GEOLOGY OF APPANOOSE COUNTY.

BY

H. FOSTER BAIN.

GEOLOGY OF APPANOOSE COUNTY.

BY H. FOSTER BAIN.

CONTENTS.

INTRODUCTION.

LOCATION AND AREA.

Appanoose county is located on the southern boundary of the state a little east of the middle. Davis county joins it on the east, while Monroe and Wayne counties join it on the north and west respectively. In shape it is an approximate parallelogram; it extends twenty-four miles from east to west and a little more than twenty-one miles from north to south. The west county line is slightly longer than the east line, owing to the fact that the southern boundary of the state is not quite parallel to the section lines.

In all Appanoose contains twelve complete congressional townships with parts of four more. The total area of the county is 658 square miles. This is divided into seventeen civil townships which are named on the accompanying map with the exception of Center, which lies wholly within Vermillion township and is co-extensive with the city of Centerville.

PREVIOUS GEOLOGICAL WORK.

The earliest geological survey of the state—that conducted by Dr. David D. Owen under the auspices of the Federal government—was not extended into this county. Upon the map published as a result of this survey the region now known as Appanoose county is represented as within the coal measures. This is the first information published bearing on the geology of the area under consideration. The work of the Hall survey was confined to the region east of this county, though on the map of the eastern part of the state published as a result of Hall's work, Appanoose is again represented as lying within the coal field.

In 1867 both Dr. White and Mr. St. John visited the county and made a few brief observations.* A few years later C. J. Norwood, while engaged in a geological survey of neighboring counties in Missouri, examined the coal outcrops near

*First and Second Ann. Repts. of State Geologist, p. 40. Des Moines, 1868. Report of Geol. Surv. Iowa, Vol. II, p. 270. Des Moines, 1870.

Hilltown.* More recently, Winslow† has reviewed the geology of neighboring counties in Missouri; incidentally throwing considerable light on the geology of Appanoose.

Up to the organization of the present survey no detailed examination of the structure of the county had ever been made. The field work which forms the basis of this report was carried on during portions of the summers of 1893 and 1895. Several short preliminary papers‡ were published at the close of the first season.

PHYSIOGRAPHY.

TOPOGRAPHY.

Appanoose county is well up on the divide, between the Mississippi and Missouri rivers. The actual watershed lies to the west of the county. It is not, however, a marked physiographic feature, and finds expression rather as a high plain than as a ridge. In this county the plain slopes gently towards the east. There is a second and much slighter slope towards the south. The inequalities which were developed in the surface of this plain, by erosion during preglacial times, have been to some extent obscured, but are occasionally encountered in mining operations. The present surface is a drift surface. The topographic forms are engraved forms, cut in the even surface by erosive forces. Embossed forms have so far not been observed. Foldings and flexures of the strata, while present, are not of sufficient intensity to have influenced the topography.

The general surface of the country is a flat, even plain. This is cut into and divided by the river valleys. The divides, however, present an unbroken, even surface. In crossing a stream one leaves the open prairie, descends and traverses a relatively narrow bit of broken and low-lying country, and then reascends to a plain corresponding to the one from

*Rept. of Geol. Surv. Mo., 1873-1874, p. 295. Jefferson City, 1874.
†Geol. Surv. Mo., Prelim. Rept. on Coal Deposits. pp. 54-56. Jefferson City, 1891.
‡Proc. Iowa Acad. Sci., Vol. I, pt. iv, pp. 33-36. Des Moines, 1894.
American Geologist, Vol. XIII, pp. 407-411. Minneapolis, 1894.
See also Keyes: Coal Deposits of Iowa, Iowa Geol. Surv., Vol. II, pp. 406-424. Des Moines, 1894.

which he descended. The valleys are not narrow, sharp gorges, however, but are relatively wide and bounded by gently curving hillsides; yet, as compared with the width of the divides, they are much narrower.

The general character of the plateau surface is excellently shown south and west of Centerville, along the Chicago, Rock Island & Pacific railway.

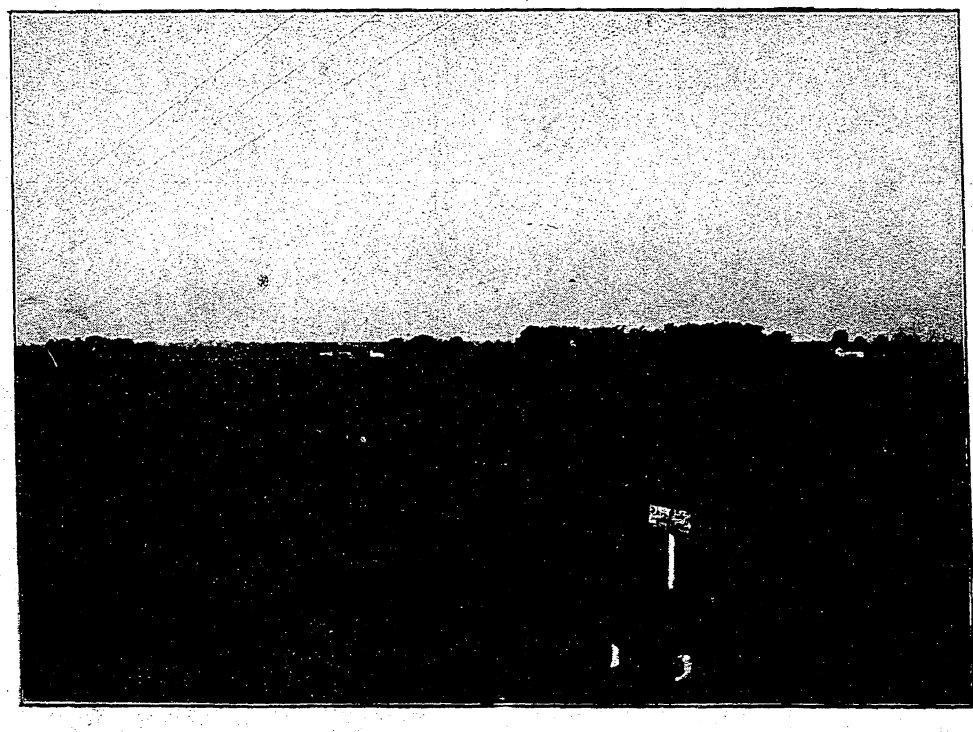


FIG. 52. General view of plateau surface near Eldon mine No. 2; southwest of Centerville.

The divide between North Shoal and Cooper creeks, along which the railway runs from Centerville to Seymour, is typical. The Chicago, Milwaukee & St. Paul railway runs over a similar plain from Seymour to Jerome, and again from Moravia to Trask. The Iowa Central traverses the latter plain from Albia to Maine, and the Keokuk & Western runs over the tableland between Walnut creek and South Chariton river from Garfield to Promise City. Over these drift plains railway construction is simple. The line follows the most easily purchased right of way rather than any line of grade. The wagon roads are laid out along land lines and require but little

grading. The farm fences run in straight lines, and the fields are large and right-angled.

The separate areas of upland plain are essentially all portions of one continuous surface. They rise to the same general level, and when standing upon the plain an even skyline is seen. Cut into this plain is the rather broad valley of the Chariton river, running from northwest to southeast across the county. Leading back from it to the southwest are the valleys of South Chariton, Walnut, Cooper, and several minor streams. Along these streams are numerous side branches, usually coming into the main stream at right

FIG. 53. Valley of Manson branch near Centerville. The shaft house of the Centerville Block No. 8 may be seen near the center of the picture.

angles. Manson branch, a small tributary of Cooper creek, joining it near Centerville, is a good representative of the minor streams. It has a rather narrow, though not sharply cut valley, bounded in the main by gently sloping drift-veneered hills, as shown in figure 53.

TABLE OF ELEVATIONS.

In the following table of elevations the altitudes as given by the Chicago, Rock Island & Pacific railroad profile have

been taken as a basis. The elevations of points not reached by that road are given as shown upon the profiles of the various other roads, plus or minus the amount necessary to bring them into harmony with the chosen basis. At railway crossings the differences were obtained by carefully checked barometric readings. Where two elevations are given, the upper is from the profile, the lower from the barometer reading.

Brazil	1,017
Centerville.	
C., R. I. & P. depot	1,017
K. & W. depot	1,007
Chariton river bridge.	
C., M. & St. P. Ry.	983
Iowa Central Ry.	927
C., R. I. & P. Ry.	866
K. & W. Ry.	821
Cincinnati	1,027
Cooper creek bridge, Iowa Central Ry.	867
Darby	1,048
Dean	819
Dennis (bridge)	927
Eldon Mine No. 2	1,032
Exline	1,005
Forbush	1,067
Garfield	1,039
Guinn	939
Iowa Central crossing.	
C., M & St. P. Ry.	1,051
Iowa Central Ry.	1,076
Jerome	1,059
Keokuk & Western crossing.	
C., M. & St. P. Ry.	1,059
K. & W. Ry.	1,037
Maine	977
Moravia	1,041
Moulton	983
Mystic	1,006
Numa	1,041
Plano	1,069
Relay	897
Sedan	821
Seymour	1,079

Udell	1,000
Unionville	940

DRAINAGE.

The waterways of Appanoose county belong in part to the Mississippi and in part to the Missouri system. Across the northeastern corner of the county Soap creek flows. This stream has its source in Monroe county and flows south and east to the Des Moines river reaching that stream just below Eldon. In Appanoose county there are two branches, North Soap creek and South Soap creek. Neither of these is a very large stream, but each has a considerable number of small tributaries. The region through which they flow is rough and heavily wooded.

In Udell and Washington townships the north and south forks of Fox river originate. This is a longer and more important stream than Soap creek and flows into the Mississippi river a short distance below the mouth of the Des Moines.

The largest stream in the county is the Chariton river, which flows across it from northwest to southeast. This stream is formed by the union of two branches, one of which rises in the southeastern part of Clarke county, and the other in the northwestern part of Wayne. The two forks unite soon after entering Appanoose county and form a rather large and important stream. This river has, in this region, frequently cut through the drift and often to a considerable distance into the coal measures. Important exposures occur along its banks.

The valley of the Chariton is quite wide. From the highland near Udell to the highland east of Centerville is about six miles. The bottomland itself is often of considerable extent. Near Sedan and from there to Dean and beyond the flood plain stretches out nearly two miles east of the river. A considerable portion of this region is occupied by a shallow lake or marsh. Similar, though smaller, lakes occur at other points along the stream.

The Chariton is the most easterly of the small group of rivers which flow down over the nose of the divide between the Mississippi and Missouri. East of it, with the exception of a few minor streams in central Missouri, the creeks and rivers turn toward the Mississippi and flow into that river above the mouth of the Missouri. In the upper portion of its course the Chariton has the same general direction as this group of rivers, but as it leaves Iowa it turns due south and follows the divide from that to the Missouri river, which it reaches near Glasgow. A few rivers lying west of it take the same general course, but within a short distance the drainage runs along the normal southwest lines to the Missouri.

Within the county the river receives a number of tributaries, the larger ones being from the west. From the east the branches received are small and rather unimportant. Honey creek flows in in Chariton township, Buck creek in Walnut township, and Indian and Long Branch in Wells township. Big Walnut is the main tributary from the west; this stream rises in Wayne county, flows north and east and empties into the Chariton near Dennis. Near its mouth it receives Little Walnut.

Cooper creek is also a rather large and important creek. It rises in Wayne county near Seymour and flows into the Chariton northeast of Centerville. Near Centerville it receives Hickory creek from the north.

The southwestern part of the county is drained by Shoal creek and its branches. The main branch rises in Wayne county and flows east, then south, then east again to the Chariton river in Putman county, Missouri.

ORIGIN OF PRESENT PHYSIOGRAPHY.

The origin of the present topography of Appanoose county is a matter of some doubt. It seems clear that the present valleys are entirely the result of river action. There are no faults, folds or other structural features which have determined them. It is also probable that the upland drift plains

have not been essentially modified since the ice of the glaciers melted away. At several points shafts or borings upon these plains indicate that the underlying rock surface is quite irregular and that the present surface features are largely a result of the filling in of these irregularities by the drift. At the same time it is clear that the valleys of the Chariton river, Walnut, Cooper, Soap, and other creeks, including all the more important and many of the minor streams of the county, flow in what are essentially preglacial channels. At many points along these streams undisturbed drift is found in their valleys; while shafts, borings or wells show that the coal measures rise in the bordering hills some distance above the water.

