

## PARKE, FOUNTAIN, WARREN, OWEN, AND VERMILLION COUNTIES.

In addition to making the survey of Clay and Greene counties, a small portion of the time available for this year's work was taken to ascertain the limits and probable extent of the *iron-smelting* or "*block-coal*" seams in the coal field lying to the northward of Clay county, leaving that portion of the basin which lies to the southward and west of those counties to be examined next season, it being found impossible for me to examine both districts in the few months that could be given to field explorations. Having made only a hasty reconnoissance of the counties named at the head of this section, and which are to be hereafter surveyed and reported upon in detail, my present sketch of their geology will necessarily be brief.

### PARKE COUNTY.

In the eastern part of Parke county, and spreading over a belt of country from two to six miles in width, and in length extending from Clay county on the south, to Fountain county on the north, there are from one to three beds of "*block-coal*." In the southeastern part of the county, in Raccoon township, there are, at least, three beds. The position of these coal seams are designated by the letters F, I, and K, on the vertical section of the coals given on page 37, in the report on Clay county. I is the main "*block-coal*" at Brazil, F is the lower, and K the upper seam.

On the branches of North Otter creek, in Raccoon township, coal I outcrops at a number of places where it is from four to five feet in thickness, being an excellent quality of iron-smelting or "*block-coal*." As yet but little effort has

been made, in this part of the county, to develop the coals; but since the commencement of work on the Indianapolis & St. Louis railroad, which will, when completed, furnish an outlet for mineral fuel, public attention has been called to this locality, and the coal lands are rapidly rising in value.

In parts of this district the lower "block-coal" seam F, which lies from twenty-four to thirty feet below coal I, attains a thickness of four feet, and is also a good quality of "block-coal" for smelting iron.

The "block-coal" belt in Parke county is broken into irregular basins by the conglomerate which crosses the belt along the Big and Little Raccoon creeks, and on Sugar creek. After passing beyond the conglomerate ridges on Big Raccoon creek, coals I and K make their appearance in the northwest corner of Raccoon township, and again after crossing the conglomerate ridge on Little Raccoon creek, they are found on Sand creek, in Washington and Adams townships.

The "block-coal" I, at Mr. Buchanan's mine, on Sand creek, is four feet thick. A specimen for analysis was taken from this mine, and gave the following result:

Specific gravity, 1.232; a cubic foot will weigh 77 lbs.									
Coke,	-	-	64.5	{	Ash, white,	-	-	-	2.0
					Fixed Carbon,	-	-	-	62.5
Volatile matter,			35.5	{	Water,	-	-	-	4.5
					Gas,	-	-	-	31.0
			<u>100.0</u>						<u>100.0</u>

coals on Sand and Sugar creeks, in Washington and Sugar Creek townships :

Soil and drift - - - - - 10 feet 0 inches.

Sandstone and shale - - - - - 8 " "

Fossiliferous limestone, containing *Productus wabashenses*, *P. cora*, *P. semireticulatis*, *Spirifer cameratus*, *Athyris subtilita*, *Chonetes mesoloba*, *Bellerophon carbonaria*, *B. percarinatus*, *Orthoceras rushensis*, *Cyathaxonia prolifera*, large stems of *Encrinites* and *Eupachyrinus tuberculatus*, M. and W. - 2 feet 10 inches.

(Hon. B. E. Rhoads, to whom I am indebted for the name of this new and interesting crinoid, which has been recently described by Professors Meek and Worthen, informs me that it was found in this limestone, on Sand creek.)

Pyritiferous shale - - - - - 1 foot 0 inches.

Coal K, varying from a bituminous caking coal to a "block-coal" - - - 3 feet 6 inches.

Fire clay - - - - - ?

Gray siliceous shale, with iron-stone - 20—30 feet.

Coal I, "block coal" - 3 feet 6 inches to 4 feet 6 inches.

Fire clay, good quality - - - - - 3 " 0 "

Sandstone, building stone, containing fucoidal markings that closely resemble the *Fucoides Cauda-Galli* - - 5 " 0 "

Siliceous shales, with bands of good iron-stone - - - - - 20 " 0 "

Coal F - - - - - 0 " 6 "

Soft, reddish, thick-bedded sandstone, conglomerate - - - - - 15 " 0 "

Bed of Sand creek - - - - - 0 " 0 "

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100 feet 4 inches.

A specimen of the caking variety of coal K, taken from Mr. Batty's mine, on Sand creek, gave the following result :

Specific gravity, 1,231. A cubic foot will weigh 77 lbs.

Coke, - - - - -	58.5.	{	Ash, white, - - -	2.5.
			Fixed carbon, - - -	56.0.
Volatile matter, -	41.5.	{	Water, - - - - -	3.0.
			Good illuminat'g gas,	38.5
	100.0.			100.0.

Coke swollen and porous.

This coal is mined in large cubes, and is a good steam and grate coal. Block-coal, suitable for blast-furnaces, is also found on Sugar creek, and its branches, in Sugar Creek township, ten to twelve miles northeast of Rockville, and the seam is here from thirty to forty inches thick.

In the western part of Parke county the southwesterly dip of the coal strata has brought up the higher beds, which in this county belong to the bituminous caking variety of coal, and are not suited for blast-furnaces.

The mammoth coal L, which is the equivalent of the coal at Lost creek mines, Staunton, Cloverland and Highland, on the Terre Haute & Indianapolis railroad, ranges from five to seven feet in thickness, and is opened and mined at the following places: Roseville (Gen. George K. Steele's mine), on the Evansville and Crawfordville railroad; Rosedale, on Big Raccoon creek; Clinton Locks; Jose Butler's, on section 7, town 15, range 8 west; and on Leatherwood creek, about four miles northwest of Rockville. At Jose Butler's mine the lower part of the bed possesses the quality of a "semi-block-coal." In this part of the county the underlying coal seams will rarely be found thick enough to be mined on a large scale with profit.

Section of the strata at Jose Butler's, on section 7, town 15, range 8.

Soil and drift, - - - - - 30 ft. 0 in.

Concretionary limestone, containing *Productus*

*costatus*, *P. Rogersii*, *Spirifer cameratus*,

*Athyris subtilita*, - - - - - 0 ft. 6 in.

Black sheety shale, splits in thin laminæ, - 1 ft. 6 in.

S. G. R.—8.



Coal M?	- - - - -	1 ft. 0 in.
Fire clay,	- - - - -	3 ft. 0 in.
Greenish argo. shale,	- - - - -	4 ft. 0 in.
Black pyritiferous sheety slate, with fish-teeth, <i>Petrodus occidentalis</i> , spines and scales, <i>Cardinia fragilis</i> and <i>Aviculopecten rectilateraria</i> ,		1 ft. 0 in.
Coal L,	<div> <div> <div>Upper part containing irregular bands of iron pyrites, - - - 2 ft. 5 in.</div> <div>Pyritiferous clay part- ing, - - - 0 ft. 1 in.</div> <div>Bituminous coal - 1 ft. 0 in.</div> <div>Block-coal, - - - 1 ft. 6 in.</div> </div> </div>	5 ft. 0 in.
Fire clay,	- - - - -	5 ft. 0 in.
Argillaceous shales,	- - - - -	4 ft. 0 in.
Soft schistose sandstone	- - - - -	10 ft. 0 in.
Shales, covered,	- - - - -	21 ft. 0 in.
Black sheety slate,	- - - - -	0 ft. 6 in.
Coal,	- - - - -	1 ft. 6 in.
Gray shale,	- - - - -	8 ft. 0 in.
Black sheety slate, with fossil shells, of which <i>Cardinia fragilis</i> , <i>Orthoceras Rushensis</i> , were all that could be recognized,	- - - - -	3 ft. 0 in.
Coal,	- - - - -	0 ft. 6 in.
Gray shale,	- - - - -	6 ft. 0 in.
Black pyritiferous shale, passing into hard gray fossiliferous limestone, containing <i>Productus</i> <i>cora</i> , <i>P. costatus</i> , <i>P. wabashensis</i> , <i>Spirifer cam-</i> <i>eratus</i> , <i>Bellerophon carbonarius</i> , <i>B. Montfort-</i> <i>ianus</i> , <i>Orthoceras Rushensis</i> , <i>Chonetes mesolo-</i> <i>ba</i> , <i>Cyathaxonia prolifera</i> , and large stems of <i>crinoids</i> ,	- - - - -	1 ft. 6 in.
Bed of branch.		

The limestone forming the lower stratum in this section was also seen at Armiesburg, where it is underlaid by a coal bed that may be seen in Big Raccoon creek at low water, which, in my opinion, is coal K.

The Evansville & Crawfordsville railroad runs in a northerly direction through the southern part of Parke county to

Rockville. At Roseville this road reaches the outcrop of the caking coal L, which is mined by Gen. George K. Steele, and at Catlin Station passes through a portion of the "block-coal" field. From one and a half to two miles east of this station "block-coal" I (?), from three to three and a half feet thick, and of excellent quality, has been opened on Mr. James Knight's land, section 4, town 14, range 7 west, and on the adjoining land to the west, belonging to Mr. Sunderland; and may be found underlying a broad district of country convenient to this road.

The Indiana & Illinois Central railway is located to run on an east and west line through the county, passing through Rockville and Montezuma. It will cross the "block-coal" field between Little Raccoon creek and Rockville; and the bituminous caking-coal field between Rockville and Montezuma.

Papers of association have recently been filed by the Indianapolis & St. Louis railroad company for the purpose of building a road from Brazil, on the Terre Haute & Indianapolis railroad, to run northward through Carbon, and from thence along the valleys of North Otter and Raccoon creeks to Montezuma, on the Wabash river, where it connects with the Evansville, Terre Haute & Chicago railroad, and with the Indiana & Illinois Central railway, under the name of the Raccoon Valley railroad; thus giving a direct route from the "block-coal" field, in the southern part of Parke, and northern part of Clay counties, to Chicago, on the north, and Decatur, on the west. The company having this road in hand has ample means at their disposal, which gives assurance that it will be built, and, when completed, will afford additional advantages for obtaining iron ores from Lake Superior.

*Iron-Stone.*—Where the creeks and branches cut through the shales that underlie the lower beds of coal, several bands of clay-ironstone are exposed to view, and the beds of the streams are, in such places, covered with ore that have been washed from the banks above. Though the quantity of this ore, at any one locality, may not be suffi-

cient of itself to supply blast-furnaces, it may nevertheless be obtained in sufficient quantity to form an advantageous mixture with the Iron Mountain or Lake Superior ores.

*Building Stone.*—The conglomerate sandstone, which forms high cliffs on Big Raccoon, Little Raccoon and Sugar creeks, may be quarried in blocks of any required dimensions, and will make a handsome and durable building stone. At Mansfield, on Big Raccoon creek, this rock is of a beautiful reddish-brown color, closely resembling in appearance the brown sandstone of which the Smithsonian Institute at Washington, D. C., is built. It has been used in the construction of the abutments to the bridge which crosses the creek at Mansfield, where it has been exposed to the weather for several years, and gives evidence of being a durable stone.

A similar colored sandstone, from the conglomerate bluff on the Little Raccoon creek, was used in the foundation of the large bank building in Rockville, and is highly spoken of as a building stone.

#### FOUNTAIN COUNTY.

From Parke county on the South, with here and there breaks in the continuity of the strata, the "block-coal" is traced through the central portion of Fountain county, as far north as Big Shawnee creek, in Shawnee township, and is partially opened and worked from outcrops at many places throughout this district.

In Shawnee township the seams of "block-coal" are generally thin, ranging from one and a half to two feet, but the quality is good. The most northerly coal seen in this county is about two and a half miles south of Attica. It lies on the top of the conglomerate sandstone, and is mined by stripping. This coal has not been worked for some time, and the pits from which it was mined by stripping were filled with debris so that I could not see its depth, but was informed that it is about eighteen inches thick. A few pieces of coal were found at the old pits, which

served to indicate that it possessed the character of a good "block-coal." In the shales which overlie this coal, there are numerous nodules of earthy carbonate of iron that contain zinc-blende (sulphuret of zinc). A specimen of iron-stone from this locality, collected by the former State Geologist, Prof. Richard Owen, was at his request examined by me, and found to contain a notable quantity of rose-colored cobalt (*Remingtonite*).

In Van Buren township, on Dry Run, North Fork and East Fork of Coal Creek, "block-coal" has been mined for home consumption at a number of outcrops. The depth of the beds varies from two and a half to four feet, and the quality is equal to that of Clay county for the manufacture of iron.

On Mr. Geo. Lease's land, on the north fork of Coal creek, section 30, town 20, range 7 west, the following section was seen:

Drift, - - - - -	2 ft. 0 in.
Soft shale, - - - - -	0 ft. 6 in.
Coal, - - - - -	1 ft. 6 in.
Fire-clay, - - - - -	1 ft. 0 in.
Buff and gray argillaceous shale, -	8 ft. 0 in.
Coal (I?) good "block-coal," - -	3 ft. 0 in.
Fire-clay, - - - - -	?
Black bituminous shale, with one to two inches of coal occasionally mixed through it, - - - - -	20 ft. 0 in.
Bed of creek,	<hr/> 36 ft. 0 in.

This coal may be traced for a distance of one and a half miles farther up the creek by outcrops. It appears to occupy the position of the middle "block-coal" bed (I) of Clay county, but my hasty examinations in this county will not enable me, at this time, to decide upon its position in the continuous section of the coals given on pages 37 to 45.

Where seen, at Mr. Lease's in the above section, the coal appears to be split up by intercalated shales, and I was shown an opening farther up the creek where the bed is united, and its depth thereby augmented to four and a half feet.

\* At William Davis' place, on section 31, town 20, range 7, is found:

"Block-coal,"	-	-	-	-	1 ft. 6 in.
Argo. shale,	-	-	-	-	1 ft. 0 in.
Hard, impure limestone,	-	-	-	-	3 ft. 0 in.

On the south side of Mr. Davis' farm, in the face of a low bluff, a bed of good "block-coal," full three feet thick, outcrops at a number of places, and probably lies from six to eight feet below the limestone of the above section which was seen on the north part of the farm.

