleair, where it forms an abrupt escarpment on the east bank of the stream. The upper part being a heavy bedded, rough sandstone, the lower part shaley, with five or six bands of ironstone, in all from four to six inches thick. The latter is underlaid by shales and a thin coal. This coal was covered with water at the time of my visit, it being in the bed of the river, and is only exposed at low water. It is reported to be twenty inches thick, and is probably the equivalent of coal A. The section made of the rocks in the bank of the river, immediately above the coal, which is in section thirty-four, town eleven, range six west, and several hundred yards below the bluff of bedded sandstone, is here given. (Three feet of the lower part is given from report):

Soil and drift,	6 ft.
Blue argillaceous shale, with four to		
six inches of ironstone,	5 ft.
Schistose sandstone, with marks of		
false bedding,	8 ft.

Coal A.,	1 ft. 8 in.
Bed of Eel river,	0 ft. 0 in.
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	20 ft. 8 in.

Coals A. and B. outcrop, also, in a ravine, near Mr. Kincaid's house, in section twenty-one, town eleven, range five west, where I obtained the following section:

Drift,	8 ft.
Coal dirt, (B?),	- ft.
Siliceous shale, fissile,	10 feet.
Siliceous shale, compact,	2 ft.
Coal (A?) "block coal,"	1 ft.
Very white fire clay,	2 to 3 ft.

Two hundred yards further down the branch, into which the waters of this ravine run, the siliceous shale of the above section is replaced by a compact sandstone, from the base of which—and probably from off the coal—there breaks up in the bed of the branch a spring of mineral water, charged with carbonate of protoxide of iron, sulphate of protoxide of iron, and other mineral salts, most likely derived from the pyritic shales which form the roof of the coal.

From Bowling Green the millstone grit passes southward in the direction of Hausertown, in Owen county, and strikes White river at Point Commerce, in Greene county. Another branch of the main ridge, which starts off from the neighborhood of Hausertown, passes to the westward of Worthington, in Greene county, and crosses White river at the point known as "the Ripple," a few miles above Fairplay ferry; and to the northward of Bowling Green it skirts along the entire eastern boundary of the county, and in places extends in tongue-shaped points far out into Putnam county. At the base of the millstone grit is the great repository of limonite iron ore, not only in this State, but likewise in Ohio, Kentucky, Tennessee, Illinois, Missouri, Arkansas, and the territory of New Mexico. And in Clay county we find more or less iron ore all along its outcrop, but the main deposits yet seen lie to the southward in Greene county.

When argillaceous shales predominate at the base of this formation, the iron ore partakes of the character of an earthy carbonate, and lies in bands stratified with the shale; where sandstone forms the base, the iron ore is a silicious brown oxide.

The first variety of ore has been mined to a considerable extent south of Eaglesfield, in the western border of Putnam county, and smelted at the Planet furnace, but the expense of mining and transporting the ore to the furnace was too great to prove remunerative, and the mines have been abandoned.

The ore band is only four to six inches thick, and could only be mined by removing a large amount of worthless material, after which it had to be hauled two and a half miles to the railroad. The silicious oxide of iron is found in vast quantities in Greene county, and still further to the southward, which leads me to infer that it will yet be found abundant to the northward of that county, along the outcrop of the millstone grit.

At no place along the line of my survey has the millstone grit been represented by a conglomerate, or sandstone charged with quartz pebbles, but it varies in its lithological features from a thick bedded sandstone, of various colors, to silicious shale; its total depth is very irregular, also, being much greater at some places than at others.

This frequent variation in the depth and character of these strata, renders the study of the millstone grit epoch very difficult, especially in this region, and it is therefore quite possible that I have, in some places, along the margin of the basin, committed the error of mistaking its shales for coal-measure strata, and *vice versa*, especially where the country is level, and no well marked characters can be found to serve as a guide; for it must be borne in mind that in this part of the carboniferous basin the millstone grit is coal bearing, and the quality of its coal appears to differ, in no respect from the true coal measure beds, being, like them, "block," or non-caking coal.

COAL MEASURES.

In order to show more clearly the position of the coal strata and subordinate formations in Clay county, a vertical section is given, which represents the geological order of the strata between Greene Castle on the east and Terre Haute on the west, constructed from outcrops along the line of the Terre Haute and Indianapolis railroad, and from the record of deep bores. (*See colored section.*)

In the city of Terre Haute, at about the level of the crossing of the Terre Haute & Indianapolis and the Evansville & Crawfordsville railroads, a bore was made for Mr. Chauncey Rose, which went to the depth of seventeen hundred and ninety-three (1793) feet, passing through the carboniferous, and stopped in the subcarboniferous rocks, just above the Marcellus shale, as I propose to show, by the comparison of its section with that of other bores.

At Terre Haute, three horizons of salt water are noted in the carboniferous strata, and there are probably others, still lower down, that are not recorded, for the reason, possibly, that the brine above was not stopped out but allowed to fill the bore for some depth below.* A "show of oil" and two oil-veins were passed, from the lower of which there was a considerable flow of oil. The sulphur-water which is found in the lower one hundred feet, rises to a considerable elevation above the surface, with an irregular pulsating flow, and is mixed with gas emitting a strong odor of sulphuretted hydrogen, and leaves on the reservoir a deposit of sulphur. The analysis made of this water, for Mr. Rose, by J. G. Pohle, M. D., indicates that it possesses fine medicinal properties. From one gallon of the water he obtained 365.067 grains of solid matter, composed of

Chloride of Sodium,	. . .	316.000	grains.
Chloride of Magnesium,	. . .	6.428	"
Chloride of Calcium,	. . .	4.816	"
Chloride of Potassium,	. . .	1.232	"

* Since writing the above I have been credibly informed that good brine was reached at several horizons in this space, and that at thirteen hundred feet a brine was struck which indicated 13° on Baume's Saltometer. Fifty gallons of brine of this strength will make one bushel of salt, fifty-six pounds.

Bicarbonate of Soda,520	grains.
Sulphate of Lime, . . .	2.325	"
Bicarbonate of Magnesia, . .	6.420	"
Bicarbonate of Lime, . . .	25,026	"
Silicic Acid and Alumina, . .	1.200	"
Nitrogenous organic matter, .	1.100	"
Bromide of Magnesium, . . .	trace.	
Sulphate of Calcium, . . .	trace.	
Phosphates of Lime, . . .	trace.	
Also, Sulphuretted Hydrogen, and Carbonic gas.		

365.067 grains.

For the record of the bore at Reelsville, on the Walnut Fork of Eel river, in Putnam county, I am indebted to Mr. David N. Barnett, who lives a few miles south of the well. This bore is twelve hundred and forty (1240) feet deep, and notwithstanding it commences by the railroad levels, one hundred and seventy-six (176) feet above Terre Haute, it starts in strata that are geologically seven hundred and fifty-four (754) feet below the surface at that place, and penetrates strata that are two hundred and fifty (250) feet below the bottom of the Terre Haute artesian well.

This difference in the geological horizons of the two places is readily accounted for, by a very slight dip of the strata to the west. At Reelsville four horizons of salt water are passed, one in the subcarboniferous limestone, two in the subcarboniferous sandstone, and the fourth below the Marcellus shale, and probably in the Devonian. Near the bottom of the well, and in silurian strata, artesian sulphur-water is reached, that appears, from the taste, to be very similar, in its mineral constituents, to the artesian water at Terre Haute. It rises in a copious stream to the height of twenty feet, or more, above the surface.

Another great well was bored for oil, at Lodi, in the south-west corner of Fountain county, which passed through five distinct horizons of salt water, one in the

coal-measures, another at the base of the millstone grit, and three in the subcarboniferous sandstone; the lower brine, marked seven and a half degrees of Baumé, being equal in strength to the brine at Kanawha.

For a detailed, highly interesting and accurate record of the bore at Lodi, I am under obligations to Mr. John Collett, of Eugene, in Vermillion county, Indiana, who carefully examined the borings as they were brought up, and noted down his observations at the time, in a book which is replete with information concerning the materials passed through. At about the same geological level as in the well at Reelsville, a most remarkable stream of sulphur-water was reached, which rushed with tremendous force up a ten-inch tube to the height of forty-three feet above the level of the ground, and discharges about one hundred thousand barrels of water per day. An analysis of this water was made by Dr. Pohle, from which it appears to be one of the most remarkable and valuable medicinal waters found in the world. Around the well sulphur is deposited in solid flakes on every substance which is reached by the spray from this gigantic fountain, and the odor of sulphydric acid may be readily perceived, under favorable conditions, at a distance of half a mile from the well.

The Marcellus shale, which is also found in the Lodi bore, being everywhere a black bituminous rock, that will burn when thrown on the fire so long as the bitumen lasts with which it is charged, but its stony substance remains unchanged, and though often mistaken by the uninitiated for coal, on account of its color and limited inflammability, it is entirely worthless for fuel; but, on account of its marked features and great depth, being seventy feet at Reelsville and sixty feet nine inches at Lodi, as shown by the bores; it is of special importance as a guide to the geologist, from its forming a conspicuous horizon that is readily recognized by the well-borer.

Now, taking this Marcellus shale as an established base, and arrange accordingly the sections of the three bores,

ARTESIAN WELL
AT FERRE HAUTE.

Diagram No. 1.

Feet		Feet		Feet	
DRIFT.	150	Mill Stone Grit.	50		
Salt Water.		Top of Bore.			
Coal Measures and Mill Stone Grit.		Sub Carb. Limestone.	320	Coal Measures and Conglomerate.	
Salt Water.	604			Oil Bloom.	203
Salt Water.		Salt Water.		Brackish Water.	
Sub Carb. Limestone	37			Sub Carb. Sandstone.	
Show of Oil.					
Sub Carb. Sandstone.	1001				
		Sub Carb. Sandstone.		Show of Oil.	
9 inch Oil Vein.				Salt Water.	710
Salt Water, 13°, tested by N. Thomas		Salt Water.	680	Salt Water, $6\frac{1}{2}^{\circ}$	
10 inch Oil Vein.		Salt Water.		Salt Water, $7\frac{1}{2}^{\circ}$ 15 oz. per gall.	
Wh. Sulph. Water.				Salt Water, $9\frac{1}{2}^{\circ}$	
Place of Marcellus Shale.		Marcellus Shale.	70	Marcellus Shale.	60
		Salt Water.			
		Devonian and Silurian Rocks.	180	Wh. Sulph. Water.	144
		Wh. Sulph. Water.		Devonian and Silurian Rocks.	