At many points the streams flow over drift, and apparently the river valleys have at some time been deeper at these points. At others, while the channels are evidently preglacial, there is no evidence that they were ever of any great depth. Walnut creek, near Mystic illustrates this well. The rivers do not altogether follow their preglacial channels, nor are all the preglacial channels occupied by present rivers. In Douglas township (Tp. 70 N., R. XVII W., Secs. 33 and 34) three diamond drill borings, carried to depths of 47, 76 and 120 feet respectively, show nothing but drift. The exact elevation of this land is not known but it does not differ greatly from equally high ground upon which coal measures occur at much less depths. At Dennis the coal measures are exposed in the bluff of the river to a height of more than 25 feet. Back on the bluffs (Sec. 7, Se. qr., Sw. ¼) a hole 135 feet deep failed to go through the drift. Running from this point south and passing east of Forbush is a buried channel in which bore holes, 100, 95, 105 and 124 feet deep, have failed to touch bottom. On each side of this channel coal is found at depths of 49, 65, 67, 14 and 52 feet. The mine at Forbush is 65 feet deep. Only a portion of this depth is in drift, and yet a short distance southeast (Tp. 69 N., R. XVII W., Sec. 18, Sw. qr., Ne. ¼) a bore hole 100 feet deep on lower ground failed

to pass through the drift. The Chariton river, in this portion of its course, has evidently been thrown far out of its old channel. The depth to the bottom of the old channel is not known, but it is estimated that the present river is at least 100 feet above the old river bed. Its location, so far as known, is marked on the geological map accompanying this report by the absence of the usual coal seam.

At many other points in the county buried channels have been encountered. Such a channel lies between the Lodwick and old "Sandbar" mine at Mystic, another was encountered in sinking the Gladstone shaft northeast of Jerome, and Winslow* mentions a similar channel at Lucerne, Mo. These preglacial channels are quite troublesome in mining operations in the region surrounding Pearl City. At Moulton the drift is known to be of considerable thickness. Possibly this is due to the presence of an old channel.

It would seem that while the major and many of the minor features of the present topography had their origin in preglacial time, there have been many and important changes in the positions of the rivers since; and that the drainage level was at one time at a considerably lower plane. The deeper channels are not always, perhaps are rarely, followed by the present rivers.

Any explanation of the origin of these rivers must not require any great degree of long-continued stability, but must take into account the very great changes in the direction and position of the streams which occurred during the glacial period. Except for this fact the explanation given by Tilton† for the rivers of Warren county would seem to apply equally well for those of Appanoose county; the Chariton being then regarded as a subsequent, and Walnut and Cooper creeks as obsequent streams. This would, however, appear to imply a much greater degree of stability in the drainage lines than can, in view of the facts presented by this immediate region, be conceded. Later studies may remove this objection.

*Prelim. Rept. on Coal, Mo. Geol. Surv., p. 58. Jefferson City, 1891.
†Iowa Geol. Surv. Vol. V, pp. 310-313. Des Moines, 1896.

However much older the present topography may be, it is certain that in many of its most minute details it was developed before the loess-silt was deposited. The latter deposit is shown in many railway cuts and exposures mantling an older drift surface, and in very many particulars this older surface has the same form as that now existing. This is well shown in cuts near Moravia in which the dividing line between the drift and the loess-silt is conspicuous. This line is in most instances approximately parallel to the contour of the present surface; though the loess-silt is usually slightly thicker on the crest of the divides than farther down the slope.

STRATIGRAPHY.

Geological Formations.

The formations of Appanoose county belong to two different periods. The indurated rocks represent the Des Moines terrane of the coal measures, and the overlying unconsolidated beds are referred to the Pleistocene. The following classification shows the taxonomic rank of the strata present.

Classification of Formations.

GROUP.	SYSTEM.	SERIES.	STAGE.	SUB-STAGE.
Cenozoic.	Pleistocene.	Recent.		Alluvium.
		Glacial.		Loess-silt.
			Kansan.	Drift.
Paleozoic.	Carboniferous.	Upper.	Des Moines.	Chariton. Conglomerate. Appanoose beds.

CARBONIFEROUS.

The Carboniferous strata of the Mississippi valley are divisible into two great series; the Lower Carboniferous or Mississippian series and the Upper Carboniferous or Pennsylvanian

series. The rocks of the latter alone outcrop within the district under consideration. The Saint Louis limestone, which is, in Iowa, the topmost member of the Mississippian series, is exposed along the Des Moines river near Ottumwa and in the vicinity of Eldon. At Ottumwa it lies at an elevation of about 680 feet. As shown in the cross-section along the Chicago, Milwaukee & Saint Paul railway, the rocks have a gentle dip to the southwest of about ten feet per mile. If this dip is constant, as seems probable, the total fall between Ottumwa and Centerville would be about 220 feet. If to this be added the difference in altitude between the highest outcrops of Saint Louis near Ottumwa and the railway station at Centerville, 137 feet, the distance to the top of the Saint Louis at the latter point would be about 357 feet. Near Cleveland, in Lucas county, borings have shown that the Saint Louis lies much nearer the surface than is compatible with the hyphothesis of a simple, regular, southwestern dip. While the surface of the Saint Louis is known to be exceedingly irregular, it is not thought that these irregularities alone will account for the nearness to the surface of the Mississippian rocks in western Lucas county. It seems much more probable that in this immediate vicinity the southern component of the dip is more important than the western. If this be true, the depth to the Saint Louis at Centerville would be importantly increased.

In the deep well put down at Centerville some time since the upper surface of the Lower Carboniferous, as pointed out by Norton,* was not well marked. So far as the samples show, it might be at almost any depth between 500 and 1,240 feet. In the well put down in the summer of 1895 it is thought that the Lower Carboniferous was encountered at about 600 feet, though the exact depth cannot be told without a much fuller examination of the drillings.

The importance of the location throughout this region of the upper surface of the Saint Louis arises from the fact that

*Iowa Geol. Surv., IV, page 174. 1895.

limestone marks the base of the coal measures. Throughout the region north and east of Appanoose county the coal measnres are almost entirely free from limestone, so that in prospecting it is comparatively easy to tell where the drill passes into the lower rocks. The lithological change which the Lower Carboniferous undergoes to the southwest, whereby the heavier limestones, seen at the surface in Wapello, Van Buren and neighboring counties, are replaced by shales and thin-bedded limestones,* introduces a new element of difficulty and uncertainty into all deeper prospecting in this region. This conclusion rests, however, upon comparatively slight evidence, and it is possible that later borings may show different results. For the present, it must be considered probable that the base of the coal measures is within about 600 feet of the surface at Centerville, and that it probably lies at a considerably less depth at points in the northeastern portion of the county.

Upper Carboniferous.

The Upper Carboniferous is the great coal-bearing series of the continental interior. It is divisible in Iowa into two members—an upper, the Missouri stage, and a lower, the Des Moines stage. The strata of the Upper Carboniferous represents a continuous sequence. There is no absolute dividing line between the shore-laid deposits of the Des Moines and the maritime beds of the Missouri formation. The relations between the shore and open sea deposits are particularly intimate in the region under immediate discussion. The difference, however, between open sea beds of the more typical exposures of the Missouri terrane and the shore deposits seen in typical areas of the Des Moines terrane is quite striking, and the division of the Upper Carboniferous into two stages. is of the highest practical utility. The dividing line between the two is at the base of the Winterset limestone of Iowa, which is probably, continuous with the Bethany Falls lime stone of Missouri.

*See Norton; op. cit.

The beds of Appanoose county afford excellent illustrations of the fact that the minor differences in faunas are due to local conditions of life, which conditions may now be inferred from the character of the strata then laid down. Certain forms present in the thin limestones of this county occur much more abundantly in the later beds of the Missouri terrane, not so much because the beds are later as because they are limestones, and hence were formed under marine conditions.

The fossils found in the limestones of the region indicate close relationship between the Appanoose beds and the Missouri formation. In the interbedded shales, however, forms characteristic of the Des Moines strata are found, and the fact that the beds are below the Winterset limestone necessitates their reference to the Des Moines formation.

DES MOINES STAGE.

As has been stated, the indurated rocks of Appanoose county are below the Winterset limestone, and hence belong to the Des Moines terrane. They include representatives of both the groups of strata formerly known as the lower and middle coal measures. Practically, the entire county is covered by beds formerly referred to the latter group.

The typical strata of the lower coal measures are exposed and mined at Foster, in Monroe county, just beyond the limits of Appanoose. The only beds referable to this group known to be exposed in Appanoose county are on Little Soap creek in Udell township (Tp. 70 N., R. XVI W., Sec. 32, Sw. qr.). At this point there is by the side of the road about twenty feet of very sandy shales, with a three-inch band of good sandstone near the base.

These lower coal measures are marked throughout the state by great irregularities in the thickness and lithological character of the individual strata, as well as by the presence of numerous thick though discontinuous seams of coal. They represent the more common facies of the Des Moines terrane.

APPANOOSE BEDS.

A less usual or perhaps wholly anomalous facies of the Des Moines formation is seen in the beds underlying the greater part of Appanoose county. These beds form a group of strata which, for practical convenience in description, may be called the Appanoose beds. Taxonomically the Appanoose beds are a sub-stage of the Des Moines terrane. They are in many important particulars sharply set off from the remaining strata of the Des Moines stage.

The Appanoose beds contain the Mystic coal and related strata. Among the latter are certain limestone bands known

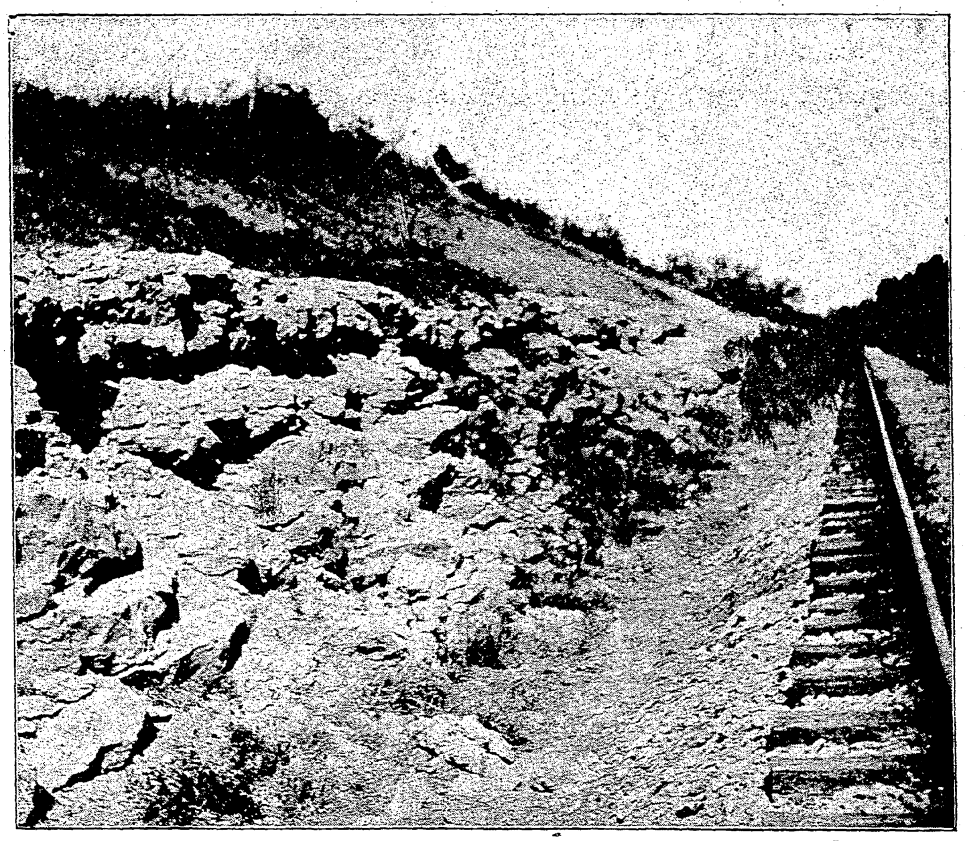


FIG. 54. Fifty-foot limestone in railway cut near Rathbun.

locally as the "floating rock," "fifty-foot limestone," "seventeen-foot limestone," or "little rock," the "cap rock" and the "bottom rock." Throughout the region these limestones maintain their normal sequence. In certain cases the

rocks run together; at points some of them may, as a result of present or preglacial erosion, be absent. In the latter case they are of course found wanting from the top downward. The uniform presence and remarkable regularity in the character of these limestones, features shared by the coal seam as well, are what give the wholly anomalous character to the Appanoose beds.