At Mr. Davis' the coal has a good-sized hill above it, and may be conveniently worked at the outcrop by a drift.

A thin seam, from eighteen to twenty inches, of "block-coal," is seen on Miller's run, in the south edge of Covington, and may be followed for some distance, by outcrops along the line of the Indianapolis, Bloomington and Western railroad, which follows that creek. A "block-coal" bed, thirty to thirty-three inches thick, is also seen on Neal's branch, in section 2, town 19, range 9, and on Phœbus branch, in section 12, town 19, range 9, which probably belongs to the same horizon as the thin seams on the south side of Covington.

On Graham's creek, a branch of Coal creek, and on Coal creek, at many places, both in Wabash and Fulton townships, there are from two to three beds of bituminous caking coal. The lower bed is, however, in many localities, a *semi*-"block-coal." The places of these coals on Coal creek are provisionally given in the following sections:

Section at Mr. Mercer's mine on a branch of Coal creek, on section 30, town 19, range 8 west:

Covered slope to top of hill,	-	20 to 30 feet	0 inches.
Black slate,	- - - - -	1 "	0 "
Coal,	- - - - -	1 "	6 "
Gray argillaceous shale,	- - - - -	35 "	0 "
Coal I?	{ Hard, ringing coal, - 2 ft. 2 in. } { Semi-"block-coal," - 10 in. } { Caking-coal, - - - 1 ft. 0 in. }		4 ft. 0 in.
Fire-clay,	- - - - -	-	? ft.

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71 feet 6 inches.

A section was obtained on the Lafayette company's land, section 1, town 18, range 9, about one mile to the southwest of the former, which shows a middle coal that was not observed there:

Drift,	- - - - -	4 feet	0 inches.
Shale,	- - - - -	? "	"
Black slate,	- - - - -	1 "	0 "
Coal,	- - - - -	1 "	6 "
Shale,	- - - - -	8 "	0 "
Coal K?	- - - - -	3 "	6 "
Shale,	- - - - -	14 "	0 "
Coal I?	- - - - -	4.8 to 5 "	0 "
Covered slope to branch,	- - - - -	10 "	" "

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47 feet 0 inches.

On the Wallace place, in Fulton township, close to the Parke county line, in section 36, town 18, range 9, on Coal creek, the following section was seen:

Drift and covered slope,	- - - - -	20 feet	0 inches.
Flaggy sandstone,	- - - - -	6 "	0 "
Black sheety shale,	- - - - -	8 "	0 "
Limestone,	- - - - -	2 "	0 "
Semi-"block-coal," K? (which thickens up to four feet on the place of Jno. and Jas.			
Allen, on the opposite side of the hill,) 1	-	8 "	"
Fire-clay, (good potters-clay,) -	-	2 "	0 "

Shale with covered space, - - -	- 16 feet 0 inches.
Sandstone, - - - - -	2 " 0 "
Coal I? - - - - -	5 " 0 "

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62 feet 8 inches.

Close to Mr. Norman Thomas' house, on Silver Island, in the southwest corner of Fountain county, there is a high bluff, which faces the Wabash river, and presents a fine exposure of the coal measure strata. The following section was furnished by Mr. John Collett, of Eugene:

Drift, - - - - -	20 to 30 feet 0 inches.
Gray argo. shales, - - - - -	2 to 3 " 0 "
Coarse, black sheety slate, - - -	4 to 5 " 0 "
Coal, brash, - - - - -	0 " 8 "
Clay shale, place of quarry-rock, -	6 " 0 "
Ferruginous, fossiliferous limestone,	0 " 6 "
Black bituminous sheety slate, -	1 " 10 "
Coal, - - - - -	1 " 6 "
White fire-clay, - - - - -	3 " 6 "
Arenaceous shale with ironstone, -	8 " 0 "
Band of nodular ironstone, - - -	0 " 6 "
Black bituminous shale, - - - -	2 " 0 "
Fatty-coal, - - - - -	1 " 6 "
Siliceous fire-clay, - - - - -	2 " 6 "
Clay shale, with siliceous ironstone,	5 " 0 "
Gray argo. shale, with bands of ironstone,	4 " 8 "
Black band ironstone, - - - - -	0 " 4 "
Cannel coal(?) slate, - - - - -	0 " 8 "
Black sheety slate, with fish remains,	1 " 0 "
Coal (choice caking-coal), - - -	1 " 8 "
Fire-clay, - - - - -	6 " 0 "
Clay-shale, with ironstone, - - -	2 " 0 "
Bituminous, fossiliferous limestone,	4 " 10 "
Coal K(?), - - - - -	4 " 0 "
Fire-clay, - - - - -	4 to 5 " 0 "
Soft sandstone, - - - - -	2 " 0 "
Siliceous ironstone, - - - - -	8 inches to 1 " 2 "

Flaggy sandstone, - - - -	6 feet 0 inches.
Coal I(?), semi-"block-coal," - -	3 " 0 "
Sandstone in river bed.	

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 113 feet 10 inches.

It is my opinion that the second coal from the bottom in this section is coal K, and the mammoth bed L, which lies from ten to fifty feet above it, is here split up and represented by thin coals and beds of black bituminous slate.

The lower coal lies in the river bed, and occupies the position of the middle "block-coal" seam I.

Near the Wabash and Erie Canal, on the east side of Silver Island, (in which direction the county gradually slopes from the river bluff to the bottoms of Coal creek), Mr. Thomas has sunk a shaft to coal K(?), which passes through:

Soil and drift, - - - -	10 feet 0 inches.
Argillaceous shale, with ironstone, - 1	" 0 "
Limestone, - - - -	1 " 0 "
Calcareous shale, - - - -	4 " 0 "
Coal K(?), - - - -	4 " 8 "

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 20 feet 8 inches.

A few yards farther to the east the coal is mined from the outcrop, and has above it:

Fossiliferous limestone containing *Productus wabashensis*, *P. punctatus*, *Spirifer camera-tus*, *Bellerophon carbonarius*, *Chonotes mesoloba*, *Athyris subtilita*, and a variety of

other coal measure fossils, - - -	4 ft. 0 in.
Bluish-gray shale, - - - -	0 ft. 6 in.
Cannel coal, local, - - -	0 ft. 4 in.
"Semi-block-coal," - - -	3 ft. 6 in.
Streak of iron pyrites, - - -	0 ft. 0 $\frac{1}{8}$ in.
"Block-coal," good, - - -	0 ft. 4 in.
Streak of iron pyrites, - - -	0 ft. 0 $\frac{1}{8}$ in.
Caking coal, - - - -	0 ft. 6 in.

} 4 ft. 8 in.



I was informed by Mr. Thomas that there is another seam of coal, about twenty feet below this, which corresponds to the bed of coal in the Wabash river at the bluff. Half a mile east of Thomas' mine, on the west bank of Coal creek, in section 36, town 18, range 8, the Wabash Petroleum and Mining Company are mining the same seam of coal, by stripping off the clay roof, where the stratum lies near the surface. The same coal also outcrops in the hills on the east side of Coal creek, and underlies a large area of country.

On Prairie branch of Coal Creek, at Thomas Arrowhood's, on section 4, town 18, range 8, these two seams of coal, K (?) and I (?), come close together, being separated by only two feet of fire-clay, and, at one exposure which I saw, show a combined depth of ten feet. About one and a half miles northeast of Arrowhood's, at the crossing of Coal creek, near Cooper's mill, the conglomerate sandstone forms a conspicuous bluff. The position in the coal measures and the synchronism of the Arrowhood coals with the two lower coals at Silver Island is well established by deep bores that have been made close by the coals at each locality. The artesian well at Lodi, a condensed section of which is given on page 31, is situated about two hundred yards southeast of Thomas' mine, and commenced in the bottom land below the coal, consequently no coal was passed in this bore. As a more detailed account of the strata passed through in this bore may be of interest, it is given as follows:

Drift, - - - - -	5 feet	0 inches.
Soapstone, with iron nodules -	5 "	6 "
Limestone, - - - - -	2 "	0 "
Shale, - - - - -	8 "	0 "
Coal, - - - - -	1 "	0 "
White clay, - - - - -	3 "	0 "
Coal, - - - - -	1 "	0 "
Soapstone, with iron nodules, -	1 "	6 "
White sandstone, - - - - -	12 "	6 "
Fossiliferous limestone, with iron nodules, - - - - -	7 "	6 "

Sandstone, with cannel coal, bituminous coal, charcoal, and an oily substance, - - - -	10 feet	0 inches.	
Argillaceous sandstone, - - -	8 "	0 "	
Argillaceous sandstone, with iron nodules, - - - - -	16 "	9 "	
Sandstone and soapstone, - - -	12 "	7 "	
Dark clay, - - - - -	2 "	5 "	
Soapstone, with coal, - - -	3 "	7 "	
Dark sandstone, - - - -	4 "	0 "	
Shale, - - - - -	4 "	3 "	
Argillaceous sandstone, with mica, - - -	2 "	10 "	
Sandstone, fine-grained, - - -	5 "	0 "	
White sandstone, - - - -	15 "	0 "	
Bituminous shale, with "oil bloom," - - -	5 "	10 "	
Shale and coal, - - - - -	6 "	3 "	
Black shale, - - - - -	9 "	0 "	
White soapstone, - - - -	19 "	6 "	
Sandstone, (base of conglomerate?) - - -	31 "	11 "	
Shale and soapstone, with thin seams of sandstone, (brackish water), - - - - -	39 "	8 "	
Shale, - - - - -	15 "	3 "	
Hard sandstone, - - - - -	2 "	3 "	
Sandy shale and soapstone, - - -	62 "	5 "	
Sandstone, fine-grained, - - -	46 "	5 "	
Soapstone with grit, - - -	19 "	2 "	
Hard-cap and shale, - - - -	12 "	3 "	
Gritty soapstone, with shale, - - -	53 "	7 "	
Hard sandstone, with "oil bloom," - - -	10 "	4 "	
Gritty shale, with salt water, - - -	102 "	4 "	
Sandstone and flint, - - - -	8 "	2 "	
Soapstone, with iron pyrites, - - -	44 "	11 "	
(Salt water 5° Baume),			
Compact, coarse sand-rock, - - -	64 "	10 "	
Unctuous clay, - - - -	8 "	8 "	
Soapstone, with fine grit, - - -	65 "	5 "	
Flint, - - - - -	1 "	0 "	

Gritty soapstone, - - -	32 feet	4 inches.
(Salt water 6.5° Baume),		
Sandstone, - - -	58 "	1 "
Soapstone, with unctuous shale -	65 "	7 "
(Lowest salt water 7.5°),		
Brown bituminous shale, which		
burns freely, and contains specks		
of iron pyrites, (Marcellus shale),	60 "	9 "
Blue soapstone and sandstone, -	20 "	5 "
Red bituminous shale, - -	25 "	11 "
(Oily matter,) hard, coarse-grained		
sandstone, - - -	22 "	1 "
White limestone, with coral and		
shells (Devonian), - -	12 "	0 "
Magnesian limestone, - -	18 "	8 "
Sand rock, very hard, - -	22 "	0 "
Limestone, - - -	23 "	0 "

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1,118 feet 9 inches.

The above well was bored on property owned by the Wabash Petroleum & Coal Mining Company. A quantity of water from this well was sent to Dr. Pohle, of New York, for analysis, and the result obtained shows that it is one of the most valuable medicinal waters in the country. An account of this analysis was given to me for publication, by one of the proprietors of the well, Mr. Nye, of Rockville, Indiana :

"It was found to yield the following dry, saline, and other constituents from the gallon, United States standard :

" Chloride of sodium, - - -	502.464 grains.
" Chloride of calcium, - -	47.928 "
" Chloride of magnesium, - -	53.540 "
" Sulphate of lime, - - -	55.553 "
" Sulphate of potassa, - - -	.804 "
" Sulphate of magnesia, - -	3.260 "
" Sulphate of soda, - - -	2.135 "
" Bicarbonate of lime, - -	2.904 "
" Bicarbonate of magnesia, - -	1.104 "
" Bromide of magnesium, - -	.880 "

" Iodide of magnesium, - - -	trace.
" Silicic acid, - - - -	.520 grains.
" Phosphate of lime, - - - -	1.200 "
" Sulphur, mechanically suspended, -	.500 "
" Nitrogenous organic matter, -	.800 "
<hr/>	
" Total solid matter, - - -	673.937 grains.

" It has a pleasant saline and sulphurous taste, and emits the odor of sulphuretted hydrogen.

" Specific gravity at 60° F., 1.0112.

" Gaseous matter in one gallon :

" Sulphide of hydrogen, - 7.94 cubic inches.

" Carbonic acid gas, - - - undetermined.

" Nitrogen and oxygen, - undetermined."

About one quarter of a mile west of Thomas Arrowhood's mine, a well was bored for salt to the depth of seven hundred feet, and passed through five feet of coal (the lower bed) at the depth of twelve feet, and no other coal was found in the well.

South-east of Thomas Arrowhood's, on the same section, the upper part of his great bed—which is generally overlaid by limestone—is seen where it is about four feet thick, and entirely disconnected from the lower bed.

Some of the best bituminous caking-coals in the State are to be found on Coal creek, and when rendered accessible to market by the railroads that are now being built, they will be eagerly sought after for fuel and gas purposes.

The Thomas' coal, K ? is for the most part a semi "block coal," and in my opinion will answer as fuel in the raw state, to manufacture pig-iron. A specimen was analyzed, and gave the following result:

Specific gravity, 1.277 ; a cubic foot weighs 77 lbs.			
Coke, . . . 64.3	{	Ash, dark brown, - - -	4.5
		Fixed carbon, - - -	59.8
Volatile matter, 35.7	{	Water, - - - - -	3.0
		Gas, - - - - -	32.7
<hr/>			<hr/>
100.0			100.0

The coke is light, porous, much swollen, and without lustre.

It is at present mined by a company who pay Mr. Thomas a royalty of a half cent. per bushel. They ship, by the canal, about ten tons daily to Lafayette, where it has a high reputation as a steam and grate coal.