SCALE—400 feet to one inch.

just spoken of, side by side, as shown in the accompanying diagram, No. 1, and assuming that the bore at Terre Haute stopped near the top of the Marcellus shale, a remarkable correspondence of the strata is perceived in the two bores, the agreement being almost as close as one could expect to find in two bores at a much less distance apart.

As we go westward the subcarboniferous limestone appears to have given place to shale and sandstone.* The former is three hundred and twenty feet thick at Reelsville, but is only thirty-seven feet thick at Terre Haute, and was not found at all at Lodi—though a few feet of limestone, equivalent to the Keokuk limestone, is seen at the base of the millstone grit at Williamsport, about twenty-five miles a little east of north, from the former place.

In the record of the bore at Lodi, Mr. Collett, for whose opinion I have great respect, marks the base of the conglomerate at five hundred and sixty-five feet; but in this I must differ from him, and place it as shown in Diagram No. 1, at the depth of two hundred and three feet and nine inches. In justification of this correction, it may be well to state, that the millstone grit is found a few miles to the northeast and south of Lodi, and is universally along the margin of the basin, overlaid by coal seams, with no great space intervening, and very often coal is found below it.

The horizons of salt water correspond so completely in the two bores that we are at once led to conclude that throughout Clay county, and the entire coal field of this State, deep wells are likely to reach good salt water, equal in strength to the brines on the Kenawha river in Virginia at about the levels indicated on the section of the bores in the preceding diagram.

On account of the great development of the subcarboniferous sandstones and shales in which petroleum is found so abundant in Pennsylvania, Ohio, and West Virginia, our

* This is not shown on the colored section. The depth of the limestone at Reelsville is carried through to Terre Haute. The limestone, as we go west, appears to be displaced by sandstone and shales that are synchronous with the limestone at Reelsville.

prospect for oil in this part of Indiana is not so discouraging as geologists have, heretofore, been led to believe. In fact, from the present evidence, there is strong probability that oil may be found in sufficient quantities to pay for working. The few unsuccessful wells that have been bored in Indiana serve by no means to definitely settle the question with regard to the possibility of finding oil in paying quantities, nor to discourage further efforts in its search. In Pennsylvania, and elsewhere, we find numerous wells bored that fail to reach oil; indeed, it is a well established fact that barren wells are more numerous than productive ones in the most highly favored oil territory. Measuring from the Marcellus shale (on Diagram No. 1) upwards, the space between it and the millstone grit, at Reelsville, is one thousand feet; at Lodi, seven hundred and ten feet; and at Terre Haute, (assuming that the bottom of the bore at that place is near the top of this shale,) one thousand and thirty-eight feet. Now, since the *colored section* is made to a scale of two hundred feet to the inch, in vertical height, the depth to which a bore will have to go to strike the oil or brine horizons, at any given point between Greencastle and Terre Haute, may be readily determined with a remarkable degree of accuracy.

From Reelsville, in Putnam county, the strata dip to the westward at the rate of about thirty feet to the mile of horizontal distance. This low rate of dip is not rendered perceptible unless followed to some distance, when the changes it brings about in the strata are made wonderfully manifest. The subcarboniferous limestone and millstone grit are carried below the surface; the former seven hundred and fifty-four feet below the crossing of the Terre Haute & Indianapolis and the Evansville & Crawfordsville railroads at Terre Haute, which point is four hundred and eighty-three feet above high tide of the Gulf of Mexico, and about fifty-two feet above the low water of the Wabash river.

The coal measures make their appearance along the line of this section, in Clay county, increasing rapidly in thick-

ness as you proceed toward the Wabash river, and for some distance beyond that stream in Illinois. As the strata increase in depth, the beds of coal disappear, and are replaced by shale and other rock. Their absence being first noticed in the lower strata in Marshall county, Illinois, not more than twelve miles west of the Wabash river, where, notwithstanding a still greater development of the coal measures, by the acquisition of superior strata, we see they are, nevertheless, barren of coal beds of a workable thickness, from the upper to the lower strata.

The following diagram (No. 2) exhibits a connected section of the coalmeasures and coal beds in Clay and Greene counties, extending down to the base of the millstone grit, which contains two or more coal beds, one of which is of good workable thickness. The short time that has yet been given to the survey of the coal field in this State renders it highly probable, as I make no pretensions to infallibility, that some errors may still exist in regard to the placing of the seams of coal in this section. It is, therefore, only provisionally given at this time, in order to facilitate their study.

The space between coals B and F appears to be barren of coal seams in the counties examined, and a skip in the order of lettering has been made, with the expectation that coal-beds will be found to fill out some of the blanks, at least in other parts of the State.

Coals A and B are to be seen along the eastern border of Clay county, and in places some miles beyond, and within the limits of Putnam county; but here, so far as yet discovered, they are too thin for profitable working, especially while thicker beds can be had close by. The quality of the coal is generally good but variable, being, at some places, non-caking, or "block," and at others "caking-coal."

Where the former character prevails, these coals will answer for making iron in blast-furnaces.

On the east side of Bowling Green, and at the foot of a ravine, the space between coals A and B is twelve to fifteen

feet, which gradually diminishes as you ascend to its head, where they unite in one seam from one and a half to two feet thick. Coal A ranges from one and a half to three feet in thickness, but B seldom exceeds one foot. As these coal seams have already been alluded to in connection with the millstone grit, and the horizon at which they may be found being clearly set forth in the connected section, I will now proceed to speak of the more important coals, from a manufacturing point of view, to be found within the entire limits of the *great western coal field*.

These coals are marked F, I, and K, on the connected section, and may be referred to as "lower block," "main block," and "upper block-coals."

The main "block-coal," I, ranges from three feet eight inches to four feet four inches in thickness, and the lower and upper coals from one foot six inches to three feet six inches. They were first mined in the vicinity of Brazil, and are found occupying a belt that, in Clay county, is from three to ten miles in width, and in length extending from the northern limits of the coal basin, in Warren county, as far south as the present limits of my survey, in Greene county; and it is my opinion that it will be found still farther south.

"Block-coal" is a name used by miners to designate a variety of non-caking bituminous coal, which was first discovered on the western border of the Appalachian coal-field, along the Mahoning valley, in the State of Ohio, where it is also extensively used in blast-furnaces, direct from the mine. In many respects it closely resembles the Scotch "splint" coal; it is free burning, contains a small amount of white ash, is remarkably free from sulphur, has a splinty fracture, and emits a dull ringing sound when struck with the hammer. The beds of this coal are traversed by narrow vertical fissures, that are, nevertheless, quite distinct, the main system of which run a little east of north, and being crossed at right angles by others, they separate the coal strata in such a manner that the coal may be mined in large cubes or blocks, which exhibit the whole depth of the bed—hence the probable origin of the name

Diagram No. 2.

CONNECTED SECTION OF COAL MEASURES IN CLAY AND GREENE
COUNTIES, INDIANA.

SPACES.

FEET	IN.		FEET	IN.	
			23		<i>Dryt.</i>
43	6		19		<i>Hard-Pan.</i>
			1	6	Sandstone with Iron Ore.
			4		<i>Coal N.</i>
			7	6	<i>Fire Clay.</i>
			1	6	<i>Sandstone.</i>
31	4		12	9	<i>Shale.</i>
				6	Fossiliferous Iron Ore.
			7	7	<i>Shale.</i>
			1	6	Bituminous Shale.
					<i>Coal M.</i>
			5	8	<i>Fire Clay.</i>
			4		<i>White Sandstone.</i>
30			5		<i>Dark Sandstone.</i>

CONNECTED SECTION OF COAL MEASURES—Continued.

SPACES.					
FEET	IN.		FEET	IN.	
			14	6	White Sandstone.
				10	Bituminous Shale.
			7		Coal, L.
			4		Fire Clay.
14	2		4	6	Sandstone.
			1	6	Bituminous Shale.
			2	6	Fossiliferous Limestone.
			1	8	Bituminous Shale.
			1	10	Coal K, (Upper Block).
			5		Fire Clay.
14	6		9	6	Shale.
				7	Coal, J.
			4		Sandstone.
11			7		Fire Clay.
			4	4	Coal I, Main Block.
12	6		10	6	Fire Clay.
			2		Bituminous Shale.
			1	5	Coal, H.
			3	9	Fire Clay.
25	2		4	6	Slate.
			5		Fire Clay.

CONNECTED SECTION OF COAL MEASURES—Continued.

SPACES.		FEET IN.		
24	6		2	9 Shale.
			3	1 Sandstone.
			5	6 Shale.
				7 Bituminous Shale.
				5 Coal. G.
			1	6 Shale.
			4	White Sandstone.
			1	4 Dark Sandstone.
			7	Shale.
			2	Sandstone, Dark.
263	9		6	2 White Sandstone.
			2	6 Bituminous Shale.
			3	8 Coal, F, (Lower Block).
			7	Sandstone.
			1	3 Fine Clay.
			5	Gray Shale.
			109	Argillaceous and Siliceous Shales bored into at Harmony, Clay Co.

CONNECTED SECTION OF COAL MEASURES—*Continued.*

SPACES.

FEET	IN.		FEET	IN.	
			150		<i>Millstone Grit, Shales and Massive Sandstone.</i>
			2		<i>Coal, B.</i>
20			20	4	
			3		<i>Coal, A.</i>
			3		<i>Argillaceous Shales.</i>
					<i>Heavy Deposits of Iron Ore.</i>
					<i>Sub-Carboniferous Limestone.</i>

RECAPITULATION.		
FEET IN.		
43	6	
4		Coal, N. (Perring).
31	4	
	6	Coal, M.
30		
7		Coal, L. (Staunton).
14	2	
1	10	Coal, K. (Upper block).
14	6	
	7	Coal, J.
11		
4	4	Coal, I. (Main Block).
12	6	
1	5	Coal, H.
25	2	
	5	Coal, G.
24	6	
3	8	Coal, F. (Lower Block).
263	3	
2		Coal, B.
20	4	Millstone Grit.
3		Coal, A.
3		
522		Total.
Aggregate Thickness of Coals---28 9-12 Feet.		

