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Creators: [Selby, Augustine Dawson, 1859-](#)

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NOTES ON THE BARREN MEASURES.

BY AUGUSTINE D. SELBY, OF IRONTON.

The Barren Coal Measures of Prof. H. D. Rogers, as assigned in the early survey of Pennsylvania, are designated LOWER and UPPER, —the Upper Barren Measures lying above the Waynesburg coal; with these I have nothing to do to-day, as they do not appear in this region. The "Lower Barren Measures" as named above, or the No. XIV of Prof. Wm. B. Rogers's Virginia Reports, have for the lower limit the TOP of the Upper Freeport or Waterloo coal, and for the upper the BOTTOM of the great Pittsburgh or Pomeroy seam. The Black Flint of the Kanawha so nearly coincides in position with the Upper Freeport coal that it is sometimes spoken of as the lower member of the Barrens. I shall use the term Barren Measures in these notes, as including the strata of Roger's LOWER division or No. XIV.

In Vol. II, Ohio Geology, page 155, Prof. Newberry speaks of the Barrens as including the interval between the Mahoning sandstone and the Pittsburgh coal, while the term as used by Prof. I. C. White, of West Virginia, and stated by Prof. Orton in Vol. V. Ohio Geology, includes as before given the rocks between the Upper Freeport and Pittsburgh coals.

The Barrens consist, as is well known, chiefly of highly colored shales, and of sandstones. Red is the predominant color with the shales though many different colored strata are often found. The name BARRENS, has been given because of the almost entire absence of workable coal seams, and they are so far as economic interest is concerned generally unproductive. Included in these measures are the two crinoidal limestones, the Ames usually called the Crinoidal and the Cambridge or Pine Creek Limestone of Pennsylvania Reports, which aside from the Ferriferous or Gray Limestone of our Iron-ton hills, are the most persistent and useful guides in studying the stratigraphy of southeastern Ohio.

Having been gathering notes on these measures for the past two years in this State and in the adjacent counties of West Virginia and Kentucky, I have brought them together in loose form in this paper. I should wish that they were more exact or more valuable, but trust they may have some stratigraphic interest if directing attention to but little of economic value.

The variability of the elements in the Barrens is always noticeable, but no other variation seems more marked than their thickness taken

as a whole; and beside this we note the varying intervals at which the persistent limestones reappear, as well as the shifting quality and quantity of the various economic materials included. The general section of Lawrence Co., O. Geology, Vol. V., page 122, makes the interval between the Cambridge limestones and Upper Freeport coal 120 feet—or varying from 110 to 130 feet. While the interval from the Cambridge to the Pittsburgh coal has, so far as I know, never been definitely determined for this southern projection of the State, the reports of Gallia and Meigs counties by Prof. Andrews, almost uniformly give the thickness of intervening rocks as 240 feet. The figures would indicate a total thickness for the Barrens of 350 to 375 feet in Lawrence county. This inferential thickness is very much short of the actual. A leveled section, made by the writer, just above the mouth of Indian Guyan Creek, in Union township, Lawrence county, from low water in the Ohio to the top of the river hill gave the following:

Concealed by alluvium.....	25'
Ames or Crinoidal limestone, thin and shaly (fossiliferous, with coal blossom under it)...	10''
Interval concealed (shales and sandstones) to	148'
Place of Elk Lick coal, fire clay here	6'
Massive sandstone, pebbly at base (55' ft.) to	200'
Blossom of Little Pittsburgh coal at	205'
Interval concealed and sandstone	
Nodular limestone, thin	281'
Kidney iron ore	299'
Laminated sandstone 15 ft. and shales	
Pittsburgh coal worked by Mr. Daniels	324'
Concealed to top of hill estimated	375'

The interval here from crinoidal to the coal is nearly 300 feet. It is four or five feet more back of Huntington, W. Va., about two miles below the mouth of Indian Guyan Creek on the opposite side of the Ohio.

The Crinoidal limestone is well exposed in both of these places, carrying its characteristic fossils and the Pittsburgh coal is worked at the top of each, on the Ohio side being 24 to 30 inches in thickness and 36 to 40 inches on the W. Va. side.

The Cambridge is at least 85 feet below the Ames. It is usually reported as 140 feet below in Lawrence county, but the indications bear me out in saying, that this interval decreases as that above the Ames grows greater. Where the Crinoidal and Cambridge appear in the same hill two miles below Huntington (I have not had equal opportunity to observe on the Ohio side of the river) the interval of shales and sandstones, carrying a thin slaty coal about midway, is about 85 feet. This section is 3 to 3½ miles from the Daniels' hill section given above. By these sections the interval of 240 feet has grown to 390. Beside the increase in thickness of the measures above the Crinoidal there appears an equally strongly marked thickening of the Mahoning sandstone series below the Cambridge and above the Upper Freeport coal. These intervening strata 110 to 130 feet thick in the western and northern portions of the county are apparently more than doubled along the Ohio. I might wish for some further data here, but give that collected subject to correction later on. In the section back of Catlettsburg,

Ky., this interval is 150 ft. and as obtained from the well record at Huntington it is 260 to 270 feet.