A trial of the relative heating value, and capacity for generating steam, was made of the Danville, Illinois coal, and Thomas' "Silver Island" coal, in a steam mill at Lafayette, last July (1869), with the following result:

4,210 pounds of Silver Island coal kept the steam up to full 60 pounds, for seven hours and forty-five minutes, while 4,260 pounds of Danville coal would only sustain the same pressure of steam for five hours and twenty-five minutes. This test shows a gain of 42.8 per cent. of heating capacity for the former coal; or, in other words, seventy bushels of Silver Island coal are equal to one hundred bushels of Danville coal.

*Iron-ore.*—In the shale above and below the coal seams on Coal creek, there are to be found numerous bands of ironstone (earthy carbonate of iron), that will go a great ways toward supplying blast-furnaces. In the bluff facing the Wabash river at Mr. Thomas', the bands of iron-stone will, in the aggregate, amount to more than two and a half feet in depth; and similar beds are to be seen on Coal creek.

*Salt-Brine.*—Good strong brine may be obtained anywhere in the vicinity of Coal creek or its branches, in Fulton and Wabash townships, and in the southern part of Troy township, by wells, at the depth of six hundred to one thousand feet.

Three wells have been bored for salt and oil in the above named district, and they all passed through several veins of brine, varying in strength from 6.5° to 9.5° Baume. The horizon of these brines may be seen by reference to the section of the bore made near Lodi, given on page 37. It

will require from sixty-five to seventy gallons of the best brine to make a bushel (50 lbs) of salt, which is fully as strong as the brine on the Kanawha river in Western Virginia.

Mr. Norman Thomas, of Silver Island, made salt for many years, in this county, from a brine obtained from a well which he bored on Coal creek, and only suspended operations in consequence of not having sufficient manufacturing facilities to compete with the salt works of Michigan and New York, which, at that time, were sending salt to northern Indiana at an extremely low rate of freight by means of the Wabash and Erie Canal.

Some years ago I made an analysis of the brine from the "Thomas salt-well," that was published by Prof. Richard Owen in a report that he made to the Wabash Petroleum and Coal Mining Company, which is reproduced here, together with the remarks made by Prof. Owen in relation thereto:—

"By Baume's scale, the brine sent by you indicated  $8\frac{1}{2}^{\circ}$ , (distilled water at  $60^{\circ}$  F. being zero,) every degree denoting one per cent. of salt, and  $36\frac{1}{2}$  being the greatest amount that water at any temperature can take up. The specific gravity of the same brine (distilled water at  $62^{\circ}$  F. being 1000,) was found to be 1060. To render the above more intelligible to salt boilers, I may add that the brine you sent floats an egg, with a portion appearing above the water. Salt makers are in the habit of saying that, under ordinary circumstances of cheap fuel and proximity to market, any brine will pay in which an egg will float. But as this is a very indefinite standard, the egg floating higher or lower in different brines, I have compared the egg test with the salt hydrometer of Baume, and here give the result. In water containing  $8\frac{1}{3}$  to 9 parts of salt in 100 (hence indicating  $8\frac{1}{3}$  to  $9^{\circ}$  Baume) a fresh egg will float, but be nearly covered. At anything below  $8^{\circ}$  it sinks, but at  $10^{\circ}$  to  $10\frac{1}{2}^{\circ}$  B., (or specific gravity 1075 to 1080,) and in all brines above that strength, an egg will float high.

"The brine from your 'Thomas well' gave of solid matter 84.82616 parts in 1000. That solid matter consisted of the materials given below:

"Carbonic acid (free), - - - -	0.01615.
"Oxide of iron and silica, - - - -	0.02880.
"Carbonate of lime, - - - -	1.83850.
"Sulphate of lime, - - - -	0.04991.
"Chloride of magnesium, - - - -	0.90823.
"Chloride of calcium, - - - -	3.68225.
"Chloride of sodium (pure salt,) - -	78.30232.
"Water, and trace of organic matter, -	915.17384.
<hr/>	
"Total solid matter in 1000 grains, -	84.82616.

"Your well requires 72.4 gallons of water to produce a bushel (fifty pounds) of pure salt."

I also copy, from *Kane's Chemistry*, the following "*Table showing the number of gallons of Salt Water producing a bushel of salt, in different parts of the United States:*

Nantucket Salt Water, - - - -	350
Boon's Lick, Missouri, - - - -	450
Conemaugh, Pennsylvania, - - - -	300
Shawneetown, Illinois, - - - -	280
Jackson, Ohio, - - - -	213
Lockhart, Mississippi, - - - -	180
Shawneetown, 2d Saline, - - - -	123*
St. Catharine, Upper Canada, - - - -	120
Zanesville, Ohio, - - - -	95
Kanawha, West Virginia, - - - -	75
Grand River, Arkansas, - - - -	80
Illinois River, - - - -	80
Montezuma, N. Y. (old wells), - - - -	70
Grand Rapids, Michigan, - - - -	50 to 60
Muskingum, Ohio, - - - -	50
Montezuma, N. Y. (new well), - - - -	50

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\* New Saline, 75 gallons.

Onondaga, N. Y. (old wells),	-	-	40 to 45
Onondaga, N. Y. (new well),			
Syracuse, - - - - -	-	-	30 to 45

The "Thomas Well" still produces a good flow of brine, which, at the time of my visit, was pumped by hand, and made into salt on a limited scale by a man who was permitted to use the Company's kettles, nine in number, free of charge. He collected the fuel used under the kettles from the fallen forest trees, and carried it to the works upon his shoulders, pumped the water, and in fact did all the work about the establishment himself, and was making about one barrel of good white salt per day. I had no means of testing the strength of this brine at the well, and the small bottle of brine collected for examination at the laboratory, was broken in the transit.

The saliferous strata in this State are reached in the subcarboniferous sandstone formation, which underlies the limestone, and is co-extensive with the coal measures.

*Building Stone.*—The conglomerate sandstone in this county furnishes an abundance of good freestone for building purposes. In color it ranges from whitish-gray to a brownish-red.

Quarries of this stone have been opened near Attica, on the Toledo, Wabash and Western railroad, in Logan township, and afford a coarse-grained, grayish-brown, durable sandstone, that can be quarried in blocks from one to four feet or more in thickness, and of any required length and width. Other quarries have also been opened at Portland, on the Wabash and Erie canal, where a stone similar to that from Attica is obtained.

#### WARREN COUNTY.

My examinations in this county were very limited, being made solely with a view of determining the character of the coal-beds on the northern limits of the Indiana coal-field.



The stratified rocks of this county belong, for the most part, to the millstone grit epoch; the prominent feature of this formation being a heavy bedded sandstone, that occupies the geological position of the conglomerate sandstone; but here it contains no quartz pebbles. It is a coarse-grained, durable building-stone, and in color it varies from grayish-brown to reddish-brown. The jail at Williamsport is constructed of rock quarried from this member of the series which forms the Williamsport falls, sixty to seventy feet high, and outcrops in all the hills around the town.

In the road, on the north edge of Williamsport, there is an outcrop of subcarboniferous limestone, of a few feet in thickness, which contains a few fossils characteristic of the Keokuk beds. Half a mile south of the town there is a very good spring of cool chalybeate water, that breaks out from the base of the conglomerate sandstone, from which is deposited a large quantity of calcareous tufa and ferruginous matter.

A qualitative chemical examination of this water was made in the laboratory after my return home, and its principal constituents are :

Sulphate of protoxide of iron.

Carbonate of protoxide of iron.

Bicarbonate of lime.

Bicarbonate of magnesia.

Chloride of sodium (common salt).

Sulphate of soda (Glauber salts), small quantity.

Sulphate of magnesia (Epsom salts), small quantity.

Free carbonic acid.

This is properly a saline chalybeate water, and its medicinal properties are tonic and aperient.

The coal-measure strata which make their appearance in Pine township, contain at least two seams of good "block-coal," from two and a half to four feet thick. The principal mine visited was on a branch of Pine creek, and

was opened and worked to a considerable extent by Alexander A. Rice, of Attica, on section 19, town 23, range 8. The section at this mine is as follows:

Drift, - - - - -	10 feet.
Buff siliceous shale, - - - - -	2 "
Coal I? good "block-coal," - - -	4 "
Fire-clay, - - - - -	2 "
Gray shale, - - - - -	18 "
Shale, with bands of sandstone, - -	8 "
Blue argillaceous shale, with bands of ironstone, - - - - -	6 "
Bed of Creek,	<hr/> 50 feet.

At Dick's mill, on Pine creek, the following section was seen, which underlies the section obtained at the coal-mine:

Drift, - - - - -	10 (?) feet.
Bluish argillaceous shale, with bands of iron-stone, - - - - -	60 (?) "
(The lower band of iron-stone is fully six inches thick.)	
Rough, false-bedded sandstone, with stems of plants much broken, -	8 "
Bed of Pine creek.	

This section underlies all the coal.

Coal has been mined at a number of other places in Pine township, which I did not have time to visit; but, as the county is to be surveyed in detail hereafter, and the object of my visit having been accomplished in tracing the iron-smelting or "block-coal" to the northern limits of the coal basin in Indiana, further examination was not deemed necessary at this time.

## OWEN COUNTY.

My examinations in this county were confined to a very narrow strip along the southwestern border of the county, in Marion and Jefferson townships. In these townships the "block-coal" seam I ranges from three-and-a-half to five feet in thickness, and, in quality, is equal to any in Clay county for manufacturing iron. All that is needed to bring the coals of this district into market and induce the building of blast-furnaces, is the establishment of railroad facilities.

## VERMILLION COUNTY.

The survey of this county was made by my assistant, Prof. Frank H. Bradley, whose able and interesting report will be found in this volume, page 136. It only remains, therefore for me to add a few remarks embracing an account of the result of my own observations, made subsequent to the survey of Prof. Bradley, and during a trip hastily undertaken, at the request of a number of the leading citizens of the county.

Previous to my personal examinations in this county, it was not known that "block-coal" could be found within its borders, and its discovery was first made public through the newspapers, immediately after my return to Indianapolis, on the 15th of November, 1869.

The "block-coal" of Vermillion county, so far as known at present, underlies all the ridge land between Highland, on the south, and Newport, on the north. But it is my decided opinion that it will be found still farther to the south, as the same seam underlies the greater part of the county from the Indiana blast-furnace, on the south, to the Horse-shoe on the Little Vermillion river, on the north.

Owing to the inclemency of the weather and the want of time, I was unable to determine the width of the field.

The total thickness of the bed ranges from five to seven feet, and is separated into two or more seams by thin partings of shale or fire-clay. The lower part of the bed (from

thirty to thirty-six inches) is good "block-coal," and the upper two to three feet above the clay parting is caking-coal.

On the map of Vermillion county which accompanies this volume, and in Prof. Bradley's report, this bed of coal is marked No. 6, and is, in my opinion, equivalent to the mammoth coal L of the connected section of Clay county coals, given on pages 37 to 45.

I am led to this conclusion not only from stratigraphical investigations, but from the fact that coal L, on the Terre Haute & Indianapolis railroad, in Clay county, and still further south, in Greene county, contains in its lower portion more or less "block-coal." This character of the mammoth seam is also apparent in General Steele's mine at Roseville, in Parke county, and quite marked at Jose Butler's, in the same county, a few miles southeast of Highland. At Mrs. Leatherman's, on section 27, town 16, range 9, and at Mr. Farman's mine, and the Groves' or Mill bank, south of Newport, from thirty to thirty-six inches of the seam is good "block-coal." A sample from the Mill bank was subjected to approximate analysis, and gave the following result:

Specific gravity, 1.289; a cubic foot weighs 80.5 lbs.			
Coke,	-	52.2.	{ Ash, white, - 4.5.
			{ Fixed carbon, - 47.7.
Volatile matter,	-	47.8.	{ Water, - 3.5.
			{ Gas, good illumin't'g, 44.3.
		<hr/> 100.0.	<hr/> 100.0.

This is a free-burning, non-caking, white ash coal, contains a small quantity of water, and has a larger quantity of gas than Pittsburg coal. It appears to be free from sulphur, and will undoubtedly make a good blast-furnace coal.

The Evansville, Terre Haute & Chicago railroad, which crosses the Wabash river at Clinton, and runs through the entire length of this "block-coal" field, will afford excellent facilities along its line for the location of blast-furnaces. As this railroad connects at Danville with another railroad run-

ning direct to Chicago, and is crossed at Highland by the Indiana & Illinois Central railway, running west to Decatur, in Illinois, no location in the "block-coal" region of the State can be more favorable for manufacturing iron, and for obtaining the Lake Superior iron ores at a low rate of freightage.

In close proximity to the "block-coal," large quantities of earthy carbonate of iron can be obtained from the shale-beds which underlie it. Bands of this character of iron-stone, that have a total thickness of from six to ten inches, or more, may be seen near the "Mill-bank," where the subordinate shales have been washed bare on the slopes of the ridges, and in the deep cuts made through the strata by the small creeks and branches.

Prof. Bradley, in his report, mentions a number of localities where iron-ore in considerable quantity can be obtained, and there are, no doubt, many others that have not yet been discovered.

The Indiana Blast-furnace, in the southwest part of the county, obtained its ore from this geological horizon, and experienced no difficulty in finding an abundant supply, though it was in blast for a number of years, and consumed daily from thirty to forty tons of ore.

At the time of my visit to the Indiana Blast-furnace, Mr. Sparks, who lives on the property, and is one of the owners, was absent from home, consequently I was unable to learn anything definite regarding its history; and, as yet, no answer has been received to a note which I left at his residence asking for information on this subject. It is reported, however, that it went out of blast soon after the breaking out of the rebellion; and owing to its distance from railroad facilities, and the growing scarcity of timber for charcoal, it has not since been put in blast, but not from any want of ore.

The outer wall of the stack is built of sandstone, and I should judge it to be about forty-feet high, and nine feet across the boshes. It was arranged for hot-blast, and used charcoal for fuel. The daily make of metal would be about

nine tons. The boilers, engine, and blowing cylinders appeared to be in good order.