"block coal." The sides of the blocks are regular, and usually stained with oxide of iron, which is probably caused by the infiltration of ferruginous waters along the joints. When entries are driven across the main joints of the block-coal beds, the face of the mine presents the zigzag, notched appearance, of a Virginia worm fence.

Block-coal has a laminated structure, and splits readily into sheets, that have their surfaces covered with a dull-black, soft, fibrous, carbonaceous matter resembling charcoal; while, on the other hand, it is difficult to break in the opposite direction to the laminæ; and this fracture exhibits a splinty structure marked by alternate layers of dull and shining black coal. In coking, it scarcely swells or changes form, and never cakes or runs together. It is this latter character which gives to the "block-coal" its peculiar value as a fuel for smelting iron ores, while it has sufficient bitumen—in the form of gaseous matter—to render it highly inflammable; and the blocks retain their shape until burnt to ash, in such a manner as will admit the ready passage of the blast and flame through the entire mass of fuel, ore and flux.

On the other hand, the bituminous, caking-coals, of which the Pittsburg coal may be taken as the type, swell and run together, so that the blast cannot force the flame through the contents of the furnace, and the whole mass becomes chilled for want of sufficient heat to melt the ore.

By reference to the map of Clay county, which accompanies this report, the outcrop, and mining-shafts, and all coal-beds, are designated by a black square (■), and the equivalency of the coal-beds by letters, corresponding with those of the continuous section.

In the northern part of the county, and in the vicinity of the Terre Haute & Indianapolis railroad, numerous shafts are sunk, and a great many bores have been made for the purpose of determining the extent and limits of the main "Block" coal-bed (I). My researches go to show that that portion, at least, of the coalmeasures in which this coal is found, is much disturbed by horsebacks and other

irregularities in the strata; hence the manifest necessity of making frequent bores over level tracts of land, where no outcrops are to be seen, in order to ascertain the best location for sinking a mining shaft, and to acquire the assurance that a wave in the rocks has not brought up the strata of coal to a position that left it liable to be cut away by the disintegrating forces which covered this county with debris during the glacial epoch.

The spaces between the *upper, middle and lower* "block" coal beds, (K., I. and N.,) are subject to great changes, as will be shown by the sections which are to follow, and I have reason to believe that, in some places, two of these coals are united in one bed. Then again, on going west from Brazil these spaces are seen to contain one or more intercalated seams of coal. East of the Planet furnace, on section twenty-two, town thirteen, range six west, the sandstone, which locally overlies coal I, outcrops in a small branch of Croy's creek. The coal below it is worked by a shaft at the furnace, and also by another shaft (the Star mine) one and one-quarter miles northwest of the former, on the northeast quarter of section twenty-one, in the same township and range. Both of these mines are owned and worked by the Indianapolis Rolling Mill Company, and I am indebted to Mr. E. Jones, foreman at the furnace, and to Mr. Haggert, superintendent of the mine, for much information and valuable assistance in obtaining an accurate detailed section of the shaft at the "Star Mine," which is eighty-seven feet six inches in depth; seventy feet to the bottom of the coal.

SECTION OF STRATA IN "STAR MINE."

Red clay,	14 feet 7 inches.
Hard pan,	4 ft.
White sandstone,	23 ft. 6 in.
Silver-gray sandstone,	15 ft.
Blue argillaceous shale,	1 ft.
Light-gray sandstone, with carbonaceous markings in the seams,	2 ft. 11 in.

Blue argillaceous shale,	3 feet 3 inches.
Block coal, I,	4 feet 8 inches.
Soft, dark fire clay, containing roots of plants,	3 feet 6 inches.
Light-gray sandstone, in the bottom of shaft,	15 feet.

87 feet 6 inches.

This shaft is located in a small basin, as the coal appears to rise from it in all directions. The mine is reached by a switch from the Terre Haute & Indianapolis railroad, and the coal is used for making iron at the Planet furnace, which is owned by the same company as above mentioned.

For manufacturing iron, this coal is not surpassed by any in the county, as may be seen by the following exhibit of its analysis:

Specific gravity, 1.264; weight of a cubic foot, 79 lbs.

Coke, 64.00.	{	Ash, white, 2.5.
	{	Fixed carbon, 61.5.
Volatile matter, . . 36.00	{	Water, 3.5.
	{	Gas, 32.5.
		<hr/>
		100.0.

The structure of the coke shows but little change from that of the coal. It is not swollen and puffed out, but lamellar, dense, and without lustre. The large amount of fixed carbon, and the small quantity of ash and water which this coal contains, gives it a higher rank for heating purposes than is possessed by the caking coals brought to Indianapolis from Pittsburg. An analysis was made of a picked specimen of Pittsburg coal, obtained from one of the Indianapolis coal dealers, and is here given for the sake of comparison:

Specific gravity, 1.189; a cubic foot weighs 74 lbs.

Coke, 57.9.	{	Ash, white, 1.0.
	{	Fixed carbon, 56.9.
Volatile matter, . . 42.1.	{	Water, 1.0.
	{	Gas, 41.1.
		<hr/>
		100.0.

Coke very much swollen and puffed out; form of the coal quite changed. It contains 4.6 per cent. less carbon than the Star mine coal, but has less ash and less moisture. The latter quality adds to its value, while the loss in carbon depreciates it.

The superiority of the Star mine coal for fuel is due, mainly, to the fact of its being an open, free-burning coal, that ignites readily, and will reach the initial heating point in a much shorter space of time than the Pittsburgh coal, which property renders it of great value as a steam producing coal, and incomparable for locomotive use.

Going south from the Planet furnace, and before reaching Harmony, a village on the Terre Haute & Indianapolis railroad, the coal strata outcrop or have been removed by denudation, as a bore made at that place to the depth of one hundred feet—after passing through the drift or glacial deposit—was in argillaceous shales to the bottom, and passed no coal.

At Knightsville, two miles west of Harmony, on the Terre Haute & Indianapolis railroad, the main "block" coal, I, is mined by the Western Iron Company to supply their two blast-furnaces. The following analyses were made of two specimens of coal taken from these mines, that possessed the general appearance of all the coal taken from this bed:

(a.) Specific gravity, 1.176; a cubic foot weighs 73.5 pounds.

Coke, 60.1	{	Ash, white,	0.3
		Fixed Carbon,	59.8
Volatile Matter, 39.9	{	Water,	9.0
		Gas,	30.9
<hr/> 100.0			<hr/> 100.0

Form of coal but little changed in coking, and it does not cake and run together.

(b.) Specific gravity, 1.167; a cubic foot weighs 72.93 pounds.

Coke, . . . 59.0	{	Ash, white,	2.0
		Fixed Carbon,	57.0
Volatile matter, 41.0	{	Water,	8.0
		Gas,	33.0
<hr/>			<hr/>
100.0			100.0

Character of coke same as in the preceding.

At the Western Iron Company's Furnaces, the sandstone over the main coal is not so thick as it is at the star mine, and the shaft is only forty feet deep, and the coal averages three feet nine inches in thickness. Going to the northwest of these furnaces, the coal strata rises, so that in two hundred and seventy yards from the shaft, it may be reached at the depth of eighteen feet.

I am under obligations to Mr. William Watson, superintendent of the Western Iron Company's works at Knightsville, for the following instructive sections of bores made under his supervision on the Bahan farm, in the south-west quarter of section 21, township 13, range 6, west:

(No. 1.)—

Surface, soil and clay,	7 ft.
Soft clay and sand,	2 ft.
Hardpan,	13 ft. 10 in.
Hard clay and sand,	13 ft. 2 in.
Soft brown clay, with driftwood,	2 ft. 0 in.
Soapstone,	1 ft. 8 in.
Coarse gravel and sand,	ft. 4 in.
Hard clay and sand,	8 ft. 6 in.
Sandstone,	0 ft. 2 in.
Soapstone,	6 ft. 5 in.
Coal K (top seam),	0 ft. 1 in.
Fire Clay,	1 ft. 1 in.
<hr/>	
	59 ft. 3 in.

(No. 2.)—Section of bore on same farm :

Surface and Clay,	7 ft. 6 in.
Soft clay and sand,	7 ft. 0 in.
Hardpan,	1 ft. 0 in.
Hard brown sandstone,	5 ft. 2 in.
Potters' clay, probably the under clay to coal K,	1 ft. 2 in.
Blue slate,	2 ft. 2 in.
Iron ore,	0 ft. 3 in.
Blue slate,	2 ft. 2 in.
Iron ore,	0 ft. 1 in.
Blue slate,	1 ft. 5 in.
Iron ore,	0 ft. 1 in.
Blue slate,	0 ft. 7 in.
Slate, with thin sandstone,	1 ft. 3 in.
Soapstone,	5 ft. 3 in.
Sandstone,	26 ft. 1½ in.
Slate,	0 ft. 1 in.
Coal I,	4 ft. 3 in.
Fire clay,	0 ft. 0 in.

65 ft. 9½ in.

The fire-clay, 43 feet 9½ inches above coal I, is probably the under clay to coal K.

(No. 3.)—Section of bore on same farm :

Surface-soil and clay,	8 ft. 6 in.
Soft clay and sand,	7 ft. 0 in.
Hardpan,	2 ft. 0 in.
Hard sandstone,	6 ft. 1½ in.
Soft, bluish sandstone,	7 ft. 6 in.
Coal K, top seam,	2 ft. 2½ in.
Rash coal,	0 ft. 6 in.
Fire-clay, good quality,	4 ft. 9 in.
Sandstone,	0 ft. 2 in.
Light-blue sandstone,	9 ft. 6½ in.
Rotten limestone (?),	3 ft. 8 in.

Blue shaly sandstone,	9 ft. 2 in.
Sandstone,	10 ft. 5½ in.
Coal I, main "Block,"	4 ft. 2 in.
Fire-clay,	0 ft. 0 in.
<hr/>	
	72 ft. 9 in.

The space between I and K, in this bore, is 42 feet 5 inches—very nearly what it is in bore No. 2, assuming its place to be above the potters' clay.