The following records of diamond drill borings will give an excellent idea of the order and character of the different beds. These records are chosen from a large number made under the direction of Messrs Clarke & Peatman of Centerville, and kindly furnished by them. The agreement which may be noticed between these records is characteristic of the whole number of the borings. Numerous additional borings, shafts and natural exposures, show that the same sequence obtains throughout the county and over a considerable portion of the surrounding area.

BORING NO. 1.

(Tp. 69 N., R. XVII W., Sec. 19, Sw. qr., Ne. ¼).

		FEET.	INCHES.
26.	Surface dirt	2	
25.	Yellow clay	12	
24.	Limerock	6	
23.	Shale, argillaceous, blue	4	
22.	Shale, argillaceous, gray	16	
21.	Shale, gray	14	
20.	Limerock	4	
19.	Shale, argillaceous, blue	7	
18.	Limestone	1	
17.	Shale, blue	4	
16.	Limestone	2	
15.	Shale, bituminous	2	3
14.	Coal	2	5
13.	Clay		3
12.	Coal		10
11.	Fire clay		3
10.	Shale, argillaceous, blue	7	
9.	Shale, gray, hard	12	
8.	Limestone	1	
7.	Shale, black	3	
6.	Shale, gray	3	

		FEET.	INCHES.
5.	Shale, blue	5	
4.	Limestone	2	
3.	Shale, gray	3	
2.	Shale, black	3	
1.	Shale, gray	8	

This boring is of exceptional interest in a few particulars. In it the coal is much thicker than is usual. The cap rock is apparently divided by a bed of shale (No. 17). The clay between the coal and the bottom rock (No. 8) is of more than usual thickness, though it is probable that a portion of the shale (No. 9) in reality belongs with the bottom rock. This boring is one of the very few which have been carried to any considerable depth beneath the coal, and is of particular value in indicating that the same regularity of structure which is found above the coal obtains, for some distance at least, beneath it. The presence of black shales beneath the coal bed now worked indicates the probable presence of coal horizons.

BORING NO. 2.

(Tp. 69 N., R. XVII W., Sec. 17, Nw. qr., Nw. ¼.)

		FEET.	INCHES.
27.	Surface dirt	2	
26.	Yellow clay	5	
25.	Sand	2	
24.	Yellow sandy clay	10	
23.	Boulder		6
22.	Yellow sandy clay	12	
21.	Boulder		6
20.	Yellow sandy clay	9	
19.	Blue clay	9	
18.	Boulder		6
17.	Blue clay	1	
16.	Sand	1	
15.	Sandy clay	8	
14.	Sand	2	
13.	Sandy clay	11	
12.	Limestone	1	
11.	Shale, arenaceous	21	
10.	Shale, gray	3	
9.	Shale, argillaceous	6	

		FEET.	INCHES.
8.	Limestone	4	
7.	Shale, gray	15	
6.	Limestone	2	
5.	Shale, bituminous	3	
4.	Coal	1	2
3.	Clay		3
2.	Coal		5
1.	Fire clay	1	

This boring shows an unusual thickness of drift and a less than usual thickness of coal; the difference in the latter being in the lower bench.

BORING NO. 3.

(Tp. 70 N., R. XVIII W., Sec. 35, Se qr., Ne. ¼.)

		FEET.	INCHES.
20.	Surface dirt	11	
19.	Yellow clay	2	
18.	Sand	3	
17.	Yellow sandy clay	3	
16.	Limestone	5	
15.	Shale, argillaceous	9	
14.	Shale, gray	10	
13.	Sandstone, blue	2	
12.	Shale, argillaceous, blue	4	
11.	Shale, gray	6	
10.	Limestone	1	
9.	Shale, argillaceous	9	
8.	Limestone	1	
7.	Shale, argillaceous	4	
6.	Limestone	1	
5.	Shale, bituminous	2	
4.	Coal	1	7
3.	Clay		3
2.	Coal	1	1
1.	Fire clay	1	6

In this boring the coal is shown in its normal thickness. The cap rock is again split by shale as noticed in boring No 1.

BORING NO. 4.

		FEET.	INCHES.
19.	Surface dirt	2	
18.	Yellow clay	10	
17.	Yellow sandy clay	6	

		FEET.	INCHES.
16.	Boulder		9
15.	Yellow clay	11	
14.	Boulder		6
13.	Sandy clay	8	
12.	Sand	5	
11	Sandy clay	7	
10	Shale, argillaceous, gray	20	
9.	Limestone	2	
8.	Shale, blue	14	
7.	Coal		9
6.	Clay		2
5.	Coal		10
4.	Clay		6
3.	Coal		8
2.	Clay		10
1.	Fire clay	1	

This boring is not far from the Chariton river, and the thickness of the drift is indicative of the former greater width of the valley. The cap rock is probably represented in No. 8, not having been distinguished from the shale. The most unusual feature shown by the boring is the division of the coal by two mud bands rather than one, and the wholly exceptional thickness of the lower band. Such a lower band is known at numerous points, but is usually of insignificant thickness.

These borings show fairly well the normal sequence of strata as found in this county. From a study of them and numerous shaft records and exposures, the following somewhat generalized section has been made out.

		FEET.	INCHES.
17.	Limestone, gray, sub-crystalline, seen in the railway cut near Anchor No. 1 mine at Centerville, and known among the miners as the "floating rock"	2 to	4
16.	Shale, argillaceous, color variable	12 to	30
15.	Limestone, heavy ledges, exposed along Manson branch and Cooper creek at Centerville, as well as at numerous other points in the county, the "fifty-foot limestone"	4 to	10

		FEET.	INCHES.
14.	Shale, argillaceous, blue and red in color	14	
13.	Shale, arenaceous, frequently forming a well defined sandstone, as in boring No. 3 (No. 13), and the Rock Valley shaft	8	
12.	Shale, argillaceous, blue to gray	10	
11.	Limestone, somewhat variable in thickness; exposed along the C., M. & St. P. railway, between Mystic and Brazil, known as the "seventeen-foot limestone" or "little rock"	1 to 3	
10.	Shale, sometimes gray, frequently bituminous and pyritiferous	7	
9.	Limestone, sometimes gray, and coarsely sub-crystalline as at the Lodwick mine, Mystic; sometimes fine-grained, bituminous, and grading into the shales above and below, as at the Thistle mine, Cincinnati; known as the "cap rock,"	2 to 4	
8.	Shale, usually bituminous, and known as "slate;" occasionally in part soft and clay-like, then known as clod; at times heavy and homogeneous non-fissile, in which form it is known as "black bat"	1 to 3	
7.	Coal, upper bench, usually	1	8–10
6.	Clay parting "mud band"		2–3
5.	Coal, lower bench, usually		8–10
4.	Clay parting the "dutchman"		½
3.	Coal, frequently not so pure		2–3
2.	Fire clay	1 to 6	
1.	Limestone, "bottom rock," well exposed along Walnut creek at Mystic	3	6

The details of this section may vary from point to point, but the general sequence remains the same over a considerable extent of territory. It will be seen that the coal seam has several characteristics which make its recognition easy and the correlation of the various outcrops secure. The presence of the two mud bands, of which the upper is the more regular and conspicuous, with the limestones found above and below the coal, afford the best possible basis for correlation. To this is added a most remarkable uniformity in the physical character and general appearance of the coal

itself. The Mystic coal,* as it has been called by Keyes, from the excellent surface exposure occurring at that place, is thought to underlie, in workable condition, about 1,500 square miles of land in Iowa and Missouri. There is also a considerable additional area which may be ultimately proved to be underlain by this seam. The area, as now known, extends over portions of Appanoose and Wayne counties in Iowa, and Schuyler, Putman, Adair and Sullivan counties in Missouri.

The following sections, taken from widely scattered points in the field, show the close similarity between the exposures.

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

		FEET.	INCHES.
7.	Limestone, massive, gray (seen in Lone Star drift)	2	6
6.	Shale, bituminous	1	
5.	Coal	1	6
4.	Fire clay		2
3.	Coal	1	
2.	Fire clay	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 "cap-rock"	2	
6.	Shale, bituminous	1	6
5.	Coal	1	6
4.	Clay		2
3.	Coal	1	
2.	Fire clay	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

* Keyes: Iowa Geol. Survey, II, 408. 1894.

		FEET.	INCHES.
4.	Fire clay		3
3.	Coal	1	2
2.	Fire clay	1	8
1.	Limestone		

(4.) Section at Blackbird Coal company's shaft, two miles north of Unionville, Putnam county, Missouri.

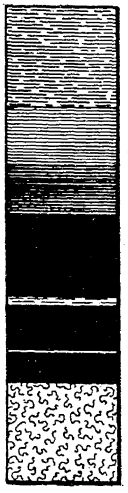
		FEET.	INCHES.
7.	Limestone, hard gray	3	
6.	Clayey gray shales (clod)		6–8
	Black fissile shale	1	
5.	Coal	1	8–10
4.	Clay parting		1–3
3.	Coal		10–12
2.	Clay	3	
1.	Limestone		

(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 parting		1–3
3.	Coal	1	
	Clay		1–2
	Coal		1–2
2.	Clay	1	4–6
1.	"Bottom rock"	1	6

The details of the strata found between the cap rock and the bottom rock are well shown in the following section measured in a small mine in the southeastern part of Appanoose county.

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



		FEET.	INCHES.
9.	Clay shale, gray, very hard	2	
8.	Shale, drab, clayey ("clod")	1	2
7.	Shale, black, fissile	1	
6.	Coal	1	8
5.	Clay parting		2
4.	Coal		10
3.	Clay parting, with pyrite		½
2.	Coal		2
1.	Fire clay, gray	2	

FIG. 55. Coal bed at the Troublesome mine.

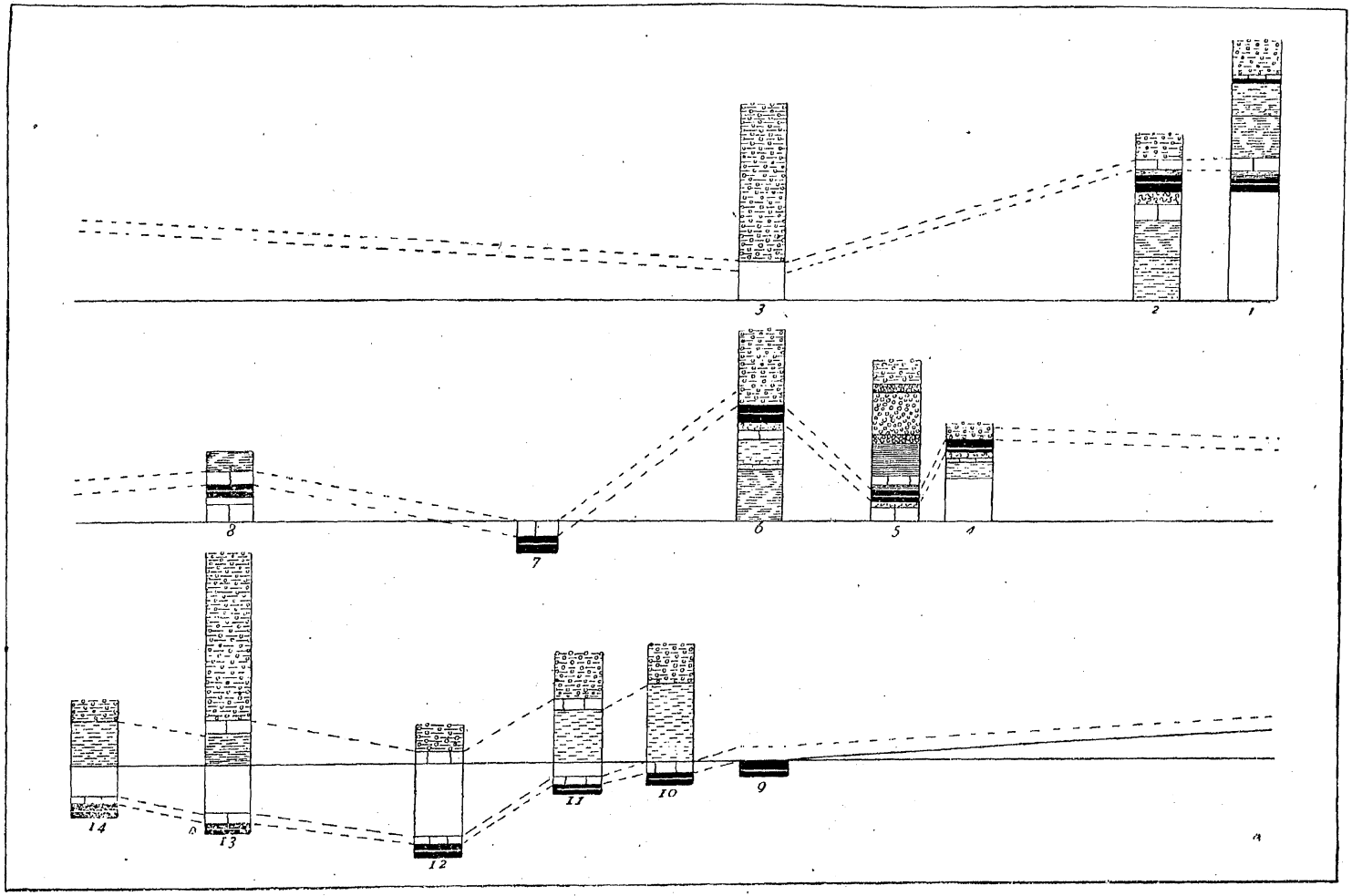
The total amount of shale overlying the coal is not usually so great. It is probable that the gray clay shale (No. 9) in part represents the cap rock. The black fissile shale immediately over the coal, usually called "slate," is quite constant. The development of the clod is on the whole exceptional. The lower mud band (No. 3) is known as "the dutchman," and is usually pyritiferous. The coal as a whole is quite free from pyrite. It is clean, soft, though brittle, breaks with a conchoidal fracture, and gives bright, glistening surfaces. It is traversed by cleat planes filled with gypsum, which cause it to break readily into cubical pieces, and it is hence a "block" coal.