I had but little opportunity to examine the character of the coal beds in the neighborhood of this furnace, but fully believe that a seam equivalent to the Leatherman and Mill bank coals may be found here of a quality that will also answer for smelting iron ores; in which case the Indiana furnace may be again put in blast, and run with profit, if placed under proper management.

The pig-iron, which is still to be seen at this furnace, bears testimony that the ores yield an excellent quality of metal. As many as three thick seams of coal, with a total depth of twelve to sixteen feet, are found over a large area of this county, and the quality will compare favorably with that of any other coals in the State.

## ANALYSIS OF COALS.

COUNTY.	NAME OF MINE OR OWNER.	Specific Gravity.	Weight of one Cubic Foot.	Fixed Carbon.	Ashes.	Coke.	Volatile combustible matter. Gas.	Water.	Total Volatile Matter.
Clay.....	Barnett's Mine <sup>*</sup> .....	1.250	78.12	57.0	1.5	58.5	37.5	4.0	41.5
Clay.....	Garlick & Collins' Mine <sup>*</sup> .....	1.230	76.87	57.5	3.0	60.5	31.0	8.5	39.5
Clay.....	Knightsville No. 1 Mine <sup>*</sup> .....	1.176	73.50	59.8	0.3	60.1	30.9	9.0	39.9
Clay.....	Knightsville No. 2 Mine <sup>*</sup> .....	1.167	72.93	57.0	2.0	59.0	33.0	8.0	41.0
Clay.....	McClelland's No. 1 Mine <sup>*</sup> .....	1.279	79.93	54.7	1.5	56.2	38.8	5.0	43.8
Clay.....	McClelland's No. 2 Mine <sup>*</sup> .....	1.279	79.93	53.0	2.5	55.5	40.0	4.5	44.5
Clay.....	"Star" Mine <sup>*</sup> .....	1.242	77.62	61.5	2.5	64.0	32.5	3.5	36.0
Clay.....	Newburg Mine.....	1.327	82.93	47.3	6.0	53.3	39.7	7.0	46.7
Greene.....	Babbitt's Mine.....	1.238	77.30	59.9	1.5	61.4	35.6	3.0	38.6
Greene.....	Bledsoe's Mine.....	1.251	78.20	63.0	0.5	63.5	29.5	7.0	36.5
Greene.....	Harrell's Mine.....	1.263	78.31	48.1	2.5	50.6	42.4	7.0	49.4
Greene.....	McKissick's Mine <sup>*</sup> .....	1.189	74.37	62.5	2.0	64.5	32.0	3.5	35.5
Greene.....	Templeton's Mine <sup>*</sup> .....	1.238	77.37	59.3	4.5	63.8	28.7	7.5	36.2
Parke.....	Batty's Mine.....	1.231	76.93	56.0	2.5	58.5	38.5	3.0	41.5
Parke.....	Buchanan's Mine <sup>*</sup> .....	1.232	77.00	62.5	2.0	64.5	31.0	4.5	35.5
Fountain.....	N. Thomas' Mine <sup>†</sup> .....	1.277	79.81	59.8	4.5	64.3	32.7	3.0	35.7
Vermillion.....	Grove's Mine <sup>*</sup> .....	1.280	80.50	47.7	4.5	52.2	44.3	3.5	47.8
Roan County, Tennessee.....	Rockwood's Mine.....	1.331	83.18	68.9	4.5	73.4	24.1	2.5	26.6
"	Pittsburg Coal.....	1.278	79.75	56.9	1.0	57.9	41.1	1.0	42.1
Lehigh, Pennsylvania.....	Anthracite Coal.....	1.590	99.37	91.0	2.5	93.5	3.5	3.5	6.5

\* "Block" coal.    † Semi-"block" coal.

# ANALYSIS OF IRON ORES AND SLAG.

COUNTY.	OWNER'S NAME OR TITLE OF COMPANY.	Specific Gravity.	Loss by Ignition.	Sesquioxide of Iron.	Protoxide of Iron.	Alumina.	Manganese.	Lime.	Magnesia.	Sulphur and Phosphorus.	Insoluble Silicates.	Per cent. of metallic Iron.
Greene ....	Richland Furnace ore bank.....	2.585	7.50	54.73	—	2.50	1.14	.12	.03	none.	34.00	38.31
Greene ....	Richland Furnace ore bank.....	2.583	11.50	56.00	—	2.00	—	10.00	3.60	none.	17.00	39.20
Monroe ...	Virginia Furnace ore bank.....	2.56	10.00	58.50	—	trace.	—	—	—	none.	31.50	40.95
Marion ...	Slag from Ind'p'lis rolling-mill		Gain .029	—	70.00	2.44	.25	trace.	trace.	—	15.94	62.37

Analysis of PEAT from St. Joseph County.....	Coke.....	36	{ Ash, dirty yellow.....	9.5
Coke: Shriveled, earthy, and lustreless.....	Volatile matter.....	64.	{ Fixed carbon.....	26.5
			{ Water.....	8.5
			{ Gas.....	55.5
		100.		100.0.



## GEOLOGY OF VERMILLION COUNTY.

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BY FRANK H. BRADLEY.

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Vermillion county is bounded on the north by Warren county, on the east by Fountain and Parke counties, with the channel of the Wabash river as a boundary line, on the south by Vigo county, and on the west by Edgar and Vermillion counties, of Illinois. It is thirty-six miles long, and varies in breadth from five to ten miles, with an average of a little less than seven miles, thus including an area of 249 square miles.

Of this area, from one-fourth to one-third consists of the rich bottoms and terraces of the valleys of the Wabash and its affluents, the Big and Little Vermillion rivers and Norton's creek. A study of the details of the terrace-topography would be very interesting, but the time allotted to the survey of this county allowed of only a passing notice of its general features. The main terrace, or "second bottom," is especially developed in the region between Perrysville and Newport, a fact probably resulting from the combined action of the two main affluents which join the Wabash within these limits. The terrace is here from one to four miles wide, furnishing a broad stretch of rich farming lands, and has an average elevation of about forty feet above the present bottoms. Below Newport the bluffs approach the river so closely that the terrace is nearly obliterated, and the bottoms themselves become very narrow. At the mouth of Little Raccoon creek the bottoms are considerably widened, but the terrace has no considerable extent, until we reach the head of Helt prairie, about six miles north of Clinton, whence it stretches southward, with an average width of from two to three miles. It narrows

again, about three miles below Clinton, as we approach the mouth of Brouillet's creek, and the county line.

At the first settlement of the country, the bottoms were heavily timbered, but a large part of the terrace was so-called prairie, being entirely clear of trees. It is probable, however, that this was the result of ancient clearing by the Aztecs, or Mound-builders, whose "mounds" are quite numerous in this region; and that, during the period when the Indians occupied the country, their annual fires prevented the growing up of the clearings.

Rising from the terrace we find more or less abrupt bluffs, which attain a general level of from 120 to 130 feet above the river, and form the slightly-elevated border of Grand Prairie. The most gradual ascent is to the westward of Perrysville, and this has been selected as the best route for the Chicago, Terre Haute & Evansville railroad, although the coal and iron interest would rather favor a location south of the Big Vermillion. South of this stream the bluffs are much steeper, and a moderate grade could be obtained only by following up the valley of one of the smaller streams. The slopes of these bluffs are generally too steep for convenient cultivation, and are, through nearly their whole extent, still heavily covered with timber, principally consisting of oaks, hickories and walnuts, though beech begins to take a prominent place as we approach the southern end of the county. In many of the ravines, and along the foot of the bluffs, there are large groves of the sugar maple, from which considerable quantities of sugar and molasses are annually drawn. Near the principal streams this timbered region extends westward to the State line; but in both the northern and middle portions of the length of the county, considerable portions of its territory form parts of the Grand Prairie, which stretches, with few breaks, northward to the Illinois river, and westward nearly to the Mississippi.

The county is well watered by its numerous streams, and by the strong springs which, especially in its northern half, burst forth at short intervals from below the "boulder-clay" of the drift period.

## GEOLOGICAL FORMATIONS.

The alluvium of the river bottoms shows the common characters of river deposits, having animal and especially vegetable remains thoroughly intermingled with the fine sand and mud washed from the drift beds higher up the streams, and occasionally deposits of small stones, derived either from the drift or from the rock formations into which the rivers have cut in various parts of their courses. The only definite knowledge obtained as to the depth of these beds refers to the prairie between Eugene and Perryville, where wells have been sunk sixty feet through alluvial sand, and then encountered six to ten feet of a soft, sticky, bluish mud filled with leaves, twigs, and trunks of trees, locally known as "Noah's barn-yard." The lake-bottom deposits, of corresponding age, which commonly underlie the soil of the Grand prairie, were found in place a short distance west of the State line, consisting of marly clays and brick-clay subsoil, and probably exist equally under such portions of the prairie as extend into this county.

The gravel beds, which commonly form the upper member of the drift formation, have not been noticed within the county, though they may exist in its western portion, where the heavy prairie soil and subsoil prevent a knowledge of the underlying beds.

The "boulder-clay," which forms the mass of the drift formation, is a tough, bluish-drab, unlaminated clay, more or less thoroughly filled with fine and coarse gravel, and including many small boulders. On the bluff west of Perryville this bed was penetrated to a depth of about one hundred feet before reaching the water-bearing quicksand commonly found beneath it. Outcrops of 110 feet have been measured, and the bed very probably attains a thickness of 125 feet or more, where it has not been subjected to denuding forces. It is much thinner in the southern part of the county. From the difference in character of the included boulders at different levels, we are led to the conclusion that the currents, which brought the materials composing these beds, flowed in different directions at different

times. To illustrate this I will give the following section, observed upon a branch of Johnson's creek, for which I am indebted to John Collett, Esq., of Eugene. (Johnson's creek debouches at the "toe" of the Horseshoe bend of the Little Vermillion, flowing from the east.)

Soil, . . . . .	0 feet	0 inches.
Boulder-clay, with pebbles of Silurian limestone and trap, . . . . .	30 "	0 "
Yellow clay, with fragments of coal, shale, sandstone, etc., . . . . .	0 "	4 "
Boulder-clay, with pebbles of Silurian limestone, . . . . .	25 "	0 "
Ferruginous sand, . . . . .	Streak.	
Boulder-clay from the northwest, with pebbles of various metamorphic rocks and trap, and nuggets of native copper, . . . . .	50 feet	0 inches.

A considerable portion of the boulders and pebbles of these beds, especially those consisting of limestone and the metamorphic rocks, are finely polished and striated on one or more of their sides, showing the power of the forces which were engaged in their transportation from their original beds. Nuggets of galena (sulphide of lead) and of native copper are occasionally met with, and have had the usual effect of exciting the imaginations of persons who are ignorant that the rocks which contain these metals do not occur nearer than the galena region of Northern Illinois and Southern Wisconsin, and the copper mines of Lake Superior. Well-diggers, in the adjoining part of Illinois, have informed me that they are accustomed to find, near the bottom of boulder-clay, a thin layer of gravel, which contains a small quantity of gold. I have never taken pains to ascertain its outcrop, as the amount is too small to be of any value.

*The coal measures* furnish the only rock formations to be found in the county. Of these the outcrop at the Horseshoe bend of the Little Vermillion furnishes the highest, and this consideration, with others, leads me to commence the review

of their outcrops at this point, although it is so near the middle of the county.

The section of the rocks exposed at the Horse-shoe is as follows, measuring from the top downward. The numbering of the beds is made continuous as far as the mouth of the Little Vermillion, while the numbering of the coals correspond with the system which Prof. Cox\* has adopted, as expressing most correctly the distribution of the different seams throughout the Indiana, Illinois, and western Kentucky coal-field.†

1. Black slaty shale, with *Discina nitida*, ?
2. Coal, "No. 8," - - - 2 ft. 6 in. to 4 ft.
3. Fire-clay, - - - ) 15 ft.
4. Soft clay shales, with ironstones, }
5. Argillaceous limestone, with *Pro-*  
*ductus longispinus*, - - - 1 ft. 0 in. to 2 ft.
6. Dark drab clay shale, - - - 1 ft.
7. Soft, nearly black shale, - - - 0 ft. 6 in.
8. Coal "No. 7," - - - 4 ft. 0 in. to 5 ft.
9. Light colored fire-clay, - - - 2 ft.
10. Dark colored fire-clay, - - - 1 ft.
11. Soft drab shale, with ironstones,  
*Productus*, etc., - - - 10 ft. 0 in. to 15 ft.
12. Fossiliferous, black slaty shale, of-  
ten pyritous, with many large  
iron-stone nodules, - - - 2 ft. 0 in. to 3 ft.

\* The system of numbering here referred to by Prof. Bradley, is given in a general section of the coal strata arranged by me for the Geological Report of Illinois, and was compiled principally from information obtained in making a survey of Gallatin and Saline counties, Illinois, and Union county, Ky.

Though the arrangement and numbering of the coal-beds in this section is believed to be accurate, for that region of the coal-field, I have not, as yet, been able to make the coal seams in this part of Indiana agree with it, and have, consequently, in my own report, used letters, provisionally, for the co-ordination of coal-beds, until a thorough study of the coal-measures in this State has been made.

E. T. C.

† A letter written by me to John Collett, Esq., of Eugene, on Nov. 26th, 1868, and published in the newspapers of the Wabash valley, used a different set of numbers for the coal-seams, as the result of an attempt to co-ordinate them with the series of numbers adopted by Prof. Worthen, of the Illinois survey, for the coals of the Illinois valley; but finding that certain coals occurring on the Wabash had no place allotted to them in that system, I have been obliged to give it up, and now substitute therefor numbers, which will serve for the present identification of the different seams, but will probably require some change when the completion of the survey of the State shall have enabled us to arrange an accurate system of all its beds.

- 13. Coal, "No. 6," - - - - 5 ft. 0 in. to 7 ft.
- 14. Soft, black, shaly clay, - - - 1 ft. 0 in. to 3 ft.
- 18. Fossiliferous, slightly sandy shales,  
with small ironstones, - 6 ft. 0 in. to 10 ft.
- 19. Drab shale, bottom concretionary, 20 ft. 0 in. to 43 ft.