(No. 4.)—Section of bore on the same farm, near the outcrop of coal I:

Surface soil and clay,	6 ft. 6 in.
Soft clay and sand,	8 ft. 6 in.
Brown hardpan.	6 ft. 6 in.
Bluish hardpan,	5 ft. 6 in.
Soapstone,	8 ft. 4 in.
Coal I, main "Block,"	2 ft. 6 in.
Rotten coal,	1 ft. 1 in.
Fire-clay,	6 ft. 5 in.
Sandstone,	3 ft. 3 in.
Pale blue slate,	1 ft. 9 in.
Arenaceous shale,	2 ft. 2 in.
Blue sandy shale,	12 ft. 8 in.
Coal F,	1 ft. 7½ in.
<hr/>	
	66 ft. 9½ in.

At "Weaver's Switch," half a mile west of Knightsville, a shaft was sunk, in 1862, by Mr. John Andrews, who superintends the mines of Andrews, Butch & Dickson, and passed through the following material:

Drift,	18 ft. 0 in.
Dark-gray sandstone, lower part soft, and mixed with coal,	6 ft. 0 in.
Coal I,	0 ft. 6 in.

Fire-clay and argillaceous shale, . . .	12 ft. 0 in.
Sandstone,	4 ft. 0 in.
Coal F,	1 ft. 8 in.
Hard arenaceous fire-clay, . . .	4 ft. 0 in.

The shaft ends here; but a bore was made which passed through strata as follows, viz:

Very white sandstone, coarse grained, and excellent for building purposes, may answer also for making glass, . . .	12 ft. 0 in.
Bluish, argillaceous shale, . . .	16 ft. 0 in.
Argillaceous shale, soft, and easily bored,	65 ft. 0 in.
	<hr/>
	143 ft. 2 in.

The coal in the "Weaver-Switch" shaft dips one foot in twelve to the east, and thirty rods in that direction, from the above described bore, Mr. Andrews put down another, which passed through the following strata, viz:

Drift,	12 ft. 0 in.
Coal I,	4 ft. 0 in.

A few yards from this he sunk a shaft to coal I, which he found at the same depth as indicated by the bore, and from the bottom of this shaft he bored sixteen feet, to coal F, passing through the same material found in the "Weaver-Switch" shaft.

As coal I has no substantial roof above it at this place, it could not be worked economically, and the shaft was abandoned.

At Brazil, and to the eastward and northward of that city, and along South Otter creek, coal I is mined in many places. The following list comprises the most prominent of the coal mining companies of that section: Garlick & Collins, three mines—one in south-east quarter of section

25, township 13, range 7 west, and two others in the south-east quarter of section 24, township 13, range 7.

The following is the result of an analysis of a characteristic specimen of coal from the first named mine.

Specific gravity, 1.230; a cubic foot weighs 76.87 lbs.

Coke, . . . 60.5	{	Ash, lead color, . . .	3.0
		Fixed carbon, . . .	57.5
Volatile mater, 39.5	{	Water, . . .	8.5
		Gas, . . .	31.0
<hr/>			<hr/>
1.000			1.000

The structure of the coal was but slightly changed in coking, and the coke was brilliant, dense and brittle; the large amount of water found in this coal, may be owing, in part, to the fact that, the specimen analyzed was fresh from the mine, and had been exposed to a rain storm the night previous.

Andrews, Butsch and Dickson, three mines; all on the east half of section 30, town 13, range 6.

Strain & Schurmann, one mine in the north-west quarter of section 31, town 13, range 6.

Jane Ernhart, one mine in the north-east quarter of section 30, town 13, range 6.

Otter Creek Coal Company, one mine in the south-west quarter of section 19, town 13, range 6.

— Jones, one mine in the north-east quarter of section 26, town 13, range 7 west.

Dr. Mansur Wright, two mines in the north-east quarter of section 25, town 13, range 7 west.

Clay Coal Company, one mine in the north-west quarter of section 19, town 13, range 6.

Niblock Coal Company's mines in the north-west quarter of section 19, town 13, range 6.

McClelland and Son, one mine in the north-west quarter of section 17, town 13, range 6.

Indiana Coal Company's mines, in the north half of section 17, town 13, range 6.

Indianapolis Rolling Mill Company, two mines; one at the Planet Furnace, in the south-east quarter of section 22, town 13, range 6, and one in the north-east quarter of section 21, town 13, range 6.

The above list, I think, comprises all the points at which the "Block" coal is being worked north of the Terre Haute and Indianapolis Railroad. A list of the openings south of the railroad will be given in due order.

The *Upper, Middle and Lower* "Block" coal seams all out-crop between the house of Mr. John Andrews and Mrs. Jane Ernhart's mine, on a small tributary of South Otter Creek. The upper seam, K, is overlaid by a fossiliferous limestone, in which I found *Productus cora*, *P. semireticulatis*, *P. Wabashensis*, *Spirifer cameratus*, *Chonetes mesiloba*, *Athyris subtilita*, and large *encrinite* stems.

In the following section, obtained at Andrews, Butsch and Dickson's shaft, just back of Mr. Henry Ashley's residence, this limestone is eleven feet thick.

Section of strata, passed through in the shaft just named, on Mr. Ashley's land, one mile east of Brazil:

Soil and drift,	20 ft. 0 in.
Fossiliferous limestone,	11 ft. 0 in.
Blueish soapstone,	6 ft. 0 in.
Coal, K, (Upper "Block,")	1 ft. 6 in.
Gray shale,	16 ft. 0 in.
Thin bedded, light-colored sandstone, containing reddish bands colored with protoxide of iron,	18 ft. 0 in.
Stiff blueish, argillaceous shale,	1 ft. 4 in.

This shale varies in thickness from 0. to eight feet.

Coal I, main "Block,"	3 ft. 10 in.
Good fire clay for pottery,	1 ft. 6 in.
Hard siliceous clay, mixed with iron balls,	6 ft. 0 in.
The shaft ends here, and from this point they bored into	
Hard blueish shale	6 ft. 0 in.
Soft sandstone, with layers of yellowish clay,	20 ft. 0 in.
Coal, F,	0 ft. 3 in.
Fire clay, ?	
Argillaceous and siliceous shale,	60 ft. 3 in.
Gray shale, with iron balls,	6 ft. 0 in.
<hr/>	
	177 ft 8 in.

This section carries us down to the shales that were bored into at Harmony, and proves, I think, the absence of coal seams in this part of the basin between coal F, and the heavy sandstone of the millstone grit.

The section of the shaft on the railroad, in Brazil, is reported as follows:

Soil and drift,	10 ft. 0 in.
Limestone,	4 ft. 0 in.
Argillaceous shales,	28 ft. 0 in.
Coal, K,	0 ft. 10 in.
Sandstone,	28 ft. 0 in.
Shale,	2 ft. 0 in.
Coal, I, main "Block,"	3 ft. 3 in.
Fire clay,	6 ft. 0 in.
<hr/>	
	82 ft. 1 in.

A bore was made to a considerable depth below the bottom of the shaft, finding no coal, and passing through noth-

ing but argillaceous shale. The depth of this bore could not be ascertained exactly, but is supposed to be about one hundred feet.

In many of the shafts and bores made in this part of Clay county the limestone above coal K, and the sandstone between K and I are wanting, their places being filled by shales.

Along the Indianapolis & St. Louis railroad, and on North Otter creek, the "block" coal bed I is seen in many places where it is of as good quality for manufacturing pig iron as any found on South Otter creek, or along the Indianapolis & Terre Haute railroad; and the building of the former road will enable the proprietors of coal lands to open up and develop the mineral resources of a large area of the "block" coal field now locked up from market for the want of transportation.

The town of Carbon, recently laid off, on the Indianapolis & St. Louis railroad, is situated about the middle of the northern tier of townships in Clay county, and occupies a position in the very heart of the "block" coal belt that is most favorable for mining operations and the erection of blast-furnaces for making pig-iron. The coal mine of McClelland & Sons is reached by a switch or branch road from the Terre Haute & Indianapolis railroad, and is now one of the most northerly mines worked in the county; and in order to show the persistent good quality of the "block" coal, as you go north from Brazil, a characteristic specimen from this mine was subjected to analysis, and gave the following result:

Specific gravity, 1.279; a cubic foot weighs 79.93 lbs.	
Coke, 56.2	{ Ash, white, 1.5.
	{ Fixed carbon, 54.7.
Volatile matter, . . 43.8.	{ Water, 5.0.
	{ Gas, 38.8.
<hr/>	
100.0.	100.0.

The form of the coal is but slightly changed by coking; coke lamellar and semi-lustrous. This coal is on section

17, town 13, range 6 west, about one and a half miles south of Carbon, and has been successfully used for making pig-iron, in the furnace of the Lafayette Iron Company and in the Brazil furnace.

South of the Terre Haute & Indianapolis railroad, the main "block" coal bed has been opened at the following places, viz:

- Ormsley Coal Co., on sec. 12, town 12, range 7 west.
- General Pierce, on sec. 18, town 12, range 6 west.
- Crawford & Co., on sec. 7 and 8, town 12, range 6 west.
- David N. Barnett, on sec. 10, town 12, range 6 west.
- Western Iron Co., on sec. 28, town 13, range 6 west.
- V. Raab, on sec. 11, town 12, range 6 west.
- Lucas, on sec. 16, town 12, range 6 west.
- McCullough, on sec. 15, town 12, range 6 west.
- B. Payne, on sec. 14, town 12, range 6 west.
- Steadman, on sec. 4, town 11, range 6 west.
- Gillfillan, on sec. 10, town 11, range 6 west.
- J. Moss, on sec. 9, town 11, range 6 west.
- G. Moss, on sec. 16, town 11, range 6 west.
- C. Moss, on sec. 9, town 11, range 6 west.
- Ashboro, on sec. 17, town 11, range 6 west.
- J. Fisher, on sec. 11, town 11, range 6 west.
- Ely, on sec. 11, town 11, range 6 west.

SOUTH OF EEL RIVER.

- Goshorn, on sec. 10, town 10, range 6 west.
- Rowe, on sec. 10, town 10, range 6 west.
- Cole, on sec. 10, town 10, range 6 west.
- Kilmer, on sec. 21, town 10, range 6 west.
- Croft, on sec. 33, town 10, range 6 west.
- Leisty, on sec. 28, town 10, range 6 west.
- P. Barrick, on sec. 34, town 10, range 6 west.

South of the Terre Haute & Indianapolis railroad, the main "block" coal bed averages about the same thickness as it does north of the road.