The well record at Huntington combined with the hill section before referred to just back of the town will give a section of the Barrens 660 feet in thickness or 300 feet greater than would be inferred from exposures to the northeastward, and Prof. White's Kanawha section yields over 800 feet of the same measures.

The Huntington well starts about 15 feet above the place of the Elk Lick coal or about 125 feet above the crinoidal limestone, and is as follows:

1. Clay, &c.....	20'	}	350	
2. Red shales including the two limestones, here, &c.....	Very shaly.....			330'
3. Sandstone (with salt water at 100 feet).....				125
4. Black shale.....	3'	}	425	
5. Coal (Upper Freeport).....	10'			
6. Shale.....	30'			
7. Coal (Middle Kitanning?).....	4'			
8. Shale.....	40'			
9. Coal (Lower Kitanning?).....	6'	}	100	
10. Shale.....	332'			
11. Hard white sandstone with strong stream of salt water at 60' therein.....			172	
12. Shales.....			108	
13. Limestone, lower Carb. or Greenbrier.....			460	
14. Slate and shales.....			23	
15. Limestone.....			15	
16. Sandstone impregnated with oil.....			192	
17. Slate.....			4'	
18. Limestone(?) This was very hard, drillers broke five bits in one turn.....			4'	
			1974	

The thickness of the Barrens here is based upon the identification of No. 5 of the well record, as the Upper Freeport coal and No. 3 as the Mahoning sandstone overlain by

the shales of No. 2. There seems no apparent doubt as to the correctness of this interpretation.— Great as is this thickening in the twenty or thirty miles under consideration, it is but part as has often been pointed out before, of the general increase in the thickness of the accumulated sediments as we approach the Appalachians. The Barrens on the Kanawha near Charleston, are 806 feet in thickness, as given by Prof. White.

I have spoken of Crinoidal and Cambridge limestones, though in fact, neither holds its character as a solid limestone here. They are, for the most part, calcareous and fossiliferous shales, the former accompanied by a non-fossiliferous or impure fellow to be paired with the fossiliferous one, the Patriot or limestone coal between them.

As to useful elements the Barrens do not disprove or qualify their christening; they are chiefly unproductive. The Brush creek coal is due in the Mahoning sandstone series, but does not come out prominently along the river. The thin red-ash coal under the Morgantown sandstone known as the Elk Lick coal, attains a maximum thickness of two feet, but is often replaced wholly by fire-clay. The blossom above the Morgantown called in the section the Little Pittsburgh, is quite promising though unexplored. It may be borne in mind that the Upper Freeport appears in the C. & O. railroad cut beyond the Big Sandy bridge 65 feet above low water level, and is worked back of Ceredo, W. Va., 10 to 15 feet above the same level, while according to the Huntington well section it is 475 feet below the surface there. The dip throws the strata below the

river and causes also, the sinking southward. These investigations have led to the placing of the syncline of the Appalachian coal field about $3\frac{1}{2}$ miles south of Huntington, and it reaches the Big Sandy river near Rockville, about 12 miles from the mouth of that stream. Beyond this line the strata rise to the southeast, but the syncline suffices to carry the Pittsburgh coal as far west as the Big Sandy hills where it is finally lost in the air.

As we ascend the Big Sandy beyond Rockville the rise of the rocks is considerable, and at Louisa and Cassville the Cambridge limestone, which must have neared river level at one point, is nearly 300 feet above it. In the high hills back of Cassville, W. Va., in Wayne Co., and extending for several miles toward Twelve Pole, an ore of considerable geologic and perhaps economic interest is found about 120 feet above the Cambridge. It is a manganeseiferous iron ore averaging 12% metallic manganese, 24% metallic iron and 25 to 35% carbonate of lime. It is low in silica and high in phosphorus. It occurs in

large, solid blocks 12 to 20 inches thick and weighing from a few hundred pounds to a ton or more. Sufficient work has not been done to prove its relations to the crinoidal limestone but it would appear that the latter is a few feet above it. I have been informed by Mr. McMillen that an iron ore carrying little or no manganese and high in iron occurs in limited quantities along Greasy Ridge in this county and at several places along the Duck Creek railroad.

I should be much gratified to have the conditions necessary to produce such formations as this manganeseiferous ore elucidated somewhat, as they are now very obscure so far as the writer's knowledge is concerned. The Barrens thus furnish us with as many geologic problems as any portion of the carboniferous are peculiarly original in the great number of variations they present. While not so attractive by reason of undiscovered wealth that may possibly be brought to light they yet furnish much material demanding further study and investigation.