Though I have looked carefully for it, I have never succeeded in finding any outcrop of the beds which overlie this section; and of the black shales which appear as its top layer, I have seen only specimens, as its outcrop was covered during the period of my survey of the county. The coal No. 8, as seen by me, had a covering merely of a few feet of soil. The samples of the roof-shales which I have seen are readily distinguished from those of coal No. 6, by their comparative freedom from pyrites, and the great numbers of *Discina* which accompany them, while this shell is only scantily present in the shales of No. 5.

The argillaceous limestone (5 of the section,) is here quite thinly laminated, being mingled with much clay; but the shales between it and coal No. 7 are here rather more solid than at some other points, and make a very fair working roof. About a mile farther up stream, at the upper end of the Horseshoe, the limestone is very solid, but the underlying shales are very soft, and appear likely to fall in the workings. The bed is not now worked at this point.

The section at this point is as follows:

- 5. Compact argillaceous limestone, 2 ft. 0 in.
- 6. Greenish shaly clay, - - - 1 ft. 0 in.
- 7. Soft black shale, - - - - 0 ft. 4 in.
- 8. Coal, No. 7, - - - - 4 ft. 0 in.
- 9 and 10. Fire-clay, - - - - ?
- Covered, - - - - 15?
- 18. Sandy shales, - - - - 10 ft. 0 in.
- 19. Dark drab to gray concretionary  
clay shales, - - - 25 to 30 ft. 0 in.

The space marked "covered," evidently includes the

equivalents of Nos. 11 to 14, but no signs of coal No. 6 could be detected upon the outcrop. It is possible that it has locally thinned out and disappeared; but from the constancy of this bed wherever I have looked for it, along a line of outcrop of more than forty miles, I believe that it and the other missing beds, will be found here also when the debris shall have been removed from the slope, with the possible addition of Nos. 15 to 17, which are absent from the locally thinned section at the "toe" of the Horseshoe. It is a little curious, however, that so near to the *only known appearance* of No. 8 in the county, we should meet with the *only apparent failure* of this constant seam. A mistake in identification of seams at once suggests itself; but I believe that no such mistake has been made in this instance.

The sandy ironstones accompanying No. 18 of the section, are interesting to the fossil-hunter, as containing numerous fragmentary remains of fishes, mingled with fragments of *Neuropteris*, *Pecopteris*, *Cordaites*, etc. The last mentioned genus is also frequently present with *Discina* and the long fin-spines of *Petrodus occidentalis*,\* in the pyritous ironstones in the roof of coal No. 6.

Upon ascending Johnson's branch, which enters the Little Vermillion at the "toe" of the Horseshoe, we find, upon the first left-hand ravine, an outcrop of coal No. 5, its presence being due to a local disturbance of the strata. As its normal relation to the section already given is better shown elsewhere, I give no section at this point. The disturbance mentioned is plainly indicated along the Little Vermillion by a great thinning of the beds below coal No. 6. This is partially shown by the variation in thickness ascribed to No. 19 of the given section; but a much greater difference is indicated by the dip of the beds at a point where the line of demarcation has passed below the level of the stream.

\* I am aware that these long spines, feathered out upon the concave side like a slab of whalebone, and somewhat thickened along the convex edge, have not been described as *Petrodus*; but their universal occurrence, in company with the conical bony scales which are referred to this genus, has compelled me to conclude that they belonged to the same animal.



About a mile below the toe of the Horseshoe, near the so-called "silver-mine" of the "slip-bank," the following section was taken:

- |                                                                                                                                  |           |                   |
|----------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------|
| 13. Coal, "No. 6,"                                                                                                               | - - -     | 4 to 5 ft. 0 in.  |
| 14. Fire-clay, top dark, bottom<br>light drab, including a band<br>of calcareous iron stone<br>("silver-ore"),                   | - - -     | 0 to 3 ft. 5 in.  |
| 15. Light bluish-drab gray shale,                                                                                                |           | 8 to 10 ft. 0 in. |
| 16. Olive colored gray shale,<br>slightly sandy, with bands<br>of siliceous iron stone,                                          | - - -     | 8 to 10 ft. 0 in. |
| 17. Nearly black clay shale,                                                                                                     |           | 1 ft. 8 in.       |
| 18. Light gray, slightly sandy<br>shale, with fossiliferous<br>bands of calcareous iron<br>stone and argillaceous lime<br>stone, | - - - - - | 11 ft. 0 in.      |
| 19. Dark drab concretionary shale<br>top fossiliferous,                                                                          | - - -     | 16 ft. 0 in.      |

Numbers 18 and 19 are especially interesting for their great abundance of fossils, of which the following are the more abundant: *Deltodus*, *Bellerophon percarinatus*, *Nautilus*, *Spirifer cameratus*, *Spiriferina Kentuckensis*, *Productus scabriculus* (very fine interiors often found), *P. punctatus*, *P. longispinus*, *Chonetes*, *Athyris subtilita*, *A. Royissii*, *Terebratula bovidens*, *Hemiphronites crassa*, *Aviculopecten* 2 sp. Along Fall branch, just above the "silver mine," on the opposite side of the river, the calcareous material of the beds equivalent to these bands is concentrated into a heavy compact limestone nearly two feet thick, with comparatively few fossils. In the branch above are numerous small, loose blocks of an impure limestone, perfectly filled with *Productus longispinus*: their proper place in the section was not ascertained. About a mile further down stream, near White's Mill, we find the following section, beginning with the bluff at the head of the mill-pond, as seen from the mill,



and running to the bluff below the mouth of Jonathan's creek:

18. Compact and pisolitic iron ore with shales, - - - - - 2 ft. 0 in.
19. Clay shales, light and dark, hard and soft, - - - - - 35 ft. 0 in.
20. Black calcareous ironstone, - - - 0 ft. 8 in.
21. Black slaty shale, - - - 2 to 3 ft.
22. Soft black shale, - - - 0 ft. 6 in.
23. Coal, "No. 5," - - - 4 to 6 in.
24. Dark-drab soft clay shale, with ferns, 2 ft. 0 in.
25. Harder shales with sandy layers, - 1 to 10 ft.
26. Quarry sandstone, coarse, ferruginous, with plant remains, - - - 4 to 9 ft.
27. Shaly sandstone and sandy shales, some layers carbonaceous, with ferns, some ripple-marked flags, - - 15 to 20 ft
28. Dark-drab clay shales, - - - 15 to 20 ft.
29. Clay shales, with thin bands of clay ironstone, full of fossil, - - - 3 to 5 ft.

The black roof-shales of coal No. 5 commonly contain large numbers of the conical teeth (or scales) and long fin-spines of *Petrodus occidentalis*. The overlying black ironstones also contain this species, together with a few Mollusks, of which the most common are *Orthoceras Rushensis* and *Cardiomorpha Missouriensis*.

From the shales, No. 24 of the section, John Collett, Esq., of Eugene, reports the following plants: *Neuropteris hirsuta*, *Pecopteris*, *Hymenophyllites*, *Asterophyllites*, *Cordaites*, *Sphenophyllum*, *Lepidodendron* and *Sigillaria*.

The ironstone bands of No. 29 of the section are crowded with fossils, mostly small, but generally well preserved. The following are the more common: *Orthoceras Rushensis*, *Pleurotomaria*, *Loxonema*, *Bellerophon Montfortianus*, *Macrocheilus*, *Spirifer cameratus*, *Astartella*, *Leda*, *Phillipsia*.

Going on toward Newport, we find the beds of the fore-

going section, as high as No. 20, exposed at intervals on the hill-sides, but gradually rising to make room for the lower beds, of which the following is an average section:

- 30. Clay shales, - - - - - 6 to 8 ft.
- 21. Black slaty shales, rich in fossils, 2 to 3 ft.
- 32. Coal, "No. 4," - - - - - 18 to 20 in.
- 33. Fire clay, dark, shaly, with *Stigmæria*, 4 to 6½ ft.
- 34. Shales, - - - - - 30 to 50 ft.
- 35. Ironstone bands and nodules in shales, 2 to 5 ft.

At Morehead's bank, one mile above Newport, on the south-west quarter of section 28, township 17 north, range 9 west, a local change of dip brings coal No. 4, which at one point had reached an elevation of nearly sixty feet above the river, down again very nearly to water level. Its roof-shales, everywhere quite fossiliferous, are here especially rich in scales, teeth, and spines of fish, including the minute comb-like teeth so frequently mentioned by Lesquereux in Owen's *Geology of Indiana* (1859-'60), and in nearly perfect specimens of a crustacean closely allied to *Ceratiocaris*.

Below this point no outcrop is visible until we reach the mouth of the river, where a bed of highly fossiliferous, calcareous ironstone, a few inches thick—probably the equivalent of No. 35 of the foregoing section—is exposed at low water. This is especially noticeable for the great numbers of *Serpulæ* which fill the entire mass, sometimes attached to other fossils, sometimes running free, as though the layer had been a calcareous mud, affording support to the thin tubes.

As we go down the bottoms south of Newport, we find, in the numerous ravines and gullies excavated in the bluffs by the small streams, fine sections of the equivalents of the beds noted in the foregoing sections, as high as the roof of coal No. 6, of which an average section is nearly as follows:

- Sandy clay shales, with pisolitic iron-  
stone nodules, - - - - - 5 ft. 0 in.
- Soft clay shales, - - - - - 2 ft. 0 in.

Coal "No. 6,"	- - - - -	4 ft. 0 in. to	7 ft. 0 in.
Indurated fire-clay,	- - - - -		3 ft. 0 in.
Clay shale, partly sandy and mica- ceous,	- - - - -		25 ft. 0 in.
Black calcareous ironstone,	- - - - -	2 in. to	2 ft. 0 in.
Black slaty shale,	- - - - -	3 ft. 0 in. to	4 ft. 0 in.
Coal, "No. 5,"	- - - - -	8 in. to	3 ft. 0 in.
White fire-clay, mostly silicious, sometimes changing to sandstone,		2 ft. 0 in. to	6 ft. 0 in.
Argillaceous sandstone, some por- tions very shaly, others solid ferru- ginous, lower portion more or less concretionary, with thin ir- regular ironstone bands,	- - - - -	70 ft. 0 in. to	80 ft. 0 in.
Light drab clay shales,	- - - - -		10 ft. 0 in.
Black shale, mostly slaty,	- - - - -		2 ft. 0 in.
Coal "No. 4,"	- - - - -		1 ft. 8 in.
Fire-clay, sometimes very dark and shaly, with a thin band of com- pact sandstone, containing <i>Stig-</i> <i>maria</i> ,	- - - - -	3 ft. 0 in. to	10 ft. 0 in.
Fossiliferous calcareous ironstone,	- - - - -		1 ft. 0 in.
Black slaty shale,	- - - - -		1 ft. 6 in.
Shaly cannel, fossiliferous,	- - - - -		2 ft. 0 in.
Coal, "No. 3,"	- - - - -		streak.
Fire-clay,	- - - - -		3 ft. 0 in.

The beds below coal No. 4, lie just at the base of the hills, and are generally more or less covered by debris, so that the exact section is often difficult to obtain; but the thin band of very hard stigmarial sandstone serves as a very reliable landmark. I observed it, either in place or slightly removed, every few rods, for some miles below Jackson's mill. The calcareous ironstone of the subjacent bed is also pretty constantly developed, being the equivalent of the before-mentioned outcrop, at the mouth of the Little Vermillion; but along the lower part of this range it is below the level of the bottoms. It is also interesting for its abundant fossils, beautifully preserved, including *Nau-*

*tilus*, *Serpula*, *Pleurotomaria*, *Productus*, *Chonetes mesoloba*, *C. punctuifera*, *Hemipronites crassa*, *Spirifer cameratus*, *Crania*, *Aviculopecten rectilateraria*, *Entoliam aviculatus*, *Cyathaxonia*, etc. The *Crania* were found attached within the outer chamber of a *Nautilus*. The underlying black shales and shaly cannel contain many *Aviculopectens*, with *Petrodus occidentalis*, *Orthoceras Rushensis*, and occasionally *Cardinia fragilis*.

On Whit. Jackson's farm, about four miles below Newport, wells sunk in the edge of the bottom many years since, but now filled up, are said to have penetrated coal No. 2, at a depth of about twelve feet. An attempt was made, during the past summer, to ascertain the truth of this by digging; but repeated floodings of their pit discouraged the workmen, and the problem is still unsolved.

About three miles below Newport, near the head of Wimsett Hollow, on section 10, township 16 north, range 9 west, one of the small branches, on the right as you ascend, has an exposure of about two and a half inches of "black band" iron ore accompanying the roof shales of coal No. 5, and containing an abundance of *Pleurotomaria*, *Bellerophon*, *Loxonema*, *Productus*, *Chonetes*, *Mytilus*, *Nucula*, *Astartella*, etc.

In the top of the bluff, east of Highland, the heavy bedded sandstone occurring just below coal No. 5, has been considerably quarried, as it here furnishes a very permanent building stone, and attains an extreme local thickness of twenty feet.

On the various branches of Little Raccoon creek, we find essentially the same section exposed piecemeal, here and there.

South of Little Raccoon, following the road under the bluffs, there appears a local rise of the strata, which, within a short distance, brings up coals No. 3 and No. 2. No. 3 is a thin seam, and has not been worked at any point, so far as known; Its level is known to be from twelve to fifteen feet above No. 2, at Wilson's coal bank, one mile above the head of Helt prairie, and in a ravine, a hundred

yards west of that point, it shows twenty inches of coal, with a roof of black slaty shale and calcareous ironstone. No. 2 is here from four to five feet thick, with only a thin covering of soil so far as yet worked. It has been opened, some time since, in the ravine aforesaid, where it is reported to be divided into two seams by a clay parting two feet thick. It appears to be the equivalent of the four foot seam worked just above Thomas's Ferry, on the Wabash, below the mouth of the Big Vermillion.

From this point the rocks dip again immediately, and about a mile farther south coal No. 4 has been opened in the edge of the bluff by the side of the road.