The general character of the exposures of the Appanoose beds is illustrated by those occurring along the Chariton river. These exposures together form plate xi. In detail they are as follows.

(1.) *Exposure on the east side of Chariton river near Hilltown (Tp. 67 N., R. XVI W., Sec. 16, Sw. qr., Sw. ¼).

		FEET.
7.	Drift	10+
6.	Cap rock	2
5.	Mystic coal	2½
4.	Fire clay	4
3.	Bottom rock, yellow arenaceous limestone	2½
2.	Blue clay shale	8
1.	Sandy shale	10

*On plate xi figure 1 is incorrectly drawn.



GEOLOGICAL SECTION ALONG CHARITON RIVER.

(2.) Exposure on the Chariton near preceding exposure (Sec. 16, Ne. qr., Sw. ¼).

		FEET.	INCHES.
6.	Drift	10+	
5.	Limestone, cap rock	2	
4.	Mystic coal	2	8
3.	Fire clay	1	2
2.	Limestone, bottom rock	1	3
1.	Shales, in part sandy, in part clayey	28	

(3.) Exposure on the west side of Chariton below Sedan (Tp. 68 N., R. XVI W., Sec. 35, Ne. qr.).

		FEET.
3.	Yellow clay	20
2.	Blue boulder clay	18
1.	Talus of boulders containing large blocks of limestone	8

(4.) Exposure near the mouth of Snort creek (Tp. 69 N., R. XVII W., Sec. 9).

		FEET.	INCHES.
5.	Drift	3	
4.	Mystic coal	2	10
3.	Fire clay	1	2
2.	Limestone	1	
1.	Shales, argillaceous, gray	4	

There are a number of dump heaps in the vicinity indicating that the coal has been worked for local purposes. A short distance above this creek is an exposure (No. 5) showing the normal sequence of coal and enclosing limestones covered by the Chariton conglomerate, which will be later described.

(6.) Dennis Mill exposure (Tp. 69 N., R. XVII W., Sec. 7, Ne. qr., Sw. ¼).

		FEET.	INCHES.
7.	Drift	18	
6.	Mystic coal and slate	4	8
5.	Fire clay	2	2
4.	Limestone	1	8
3.	Shales, arenaceous, green	6	
2.	Sandstone, yellow, local		10
1.	Shales, argillaceous, gray	12	

The cap rock, and in some places some of the coal has been removed by the erosion preceding the drift. The exposure to weathering has caused the coal to swell up to more than its normal thickness.

(7.) Darby. At Darby the coal lies a few feet below the level of the river. The limestones outcropping in the vicinity belong to the upper series and their correlation may be seen in the section along the Milwaukee road.

(8.) Near Little Walnut creek (Tp. 70 N., R. XVIII W., Sec. 26, Sw. qr., Se. ¼) coal has been mined by shallow shafts and drifts. The sequence is normal, as shown by boring No. 3 already given. There is a considerable drift covered interval between the mouth of Little Walnut and the mouth of South Chariton. In the region near Milledgeville however, there are numerous exposures.

About a mile southeast of the Milledgeville bridge (exposure 9, Tp. 70 N., R. XIX W., Sec. 15, Ne. qr.) coal has been obtained by stripping in the bed of the stream. In the same section is the following exposure.

(10.) Exposure on Chariton near Milledgeville (Tp. 70 N., R. XIX W., Sec. 15, Nw. qr., Ne. ¼).

		FEET.
2.	Drift	10+
1.	Shale, arenaceous	18

A few rods farther up the stream a similar exposure (No. 1) shows these shales to be covered by a three-foot bed of limestone. Presumably the same limestone is seen in the river near the Milledgeville bridge (exposure 12). Above this bridge there are two exposures showing essentially the same.

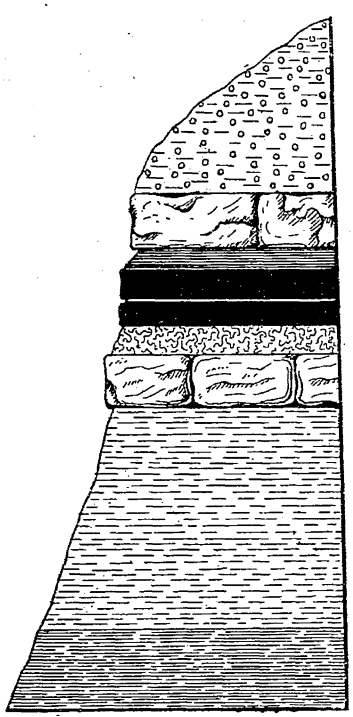
(13.) Exposure west of Milledgeville (Tp. 70 N., R. XIX W., Sec. 8, Sw. qr., Nw. ¼).

		FEET.
4.	Drift	20+
3.	Black shale fragments	½
2.	Limestone	3
1.	Shale, argillaceous	7

A short distance beyond (exposure 14, Sec. 6, Se. qr., Se. ¼) the same shales may be seen.

The Appanoose beds, as defined above, underlie all of the southwestern half of the county and not improbably a considerable portion of the eastern half. Except where removed by erosion, the strata are continuous and may be seen wherever the streams have cut deep enough to expose them. The coal is extensively mined at Centerville, Cincinnati, Forbush, Brazil and along the C., M. & St. P. railway from Jerome to Darby.

The valley of Walnut creek is one continuous mining camp, known under the different names, Jerome, Diamond, Mystic, Clarksdale, Rathbun and Darby. At Mystic and Brazil, owing to the presence of a marked anticlinal, the beds are excellently exposed. At the former point the following typical section may be seen.

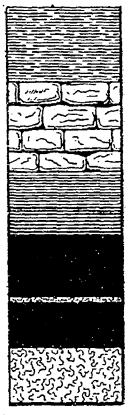


		FEET.	INCHES.
10.	Drift	12	
9.	Limestone, heavily bedded, gray, fossiliferous	2	10
8.	Shale, bituminous, fissile	1	
7.	Coal	1	6
6.	Clay parting		2
5.	Coal, with some pyrite near base	1	
4.	Fire clay	1	6
3.	Limestone, heavily bedded, fossiliferous	2	10
2.	Shale, gray, clayey	11	
1.	Shale, blue, clayey (exposed to water level)	4	

FIG. 56. Bluff on Walnut creek. Mystic.

At Centerville the coal lies at a lower level. The fifty-foot limestone is exposed along Cooper creek and Manson branch.

The beds as measured in the Centerville Block Coal Co.'s mine, No. 1, represent the average.



		FEET.	INCHES.
8.	Shale, dark blue to black, with some pyrite	2	
7.	Limestone, thinly bedded, fossiliferous	2	6
6.	Shale, drab, clayey ("clod")	1	
5.	Shale, bituminous, fissile		8
4.	Coal	1	7
3.	Clay parting		2
2.	Coal	1	2
1.	Fire clay (exposed)	1	6

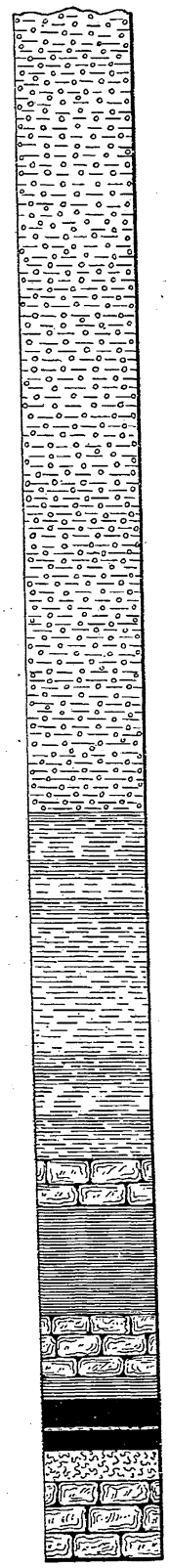
FIG. 57. Base of Centerville block shaft, No. 1. Centerville.

Four miles north at Forbush the coal is extensively mined. The following section measured in the Whitebreast mine No. 19, gives the thickness at this point.

		FEET.	INCHES.
6.	Limestone, gray to black, with pyrite in lower part	2	6
5.	Shale, gray to black	1	
4	Coal	1	5
3.	Clay parting		2
2.	Coal	1	2
1.	Fire clay, exposed	1	6

FIG. 58. Coal seam at Whitebreast No. 19. Forbush.

In the southern portion of the county the coal is mined at Hilltown (see figure 55), near Exline, and at Cincinnati. At the latter place there are a number of mines reaching the coal at depths of from 60 to 160 feet. The Albert shaft, sunk in 1893, supplies the following representative section.



		FEET.	INCHES.
11.	Drift	57	
10.	Shale, gray to black, varying in character and hardness	22	
9.	Limestone, thinly bedded, gray, fossiliferous	3	
8.	Shale, black, with pyrite in part	7	
7.	Limestone, gray, heavily bedded	4	
6.	Shale, black, fissile	1	4
5.	Coal	1	8
4.	Clay parting		2
3.	Coal	1	3
2.	Fire clay	2	
1.	Limestone, hard, heavily bedded (exposed)	5	

FIG. 59. Section of Albert shaft. Cincinnati.

Farther south, near Pearl City and Mendota, Mo., the coal comes nearer the surface and is worked by drifts.

At Numa the normal thickness of coal is found at depths of 145 feet and less. Near Livingston and northwest of Jerome it comes nearer the surface. In the northwestern part of the county and near Confidence in Wayne county the coal outcrops at numerous points and is opened up by a considerable number of slopes and shallow shafts. The section at the Young mine is representative.

		FEET.	INCHES.
6.	Limestone, gray, fossiliferous	2	6
5.	Shale, bituminous	1	6
4.	Coal	1	3
3.	Clay parting		2
2.	Coal		9
1.	Fire clay (exposed)	2	

FIG. 60. Coal bed at Young mine. Milledgeville.

East of Chariton river there are few exposures except in the immediate vicinity of Snort creek. Along Mormon creek, southeast of Moravia, at one or two points limestone ledges may be seen. Near one such exposure (Tp. 70 N., R. XVII W., Sec. 1, Se. qr., Nw. ¼) deserted slopes and dumps indicate that coal has been found. On the land of John Macyntire (Tp. 70 N., R. XVII W., Sec. 2, Se. qr., Nw. ¼) coal was formerly mined both by slope and shaft. In sinking the shaft the drift was found to be eighteen feet thick, below this was a limestone two feet thick, and about sixteen feet still lower down and just above the coal, was a second limestone one foot six inches thick. The coal bed itself showed two benches separated by a mud band as follows.

		FEET.	INCHES.
3.	Coal	1	6
2.	Clay		4
1.	Coal		6

Still farther northeast, at Foster in Monroe county, there is a coal seam, formerly worked by a slope and lying about forty feet above Soap creek. An examination of the slope in 1893 showed the following section.