The Ormsby Coal Company were not ready to begin operations at their mine south of Brazil at the time of my visit, but they have since laid a railroad track from their mines to the main trunk at Brazil, and their mines are now in complete working order. Their coal has a good reputation, both at home and abroad—being, for the most part, shipped to Chicago, where it is used for manufacturing iron.

Coal from Barnett's mine, three and a half miles south-east of Brazil, on section ten, town twelve, range six west, is hauled in wagons to the furnaces at Knightsville and Brazil, and is considered the best coal yet used in this part of the basin for making pig-iron. At Barnett's mine the main "block" coal bed I, and the lower seam F, appear to be separated by only five inches of fire-clay and seventeen inches of rash-coal, as shown in the following section:

Drift, clay and gravel,	19 ft. 8 in.
Gray Shale,	5 ft. 0 in.
Sandstone,	1 ft. 5 in.
Gray slate,	0 ft. 7 in.
Sandstone,	0 ft. 2 in.
Gray slate,	1 ft. 4 in.
Dark sandstone, with black seams,	1 ft. 0 in.
Shale,	0 ft. 9 in.
Coal I, main "Block,"	3 ft. 10 in.
Fire-clay,	0 ft. 5 in.
Rash coal,	1 ft. 7 in.
Coal F, lower "Block,"	2 ft. 0 in.
Fire-clay,	3 ft. 0 in.
	<hr/>
	30 ft. 9 in.

The coal at this mine is worked by a drift, or entry, driven in from the outcrop of the bed, on the north face of a low ridge.

A bore made fifty rods south of the opening to Barnett's mine, furnished the following section:

Drift, clay and gravel,	11 ft. 0 in.
Hardpan,	10 ft. 6 in.
Gray slate,	4 ft. 0 in.
Arenaceous slate, with small balls of iron-stone,	3 ft. 0 in.
Black Slate,	1 ft. 6 in.
Coal I,	3 ft. 6 in.
Fire-clay,	0 ft. 0 in.
	<hr/>
	33 ft. 6 in.

Another bore was made a short distance from the above, and to the north-west, which passed through the same material, and found the coal four and a half feet thick.

A specimen of coal from Barnett's mine gave, on analysis, the following result: Specific gravity, 1,250; a cubic foot will weigh 78.12 pounds.

Coke, 58.5	{	Ash, white,	1.5
	{	Fixed carbon,	57.0
Volatile matter, 41.5	{	Water,	4.0
	{	Gas,	37.5
			<hr/>
100.0			100.0

Coke, dense and brilliant, and form of coal slightly changed.

This may be taken as a type of the "Block" coals to the south, at Centre Point and Ashboro, and to the south of Eel river.

"Block coal" is spread over fully one-half of the county, and we may estimate a depth of four feet of this coal on at least one hundred square miles, or sixty-four thousand acres; each acre, therefore, contains seven thousand tons, of two thousand pounds or one hundred and seventy-five thousand bushels, which, at the extremely low estimate of one cent per bushel, gives one thousand seven hundred and fifty dollars as the value of the coal on each

acre, or *one hundred and twelve millions dollars* for the sixty-four thousand acres.

A short distance west from Brazil, the "Block" coal beds K and I, are brought up by a slight wave in the strata, and are cut out by the drift. At Newburg, two miles west of Brazil, the general westerly dip from the axis of the wave has again carried these coals to a considerable depth below the surface at the railroad level, and they are so much reduced in thickness as not to have been recognized in the bores made in search of them at various points between Brazil and Terre Haute.

At Newburg, Root, Price & Co. are mining coal L, from a shaft made by the side of the railroad track. This shaft passes through coal M, which is too thin to mine, and reaches coal L at the depth of forty feet. The latter coal is six to eight feet thick, and has one, and sometimes two fire-clay partings; here there is but one parting, about forty-three inches from the top. This is a bituminous, caking coal, and will not answer for the manufacture of pig-iron unless coked. The upper six inches of the bed is quite sulphurous, and should be rejected in mining. The remainder of the bed is a shining, black, cube coal, often displaying the much-admired peacock colors.

Coals M and L outcrop at a number of places in the vicinity of Newburg, and L. is opened and mined by Mr. Armstrong on the north-east quarter of section 10, town 12, range 7; Mr. Keneda, south-east quarter section 3, town 12, range 7; Mr. Fortner, north-west quarter section 10, town 12, range 7; Mr. Williams, south-west quarter section 10, town 12, range 7.

At Staunton, on the Terre Haute and Indianapolis railroad, four miles west of Brazil, coal L is reached by shafts, thirty-six to forty feet deep; both on the north side of the railroad, and in the town. Bailey and Company's shaft is thirty-eight feet deep, and passes through the following strata:

Clay and gravel,	9 feet.
Hardpan,	10 "
Sandstone,	12 "
Coal L,	7 "

38 feet.

A characteristic specimen of coal, from the above-named mine was analyzed, and gave the following result:

Specific gravity, 1.327; a cubic foot will weigh 83 lbs.

Coke, 53.3	{	Ash, light gray,	6.0
	{	Fixed Carbon,	47.3
Volatile matter, 46.7	{	Water,	7.0
	{	Gas,	39.7
<hr/>			<hr/>
100.0			100.0

In the water-sump below the coal, there is from eight to twelve inches of rash-coal, underlaid by four to five feet of fire-clay. Coal M. was not found in this shaft, and was probably removed by the drift. Coal L. ranges from six to eight feet in thickness, and has here, as at Newburg, a thin parting of fire-clay, three to three and a half feet from the top. In quality the coal is the same.

At Mr. Somers' shaft, one-half mile east of Bailey & Co.s' mine, coal M. lies about fifteen feet above coal L; the former is eighteen inches, and the latter seven feet five inches in thickness, has a clay parting, and is of the same quality as that seen at Bailey's and elsewhere. On the south side of Staunton, coal M lies very close to coal L, where they outcrop in the side of a ravine, and are exposed in the cut of the creek branch. Coal M is overlaid by a black shale that may be readily split into great sheets like roofing slate, but, unlike the latter, is rich in bitumen, and crumbles to pieces on being exposed to the action of the atmosphere. This shale is highly fossiliferous, and contains spines and teeth of fish, and a variety of marine

shells. Of the latter I recognised *Orthoceras rushensis*, *Nautilus decoratus*, *Productus wabashensis*, *Chonetes mesoloba*, *Athyris subtilita*, *Spirifer cameratus*, *Cardenia fragilis*, *Arca carbonaria*, *Aviculopecten rectilateraria*, very abundant, *Myalina pernaformis*, *Pleurotomaria Grayvillensis*, and *Bellerophon carbonarius*.

At some of the outcrops of this shale, south of Staunton, I saw mixed through it large concretionary boulders of dark limestone. On the land of Mr. Modisett, one mile south-west of Staunton, section 17, town 12, range 7 west, coal L has two clay partings, and is eight feet thick. The partings are about one inch thick, and coal M, 18 inches thick, is seen a few feet above it.

At Harding's mine, a few hundred yards south of Staunton, coal L. is mined from an entry which penetrates the ridge on which it outcrops.

John Andrews, an intelligent and experienced mining-boss, who lives at Brazil, put down a bore, some years ago, about a quarter of a mile north-west of Bailey's shaft, and went ninety-six feet below the mammoth bed L, and passed through the following strata:

Coal L,	7 ft. 0 in.
Fire-clay,	3 ft. 0 in.
<i>Commencement of bore—</i>	
Shale, with iron balls,	20 ft. 0 in.
Coal K, upper "Block,"	1 ft. 8 in.
Soft sandstone,	20 ft. 0 in.
Shale I, here a caking-coal,	4 ft. 0 in.
Coal,	2 ft. 6 in.
Shale,	46 ft. 0 in.
Coal F?	2 ft. 6 in.
	<hr/>
	96 ft. 8 in.

At Cloverland, two miles west of Staunton, we find the same succession of coals outcropping in the ravine on the south of the railroad, where the following section was obtained, starting at the top of the hill at Mr. Alfred West's:

Surface-soil and drift,	27 ft. 0 in.	
White sandstone,	11 ft. 0 in.	
Shale,	20 ft. 0 in.	
Hard, blue limestone, which breaks with conchoidal fracture,	2 ft. 0 in.	
Shale,	0 ft. 6 in.	
Coal M,	1 ft. 2 in.	
Fire-clay,	3 ft. 0 in.	
Bluish shale, with iron-stone,	2 ft. 0 in.	
Coal, 2 ft. 0 in.	} Coal L, 7 ft. 6 in.	
Fire-clay, 0 ft. 1 in.		
Coal, 2 ft. 0 in.		
Fire-clay, with thin band of coal, 0 ft. 5 in.		
Coal, 3 ft. 0 in.		
Fire-clay, with iron-stone,	4 ft. 0 in.	
Black shale, with fish remains,	4 ft. 0 in.	
Coal K, caking-coal,	1 ft. 10 in.	
Low water, head branch of Lost creek,	0 ft. 0 in.	
		<hr/> 84 ft. 0 in.

The following persons own mines at Cloverland, that are now being worked by stripping off the surface earth :

Alfred West, Miss Kate Brittain, and Mr. Wright.

Coal L, here averages seven feet in thickness, and when properly and carefully selected from the pyritiferous bands, which are more or less common in this bed, it is a very good article of bituminous, caking-coal; excellent as a fuel for household and steam purposes.

Going west, the dip carries the Cloverland coal below the drainage surface; and coal N, which lies about sixty feet above it, outcrops in a ravine on the south side of the railroad, about one mile west of that place, where there is an abandoned coal mine.

At Seelyville, in Vigo county, the Indianapolis Rolling Mill Company is working coal L, from a shaft that is one
S. G. R.—5.

hundred feet down to the bottom of the coal; and a few hundred yards west is Perring's mine, where they are working coal N, from a shaft that is forty-three feet to the bottom of the coal, which is here four feet thick, and has a thin slate parting about one foot from the top. This coal contains fewer sulphur bands, and is a very good bituminous caking-coal.