Thus far the heavy band of quarry rock, which holds a tolerably constant position in the shaly sandstones below coal No. 5, has served to keep the hills pretty high by reason of its slow yielding to denuding forces; but below here this band rapidly dips below water level, and there is only a small elevation between the main valley and that of Norton's creek.

[In passing from the valley of the Wabash to that of Little Raccoon, just below Highland, we find, on the contrary that this quarry sandstone is high up in the hill, and that the termination of the dividing ridge is comparatively abrupt.]

In following up the Eastern branch of Norton's creek from the head of Helt prairie, I was unable to find or hear of any outcrop—the boulder-clay covers everything. Small quantities of black shale were noticed in the drift of the western branch of the creek, but it was not traced to its source. Judging from the outcrops lower down the stream, I inferred that No. 6 outcropped on the upper part of this western branch.

Near the head of Helt's prairie, at Hawley & Helt's coal bank, No. 5 shows a local thickness of from twenty inches to two feet, with the usual roof of two or three feet of black slaty shale containing fish remains. In some portions of the mine there occurs a bed of from four to six inches of dark drab, compact clay shale, with *Pecopteris* and *Avicu-*

*lopecten rectilateraria*, intercalated between the coal and the black shale. This was not met with elsewhere.

A short distance farther down the creek, near the mouths of the ravines upon which are situated Nebeker's and White's coal-banks, this seam, which has kept near the level of the stream all the way, has returned to its usual thickness of from eight to ten inches. Near the heads of these ravines No. 6 is largely developed, and has been extensively worked. Its roof here consists almost entirely of massive concretions of pyritous carbonate of iron, only the *chinks* being filled with the black shale which commonly forms the roof of this seam. A layer of shale, however, overlies the ironstones. Many of these ironstones are rich in fossils, which are most readily obtained after the nodules have been exposed to the weather for some time. Among them we especially note, *Aviculopecten rectilateraria*, *Petrodus occidentalis*, *Productus longispinus*, *Discina nitida*, *Lingula*, *Cardinia? fragilis*, *Edmondia?* and *Solenomya*. The *Cardinia* also occurs in the overlying black shales, sometimes accompanied by *Stigmara*, all the fossils being rendered noticeable by a brilliant thin layer of iron pyrites. The section of this locality is as follows:

Black shale, some slaty, - - -	3 ft. to 4 ft.
Nodular band of pyritous and silicious ironstone, - - -	1 ft. to 2 ft.
Coal, "No. 6," - - -	5 ft. to 6 ft.
Fire-clay and soft clay shale, -	4 ft.
Ferruginous sandstone — bottom, hard firestone, - - -	6 ft. to 7 ft.
Sandy shales, changing below to dark drab clay shales with ironstones, - - -	40 ft. to 50 ft.
Black slaty shale (and locally calcareous ironstone), - - -	2 ft. to 3 ft.
Coal, "No. 5," - - -	8 ft. to 10 in.
Shaly clay, with <i>Stigmara</i> , -	?

Two and a half miles farther south, near Clinton, at



Van Ness's bank, No. 6 has descended to near high water mark, and soon passes below it as we go southward, making no farther appearance within the county, and showing again on this side the Wabash only at the point opposite Terre Haute, where Prof. Lesquereux reports it as worked near low water mark.\*

The mass of the hill between the Wabash and Brouillet's creek, below Clinton, is composed of the shaly sandstones, sandy shales, and clay shales with ironstones, which form the larger part of the sixty or seventy feet of rock between coals No. 6 and No. 7. No section was found exposed in this part of the county which would give the exact distance between these two seams. At Mr. Skidmores place, about 3 miles west-south-west of Clinton, the "dirt" of No. 7 has been seen near the top of the hill, and some traces of No. 6 in the meadows at the foot of the hill. The distance between them was here estimated at seventy-five feet. I was informed by the miller at Hedge's mill, that in diving in the pool under the dam at that point, he had seen the outcrop of No. 6, five or six feet thick, with a black slate roof. A measurement from this point to the outcrop of No. 7 in the hill above, gave the distance at about fifty-five feet.

From near this mill to the Wabash the shales of this division contain numerous ironstone nodules of various sizes, in some of which fine specimens of fossil ferns have been found, though in not nearly so great abundance as at Durkee's Ferry, a few miles farther south in Vigo county.

In ascending Brouillet's creek, above Hedge's mill, we gradually approach the level of coal No. 7. Near the Indiana Furnace we find, upon Coal creek, the following section :

Greenish sandy shales, with iron-				
stones,	-	-	-	20 ft.
Drab clay shales,	-	-	-	15 ft. to 20ft.
Slaty coal,	-	-	-	1 ft. to 3 ft.

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\* Owen's Geology of Indiana, 1859-60, p. 330.

Coal, "No. 7,"	-	-	4½ ft. to 6 ft.
Fire-clay,	-	-	6 ft.
Sandy Shales,	-	-	10 ft. to 12 ft.
Argillaceous limestone,	-	-	1 ft. to 2 ft.
Sandy shales,	-	-	8 ft. to 12 ft.
Compact sandstone,	-	-	3 ft. to 6 ft.
Greenish shales,	-	-	3 ft. to 4 ft.

The limestone here noted is a pretty constant accompaniment of No. 7 in this part of the county, at a slightly variable distance below it. It is here rather farther from the coal than I have seen it elsewhere. It is probably the equivalent of the limestone band found about fifteen feet below the same seam in the neighborhood of Danville, Illinois, though no such bed is present in the section taken on the Little Vermillion.

Going up Brouillet's creek, from the Indiana Furnace, we find No. 7 opened at various places, until within a very short distance of the State line, where it finally dips below water level. Not far above the section taken upon Coal creek, the overlying sandy shales yield, upon disintegration, large numbers of heavy ironstone nodules, which will be more particularly noticed under the head of "economical geology," although the principal source of supply lies beyond the Illinois line. A short distance beyond the line there is a streak of coal, from two to five inches thick, which may be the equivalent of No. 8, though circumstances would indicate that it more probably represents a higher seam, which is not exposed within the limits of Vermillion county. South to the county line No. 7 and its accompanying beds probably underlie the western half of the county, as the lower beds do the portion along the lower course of Brouillet's creek. Starting from the Horseshoe of the Little Vermillion I have followed the natural succession of outcrops, and am now obliged to turn about in order to deal with the northern end of the county.

In going northward from the mouth of the Little Vermillion we find, at various points along the Wabash, nearly



to the mouth of the Big Vermillion, small outcrops of the ironstones and shales below No. 3, with this seam itself sometimes in place. About a mile below the residence of Mr. John Collett, and equidistant from Eugene and Newport, No. 2 has been seen at extreme low water, with a reported thickness of five feet, and the overlying band of ironstone is visible at ordinary stages of water. But, through the whole distance, it was found impossible to get a satisfactory section connecting these two seams.

In ascending the Big Vermillion we find on its south bank, a mile below Eugene, a bluff of banks of from twenty-five to thirty feet of irregularly bedded, highly ferruginous, coarse-grained sandstone, often containing comminuted plant remains, with some large fragments of trees, etc. Some of the beds are sufficiently solid to make good building stone. In quarrying them many fine trunks and branches of *Lepidodendron* and *Sigillaria* have been found, with a few fruits of *Trigonocarpum*. This bed is supposed, from its position, to be the equivalent of the sandstone belonging above coal No. 4, though it is rather more irregularly bedded, and of a coarser structure. Its position, however, is rather peculiar, for it lies in a hollow gullied into the lower strata to such a depth as to have removed both No. 4 and No. 3, and an unknown thickness of rock below them. The edge of this gully passes just below Eugene, where, at the ford, we see this sandstone lying over the edge of coal No. 3 and of from eight to ten feet of the underlying clays and shales. The position of the southern edge of the gully is not known, but the width is probably not very great, since the roof shales of No. 4 have been seen in place about one mile to the southward, in the bed of Tipton branch. (Just above that point a quarry in the overlying sandstone has yielded some fine large stems of the new species *Syringodendron Porteri*, Lsqx.) It would appear probable then that we have here a *fossil river* of carboniferous times, which may have flowed from the hills of conglomerate sandstone which still stand upon the east side of the Wabash, and show, by the position of the later beds about

their bases on all sides, that they were really hills during the deposition of these later beds. Doubtless they were finally buried in the later deposits of the carboniferous age, and have more recently been repeatedly swept over by marine and fresh-water currents, but their relations to these later beds are evidently unchanged, and they stand to-day as they stood then—hills above the surrounding low lands.

On the river bank, back of the tavern at Eugene, the following section occurs :

Dark fire-clay,	-	-	-	-	-	2 ft. 0 in.
Soft black shale,	-	-	-	-	-	2 ft. 0 in.
Fossiliferous ironstone,	-	-	-	-	-	2 to 4 in.
Soft black shale,	-	-	-	-	-	0 ft. 6 in.
Black slaty shale and impure cannel,	-	-	-	-	-	1 ft. 0 in.
Coal, No. 3,	-	-	-	-	-	1 ft. 0 in.
Compact sandstone, with <i>Stigmara</i> ,	-	-	-	-	-	1 ft. 0 in.
Blue fire-clay,	-	-	-	-	-	2 ft. 6 in.
Buff and gray fire-clay, changing to sandy shale,	-	-	-	-	-	5 ft. 0 in.

At the sawmill above town four feet of shaly sandstone cap the foregoing section. At S. Groenendyke's mine, above town, the following section occurs, which is an average representation of the condition of No. 4 in this neighborhood :

Dark-drab shale, with bands of ironstone nodules,	-	-	-	-	-	12 ft. 0 in.
Black shale	-	-	-	-	-	2½ to 3 ft.
Shaly cannel,	-	-	-	-	-	1 ft. 0 in.
Black slaty shale,	-	-	-	-	-	0 ft. 10 in.
Coal,	-	-	-	-	-	0 ft. 14 in.
Black shale, with pyritous nodules,	-	-	-	-	-	0 ft. 15 in.
Coal,	-	-	-	-	-	14 to 20 in.
Fire-clay,	-	-	-	-	-	?

This section is peculiar as regards the shaly cannel in its roof shales, which character does not commonly appear in

connection with No. 4; but I am unable to refer this coal to any other seam.

The section upon Browntown branch is interesting, on account of the disappearance of coal No. 5, (which has been seen nowhere north of White's Mill, on the Little Vermillion,) and for the presence of a valuable band of iron ore. It is as follows:

Black calcareous ironstone, - - -	1 to 2 ft.
Black slaty shale, - - - -	4 to 5 ft.
Level of No. 5.	
Fire-clay, - - - - -	$\frac{1}{2}$ to 1 ft.
Shaly sandstone, - - - -	6 to 8 ft.
Heavy-bedded quarry sandstone, - -	9 to 10 ft.
Shaly sandstone, - - - -	1 to 2 ft.
Compact ironstone band, changing to nod-	
ules, - - - - -	0 ft. 2 in.
Sandy shale, - - - - -	10 ft. 0 in.
Compact brown ironstone, with fish re-	
mains, - - - - -	18 to 20 in.
Sandy shale and shaly sandstone, with	
some ironstones, - - - -	40 to 60 ft.
Shales of "No. 4," - - - -	?

Near this point No. 4 dips below the present level of the Big Vermillion, and comes up again only at the Hanging Rock, and on Coal branch just back of it. Throughout the intervening distance, the roof-shales are seen at low water, proving its presence; and I am informed that it was worked at several points before the building of the dam at Eugene. The upper beds of the foregoing section, however, are very irregular in this neighborhood. Valuable bands of ironstone, and more or less sandstone and sandy shales are everywhere present, but the relative positions and thicknesses of the beds are exceedingly variable, as illustrated in the following section, taken at J. Jones', about two miles from Eugene, and representing the condition of things on an outcrop of about a hundred feet in length:

Blue clay shale-top with sandy streaks,	10 to 15 ft.
Covered, - - - - -	3 to 5 ft.
Light brown ironstone, more or less calcareous, - - - - -	1½ to 3 ft.
Drab shales—some places, pure clay; others, becoming sandy and micaceous and even heavy sandstones; with pisolitic compact ironstones, especially at top,	20 ft.

At Hanging Rock, and on Coal branch just east of it, we find No. 4 well developed and considerably worked; but here, even more than is common elsewhere in the county, it is split up into comparatively thin partings, separated by shale and fire clay. I am informed that it has shown here as many as five partings. The following is the section as exposed in 1868, beginning with the capping sandstone, locally known as the "Hanging Rock sandstone," and supposed to be equivalent to the "Mahoning" sandstone of the Ohio coal-field:

Heavy-bedded soft ferruginous sandstone,	20 ft. 0 in.
Black slaty shale, with ironstone nodules,	18 ft. 0 in.
Soft black shale with <i>Productus</i> and fish-teeth, - - - - -	1 ft. 6 in.
Coal, - - - - -	1 ft. 9 in.
Fire-clay and blue shale, with pyrites, -	1 ft. 0 in.
Coal, - - - - -	1 ft. 0 in.
Fire-clay, - - - - -	1 ft. 0 in.
Coal, - - - - -	2 ft. 8 in.
Fire-clay, - - - - -	4 to 6 ft.
Black shale, - - - - -	0 ft. 6 in.
Coal, - - - - -	1 ft. 6 in.
Indurated fire-clay, - - - - -	2 ft. 0 in.

One of these partings, said to be the third from the top, has been worked on Coal branch, with a thickness of from three to four feet.

The Hanging Rock itself projects considerably, in consequence of the disintegration of the softer, somewhat

pyritous shales beneath it, forming a small shelter for cattle who frequent the place both for shelter and to lick up the copperas and alum which form in small quantities upon the surface of the decomposing shales.

Above the Hanging Rock no outcrop of No. 4 occurs, and the banks are composed of the overlying sandstones and sandy shales, with the black roof-shales of No. 5 forming a prominent feature, until we pass beyond the State line, where they are about thirty feet above the river. No. 5 itself is represented by from six to ten inches of soft drab clay shale. The roof-shales show an abundance of their usual fossils, *Petrodus* and *Aviculopecten*.