		FEET.	INCHES.
4.	Shale, argillaceous, drab	2	
3.	Coal, weathered	2	3
2.	Clay		7
1.	Coal	?	

Miners who have worked this bed declare that No. 1 of the above section is coal and runs from nine to ten inches thick. They also state that the clay is usually somewhat thicker than shown at this exposure. In a small ravine near by there is a limestone bed resembling in appearance and fossils the fifty-foot limestone of the Appanoose beds and lying at the proper distance above the coal. While in character this Soap creek seam is somewhat different from the Mystic coal, and while there are no good records of its presence between Darby and Moravia, the probability of its identity is considered sufficiently strong to justify the representation of the two seams as the same. (See plate xiv.)

There is one other area east of the Chariton in which there is a very strong probability, if not indeed a certainty, of the presence of the Mystic coal. Udell station on the Chicago, Rock Island & Pacific railroad lies on a level plain at an elevation of about 1,000 feet. In the summer of 1894 local parties did some boring in search of water. In all, four borings were put down with a churn drill; all being upon the plain referred to. In each, a seam of coal two and one-half to three feet thick was encountered at a depth of 175 feet. The drift extended down to 150 feet and below this was gray shale and limestone to the coal. Immediately above the coal the drilling was hard, indicating the presence of limestone. A few inches below the coal a second rock layer was encountered. Sometime earlier a hole was drilled on lower ground about three miles southwest of Udell. Coal was reported in this

hole at a depth of seventy-five feet. These figures agree well with what a geological section along the Chicago, Rock Island & Pacific railway shows to be probable.

It seems probable that the major portion of the county lying east of the Chariton was originally underlain by the Mystic coal. Probably that seam will be found still present under a part of the area. A considerable portion of the region has, however, been subjected, since the deposition of the coal, to erosive action of sufficient intensity to remove from large areas the coal and associated strata. This erosion was in two widely separated periods, the first being in Des Moines time and immediately preceding the deposition of the Chariton conglomerate, and the second occupying the very long period between the close of the Carboniferous and the advent of the ice age.

CHARITON CONGLOMERATE.

Along the Chariton river near the mouth of Snort creek, a small stream which is also known as Ullam's branch, there is a series of beds totally unlike those which are typical for the county and which have been called the Appanoose beds. This second and later series is, at present, known from a very few exposures only. Indeed the areal extent of the beds is almost unknown, though there is reason to believe that it is limited. The typical section, exposure No. 5 of the Mystic river cross-section (Tp. 69 N., R. XVII W., Sec. 9, Se. qr., Sw. $\frac{1}{4}$) shows the following beds.

		FEET.	INCHES.
10.	Drift	10	
9.	Coarse conglomerate	2	
8.	Fine conglomerate	10	
7.	Coarse conglomerate	2	
6.	Shale, black fissile	8	
5.	Limestone, cap rock	2	
4.	Shale, black fissile	1	
3.	Mystic coal	2	10
2.	Fire clay	1	6
1.	Limestone, bottom rock	2	

Strata 1 to 6 belong to the Appanoose beds, 7 to 9 represent the Chariton conglomerate. The latter has a matrix of reddish, ferruginous sandstone in which are imbedded small water worn pebbles and brecciated blocks of gray, drab and white limestone. The latter were evidently derived from the cap rock and associated limestones of the Appanoose beds.

FIG. 61. Chariton conglomerate; coarse grained facies.

As seen at this particular exposure the rock shows two facies, one fine-grained and the other coarser. The latter is the more typical and is represented in figure 61. The rounded water worn pebbles seen in this specimen and also illustrated

in figure 62 are of fine-grained, white to gray limestone, and present all of the physical characteristics as well as the more usual fossils found in the immediately subjacent limestone. The pebble shown in figure 62 was dug out of the soft matrix of the conglomerate. Its form shows undoubted water rounding. The weathering of the matrix and the pebbles is of course unequal, so that they are usually sharply contrasted. In addition to the rounded pebbles there are numerous smaller sharp-cornered flakes of limestone, bits of crinoid stems, and broken pieces of brachiopods found in the conglomerate. The matrix is only in part arenaceous and is quite

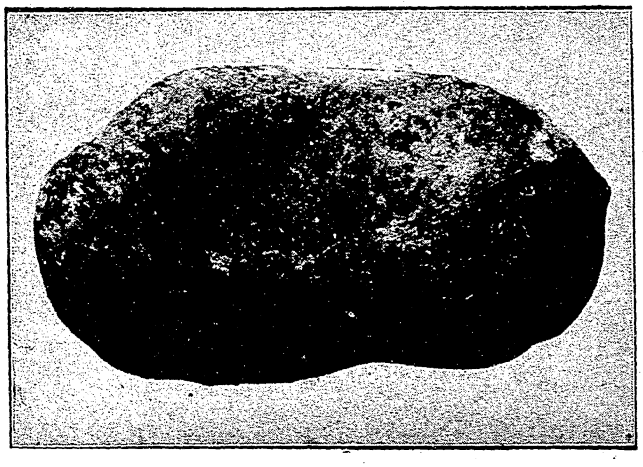


FIG. 62. Pebble from Appanoose beds taken from Chariton conglomerate.

largely made up of earthy, magnesian limestone. In the fine-grained facies this is particularly true. Small particles of coal, having all the well marked physical properties of the Mystic seam, occur in the fine-grained beds. This fact, with the general character of the pebbles as well, would seem to indicate that at the time the conglomerate was formed there were considerable inequalities in the surface, and that the preceding erosion had cut down into, if not through, the coal bed.

The wide extent and uniform character of the Mystic coal, the numerous bands of limestone of more or less regular thickness, the presence in the latter of a pelagic fauna, the

total absence of cross-bedding, current action, and heavy sandstone beds, the thick deposits of infra-littoral clay and shale deposits, and the almost total absence of arenaceous material, except as disseminated in shales, all indicate that the Appanoose beds represent a period of extreme quiet, and, unless the coal seam itself be taken as the sole evidence to the contrary, a total freedom from shore conditions. This period of quiet and uniform disposition was evidently followed by one during which the strata were elevated and eroded. The eroded fragments were gathered together and redeposited, making up the Chariton conglomerate. That this later erosion and redeposition took place during the Carboniferous rather than at some later period would seem to be indicated by the intimate relation between the fragments in the conglomerate and neighboring ledges, the apparently local nature of the phenomena, the known presence of numerous other local unconformities in the coal measures, and the large number of crinoid stems and other Carboniferous fossils found in the conglomerate in such a fresh condition as apparently to preclude the idea that they are not indigenous.

In addition to the conglomerate exposure already described the rock is known only at two other points. In the quarry of Mr. Wm. Duval (Tp. 70 N., R. XVII W., Sec. 1, Nw. qr., Sw. ¼), the stone, showing the coarse facies only, has been opened up. The quarry is along a small ravine opening off of Morman creek. The rock outcrops fifty to a hundred feet along the stream and shows a thickness of twenty-five feet or more. It lies at least fifteen feet above the stream. The rock shows the same characteristics that mark it at the typical exposure.

The third known outcrop of the conglomerate is in Monroe county, about four miles south of Albia (Tp. 71 N., R. XVII W., Sec. 3, Se. qr.). It has been quarried a little here, and used for foundation work at Foster and neighboring towns. The probable position of this conglomerate in the Ottumwa-Seymour section is indicated on plate xiv.

The uncertainty as to the extent of the erosion which preceded the deposition of the conglomerate, as well as that which preceded the drift, has made it seem inadvisable to attempt to map the areas east of the Chariton, which are underlain by the Mystic coal. Beyond the general probability of its presence, under a portion at least of the uplands, nothing can be stated. The actual delimitation of the coal-bearing areas must be left to future prospecting. It is evident that, with the large reserve areas of coal land west of the river yet untouched, it will be many years before the more problematic areas east of the river will be opened up.

The line drawn upon the map as marking the eastern limit of the Appanoose beds merely marks the limit of known territory. The coal may, and at many points probably does, extend beyond this line. It is merely intended to indicate that south and west of the line as drawn there is every reason to believe the coal present under every acre of territory where the topographical configuration does not already show its absence — except over areas of limited extent, some few known, and more perhaps unknown, where it has been removed by erosion or interfered with by faults. In Caldwell township a considerable area has been marked as barren. Prospecting over a part of this area has been carried on by the different parties. One reported the coal absent in part, though the limestones were present; the other reported the coal present. Inasmuch as the exact limits of the barren area are not known, it has seemed better to map the whole as doubtful. That is, the coal though probably present over most of the area, may be found to be absent at any point.

Geological Structure.

FAULTS.

Faults of two kinds interrupt the continuity of the coal seam within the area indicated. The first are true geological faults, and are known to the miners as slips. Figure 63 illus-

trates one found in the Thistle mine at Cincinnati. The throw in a majority of cases is a few inches only, and these

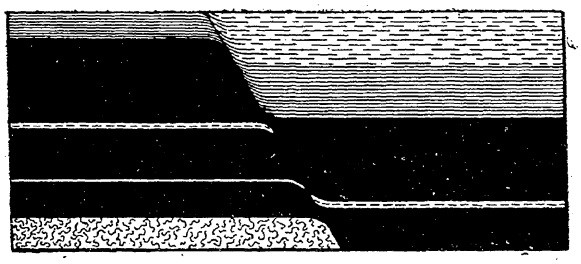


FIG. 63. Fault in Thistle mine. Cincinnati.

slips offer no serious obstacles to mining. Akin to them are the clay-filled fissures, such as shown in figure 64.

But one serious fault has been so far encountered in the field. This occurs in the Scandinavian mine and is illustrated in plates xii and xiii. The coal in the Scandinavian mine

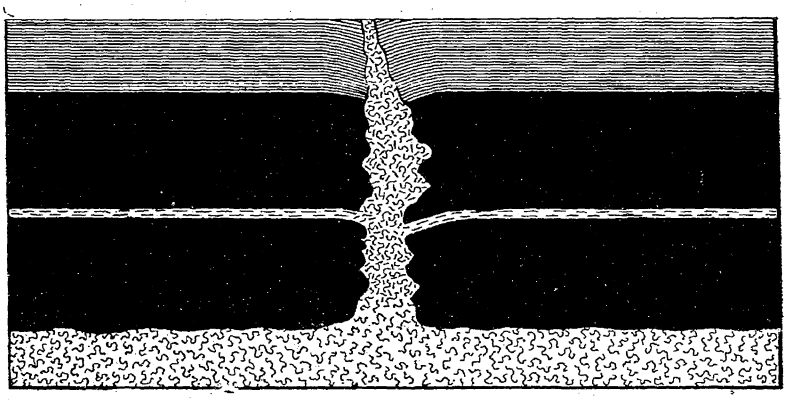


FIG. 64. Fissure in seam at Thistle mine. Cincinnati.

shows the usual characteristics. There was no indication in the earlier workings of the presence of a fault. In working south and east, however, it was found that the coal was cut off, and later workings show that the direction of the fault is about as indicated on the map. Up close to the line of fault the coal was, at most points, uninjured. It did not show the weathered surface so commonly found when the bed has been cut through by preglacial erosion, but was simply cut sharply off and replaced by limestone or slate. Since it was known that in the National mine, located to the southeast of

the Scandinavian, a fault of some description had at one time been encountered in the west workings, a few bore holes were put down in the doubtful territory. Coal of the usual character and at nearly the correct level, was found at one point. A gin shaft was sunk, but when the drifting begun the coal was soon found to be cut off to the southeast. It was relocated and the tunnel driven across the entire fault to the new workings.

In the area beyond, the coal near the fault is badly broken; but the rooms driven south and east show good coal. The map, plate xii, shows the condition of this portion of the mine in August, 1895. It will be noticed that the fourth east has been driven nearly 150 feet beyond the point at which it might be expected that the fault would appear. This indicates that the fault has either run out or changed direction. The latter is quite possibly the correct hypothesis, though it has been believed that the absence of the usual coal seam in the two deep wells put down northeast of the Scandinavian was due to a prolongation of this line of disturbance.

In working the Standard mine a "fault" was encountered about 1,000 feet north of the south line of their lease, and running east about 1,000 feet. At this point it turns to the northeast and continues to the line of the unoccupied eighty acres east of the Standard lands. It has not been traced beyond this line. Along this fault, which cannot now be examined, the roof is reported to be poor, the coal soft and in places replaced by white clay. No sticks or stones, the usual signs of preglacial erosion channels, are reported. Near the Keokuk & Western depot a local mine, now abandoned, is said to have struck a similar fault.

