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valley as that mentioned as lying just east of Buffalo bridge, Madison county, or of those in White Oak township, Warren county.

A similar statement may be made in regard to the river valleys. The rivers wander here and there over a partly alluvial plain with drift along the margins, at times even on the very banks of the rivers themselves.

Comparing these different data it is clear the river valleys were marked out chiefly in pre-glacial times. During Mesozoic and Tertiary times when this region was subject to constant erosion, wide valleys were cut into the carboniferous strata as deep as the present valleys. While the drift is an important factor in the present configuration of the country, yet in the region referred to the ice had little to do in erosion, and the waters from melting ice sought in general the natural previously determined drainage courses thus keeping open the rivers and many of the chief ravines of pre-glacial times, while only the lesser ravines have been marked out since the drift was deposited.

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## STRUCTURE OF THE MYSTIC COAL BASIN.

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The lower measures of the Iowa-Missouri coal field consist of a series of sandstones, shales, fire clays and coal beds, which have been found to interlock in a characteristically irregular manner. The different individual beds have, with rare exceptions, only a limited extent, and frequently grade into each other in a manner making their stratigraphy quite complex. This variability has been recognized by many workers\* and has recently been elaborated† so fully that only a reference is necessary in this connection.

The explanation of the irregularity is found in the conditions of the depositions of the beds. It depends primarily upon the facts indicated so abundantly by the nature of the beds themselves—that these measures are marginal depositions, and it has been suggested‡ that in this field the lower coal measures represent the marginal deposits, of which the upper coal measures are the, in part, contemporaneous open sea beds.

In certain portions of the field the irregularities may be directly traced to the influence of the uneven nature of the floor upon which the beds were laid down.

\*Swallow: Rep. Mo. Geol. Sur., p. 87, Jefferson City, 1855.

Worthen: Geol. of Iowa, vol. I, p. 250, 1858.

Broadhead: Rep. Mo. Geol. Sur., II., p. 166. Jefferson City, 1872.

Norwood: Rep. Mo. Geol. Sur., pp. 200-215, 1873-1874. Jefferson City, 1874.

†Keyes: Stratigraphy of the Carboniferous in Central Iowa; Bul. Geol. So. Am., II., pp. 277-292, 1891.

Winslow: Mo. Geol. Sur., Prelim. Rep. on Coal, pp. 21-22, 1891.

‡Winslow: Missouri Coal Measures and the Conditions their Deposition; Bul. Geol. Soc. Am., III., 109-121, 1892.

Keyes: Geol. Sur. Iowa, vol. I., First Ann. Rep., pp. 84-85, Des Moines, 1893.

The limitations of the various strata are perhaps more strikingly shown in the coal beds themselves than in any others. The few limestones known to occur in the Lower Coal Measures, such as that shown in the banks of Walnut Creek at Mystic, are of course persistent over wide areas. Certain of the sandstones, such for example as that exposed at Red Rock, in Marion county, attain a considerable geographic extent. The shales, however, and even more particularly the coal beds, usually cover areas quite limited. Indeed it is the exception to find a coal bed which can be traced more than a few miles at most.

In marked contrast to this general character is the coal seam at present worked in Appanoose and adjoining counties. As compared with the other coal seams of Iowa the extent of the one in question is quite exceptional. As nearly as can now be determined it extends over a distance of nearly fifty miles north and south and at least forty miles east and west. There is probably no other vein in the Lower Coal Measures of the State which extends unbroken over an equal stretch of territory. Not that it is now absolutely continuous over the whole extent, but that its identity may be accepted with considerable assurance.

A general section representative of the strata of this region taken from the record of several mines at Centerville is as follows:

	FEET.	INCHES.
17. Soil, fine black.....	3	
16. Clay, yellow.....	33	
15. Clay, blue, containing boulders and fragments of wood, coal and limerock.....	30	
14. Limestone.....	6	
13. Shale, argillaceous, blue.....	3	
12. Shale, argillaceous, red.....	11	
11. Sandstone, soft with thin hard layers.....	8	
10. Shale, argillaceous.....	10	
9. Limestone, compact gray.....	3	
8. Shale, bituminous pyritiferous.....	7	
7. Limestone, usually bituminous "Caprock".....	3	6
6. Shale, firm bituminous.....	1	2
5. Coal.....	1	8
4. Clay-parting.....		2
3. Coal.....	1	2
2. Fireclay.....	3	
1. Limestone (seen in the bluffs at Mystic).....	2	10

The thickness and character of these different layers vary within certain limits, but the general features of the section may be considered as fairly constant. Other bands of limestone occasionally make their appearance, and the character of the shale is of course inconstant. The presence of numbers 9 and 14 is tolerably constant throughout the field. They are known respectively as the "Seventeen" and "Fifty foot" limestones from their general occurrence at about those heights above the coal. They may be relied upon as fairly accurate guiding marks, though they have in certain places been removed by later erosion.