Though the general dip of the strata, at this place, is to the west, this coal outcrops in the hills about two and a-half miles east of Terre Haute, and is not seen again from thence to the latter place, or to the State line and beyond, at least not of sufficient thickness to justify working. The first coal bed reached in the artesian well at Terre Haute is undoubtedly L; likewise the coal which is mined by shafts thirty to sixty feet deep, one and a-half miles a little north of west from Terre Haute, and the coal at St. Mary's, in the woods, one hundred feet below the road-bed of the Terre Haute & Alton railroad. The synchronism of these coals, as designated above, from Newburg, on the Terre Haute & Indianapolis railroad, to St. Mary's, five miles northwest of Terre Haute, is, in my opinion, well established by the numerous shafts and bores made between the two points, the uniform character of the coal, and its characteristic accompaniments.

The line of eastern outcrop of coal L runs from Newburg with a northerly curve, passing through Roseville and Rosedale, to Clinton Lock, in Parke county: thence northward in Parke county, curving to the east, and passing five or six miles west of Rockville, it crosses the Wabash river a few miles south of the mouth of Sugar creek, and continues to the west of Newport, in Vermillion county, Indiana, where the continuity of the line is broken by a wave in the strata—the strike, or bearing, of which is northwest and southeast, and breaks the connection of the outcrop line with the equivalent coal bed on Coal creek, in Wabash township, Fountain county. In Vermillion county the outcrop of this coal may be traced along the Little and Big Vermillion rivers, and it is the equivalent of the seven-

foot seam of coal mined by Col. Chandler, at Danville, Illinois.

To the south of Newburg, in Clay county, the eastern outcrop of coal L bears in a southeasterly direction to Middleberry—but, through this portion of the county, it has been but little developed, for want of facilities for getting the coal to market. At Middleberry, Mr. J. Coopridger has opened a mine on the outcrop of coal L, where it is seven feet thick, with two clay partings, as at Cloverland. Though outcrops of this coal are to be seen at various points around Middleberry, very little effort has been made to work it. About half a mile southeast of Mr. J. Coopridger's, coal K has been worked by stripping. It is from four to five feet thick, and has a black sheety slate roof containing fish remains. Above the shale is an earthy, cream-colored limestone, that will make a handsome building stone, and has been used in this neighborhood for walling wells and building chimneys.

From Middleberry south, coals K, L, and N, where the measures are thick enough to contain them, are of good workable thickness, and may be traced through the western part of Greene county to the limits of the present survey on the south.

GLACIAL OR DRIFT EPOCH.

The material comprising this geological epoch, consists of irregularly arranged beds of sand, gravel, tough bluish clay with gravel, the so-called hardpan, and yellowish and more or less plastic clay, with gravel and small boulders; the latter are principally of metamorphic origin, but occasionally we find one from the sedimentary rocks, and a few have been found containing fossil shells of Silurian and Devonian date. Trunks and branches of co-existing trees are sometimes met with in sinking wells to the lower stratum of sand and gravel. The total thickness of the drift, in Clay county is from 0 to 40 feet, and in some instances even more.

The impervious clay called hardpan, constitutes the horizon of the fresh water supply for household purposes, and

is usually reached by wells at a depth of fifteen to twenty-five feet. The temperature of the water from this stratum is from 60° to 65° Fahr., being cool, healthful and pleasant to the taste; it contains small quantities of mineral salts, namely: bicarbonate of lime, bicarbonate of magnesia, a trace of protoxide of iron, chloride of sodium (common salt) and sulphates. This is termed a *hard water*, because it cannot be used for washing clothes. The acids of the salts contained in the water unite with the alkali of the soap, causing decomposition by setting free the grease, and thus destroying its detergent properties.

Many persons hold the opinion that the habitual use of hard water for slaking thirst is injurious to health, and recommend in its stead the use of rain-water. This, in my opinion, is in most cases a mere fancy, as the very mineral salts which are supposed to be injurious, are, unless found in such quantities as will give to it medicinal properties, beneficial to the living body, and supply it with some essential constituents. On the other hand, rain-water, as collected from the roofs of houses, is more or less contaminated with ammonia and poisonous gases absorbed from the atmosphere, soluble matter from the smoke and soot thrown out from the chimneys, and the microscopic organic matter washed from the roofs, much of which is of questionable benefit to the human system.

Small pieces of native copper, fragments of lead ore, and some other minerals, have been found at various places in the drift of Clay county, but they are of rare occurrence, being far removed from their native beds, which lie to the northward.

ECONOMICAL GEOLOGY.

The entire coal area of Clay county comprises about three hundred square miles, or 192,000 acres; and the total depth of coal over this area, including all the seams from N, at the top of the measures, to A, at the base of the millstone grit, is twenty-eight feet nine inches; but as some of

the seams comprising this grand total are not thick enough to mine over the entire area, a reasonable deduction is made on this account; also, for loss from outcrops, horsebacks, waste, etc., etc., and the available depth of "Block" and caking coals is placed at the low average of six feet. This depth of coal strata will give, as the product of one acre, 10,500 tons, or 294,000 bushels of coal, which, if estimated at \$2.50 per ton, the present market value of coal delivered on the railroad cars in Clay county, will make the sum of \$23,250 as the value of the average product of an acre of coal land.

If estimated at this rate for the entire area of 192,000 acres, we have four thousand four hundred and sixty-four millions (\$4,464,000,000) of dollars as the probable value of the coal of this county alone.

For want of suitable transportation and a ready market, only a small portion of the three hundred square miles of coal-lands can be made available for mining purposes for many years to come; therefore, the commercial importance of the coal is not so readily realized, and the above figures may at first appear startling to those who have not fully contemplated the subject. Let us, therefore, make an estimate from another point of view. The area of the iron-smelting, or "Block" coal in Clay county, which is included in the above estimate, cannot be less than one hundred square miles, or sixty-four thousand acres, under which the coal may be averaged at four feet in thickness, being much less than the combined thickness of the five beds, A, B, F, I, and K, and we have seven thousand tons as the product of one acre, worth, at \$2.50 per ton, (the market price on the cars in Clay county,) \$17,500 per acre. At this rate of calculation, the 64,000 acres will give one thousand one hundred and twenty millions (\$1,120,000,000) dollars as the present value of the available "Block" coal of Clay county.

The price per ton at which the "Block" coal is herein estimated, cannot be looked upon as above its value, when we take into consideration its convenience to market and

superior quality as a fuel for smelting iron. Each succeeding year its value must be enhanced, and mine owners had better let it remain in the ground than dispose of it at a less price. In fact this coal should be used only for making iron, notwithstanding that, for heating purposes, and for generating steam, it stands unrivaled in the West, even by the famous Youghiogheny coal of Pennsylvania; and for the use of locomotives it has no superior. As a blast-furnace coal to smelt iron ores, it has been amply tested in the five furnaces that are now using it in Clay county, and leaves nothing to be desired. The pig-iron made at the Clay county blast furnaces, from Iron Mountain and Lake Superior iron-ores, by the use of block-coal as a fuel, commands from two to three dollars more per ton, at the furnace, than the same grade of pig-iron made in Kentucky and Ohio will command in Indianapolis.

With regard to the exact cost of making a ton of pig-iron at any particular locality, very little reliance can be placed on the various published statements that have been collected from blast-furnace managers. We have no right to expect from iron-masters an exhibit of the exact cost of producing iron, or the profits arising from their business; but it may in reason be said, that with a superior article of coal, and her proximity to the ore, Indiana affords highly favorable facilities for manufacturing pig-iron, and will soon take her position in the front rank as an iron-producing State.

Coal and iron, next to agriculture, forms the basis of a country's wealth. England, to-day, owes her greatness as a nation more to the coal-fields that lie within her borders than to any other cause. Without cheap fuel what would become of her vast workshops, that have made her mistress of the markets of the world? All civilized nations fear her competition, and a tariff only can protect our infant manufactories from her blighting competition.

But England is now in the zenith of her manufacturing strength; her warehouses are filled with goods, and all the markets of the world are glutted with the products of her

skill and enterprise. Still, with her vastly superior natural resources, America can look ahead to the time when the failing coal-fields of England will mark the decline in her manufactures, and place the former in the ascendancy.

The six to eight foot bed of bituminous caking-coal L, that is mined at the various railroad stations west of Brazil, is, if freed by careful selection from the bands of iron-pirites with which it is more or less contaminated, an excellent coal for fuel and for generating steam, and will make, in properly arranged coking-ovens, a hard, metallic-looking coke that will answer for smelting iron. As yet, the value of this mammoth bed of coal is hardly realized.

The following is an exhibit of the quantity and value of "Block" and bituminous caking-coals mined daily in Clay county :

"Block" coal, shipped daily from Clay county, 410 tons.	Value, at \$2 50 per ton,	\$1,025 00
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"Block" coal used daily in blast-furnaces in Clay county, 300 tons,	at \$2 50 per ton,	750 00
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"Block" coal mined daily in Clay county, 710 tons,	at \$2 50 per ton,	1,775 00
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Bituminous caking-coal mined daily in Clay county, 60 tons,	at \$2 00 per ton,	120 00
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Total coal mined daily in Clay county, 770 tons.	Total value,	\$1,895 00
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Approximate yield of coal for one year, 230,000 tons.	Value,	\$366,000 00
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BLAST FURNACES.

There are five blast-furnaces in Clay county, that are making pig-iron with raw *block-coal*. They all run upon the hot-blast principle, and the blast is heated in gas-ovens by the waste gas brought from the top of the stack. The total working capital employed at these furnaces is about six hundred thousand dollars. Combined, they consume daily :

300 tons of "Block" coal.

150 tons of Lake Superior and Iron Mountain ore.

50 tons of limestone for flux.

The daily make of iron is about 110 tons, worth, on an average, at the furnaces, forty dollars per ton; this includes all grades. The total value of each days' run of iron is, therefore, four thousand four hundred dollars, or about one and a half millions dollars per annum, after allowing a large margin for mishaps and loss from accidents. The number of men employed at these furnaces, not including coal-miners, is about two hundred.

All the furnace companies own collieries, and give employment to a great many more men who are engaged in mining "block" coal for the furnaces, and also for market, but the accounts for each branch of business are kept separate.

The view which forms the frontispiece to this Report is taken from a photograph of the magnificent blast-furnace at Brazil, now run by Messrs. Garlick & Collins.*

The Brazil furnace was built in 1867, and "blowed-in" on the 8th of December of that year, and is one of the largest and best conducted blast-furnaces in the West. At my request, Messrs. Garlick & Collins very obligingly furnished me with statistics in regard to this furnace, which it is thought may prove of general interest to the public. It

*It was my intention to have published views of all the blast-furnaces of this county, but the promised photographs were not received from the other proprietors.

is what is termed a cupola furnace, and is formed by joining at their base two truncated cones of solid brick work, the upper cone being supported on iron columns. Both are formed internally of good refractory fire-brick, and have a shell of boiler-iron one-quarter of an inch thick.