In going north from Eugene, I have, thus far, been unable to connect the sections of the south part of the county with the outcrops found at and above Perrysville. Below Perrysville the only outcrops known belong to the conglomerate or millstone grit, which is so largely developed on the east side of the Wabash; and the relations of this, even to the higher beds on that side of the river, are still undecided.

The Perrysville section is as follows:

Coal (reported, as found in wells),

No. 1,?	- - - -	8 in. to 1 ft. 6 in.
Fire-clay,	- - - -	2 ft. 0 in.
Soft blue clay shale,	- - - -	12 ft. to 15 ft. 0 in.
Bluish drab shaly limestone,	- - - -	2 ft. to 3 ft. 0 in.
Blue limestone, bottom rich in fossils,	- - - -	3 ft. 0 in.
Light blue and drab shaly clay,	- - - -	1 to 2 in.
Soft, black, shaly, calcareous clay,	- - - -	4 ft. to 6 ft. 0 in.
Black slaty shale,	- - - -	3 ft. to 4 ft. 0 in.
Soft, black, shaly, calcareous clay,	- - - -	3 ft. to 4 ft. 0 in.
Light drab calcareous argillite,	- - - -	
rich in fossils,	- - - -	1 ft. to 4 ft. 0 in.
Soft, black, shaly, calcareous clay,	- - - -	1 ft. 0 in.
Black slaty shale,	- - - -	5 ft. to 0 ft. 6 in.
Soft black shale,	- - - -	12 ft. to 15 ft. 0 in.
Dark drab shale, with ironstones at top,	- - - -	27 ft. 0 in.

*Exactly the same* section occurs on Rock creek, in Warren county, where the beds lie directly, and apparently conformably, upon a set of shaly sandstones, which are continuous with the conglomerate sandstone of Williamsport, only becoming more purely quartzose and more solid as we descend the section. These shaly sandstones include a thin bed of very impure brash coal, about sixty feet below the limestone, which may represent "No. 1 A," but more probably belongs to an unnumbered seam commonly known as the "conglomerate" coal. Three or four miles below Rock creek, near Evans's coal mines, we find another band of limestone of very similar character, from thirty to forty feet above the equivalent of the Perrysville bed, and marks of one or more coal seams between them. Above this upper limestone are the two beds now worked, which considerably resemble Nos. 3 and 4. I believe that, by a little careful work in that neighborhood, one could find a section which would settle the doubtful points.

Wells sunk below the limestone at Perrysville, to a reported depth of ninety feet, are said to have encountered no coal, and it appears doubtful, at present, whether any valuable seam, at least, exists there.

The old limekiln just above Perrysville, on the bank of river, was dug in the soft clay shale of the base of the foregoing section, and shows no disturbance of the layers; yet within fifteen feet of this kiln we find a small quarry of sandstone, which extends from the base to the top of the bluff, cutting off even the limestone. Judging from observations on the east side of the Wabash, I conclude that this is an extension of the conglomerate sandstone, which either stood as an island or projected as a promontory in the old sea whose mud composed these shales and limestones. Just north of this point, the limestone is thicker than at any point south of it, and a slight difference has been noticed in the fossil contents upon the two sides, although, for half a mile to the southward, this feature is constant. On the north side the limestone runs only a few rods, giving no opportunity to ascertain whether the more

southern characters would obtain at a suitable distance from the obstacle. On the north side, close to the sandstone, some thin streaks and patches of coal have been observed, none of which appear to the southward. The lower shales, also, upon the north side, contain a few ferns and other coal-measure plants, none of which have yet been detected upon the south side. As the appearance and contents of these beds, as seen upon Rock and Redwood creeks, in Warren county, seem to be identical with their appearance and contents on the south side of this sandstone hillock, I am disposed to assume that these are the normal conditions of rocks deposited at that period in the open sea, and that the changed conditions on the other side have resulted from special local influences.

Along all the small streams which fall into the Wabash, between Perrysville and Covington, there are beds of fern-bearing shales, accompanied by thin seams of coal, which appear to belong *below* the Perrysville beds; but I have been unable to find any certain clue to their exact position. Their fossils indicate that they are *low* in the series, but cannot help us to any more definite conclusion. *Neuropteris hirsuta*, *Alethopteris Serlii*, *Cordaites borassifolia*, and *Gymnocalymma ammonis*, are the most abundant fossils of these beds, while *Lepidodendron*, *Lepidophyllum*, *Trigonocarpum*, *Asterophyllites*, *Hymenophyllites*, *Filicites*, and fragments of bivalve crustaceans are occasionally met with.

As the Perrysville beds contain a very interesting group of fossils, I give here a complete list of the forms thus far collected at that point. From the limestone: *Phillipsia scitula*, *P. Sangamonensis*?, *Bellerophon*, *Naticopsis* n. sp., *N. nodosa*, *Euomphalus rugosus*, *Loxonema* 2 or 3 sp., *Spirifer cameratus*, *S. lineatus*, *Spiriferina Kentuckensis*, *Athyris subtilita*, *Rhynchonella Osagensis*, *Productus semireticulatus*, *Chonetes mesoloba*, *Hemiphronites crassa*, *Discina nitida*, *Lingula*, *Placunopsis*, *Aviculopecten*, *Fusulina cylindrica*, Crinoid stems and Bryozoans: from the black shales: *Orthoceras Rushensis*, *Nautilus*, *Euomphalus*?, *Productus*, *Chonetes mesoloba*, *Discina nitida*, *Edmondia*?, *Aviculopecten*.

*ten rectilateraria*, *Spirifer planoconvexus*, *Petrodus occidentalis*: from the calcareous argillite: *Nautilus latus?*, *Goniatites*, *Macrocheilus* (large), *Pleurotomaria carbonaria*, *Spirifer cameratus*, *Rhynchonella*, *Athyris subtilita*, *Productus*, *Chonetes mesoloba*, *Aviculopecten Coxanus*, *Solenomya radiata*, *Cyathaxonia prolifera*.

All of the rock strata here described have a general dip toward the southwest, at a rate of from fifteen to twenty feet to the mile, but this is modified greatly by various causes, so that it were possible to find local dips in almost any direction, and sometimes with quite a rapid pitch. Starting, then, from the eastern side of the county, where we stand upon the lower beds, we pass, on level ground slowly, on rising ground more rapidly, to higher and higher beds; until, when we reach the State line, if upon moderately high ground, we stand upon or above beds higher than any which we have crossed in our trip. The *principal* irregularities of dip have been pointed out as we went along; but the accurate delineation of these irregularities would require far more careful and expensive examinations than could be afforded.

Having thus sketched, as much in detail as seemed advisable, the distribution of the rock formations of the county, though with the omission of multitudes of interesting details, I will now proceed to that part of my report which should treat of

#### ECONOMICAL GEOLOGY.

The first subject to which the seeker for mineral wealth, in this county, would turn his attention is the coal supply. The first impression of the superficial observer would be that there is a great abundance for all demands; and the final conclusion of the scientific explorer must be that good coal can *now* be mined profitably under at least *one-half* of the area of the county, and *ultimately* under probably *two-thirds* of the remainder. A thickness of eight feet would probably be a small enough estimate for the coal underlying every square foot of the county. This would give, at



the usual estimate of one million tons to the square mile for every foot of thickness, the amount of 1,950,000,000 tons, or 48,750,000,000 bushels, as the supply of the county.

The highest workable seam is No. 8. This makes its only appearance in the county, and, indeed, in this whole region, at the Horseshoe bend of the Little Vermillion, where it shows a thickness of from two and a half to four feet, with a roof of black clay shale. It is a fat caking coal, rich in gas, and very sooty; good for blacksmithing or for grate fuel. Ash gray. This seam was formerly dug to some extent, but is at present neglected, in consequence of the large development of No. 7 and No. 6 at the same point.

At this locality, also, we find one of the only two localities within the county where No. 7 is worked. In the immediate neighborhood of the Horseshoe there are quite numerous openings into this seam, but only three or four of them are now worked. This is the equivalent of the main coal at Danville. It is a fat caking coal, good for engine or house fuel, and fair for blacksmithing if picked; but it is rather apt to be somewhat sulphurous. Ash reddish-brown. At the upper end of the Horseshoe, on Mr. Patrick's land, it has been considerably worked, with an average thickness of four feet; but the mines are now deserted. The shale between the coal and the heavy limestone roof appears to be rather soft, and the difficulty of supporting it has probably assisted in causing the desertion of the mines. At the "toe" of the Horseshoe the shale seems to be more compact, and stands very well in the two mines now open in this seam.

A barrel of coal, said to have been taken from this seam at Hibberly's bank, was sent by Josephus Collett, Jr., Esq., of Newport, to the rolling mill at Indianapolis, which, upon trial, proved to be fit for smelting iron. This is far better than the common coal of this seam; and I am rather inclined to believe that a mistake was made regarding the source of the coal sent, its character closely resembling that of the coal of No. 6.

As already stated, No 7 has not been seen north of this

place within the county; but there is reason to believe that it occurs on the highest part of the ridge east of the Little Vermillion, nearly or quite continuously, to its outcrop near Georgetown, Illinois. Below the Little Vermillion it is undoubtedly in place along all the western boundary of the county, and can be reached by shafts sunk in the prairie whenever any considerable demand may arise for coal.\* It does not, however, run far enough east to outcrop along any of the streams in the lower part of the county, until we reach Brouillet's creek, along which it is worked, at short intervals, all the way from the State line to Hedges' Mill, and also on Coal creek, in the adjoining part of Vigo county. In this southern extension we find the seam thickened up to nine feet in some places; but, of this, the upper one to three feet consist generally of a very impure "brash" coal, which is rejected in mining, under the false name of "slate." These openings supply a large demand through the adjoining part of Grand prairie. The outcrops are conveniently located, and the supply seems inexhaustible.

Along the Big Vermillion No. 6 is nowhere seen, east of the Illinois line; but it undoubtedly underlies a considerable portion of the space between that stream and the Little Vermillion, along which latter its outcrop is continuous from a point three miles below Georgetown to the "silver mine" below the Horseshoe. Throughout this distance openings are frequent, and large quantities of coal have been taken from them, but none are now extensively worked. It has been recently reported, also, upon W. Eggleston's land, about one and a half miles southeast of the "silver mine."

This seam also underlies the entire western portion of the county, but runs farther east than No. 7, outcropping in the higher hills along every stream between Newport and Clinton, just below which latter place it passes below the level of the Wabash. Where it first enters the county, along the

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\*Serious difficulty can arise, in attempting to mine the coal at points upon the prairie, only from the possible presence here of the thick bed of water-bearing quicksand, which underlies the boulder-clay in the western parts of Edgar and Vermillion counties of Illinois.

Little Vermillion, this seam has a roof of soft dark-drab clay shale, containing fragments of ferns and the shells of the small Crustacean, *Leaia tricarinata*. But, as we descend the stream, this gradually becomes darker and harder until, at the Horseshoe, it is changed to or replaced by black slaty shales containing *Discina*, *Petrodus*, and other marine fossils, and accompanied by many large, black ironstone nodules, more or less sulphurous. This latter character is still more largely developed near Clinton, where the roof consists almost entirely of spherical nodules of sulphurous ironstone, two to three feet in diameter, closely packed together, and only the small interstices filled with black shale. The thickness of the seam is variable, ranging from four to seven feet. Through the northern part of the county, at least, it is generally a very pure coal, with the lower thirty to thirty-six inches—below the clay parting—a free-burning “block-coal,” every way suited for smelting iron in the raw state. The upper portion of this seam swells some in burning, but makes a choice fuel for engine or house use. Ash white. The coal brought to Clinton from Nebeker’s bank (No. 6) was observed to contain much of the “block,” but circumstances prevented me from ascertaining how large a portion of the seam shows that character. Coal from this mine has displaced, for steamboat use, the product of mines nearer to Clinton.

No. 5, in the immediate neighborhood of so much larger seams of better coal, is not a very important source of fuel, and has been dug from only for local use except at two points, viz.: at Burns’ bank, east of Highland, and at Hawley & Helt’s bank, near the head of Helt Prairie. At Burns’ bank, the seam is locally thickened to an average of about thirty-three inches, but yields only a rather coarse coal which burns with much flame and smoke, and leaves considerable cinder. Both here and at Hawley & Helt’s bank, the coal was well spoken of as house fuel. At the latter place, the local thickness of the coal is about twenty-two inches. At all other points where this seam was encountered, it showed only from six to twelve inches of

rather impure coal, and is entirely wanting at all points north of White's mill. At Burns' bank, and at two or three points along Jonathan's creek, the ordinary black roof-shales are wanting, and a rather solid sandstone takes their place; and at Hawley & Helt's bank, as previously stated, a few inches of dark drab compact shale are found between the coal and its roof. It has been observed that where the fire-clay of this seam is not silicious, the coal is apt to be more impure and less in quantity. I have not yet ascertained whether this law holds good where the coal is entirely wanting, as in the northern part of the county.

No. 4 takes a rather more prominent place among the sources of fuel, but is still in the background when compared with the higher seams. This is a very irregular seam, and the amount of fuel which it would yield at any unexplored point, could not be calculated with any certainty. Its different partings vary greatly in thickness, and often in character. As a general rule, the upper portions are composed of a good blacksmithing coal, rich in bitumen, while the lower parts are more splinty. It is liked for house use, but is not extensively mined on account of the thinness of the partings. The principal openings are at and near the Hanging Rock, on the Big Vermillion, about four miles above Eugene, on section 28, township 18 north, range 10 west. Ash reddish-gray, some clinkers. These are among the oldest workings in the county. At S. Groenendyke's mine, near Eugene, this seam has been considerably worked for house fuel. Just below Eugene, as already stated, No. 4 and No. 3 are both cut off by the previously described channel, now filled with sandstone; but its disappearance is only for a short space, since it appears again within a mile of town and continues southward, though it is nowhere worked until we reach Morehead's mine, a mile above Newport. In the ravines below Newport, and upon the branches of Little Raccoon, this seam has been frequently opened in a small way for local supply, but is nowhere of much importance. Its last appearance is about a mile below Wilson's bank, near the head of Helt prairie.