An examination of the coal in the above section shows that it has several points which are peculiarly characteristic, and make its recognition easy and secure.

The following five sections are taken from different parts of the field, and are a few of a large number showing the characteristics of the vein. They

will show the main evidence relied upon to establish the identity of the seam, though much confirmatory material could be added from the nature of the coal and the general geological and topographical relations of the region:

(1.) Section measured as exposed along Walnut Creek at Mystic, in the north central part of Appanoose county:

	FEET.	INCHES.
7. Limestone, massive, grey (seen in Lone Star drift).....	2	6
6. Shale, bituminous .....	1	
5. Coal.....	1	6
4. Fireclay.....		2
3. Coal.....	1	
2. Fireclay.....	1	3
1. Limestone.....	2	10

(2.) Section as seen in a mine at Seymour, Wayne county, at a depth of 242 feet:

	FEET.	INCHES.
7. Limestone "Caprock".....	2	
6. Shale, bituminous.....	1	6
5. Coal.....	1	6
4. Clay.....		2
3. Coal.....	1	
2. Fireclay .....	1	2
1. Limestone bed-rock.....		

(3.) Section examined in a mine at Centerville, Appanoose county, at a depth of 150 feet:

	FEET.	INCHES.
7. Limestone.....		
6. Shale, black.....	1	
5. Coal.....	1	5
4. Fireclay.....		3
3. Coal.....	1	2
2. Fireclay.....	1	8
1. Limestone.....		

(4.) Section at Blackbird Coal Company's shaft, two miles north of Unionville, Putman county, Missouri:

	FEET.	INCHES.
7. Limestone, hard gray.....	3	
6. } Clayey gray shales (Clod).....		6-8
} Black fissile shale.....	1	
5. Coal.....	1	8-10
4. Clay parting .....		1-3
3. Coal.....		10-12
2. Clay.....	3	
1. Limestone.....		

(5.) Section of coal bed at Stahl, Adair county, Missouri:\*

	FEET.	INCHES.
7. Limestone.....	1	10-12
6. } Clay (Clod).....		2-3
} Black fissile shale.....	1	6-12
5. Coal.....	2	
4. Clay partings.....		1-3
3. { Coal.....	1	
{ Clay.....		1-2
{ Coal.....		1-2
2. Clay.....	1	4-6
1. "Bottom Rock".....	1	6

\*Sections IV and V taken from Missouri Geol. Sur., Prelim. Rep. on Coal, pp. 56 and 61 Jefferson City, 1891.

An examination of these different sections shows a remarkable persistence of character. The thin clay parting remains constant between two and three inches over the whole distance. The greatest variation is shown in the underlying fire clay and overlying shales.

In Iowa this coal has been found along both branches of the Chariton river in the northeastern part of Wayne county, and mined near Grflinsville and Milledgeville, in the northwestern part of Appanoose county. Its presence on Little Walnut creek, near Walnut City, is known. It is well exposed along Big Walnut, and is extensively mined at Brazil, Mystic and Rathburn. It has been mined at Plano, Garfield, Dennis, and a few miles southwest of Moravia. There is a coal exposure on Soap creek, at Foster, in Monroe county, which may be the same. At Centerville, Numa, and Jerome, the coal is mined at depths of about one hundred and twenty-five to one hundred and sixty feet, while at Seymour in Wayne county, it is reached at two hundred and forty-three feet; and at Howard, in the same county, is reached at a slightly less depth. At Livingston and Cincinnati, in the southern part of Appanoose county, it lies nearer the surface; near Hillstown, in the southeastern part of the county, it outcrops along the Chariton. Coal is mined at Coatsville, in Schuyler, Stahl, in Adair, and Mendota, Unionville, and other points in Putman counties in Missouri, which has been considered\* to belong to the same seam, and part of it at least, has been directly correlated† with the Mystic coal. Without doubt this is a continuation of the vein mined in Iowa; since the mines at Cincinnati, Iowa, and Mendota, Missouri, are only a short distance apart, and the same is true at Hillstown and Coatsville. The character of the coal, and the attendant strata, as well as the general geological relations in the region in question, all bear on this assumption.

The presence of a seam of coal with such exceptionally uniform character and wide geographical limits within the boundaries of the lower coal measures as now recognized, is an item of considerable economic, as well as scientific interest. It has had a very important bearing upon the development of the coal industry of that portion of Iowa, and has been one of the leading factors in the remarkable growth which that industry has there experienced.

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### SIGOURNEY DEEP WELL.

BY H. FOSTER BAIN.

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During the summer of 1888 a deep well was drilled at Sigourney, in Keokuk county. Captain Parker, who was at that time mayor, carefully preserved samples of the different strata passed through. These samples have recently been re-examined, and form the basis of the following notes.

\*Winslow: Geol. Sur. Mo., Prelim. Rep. on Coal, pp. 54-62, Jefferson City, 1891.

†Norwood: Rep. Mo. Geol. Sur., 1873-1874, p. 295, Jefferson City, 1874.