Height of furnace, - - - - -	60 feet.
Diameter across the boshes, - - - - -	14 "
Diameter of hearth, - - - - -	5 "
Diameter of trunnel-head, - - - - -	6 "

The engine and blowing cylinder are upright. The former is eight hundred horse power. The steam cylinder is six feet long, and thirty-three inches in diameter. The blowing cylinder is six feet in diameter, and has a six foot stroke. Ranged on each side of the engine-house, and used alternately, there is a nest of four boilers, thirty-six feet long and forty inches in diameter. The arrangement for heating the blast consists of two large gas ovens, that are divided into two sections, each of which contains eighteen pipes, making, in all, seventy-two "Pollock" pipes. The blast is heated from 750° to 900° Fahr., and is driven into the furnace under a pressure of three to four pounds to the square inch, through seven tuyers, with nozzles three and a half inches in diameter. The cast-house and engine-house are constructed of brick, and have iron roofs. When completed, the coal-shed, or stock-house, will hold enough coal to run the furnace about four months. The ore, fuel and flux are hoisted to the tunnel-head or throat of the furnace by a water balance.

Cost of construction, - - - - -	\$150,000.00.
Amount of capital employed, including cost of furnace, railroad, real estate, working capital, etc., etc., - - - - -	250,000.00.
Daily consumption of fuel, (<i>block coal</i>), - - -	70 tons.
Daily consumption of ore, - - - - -	45 "
Daily consumption of limestone, - - - - -	16 "
Daily yield of pig-iron, - - - - -	28 "

Number of persons employed, including miners of
furnace coal and coal for market, - - - 150.

Red hematite and magnetic oxide of iron, from Lake Superior and Missouri, are the ores used at this furnace, the native ore being more expensive in proportion to the quantity of iron it contains than the ore from either of the former localities.

For the week ending September 18th, 1869, the average daily run of the Brazil furnace was 62,046 pounds of pig-iron per diem. The highest yield was 73,610 pounds, and the lowest, 47,628 pounds. Total make for the week, 434,322 pounds, or 191½ tons (of 2,268 lbs to the ton, the selling weight of pig-iron,) of the highest grade of No. 1 foundry iron. Samples of this iron were obtained from the furnace, and are now to be seen in the State collection, at the office of the State Geologist in Indianapolis.

The average quantity of "block" coal used per ton of iron, during the stated period, was 4,042 pounds, only a little more than two short tons.

Owing to the great interest manifested in the manufacture of iron in this State, it is thought that a brief account of the mode of starting, or "blowing-in," as it is called by furnace men, a blast-furnace, may not prove uninteresting to the general reader.

If the furnace is a new one, it is first dried gradually by kindling a fire upon the hearth. After being thoroughly dried, it is filled well up into the boshes with good seasoned cord-wood. Upon the wood is thrown about ten tons of coke, the quantity being regulated by the size of the furnace. Above the coke the furnace is filled with evenly distributed charges of "block" coal, limestone, and a small burden of ore—say about four hundred and fifty pounds of ore, one thousand eight hundred pounds of "block" coal, mixed with coke, and occasionally some sticks of wood, and one hundred and eighty pounds of limestone. The wood is added to prevent the contents from "hanging," or sticking to the sides of the furnace. After the furnace has

been filled in this manner, to the top, the wood at the bottom is ignited. The fire ascends very slowly to the top, and the contents of the furnace gradually settle down as the wood at the bottom is being consumed. After the contents have settled down to the space that was occupied by the wood, and the surface has reached a bright glow, the charging is resumed, and the furnace kept supplied with a full burden of ore and other material requisite to make No. 1 foundry iron. Only a portion of the blast is turned on for a day or two, after which it is blown with full force.

The usual charge for making No. 1 foundry iron, at the Brazil blast-furnace, consists of: 1545 pounds of a mixture of Iron Mountain specular iron ore, Lake Superior red oxide and magnetic iron ore, scrap and mill cinder, 425 to 475 pounds of limestone, (obtained from Hamrick Station or Greencastle Junction,) 1800 pounds of "block" coal, (obtained from the mines of the company and Barnett's mine).

The ore yields about 68 per cent., and the furnace is ordinarily tapped three times in twenty-four hours.

No. 1 foundry iron is made when the furnace is worked with the above charge at its maximum heat.

B. 1 and No. 2 foundry iron is made from the same charge when, by some little irregularity, the heat is decreased in the furnace.

To make mill iron, the quantity of ore in the charge is increased, leaving the burden of coal and flux the same as before.

Pig-iron made from Lake Superior and Missouri specular and magnetic iron-ores, is always *red-short*; that is, the metal, made into bars, is easily broken when hot, but it is very strong when cold; *cold-short* iron possesses the opposite properties, and is made from silicious carbonates and the hydrated brown oxides. The dye-stone ores of Tennessee yield a cold-short iron. Silica, phosphorous, manganese, and titanac acid, when present in sufficient

quantities in ore, will produce the cold-short properties in the obtained metal.

Neutral-iron is made in the furnace, by mixing in proper quantities, the *cold-short* and *red-short* ores, and is the most valuable metal for general purposes.

The general character of the iron made in Clay county is *red-short*, but a *neutral* iron may be made by using the proper mixture of ores.

No 1 foundry iron, made in Clay county, is of a gray color, very soft, and highly crystalline; it possesses a high character for foundry purposes, on account of its uniform rate of shrinkage, and the large amount of scrap it will carry, say fifty to sixty per cent., which is from two to three times as much as can be used with either the Hanging Rock or Kentucky iron of the same grade.

B, 1, gray foundry iron, is not so soft as *No. 1*, but makes a stronger casting; scrap cannot be used with it.

N. 2, bluish-gray foundry, is both a harder and stronger metal than either of the others, but like the latter will not admit of being mixed with scrap.

No 1, mill-iron, bluish-gray, fine-grained pig, used for making bar-iron, nails, etc.

No. 2, mill-iron, inclined to be mottled, is also used for making bar-iron and nails.

White iron is made from the same stock as the latter, but results from a higher heat in the furnace; this is the best iron for making nails, cast-iron bells and railroad frogs. It is a very hard metal, and wears better than the other grades.

Red-short iron loses more carbon, and will shrink more in castings than cold-short iron, and in the mill the muck-

bars will crack on the edges in rolling, whilst bars made from neutral iron will be smooth and perfect on the edges.

The market demand for red-short pig is rapidly increasing, owing to its superior strength when cold, and the various uses to which it is applicable. By mixing it in the puddling-furnace with proper proportions of cold short pig, a neutral iron can be made.

Lafayette Blast Furnace, owned by the Lafayette Iron Co., is situated on a branch of South Otter Creek, one and a half miles north of Brazil, on the south-west quarter of section 19, town 13, range 6 west; this is also a very excellent furnace, built on the most approved plan, and is very similar to the Brazil furnace, except in regard to size, being smaller; it is quite new, having "blowed-in," for the first time, on the 20th of May, 1869.

The following statistics of the operation of this furnace, were, at my request, very obligingly furnished by Mr. B. F. Masten, one of the proprietors:

First cost of furnace when completed, not including lands, houses and railroad,	\$70,000 00
Capital stock,	80,000 00

Daily consumption of fuel, "Block"	
coal, from the company's mines,	45 tons.
Daily consumption of iron ore,	37½ "
" " " limestone,	10 "
" yield of pig-iron,	18 "

Number of hands employed at the furnace,	30.
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Height of furnace,	45 feet.
Diameter of boshes,	10½ "
" " hearth,	4 "
" at tunnel-head,	5 "
Temperature of blast,	600° Fahr.

The side of the ridge which forms the divide between South Otter creek and the furnace branch, is cut down to a vertical face, in order to locate the furnace in such a position that the tunnel-head is on a level with the table-land above. By this excellent arrangement the throat of the furnace is brought on a level with the railroad switch and coal-shaft which is near by, and the filling of the furnace is accomplished, direct from the fuel and ore-sheds, without the use of the ordinary hoisting arrangement. At the time of my visit to this furnace, it was in most excellent running order, and making, under its able management, No. 1, or best quality foundry iron. The ore used is from Missouri and Lake Superior, and the fuel was obtained from the Otter Creek Coal Co.'s shaft, only a few rods from the furnace; in fact, the excavation that was made for the foundation of the furnace cut through the coal bed.

The Western Iron Co. owns two furnaces, located at Knightsville, two and a half miles east of Brazil, on the H. & I. railroad, in the south-east quarter of section 29, town 13, range 6 west. Both of these furnaces are run with one engine, by which arrangement a considerable saving is made, not only in machinery but in the outlay for hands. They are under the able management of Mr. William Watson, an experienced superintendent from Canada, and have been highly successful in making good iron. One of these furnaces went into blast in the fall of 1867, and the other in December, 1868. I have been informed that the furnace last constructed cost about seventy thousand dollars*, and paid for itself in seven months' time; and during the first twelve months' running it made a ton of pig-iron for every hour of the time. The stacks are each fifty feet high, twelve feet across the boshes, six feet across the hearth, and four and a half feet in diameter at the tunnel-head.

The ore used is from Lake Superior and Missouri, and the fuel is "block" coal, obtained from the company's mines near at hand.

*No information was received from the superintendent on this point.

The average daily run of pig-iron is forty-five tons of 2240 pounds to the ton. The pig-iron is sold at 2268 pounds to the ton.

Daily consumption of ore, - - -	60 tons.
Daily consumption of "block" coal, - - -	100 "
Daily consumption of limestone, - - -	24 "

The limestone is obtained from Hamrick's Station and Greencastle Junction, on the T. H. & I. railroad.

The Western Iron Company, also, have in connection with their blast-furnaces a mill for making muck-bars. The running of this mill is governed somewhat by the relative market value of the pig-iron and the muck-bars. At the time of my visit this mill was not in operation.