These facts would seem to indicate that the Scandinavian fault turns toward the east and is continuous with that encountered in the Standard mine, though in the absence of an opportunity to examine the latter this cannot be stated certainly, and there must be some doubt whether after all the Standard "fault" is not a preglacial erosion channel.

MAP

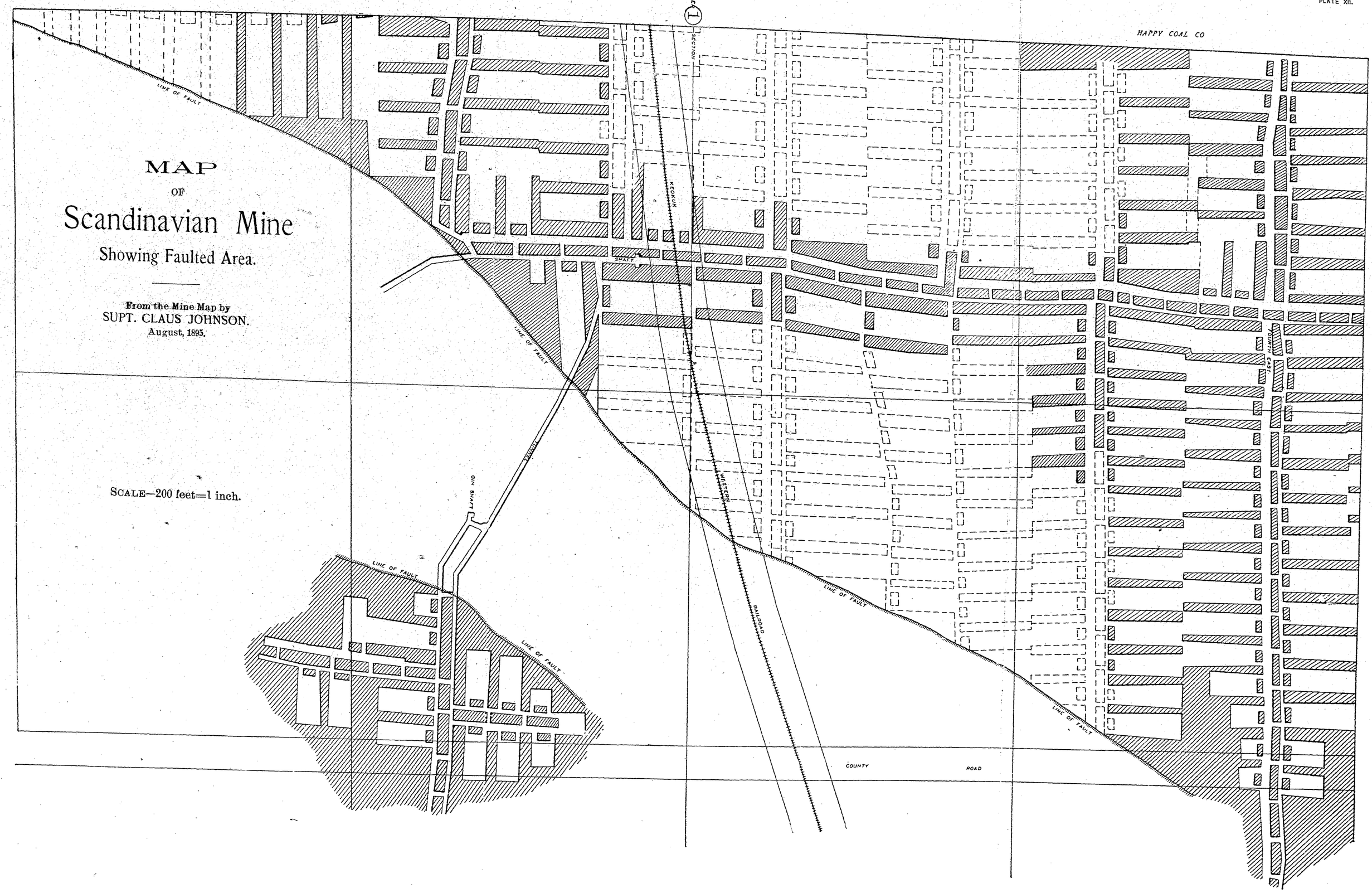
OF

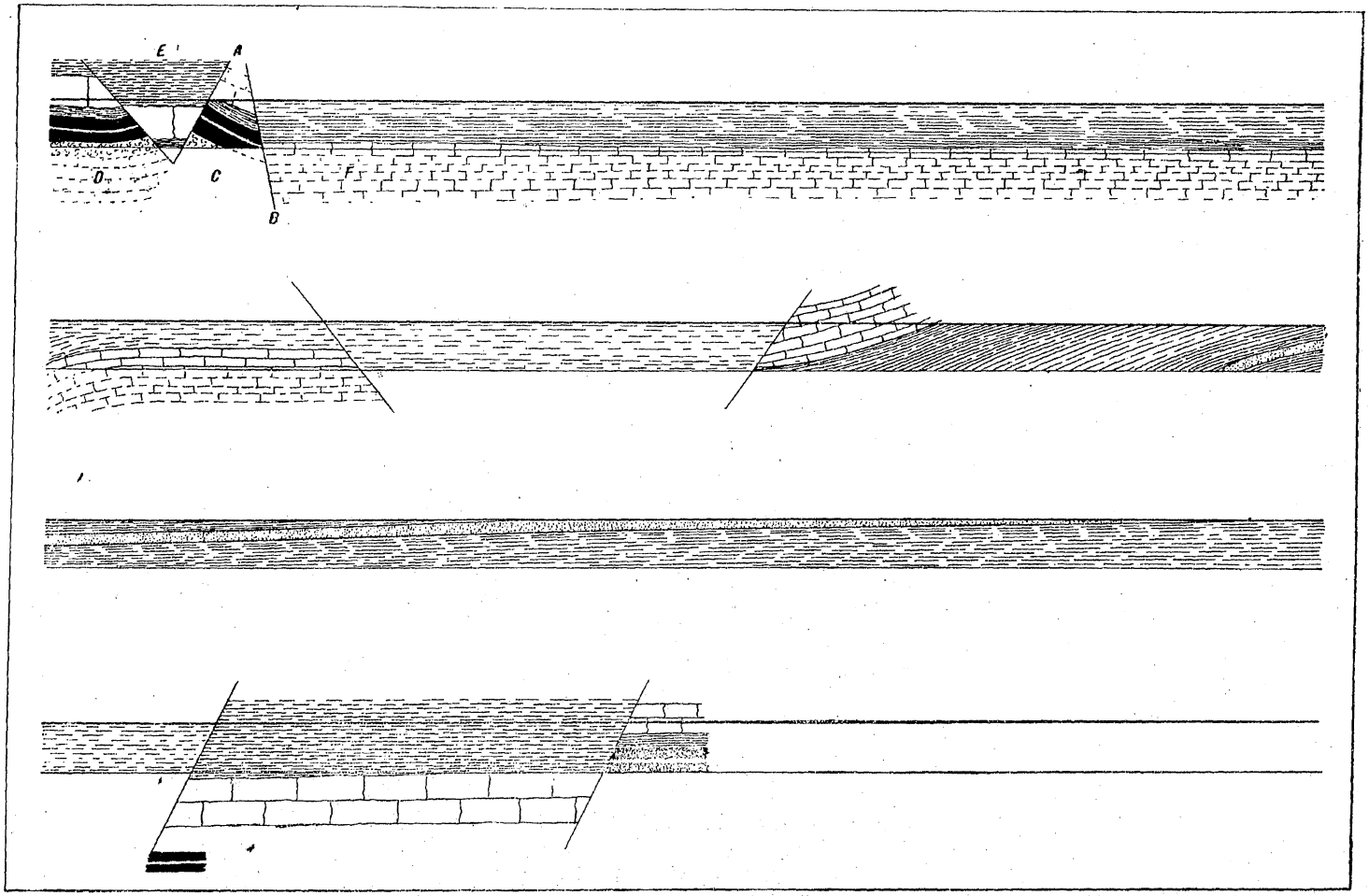
Scandinavian Mine

Showing Faulted Area.

From the Mine Map by
SUPT. CLAUS JOHNSON.
August, 1895.

SCALE—200 feet=1 inch.





SECTION ACROSS THE SCANDINAVIAN FAULT.

It will be noticed, from a study of the section along the tunnel at the Scandinavian mine, plate xiii, that there is no gain in altitude on either side of the faulted area. There is merely a long, narrow block of strata that has dropped down, as if a broad crack had opened out and allowed the strata along one edge to slip down into the opening. Essentially the same thing in miniature is shown at the point where the fault is first entered by the tunnel. The slipping of the strata along the line A–B has pushed the block C over against D and allowed the block E to drop into the resulting

FIG. 65. Shales in pit of the Centerville Brick & Tile Co., showing disturbance due to Scandinavian fault.

crack. Hence a wedge of the cap rock occupies a position between two blocks of coal. The pressure of C against the lower portion of D has produced the anomaly of strata bending upward towards a down-throw fault.

The amount of displacement is about fifty feet, as is shown by the presence of the fifty-foot limestone, F, beyond the

line of slip A–B. This limestone is recognized by its thickness and character as well as by the character of the attendant shales and the succession in which the various beds are traversed by the tunnel.

The presence of a faulted area of this size, at least three-quarters of a mile long and 450 feet wide, and having a throw of fifty feet, is unusual in the Iowa coal measures. Indeed, this is believed to be the first clearly proven instance of so great a true fault.

The time at which this disturbance took place is unknown. In the pits of the Centerville Brick & Tile Co. located on the same property, the disturbance shows in the overlying shales, as seen in figure 65.

It did not then take place until after the whole of these coal measures was deposited. Despite local belief to the contrary, there are no topographic indications distinguishing the faulted area, and the drift shows no disturbance over the fault. It must then have preceded the ice invasion. More than that it is impossible to say.

NUMA DOME.

The Appanoose beds have a general dip to the southwest. This is on the whole about ten feet to the mile, and is in a general way conformable to the upper surface of the Saint Louis. It is interrupted in this county by a broad, low anticlinal, or more probably dome-like structure, which is crossed nearly at right angles to its greatest length by the section from Ottumwa to Seymour. It is quite possible that this dome should be represented upon that section as extending farther west, and that the resulting dip to Seymour should be greater. Since, however, the data for the exact amount of this western expansion are not at hand, it has not been represented. Toward the north, along the Chariton river, the anticlinal seems to die out, or possibly bears off to the northwest. Southward it is quite apparent.

At Numa the coal is about 90 feet higher than at Centerville, while at Seymour it is something more that 100 feet

lower. At Cincinnati the coal is about fifty feet above the same seam at Hilltown, directly east. These various levels show the presence of a broad low dome reaching its maximum elevation not far from Numa.

DEEPER COAL SEAMS.

The presence or absence of deeper coal seams in this region is a matter of considerable scientific and economic import. The strata which lie below the Appanoose beds represent the more typical phases of the Des Moines terrane. This phase, in the regions north, east and south, contains numerous workable beds of coal usually of greater thickness than the Mystic seam but of more limited extent. In the section from Ottumwa to Seymour (plate xiv) it will be seen that there are, between the Saint Louis and the Mystic coal, three horizons along which coal of workable thickness has been found, as well as one minor horizon which may, or may not, show coal of a thickness sufficient to be valuable. The lowermost of these horizons is 425 feet below the Mystic coal and from ten to fifty feet above the Saint Louis. It is first seen in an exposure (No. 2) on Bear creek just south of the railway mile post 325 (Tp. 72 W., R. XIV W., Sec. 28). The section at this point shows the following beds.

		FEET.	INCHES.
11.	Kansan drift sheet	12	
10.	Shale, gray, clayey	30	
9.	Limestone, bituminous		6
8.	Shale, bituminous	8	
7.	Coal	1	
6.	Shale, black, fissile	13	
5.	Limestone, bituminous		3
4.	Shale, black, fissile	4	
3.	Coal	1	
2.	Shale, gray	2	6
1.	Shale, arenaceous	25	

About two miles west is an exposure (No. 3) of sandstone covered by bituminous shale, probably representing the horizon of the upper coal seam on Bear creek, and underlain by a coal bed which lies probably along the same horizon as the

lower coal seam at that exposure. This lower coal seam has been worked near Bidwell, by a number of small mines in which it is reported to be four to four and one-half feet thick. A bed lying at about the proper level to be its continuation has been reported in borings (No. 5) at Appanoose.