No. 3 makes no prominent show in the county. At Eugene it is too thin to be worked. In the ravine back of Wilson's bank, it is about twenty inches thick, but is neglected for the thicker and purer No. 2.

Wilson's bank is the only place where No. 2 shows above the ordinary level of the river. It is said to have been seen on the bank of the Wabash at low water mark, about a mile below Mr. John Collett's, with a thickness of about five feet. There is every reason to believe that it is continuous under nearly the entire prairie from Newport to Eugene, and beyond towards Perryville, and can be mined by shafts of moderate depth at any convenient point. Above Eugene, its outcrop, beneath the alluvium, probably holds a general north-north-westerly course from the mouth of the Big Vermillion, parallel to the outcrops of the higher seams.

I am also of the opinion that the coal, from two to three feet thick, which outcrops near low water mark on the east side of the Wabash at Thomas' ferry, and which is one of the partings of No. 1, probably runs under the same region, and will be found of workable thickness; but there are no *certain* data for this opinion.

To the northward of Eugene, these lower seams are nowhere visible: in fact, no rock is seen upon the surface between the floor of No. 4, on the upper part of Coal branch, and the fire-clay above the limestone at Perrysville. But, from the general regularity of the outcrops, wherever exposed in this region, it appears probable that after the completion of the Terre Haute and Danville railroad, it will be found profitable to bore for these lower seams, at some point or points upon the prairie west of Perrysville. A boring of two hundred feet would reach the lowest workable seam anywhere in that region, and, over a considerable part of it, one hundred and fifty feet would probably be sufficient.

Although the thin seams to the northward of Perrysville have not been co-ordinated with the beds of the connected section, yet there is reason to account them partings of

No. 1. Coal, from twelve to eighteen inches thick, occurs at several points hereabouts, and has occasionally been dug from the outcrop for local use. The seams will never be of any considerable importance.

*Iron.*—Accompanying the coal-measure rocks in this county, we find several valuable deposits of iron-ore. The principal ore is an impure carbonate of iron, occurring in nodules and irregular layers or "bands." Such nodules, accompanying the sandy shales above coal No. 7, furnished, for several years to the Indiana Furnace, on Bouillet's creek, an abundant supply of ore, yielding, on an average, thirty-three per cent. of iron. The ore varies much, however, some specimens yielding as high as forty-five per cent. while others would barely give twenty-five per cent. The principal source of this ore lies west of the State line, but much of it also occurs east of the line, along the branches of Brouillet's creek, both above coal No. 7 and between it and coal N. 6. At the latter level, the greatest abundance of ore was seen about a mile below Skidmore's place before-mentioned, in the ravines upon the east side of the creek. A few of these nodules are somewhat pyritous, but these could readily be detached in preparing the ore for the furnace. An attempt was once made here to use the coal of No. 7 in the furnace, and a number of kettles were cast from the iron produced; but the metal proved brittle, probably from the presence of sulphur, and the attempt was not renewed. No iron has been made here since 1859.

Coal No. 6, which, in this part of the county, generally furnishes a good "block" coal from its lower benches, apparently lies about fifty feet below the creek-bottom at this place; it would probably pay to open it and use the coal in the furnace, which is now lying idle, principally, it is said, in consequence of the scarcity of charcoal.

Small quantities of this ore were seen at two or three points, near the Horseshoe of the Little Vermillion, coming from the shales above No. 7; but the supply is limited.

Just west of the Illinois line, the shales above No. 6 yield large quantities of this ore.

Similar nodules were noticed along the Wabash, near the mouth of Spring creek above Perrysville; but the amount appeared to be too small to be of any practical importance.

The heavy ironstones mentioned as forming the roof of No. 6 in the vicinity of Clinton, generally contain so much pyrites as to render them valueless as ores, considering the present state of our knowledge upon the subject of freeing iron from sulphur.

The "black band" ore above No. 5, mentioned in the section taken upon Wimsett Hollow, three miles below Newport, although a very valuable ore, is probably not sufficiently abundant to be of any economical importance when taken alone; but if the nodules of pisolite oxide of iron above No. 6, at the head of the main branch of that ravine, should prove to be sufficiently abundant for mining, this band might probably be used to advantage at the same time.

A coarse irregular band of calcareous ironstone, a few inches thick, often containing pisolitic iron "shot" through semi-crystalline calcite, with small quantities of zinc blende, accompanies the fire-clay of coal No. 6 at the "Silver mine" on the Little Vermillion, but the amount seems to be not large enough to make it of any importance.

The black calcareous ironstone which almost constantly accompanies the roof shales of coal No. 5, ought to be a valuable ore for use with the richer ones of Marquette, which are now largely shipped to Indiana for reduction. Its specific gravity, at some points, indicate a considerable percentage of iron, combined with lime suitable for fluxing. It sometimes contains silex, but this impurity is not common. The bed averages about a foot in thickness, but frequently thickens to three feet. The most favorable localities for examining it would be along the Big Vermillion, from the State line to within a mile of Hanging Rock, near the head of More branch, on Browntown



branch, and at White's Mill on the Little Vermillion. At all these points it could be very easily mined. On the branch next east of Tipton Hollow, two miles below Eugene, large irregular concretions, ten to twelve feet in horizontal diameter, and two or three feet thick, occur in this bed. This structure is not common in the bed, but the sort of roughly conchoidal fracture, which generally characterizes it, may be semi-concretionary in its nature. This structure may well be called "shucky."

Upon Browntown branch, and along the Big Vermillion, as far as More Branch, there is a heavy band of quite pure light-brown calcareous carbonate of Iron, which is of considerable value. At some points the lime largely predominates, but the whole bed would probably average twenty-five per cent. of iron. The combination of this considerable amount of iron, with limestone suitable for fluxing, renders this, also, a very valuable ore for mixing with the richer oxides in the smelting-furnace. The seam varies from eighteen inches to three feet in thickness, and deserves more attention than it has yet received. On Browntown branch, it was observed to contain rather numerous rhomboidal fish scales, and it is possible that, upon analysis, it will be found to contain too much phosphorous to be fit for the furnace. Large quantities could be mined with very little trouble.

The shales lying between No. 4 and its heavy sandstone cover, frequently contain small quantities of ironstone nodules, as at Hanging Rock, where many of them contain fossil plants. But at no point do we find any considerable amount of ore at this level.

Near the top of No. 3 we find, pretty constantly, a band of a few inches of compact ironstone, filled with fossil shells of numerous species, as at the mouth of the Little Vermillion, and in the numerous ravines along the edge of the bluffs between Newport and Highland. At Zener's saw-mill it is a foot thick, and easily mined.

Close above No. 2, along the bank of the Wabash, about four miles below Eugene, we find a heavy bed of com-



pact limonite (hydrated oxide of iron), which promises to be of considerable importance. The outcrop was covered with water at the time of my visit, but masses a foot thick, lying upon the bank, showed its character, and its full thickness was reported at from two to three feet. It would probably yield from forty to forty-five per cent. of iron. Except in times of freshet, it could be easily mined by stripping.

On Thomas Helt's land, along the bottoms of Norton's creek, near the head of Helt prairie, a bed of bog iron ore, said to be three feet thick, covers from six to eight acres. It was dug into some years ago, but none of it is now exposed.

On the whole, the county is abundantly supplied with iron ore of good quality, and the near neighborhood of the beds to the seams of "block" coal, will soon make this one the most important centers of iron production in the West.

Zinc blende (sulphide of zinc) frequently occurs, in small quantities, in the cracks and cavities of the ironstone nodules which accompany the shales above coal No. 6, and in the ironstone band which is found just above coal No. 4, along the Little Vermillion; but the amount is too small to be of any value. It was the scanty presence of this mineral in the pisolitic calcareous ironstone locally accompanying the under-clay of No. 6, which gave rise to the so-called "Silver-mine" at the "Slip-bank" of the Little Vermillion, on section 32, township 17 north, range 10 west. To geologists, it were needless to say that no silver bearing rocks occur in this region.

It is said that minute fragments of galena (sulphide of lead) have been seen in some of these nodules; and here, as everywhere else, "the Indians" have the credit of having mined lead in large quantities. Possibly they did "mine" it here; but, if so, it was only after they had first brought the ore from the Galena region, and buried it. Chunks of galena and of the native copper of Lake Superior are occasionally found in the drift. One of the small streaks of gravel, which occur in the "boulder-clay," is said to yield

minute quantities of gold, through all this region, but not in sufficient quantities to pay fair days' wages for washing it.

*Clays.*—Next to coal and iron, the under clays of the coal seams take the most important place among the mineral resources of the county. The bed which underlies coal No. 5 seems to be, both from its character and extent, the most valuable one of all, being generally of a lighter color than the underclays of the other seams. At Burns' bank, east of Highland, it was especially noticed as being nearly pure white, and from two to six feet thick. At some parts of its outcrop, as at certain points on Jonathan's creek, the clay, which is everywhere quite silicious, is locally changed to a very compact, semi-crystalline sandstone, full of the rootlets of *Stigmaria*, similar to that before mentioned as marking the level of No. 4, below Newport. This clay is continuous through the whole outcrop, though of varying thickness. In the southern portions of the county it was noticed that the thinner and more "brash" portions of the seams had the more silicious fire-clay. The material seems especially well fitted for the manufacture of tiling, both useful and ornamental, as well as for fire-brick. For the latter purpose the under clays of No. 6 are also suitable, though likely to make a darker brick. On Trosper branch of the Big Vermillion, perhaps a mile west of the State line, and four miles northeast of Georgetown, Illinois, these clays, including some thin intercalated beds of limestone, are over sixteen feet thick, and show a considerable variety of colors. At no point within the county was so great a thickness observed, from two to six or eight feet being the ordinary thickness; but it is not improbable that, at some of the openings of this seam which will certainly be made upon the ridge between the Big and Little Vermillions, clay of similar thickness and coloring may be met with.

*Building Materials.*—In a letter from Mr. John Collett, of Eugene, dated 3d of January, 1870, he says:

"Bricks have been manufactured at about forty-five different localities in this county, embracing every variety of

material. Those manufactured from the 'boulder-clays' of the table-lands adjoining the Grand prairie, especially when made of materials unexposed to oxidation of the air, are of light color, somewhat approaching the brownish cream color of the 'Milwaukee' brick; in other respects are a fair article. Bricks have often been made from the sandy loam of the creek and river bottoms, sometimes adding a small proportion of 'terrace' or 'boulder-clay.' This material requires more care in burning, as the alkaline potash, etc., held in solution by the water, is set free by access of air, and this, with the great amount of vegetable matter, readily forms, in connection with the sand, a coating of glass. Experiments have been made at Perrysville, and at Newport, resulting in the manufacture of good fire-brick from the 'under clays' and decomposed shales and soapstones so abundant throughout this county."

Of stone suitable for building purposes there is no lack. Some of the more heavily bedded, slightly ferruginous sandstone layers of the sandy shales between coals No. 7 and No. 6 have been quarried, on a small scale, along the hill between Clinton and the mouth of Brouillet's creek. The heavy bedded sandstone, which commonly lies from ten to thirty feet above coal No. 4, has yielded more stone for building purposes than any other bed in the county. Along the Little Vermillion, just below White's Mill, it generally varies from four to nine feet in thickness, and is a fine building stone, but some of the accompanying layers, though looking quite solid in the quarry, will not resist the disintegrating action of the weather, and must be rejected. From this layer considerable rock has been quarried, along the Big Vermillion, below Eugene; on Tipton branch, south of Eugene; along the Little Vermillion, as just stated; and in the bluffs east of Highland. At the latter place the face of the quarry, twenty feet thick, shows well as viewed from the river. Among the shaly sandstones just below the quarry rock we frequently meet with large, thin flagstones, often showing ripple-marks. At all the quarries we find the stone

containing more or less plant remains, of the genera *Lepidodendron*, *Sigillaria*, *Syringodendron*, *Calamites*, *Cordaites*, etc.

From the upper beds of the Millstone grit small quantities of rock have been quarried, between Perryville and Covington. Some of these contain sufficient mica to make it probable that they will prove suitable for furnace hearths. When furnaces shall be established in the county, it will be worth while to test these fairly before going further for hearthstone. Some portions of the Hanging Rock sandstone also appear suitable for this use.

In the section at Nebeker's coal-bank, north of Clinton, a band of sandstone, marked as a "firestone" in the section given, has been used in fireplaces in sugar camps in the neighborhood, and found to stand well.

The limestone at Perrysville is not suited for building purposes, since its argillaceous character renders it peculiarly liable to be broken up by the frost, as is plainly shown along its outcrop. It would make a valuable lime for agricultural purposes. Another thick seam of limestone is the one described as existing on Fall branch, just below the Horseshoe of the Little Vermillion, which appears to be a pretty solid rock; but its position and thinness prevent its being of much practical value. Still another occurs above coal No. 7, above the Horseshoe, and the same remarks will apply equally well to this as to the previous one. At two or three points, as at Perrysville, lime was formerly burnt for masons' use, but the stone used was found loose in the wash of the "boulder clay." The lime now used in this county is entirely imported.

Of black bituminous calcareous shales, such as have been much used for "patent roofing," there seems to be no limit to the amount, occurring, as they do, constantly above No. 3, generally above "No. 4," abundantly covering "No. 5," forming a considerable part of the roof of No. 6, and the roof of "No. 8," so far as seen.

I cannot conclude the report of the survey of this county without returning my hearty thanks to the many citizens

thereof who have, in all cases when called upon, rendered most efficient assistance; but these are especially due to William Gibson, Esq., of Perrysville, for guidance and repeated assistance in my attempts to ascertain the truth regarding the distribution of the rocks in that part of the county, and, above all, to John Collett, Esq., of Eugene, to whose frequent hospitality and constant assistance I have been greatly indebted, from the day on which I first entered the county until the present time, his letters having followed me up, and supplied the occasional "missing links" always to be sought for in completing the report of such work.