Planet Furnace, owned by the Indianapolis Rolling Mill Company, is situated one mile northeast of Harmony, on a switch of the Terre Haute & Indianapolis railroad, and on the southeast quarter of section twenty-two, town thirteen, range six west. Its construction is similar to the furnaces already described, but is the smallest of the number.

Height of stack, - - - - -	40 ? feet.
Diameter across the boshes, - - - -	10½ "
Diameter across the hearth, - - - -	4 "

The top is closed by a cup-and-cone arrangement, and the gas is taken off through pipes, and conveyed to the oven for heating the blast. This furnace was built in the summer of 1867, and went into blast in November of that year.

Daily consumption of ore, about - - -	25 tons.
Daily consumption of "block" coal, about - - -	40 "
Daily consumption of limestone, about - - -	10 "
Daily yield of pig-iron, - - - - -	15 "

The coal is obtained from the company's mines—one situated at the furnace, the other one mile to the north-west. The latter is known as the "Star Mine."

Most of the iron made at the Planet furnace is worked up into rails at the Indianapolis rolling-mill, which is owned by the same company.

Fire-Clay.—This clay is found at the bottom of every coal-bed, and also in places where there is no coal; but it is not everywhere sufficiently refractory to admit of its being used in manufacturing fire-brick. The fire-clay in Clay county, which underlies the main "block"-coal bed I, though not as refractory as the celebrated Mt. Savage fire-clay, will, nevertheless, resist a high degree of heat, and brick made from it are quite good enough for the lining of all parts of blast-furnaces, except the boshes, where the greatest heat is encountered, and where none but the most highly refractory brick can withstand it.

Dr. Mansur Wright has established works for manufacturing fire-brick and terra-cotta work from this clay, on South Otter creek, on the southwest quarter of section 24, town 13, range 7 west, one and a half miles north of Brazil. The clay is mined on the land, in connection with the "block" coal which supplies the necessary fuel for running the machinery and burning the brick and terra-cotta ware. The color of the clay is light-gray. It contains specks of white mica, and is quite hard when first mined, but crumbles and falls to pieces after being exposed to the weather for a few days. Before being ground and tempered for the moulds, the clay is piled in heaps and roasted, in the same manner that iron-ore is roasted. This roasting of the clay destroys the organic matter and noxious gas, which would otherwise cause the clay to shrink and crack, and thereby spoil the manufactured articles, when subjected to the heat of the kiln.

The bricks are moulded by hand, five thousand being the daily average of one hand, and subsequently pressed in a Carnell hand-press, and stamped "*Brazil*." From forty-five to fifty-five thousand brick are made daily, and meet with a ready market in the various parts of the country to which they are shipped.

Potters' Clay.—This county is abundantly supplied with a variety of fire-clay, that is admirably adapted for manufacturing pottery, such as common stoneware, terra-cotta ornaments, and even a better class of ware known as Rockingham or Troy ware.

Three potteries have been established in Clay county, for making stoneware; one at Brazil, owned by Torbet & Baker; another, one mile north-east of Brazil, owned by Isaac Cordray; and the third at Harmony, owned by S. H. Brown. These potteries obtain their clay from the stratum under the upper seam of "Block" coal, K, and on the south-east quarter of section 17, town 13, range 6, on the property of the Clay Coal Co., and close to Mr. Morris' house. This locality is said to furnish the best article of clay in the county for terra cotta ornaments, statues, pottery, etc., etc. It is the principal clay used by the Terra Cotta Co. of Chicago, for making statues. At the time of my visit, wagons were loading with this clay for Marshall county, Illinois. It is sold at the mine for one dollar and sixty-five cents per ton, and delivered on the cars at three dollars and fifty cents per ton. The stratum is two and a half feet thick, and is mined in connection with the coal, which is twelve to eighteen inches thick.

The commercial importance of this branch of manufacture, yet in its infancy, may be seen from the following exhibit of the amount of ware made at the three establishments now at work:

Torbet & Baker, . . .	80,000	gallons	per	annum.
Isaac Cordray, . . .	50,000	"	"	"
S. H. Brown, . . .	70,000	"	"	"
<hr/>				
	200,000	"	"	"

The stoneware made at these potteries presents a fine appearance, is very strong, of a bluish-gray color, quite smooth and free from cracks in the glazing; it meets with a ready market, and is sold at eight cents per gallon de-

livered on the cars, producing to the county an annual revenue of about sixteen thousand dollars.

Salt Brine.—I am not aware that any brine springs have been found as yet in this county, but it is made quite manifest, by the bores at Reelsville, in Putnam county, at Lodi, in Fountain county, and at Terre Haute in Vigo county, that a brine can be had by boring to the depth of one thousand to fifteen hundred feet below the level of the railroad, quite as strong as the brine at Kanawha.

I have been informed by Mr. N. Thomas, of Silver Island, in Fountain county, Indiana, who formerly lived on the Kanawha river, and is a practical salt-maker, that he was present in Terre Haute when a brine was struck in the artesian well at that place, at the depth of thirteen hundred feet; and, at the request of Mr. Rose, he made a test of this brine, and found its strength to be 13° of Baume's saltometer, which is equal to fifty (50) pounds of solid saline matter in forty-seven and six-tenths gallons brine. It might, therefore, be safely estimated that fifty gallons of this brine will yield one bushel, (fifty pounds,) of good salt.

When coal is abundant and cheap, as in this county, it is needless to add that such a brine is of great value for the manufacture of salt, to supply a large and increasing market, and for the manufacture of soda-ash, caustic soda, bicarbonate of soda, etc.

The amount of salt made annually in the United States, is estimated at about eighteen millions of bushels, and the consumption is about thirty-four millions of bushels—or nearly double the quantity produced. So there can be no danger of an over-production of salt from home manufactures, for some years to come.

A good brine in Clay county can be made doubly profitable in connection with the iron pyrites and pyritiferous shales found in the upper part of the mammoth coal-bed L, by manufacturing, through the means of a chemical

interchange of their elementary constituents, in addition to common salt, bicarbonate of soda and soda.

Building-Stone.—The sandstone which overlies the main "Block" coal I, is, in places, an excellent building-stone, and is extensively used in Brazil for making foundations, lintels, steps, and other parts of buildings.

The principal quarry of this rock now opened, is owned by Mr. Simonson, on section 7, town 12, range 6, one and a half miles south of Brazil. It is a bluish-white, hard, micaceous, coarse-grained, durable sandstone, and presents a handsome appearance in buildings. On Dr. Wright's property, and at quite a number of localities on South Otter creek, there are fine exposures of this sandstone, but as yet very little attention has been paid to opening quarries for market.

The limestone that overlies the upper seam of "Block" coal K, was quarried on Mr. Henry Ashley's place, about a half mile south-west of Brazil, many years ago, for building the abutments to bridges and culverts on the national road; It ranges from two to ten feet in thickness, and may be found at a number of places on the Ashley land, on Garlick & Collins' land north of Brazil, and on the property of Mr. Grimes, in the neighborhood of the village of Ashboro. It cracks and falls to pieces after some years' exposure to the action of the weather, and cannot be considered a durable building stone.

The subcarboniferous limestone exposed on Jordan creek, near Bowling Green, may, when opened up, furnish good stone for building purposes, and will serve to make a good article of quicklime.

Iron-Ore.—The shales at the base of the millstone grit contain, everywhere, more or less clay iron-stone, and siliceous hydrated brown oxide of iron, but as yet no locality is known in Clay county where it is in sufficient quantity to supply a blast-furnace; however, if suitable transportation could be had, it might be used advantageously at the

present furnaces, to mix with the Lake Superior and Missouri ores.

At Mr. Thomas Cromwell's, on section 3, town 10, range 6 west, there is a deposit of excellent bog iron-ore. The exact extent of this ore can only be determined by instituting borings at a number of places, as it lies buried, for the most part, beneath the superimposed soil along the margin of a level, wet prairie. Mr. Cromwell informed me that he had dug into the ore to the depth of four to five feet, at several places on his land, without reaching the bottom, and that he has traced it for more than a mile in an east and west direction, on the south side of Eel river. The width of the deposit is about sixty feet at Mr. Cromwell's.

Mineral Waters.—At Mr. James Ferguson's house, on on the south-west quarter of section 21, town 11, range 6, there is a good cool spring of chalybeate water. The iron is both in the state of a bicarbonate and sulphate of protoxide of iron, along with a small quantity of saline sulphates, carbonates of lime, magnesia, and chloride of sodium; its properties are slightly diuretic, aperient, and alterative. There is another spring of chalybeate water, which apparently possesses similar properties to the Ferguson spring, at Mr. Kincaid's, on northeast quarter of section 21, town 11, range 5.

In boring for coal, on section 25, town 13, range 7, at the depth of thirty feet the bore struck a horseback, and got a flowing well of good, cool drinking water, with no more mineral matter than is found in the water of the neighboring wells.

Agriculture.—In an agricultural point of view, Clay county cannot be said to stand in the front rank. The upland soil is principally derived from the *drift*, and is a cold, wet, clay soil, varying in color from ash-gray to yellowish-red. The tenacity with which it holds water renders underdraining indispensable to good culture. A top-dressing of lime, wood-ash, or even coal-ash, would prove highly beneficial to this character of soil. The soil in the

bottom, along the streams, is, for the most part, a clay loam with subsoil of clay. In the small prairies there are two kinds of soil, one a dark blackish muck, and the other a black sandy loam; the former is wet and unproductive, unless drained by ditches and exposed by deep plowing, for a considerable length of time, to the decomposing action of the atmosphere. A heavy dressing of lime would prove very beneficial to this soil. The sandy-loam soil of the prairies is decidedly the best in the county, and is well adapted to the growth of the serials, clover and grasses; orchards, also, do well on this land.

The upland, where attention has been paid to dressing and cultivation, and especially in favored localities, produces good crops of wheat, clover and grass, and here and there might be seen fine orchards, with a variety of choice fruits, such as apples, peaches, pears, cherries and plums.

Timber.—On the upland, the principal growth of timber is white, red, and black oaks, smooth shellbark and mocker-nut hickory, some ash, sugar-tree and beach; on the bottoms, water, white and burr oaks, gray ash, shellbark hickory, redbud, sassafras, dogwood and pawpaw; along the streams, sycamore and cottonwood, and on the higher banks large black-walnuts, three to five feet in diameter, and large burr-oaks. There are at least five sawmills on Eel river, in this county, cutting walnut lumber.