The coal worked at the latter place is about four feet thick and seems to represent the horizon lying 300 feet below the Mystic coal, though it is here fifteen feet nearer the lower seam than usual. If the dip be regular, and there is no evidence at hand indicating the contrary, the coal at Appanoose belongs to the horizon worked at the Deep Vein mine (No. 7) at Foster. Above it, at Appanoose, are two veins which have their representatives at Foster in beds eight and thirteen inches thick. The thicker bed represents the horizon 150 feet below the Mystic coal. How far west from Foster these various beds continue can not be positively stated, but borings made between that place and Moravia during the summer of 1895, show that they are present for some distance at least.

When the boring already referred to was carried on at Udell, one hole was carried to a depth of 300 feet. It is reported that it ended in a bed of coal which, while exact measurements can not be given, was certainly thicker than the upper vein. If the correlations already suggested be true, this lower vein at Udell would belong to the horizon 150 feet below the Mystic coal, though at this place it is a few feet above its normal level.

In Putman county, Missouri, there are two seams of coal, one two feet four inches, and the other one foot six inches thick, which, according to Broadhead,* are stratigraphically 105 and 125 feet respectively below the Mystic coal. Whether these beds extend in workable condition under the latter seam can only be told by drilling.

So far but two bore holes have been carried through the Mystic coal down to the Saint Louis within the area under

*Geol. Surv. Mo., 1873-74, pp. 280-283. 1874.

consideration. Both of these were at Centerville. Of the former no complete record is at hand, though the lower portion has been admirably worked out by Norton.*

The drillers' notes for the second well down to the Saint Louis are as follows.

		FEET.
19.	Drift	90
18.	Rock	2
17.	Shale, variegated	18
16.	Rock	2—3
15.	Shale	8
14.	Rock	5
13.	Shale	75
12.	Rock, fossiliferous limestone	2
11.	Shale, black to variegated	30
10.	Shale, arenaceous	15
9.	Coal	1½
8.	Shale, arenaceous	74
7.	Rock	2
6.	Shale, variegated	170
5.	Shale, white	30
4.	Rock	34
3.	Shale, variegated, a few thin harder bands	44
2.	Shale, arenaceous	28
1.	Limestone	

This record is exceptional in that the upper portion does not show the normal succession of strata. It is merely inserted as of possible future value in connection with later drillings; no attempt can be made at its correlation. The only coal noted is at about 115 feet below the level of the Mystic bed and in that particular the record agrees with the other borings and sections mentioned. The beds spoken of above as "rock" are probably, in most cases at least, limestone. Pieces from several of the layers greatly resemble the limestone ledges outcropping in the vicinity.

In what has been said in regard to lower horizons, it must be borne in mind that the lower coal horizons of the Des Moines formation are characteristically non-persistent; and that it is not to be expected that coal, if present, will be uniformly

*Iowa Geol. Surv., Vol. III, pp. 205-210. 1895.

distributed along any of them. The horizons indicated simply represent planes of greater probability, and the horizons 150, 300 and 425 feet below the coal now worked, are considered as most favorable. In any event there are between the Mystic coal and the Saint Louis from 500 to 600 feet of strata in which the prospects for finding coal are as good as in any unprospected territory in Polk or Boone counties.

PLEISTOCENE.

The Pleistocene beds of this region include representatives of the Kansan drift sheet, a loess-silt and certain small areas of alluvium. The entire thickness of these beds is not great except along lines of preglacial drainage. At many points the coal measures come to the surface and over large areas they are only thinly covered by drift. This is not true, however, of the region east of the Chariton, for here the surface is heavily drift covered. Indeed the divide between the Chariton and the waters of the Fox river and Soap creek is apparently very largely a drift divide. At Udell the drift is 150 feet thick. Near Moravia it is probably not much less, since the deep streamways in the immediate vicinity of the town show no exposures of the indurated rocks.

KANSAS DRIFT SHEET.

The heavy drift or till beds of the county may be referred to the Kansan age. They are excellently exposed at many points and may be studied in almost any ravine in the county. Fundamentally this drift sheet is here, as in regions farther north, a blue clay; but the upper portion is often yellow or even reddish-brown. Below, the drift is stiff and hard. Above it is more usually arenaceous, open and friable. It contains a considerable amount of local material and bits of wood and coal are not uncommon. In digging the shaft at the Anchor mine No. 2, the following section was passed through.

		FEET.
6.	Surface clay	20
5.	Sand	12

		FEET.
4.	Conglomerate	1
3.	Sand	4
2.	Blue clay	20
1.	Indurated rocks	

Numbers 2 to 5 inclusive may be referred to the Kansan drift. The blue clay here contained an unusual wealth of local material including wood, shales, limestone, pyrites and coal. No. 4, probably represents a locally indurated gravel bed.

The boulders of the drift are usually of small size. Large boulders are very infrequent. The rocks present are largely basic and show many planed and striated surfaces. They are badly weathered and may frequently be easily crushed. Along Shoal creek north of Cincinnati, and Manson branch near Centerville, large numbers have been segregated by steam action.

The upper surface of the drift, where it is covered by the loess-silt is marked by a zone of reddish-brown sandy material. It shows weathering action and the loose open character of soil. Where the drift is not covered by loess-like silt, this upper, weathered portion is usually blackened to a depth of six to eight inches.

LOESS-SILT.

The upper surface of the drift is topographically, almost parallel to the present surface. Over a considerable portion of the county it is the present surface. In other portions the drift is covered by a later deposit of loess-like silt which, in character and origin, seems much like the white clays of the Ohio valley, as described by Leverett.* The loess-silt forms a mere veneer over the drift surface. It may be examined in the various railway cuts, particularly those near Moravia already mentioned.

The deposit caps the hill upon which the public square at Centerville is located and may be seen on the high drift plain between Cooper and Shoal creeks. As seen at the former

*Amer. Geologist, X, 18-24. 1892.

point it shows particularly well its clay-like features, as contrasted with the more open porous nature of the loess proper. The loess-silt is not everywhere present. At many points the coal measures themselves form the surface rocks; at others the drift alone covers them. The loess-silt rests upon both coal measures and drift though more usually upon the latter.

ALLUVIUM.

Along the Chariton river and many of the minor streams, true alluvial deposits occur. The beds are characterized by a loose open texture, a normal sandy constitution, and a usual black color. They are usually of excellent agricultural capabilities except that certain portions of the broad flood plains need artificial drainage. In part the latter are subject to overflow.

DESCRIPTION OF PLATES.

PLATE XI.

Sections exposed along the Chariton river. The number under each exposure refers to a corresponding number in the text.

PLATE XII.

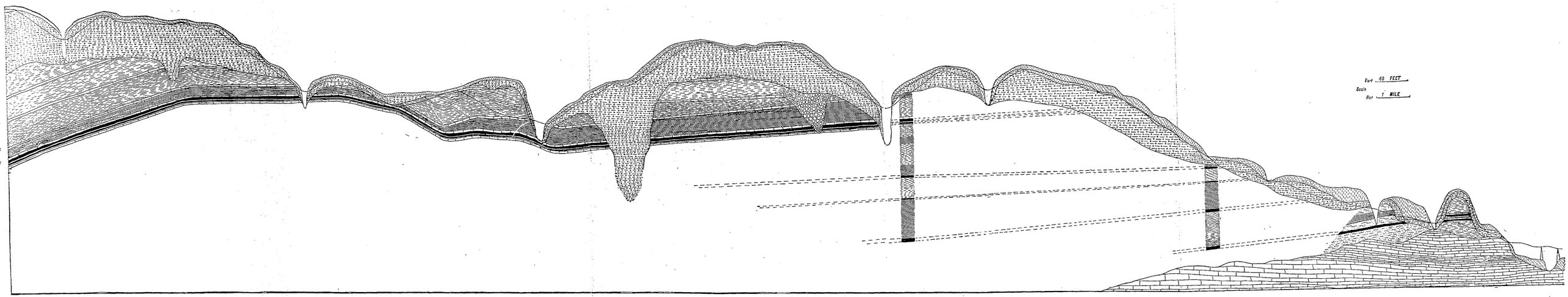
Map of the Scandinavian fault. Drawn from the mine map of Superintendent Claus Johnson. The shaded areas represent coal remaining. The land lines divide the area into forty acre tracts. The scale is about 150 feet per inch.

PLATE XIII.

Section across the Scandinavian fault. This section is based upon the exposures along the tunnel connecting the old and new workings. The vertical and horizontal scales are the same—twenty feet to the inch.

PLATE XIV.

Geological cross-section, Ottumwa to Seymour. The numbers at the bottom refer to localities as follows: (1) Des Moines river, Ottumwa; (2) exposure on Bear creek; (3) sandstone near Bidwell; (4) Bidwell; (5) Appanoose mine; (6)



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

GEOLOGICAL SECTION ALONG CHICAGO, MILWAUKEE & ST. PAUL RAILWAY FROM OTTUMWA TO SEYMOUR.

Blakesburg; (7) Deep Vein Mine at Foster; (8) Chariton conglomerate; (9) Moravia; (10) Preglacial valley; (11) Iowa Central crossing; (12) Chariton river at Darby; (13) Mystic; (14) Big Walnut creek; (15) Jerome; (16) Seymour. The formations are referred to by letters as follows: (a) Saint Louis limestone; (b) Mystic coal with cap and bottom rocks; (c) eighteen-foot rock; (d) fifty-foot rock; (e) floating rock; (f) Kansas drift; (g) loess-silt. The railway grade is represented by a continuous black line.

ECONOMIC PRODUCTS.

COAL.

COAL LANDS.

The whole of Appanoose county may be considered to be coal land since there is no portion of it which is not legitimate ground for prospecting. The area, however, which is already known to contain coal is somewhat less. The area underlain by the Mystic coal is, so far as now known, delimited upon the accompanying map. It includes in all 298 square miles, or 190,720 acres. The coal will average about two and one-half feet in thickness for the entire area, and upon the basis of 1,200 long tons per acre for each foot of thickness, should yield 3,600 short tons per acre.

Estimates made from the amount of royalty actually received show that near Cincinnati about 2,240 tons per acre is obtained in actual mining practice. The work upon which the estimates is based represents average room and pillar work as carried on in the region. According to these figures only 62 per cent of the coal is hoisted. The Pennsylvania Coal Waste Commission estimated* that in the anthracite region of that state the coal won since the opening of the mines has been not more than 35 per cent. The important differences in the thickness of the beds and the dip of the strata in the two regions, as well as many other circumstances, are favorable to the Iowa field.

*Rept. Coal Waste Comm., p. 148. Philadelphia, 1893.

Of the total area indicated as underlain by the Mystic coal, about 18,457 acres is owned or leased by mining companies or is held as coal land. This includes 16,510 acres held by mining companies and now under development, though of course not all of this area can be reached by the shafts now opened. The areas held by the local mines are in only a few instances included, since such leases are in many cases not recorded and hence are not accessible. The leases held by these companies are for small areas and the sum would not greatly increase the figures given above. In addition to the 16,510 acres now being developed 1,947 acres are held as coal lands and taxed as such. The remainder of the region is held as farm land only; although of course a considerable portion is owned by people who will eventually open it up for mining. According to these figures a little less than 10 per cent of the known coal land of the county is now taken up. A number of the companies own the land which they are developing. Others merely own the coal. Most of the mines are probably worked on leased ground. Where the coal alone is bought it costs about $10 per acre, with the option of prospecting. Coal land already prospected usually sells for about $15 per acre. Over the greater portion of the region it is not now customary to prospect with any thoroughness, if indeed any drilling at all be done. Where the land is leased the royalty is 4, 5, 5¼ or 6¼ cents per ton. Early leases were sometimes as high as 12½ cents. At 6¼ cents the royalty amounts to from $125 to $150 per acre, with an average probably of $140 with ordinary room and pillar workings. The amount obtained under long-wall working can not be stated.

CHARACTER OF MYSTIC COAL.

The Mystic coal is a non-caking, free-burning coal. It is of quite uniform texture, breaks in block form, and presents clean conchoidal surfaces. It is fragile and will not stand rough handling or long continued exposure.

The following analyses may be taken as fairly representative except in the matter of moisture. The samples were,

unfortunately, unequally dried so that the moisture content should be neglected. As arranged these analyses show first the result as obtained from analyses; in the second column the analyses have been calculated on a dry basis; in the third they are calculated on a moisture basis of 7 per cent, which is about the average for Iowa coals. The analyses were made by Professor G. E. Patrick, chemist to the survey.

ANALYSES OF MYSTIC COAL.

Thistle Mine, Cincinnati.

	Analyzed.	Calculated to dry basis.	Calculated 7 per cent water basis.
Water	5.80	.....	7.00
Volatile combustible (by difference)	37.71	40.03	37.23
Fixed carbon	53.00	56.26	52.32
Ash	3.49	3.71	3.45
Sulphur unoxidized	2.97	3 15	2.93
Sulphur in sulphates	.05	.05	.05

Diamond Mine, C. B. C. Co. No. 1

Water	10.12	.....	7.00
Volatile combustible (by difference)	35.63	39.64	36.87
Fixed carbon	48.04	53.45	49.71
Ash	6.21	6.91	6.42
Sulphur unoxidized	2.20	2.45	2.28
Sulphur in sulphates	.07	.08	.07

The coal is in demand for domestic purposes over a wide territory. Large quantities go to the markets at Omaha, Sioux City and Sioux Falls, as well as numerous other points in Iowa, South Dakota and Nebraska. Some of the Iowa product is marketed in Missouri and Kansas, though that territory is largely supplied by the Missouri mines.

While used to a considerable extent for steaming purposes, the main portion of the coal must always be sold for household use. It has never been used for gas or coke except experimentally. At one time the Diamond Coal Co. of Centerville, now succeeded by the Centerville Block Coal Co., made

some crude experiments to determine the coking value of the coal. The coal was burned in a surface heap and produced a rather light coke of good appearance but low strength. The experiment seemed to indicate that the lower bench was better than the upper. Near Confidence, in Wayne county, the same coal has been coked. Here, as at Centerville, the product was of low crushing strength. The coal is not a normal caking or coking coal. It does not melt and run together in burning; so that any coke made from it by ordinary burning would be of only moderate strength at most. It is possible that some of the newer ovens, by securing a deposition of the excess of volatile matter, might make a good grade of coke from the coal. If so, this seam would offer an excellent opportunity for the development of a coke industry since its purity and regularity guarantee a steady supply of coal having uniform coking value.

MINING METHODS.

There are three general plans of mine work in this region. The first is regular longwall, which is now used in some of the largest and best mines, and is being rapidly introduced throughout the region. The second is room and pillar, and the third is a modified form, developed in this region and for a time used largely in the smaller mines. It is known as semi-longwall.

In room and pillar work in this field, as carried on in most of the mines by hand labor, the cross-entries are driven 300 feet apart. The pillars along the main roadways are usually twenty-four feet thick. The entries are eight feet wide and taken from cap rock to bottom rock. The rooms are 150 feet long and forty to fifty feet wide. In the summer of 1895 the scale of prices was as follows.

Room work—

Coal to October 1st (screened)	$ .70
After October 1st	.80

Narrow work—Summer—	
Yardage	$ 1.10
Lifting bottom and shooting down top	.90
Coal, per ton	.70
Narrow work—Winter—	
Yardage	1.20
Top and bottom	1.00
Coal	.80

There has been a change, and the prices paid are somewhat different. At the old price a yard of entry work in summer cost about $3.40, and in winter $3.80.

In working with machines, as carried on in three of the mines of the Centerville Block Coal Co., the entries are driven ten feet wide and the cross-entries are run at distances of 400 feet. The machines in use are the Legg and the Harrison. They are used mainly in driving entries and turning rooms. But little room work proper is done by them. Compressed air, at eighty pounds, delivered from a Norwalk compressor, is used. In entry driving and turning rooms the Legg machine does the under-cutting, and is followed by a Harrison, which cuts the corners. The coal is then wedged down.

The Legg machines have a three and one-half foot bar, and are supposed to make a five-foot cut. They average, in actual work, four feet eight inches. Three cuts are made to an entry, each taking about ten minutes. The under-cut is five and one-half inches high. Two men are employed at each machine. As quick as the under-cutting is done at one point the Legg machine moves on to the next and is followed by a Harrison, which cuts out the corners. The Harrison machine requires two men, a runner at $2.30 per day and a helper at $1.60. Each machine is expected to cut sixteen corners, the equivalent of eighty entry cuts per day, which would make the cost of each forty-eight cents. Very frequently, however, as many as twenty-one cuts are made, and this reduces the average cost to about the figures given below. Measurements of cuts made in actual work show lengths of 52, 52½, 61 inches each. In shearing, a cut about four inches wide is made.

One cut, or "rib," furnishes about three tons of coal and three cars of dirt. The dirt is hoisted and dumped in narrow work, but in room work is usually gobbed. In narrow work the two machines will make eight to ten entry cuts per day of ten hours, and keep from four to six followers busy. In wide work, where there are twelve under-cuts to a room, they make about thirty cuts per day and keep eight to ten men busy. A four-foot eight-inch cut on a ten-foot entry, ready for track, costs about as follows.

Under-cut	$ .24
Shearing	.37
Coal, three tons, at thirty-four cents	1.02
Brushing top	.84
Total	$2.47

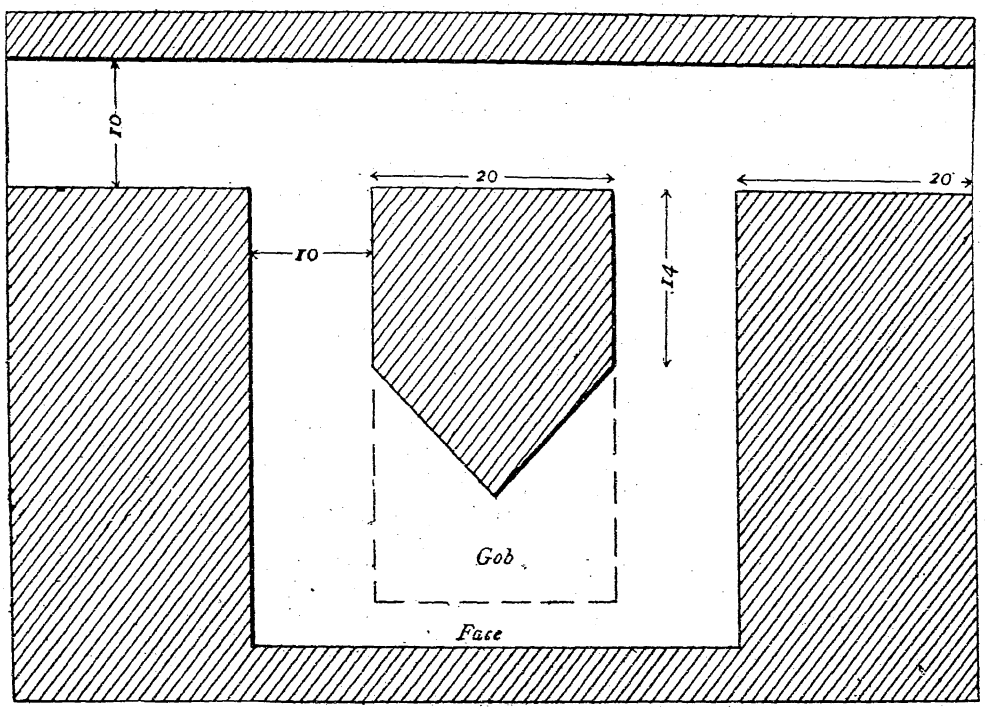


FIG. 66. Room and pillar work in Mystic coal.

In comparing these figures with hand labor it must be remembered that a machine cut is forty-eight, and a hand cut thirty-six inches. On the other hand the machine must bear the cost of repairs, depreciation, interest, etc.

In turning rooms two ten-foot doors are driven in fourteen feet, and then opened out as shown in the diagram above.

After the doorway has been cut in this distance, the room is turned over to the miners, who drive it forward by undercutting, shearing and wedging, till the room from the opposite cross-entry is met. The rooms are then left till that portion of the mine is about to be abandoned, when the pillars are pulled. By that time, usually two years or more, much of the coal is not worth saving.

In mine No. 19 of the Whitebreast Fuel Co., located at Forbush, a number of different machines were formerly used in working the coal. As they were mainly used in entry driving, a change to longwall work made them unnecessary. Two Stanley headers were used most. These machines cut out by bits a five-inch line around a circle five feet in diameter and bore a two-inch hole in the center; resembling in effect an immense auger. The machine moves forward about two feet, when a light charge of powder is used to bring down the coal. The machine is mounted on rails and driven by air at sixty pounds pressure. Three men are employed at each machine; a runner, and front and rear loaders. It makes in the Mystic coal an average of about ten feet a day, though as high as fifteen feet have been made. Detailed estimates of cost are not at hand, but the superintendent of the mine expressed himself as well satisfied with the results attained. In the same mine the Mitchell machine was at one time used to some extent.

In the semi-longwall work no machines are used, and the method is itself being gradually superseded by regular longwall. As seen in the Lodwick brothers' mine, the former work is about as follows. The usual cross-entries are driven at suitable distances along the main entry. The rooms are turned as usual with the exception that no pillar is left between adjoining rooms. As a result the work opens up as shown in figure 67.

As the work moves forward each man mines forty feet of face with his roadway in the center. He builds his own pack walls and sets the timbers. The coal is cut under one and

one-half to two feet and held up temporarily by sprags. No powder is used, as the weight brings the coal down as fast as it can be used.

The large number of mines in the district which have changed or are changing to longwall workings makes the

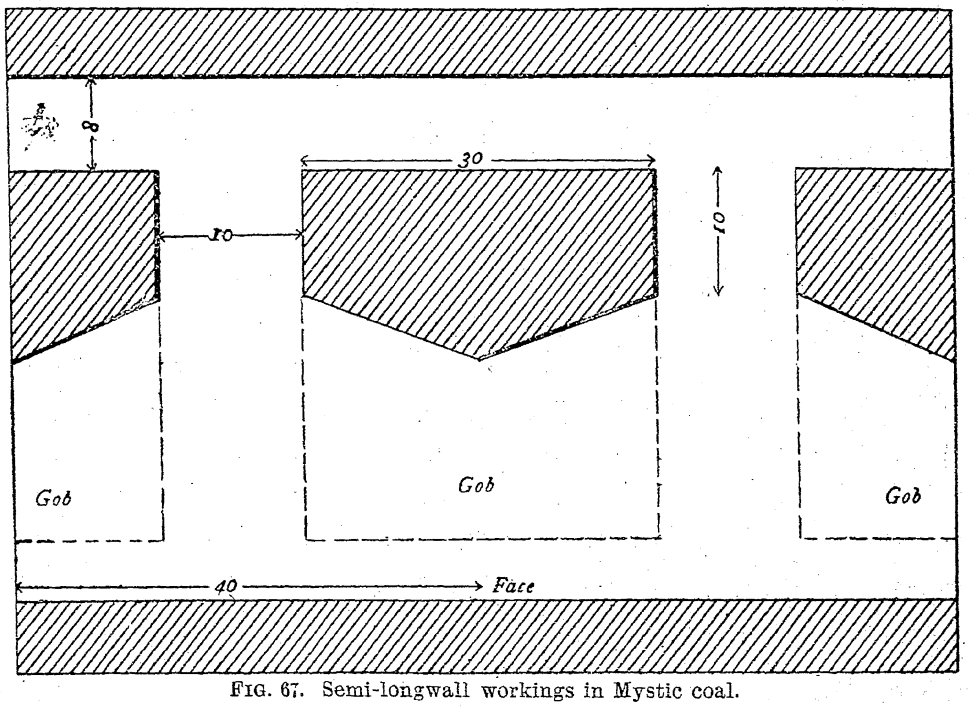


FIG. 67. Semi-longwall workings in Mystic coal.

success of a longwall machine a matter of some importance. The Peerless Coal Co. have been for some time experimenting on such a machine, but as the patents have not yet been allowed any description would be premature.

MINES.

The Appanoose county mines are scattered throughout the southwestern half of the county. They are located on the accompanying map by numbers corresponding to the following descriptions. No attempt has been made to locate all of the local banks, though it is believed that most of them appear on the map. The ease with which coal is obtained, and the small capital necessary for opening such a mine, make the number of country mines exceptionally large,

These properties, however, change hands so frequently and are worked so intermittently, that an exact list is impossible.

CENTERVILLE BLOCK COAL CO.

This company was organized in 1894 by the consolidation of several previously independent companies. Other mines have been leased and a new one opened, until now the company has nine mines of its own, and in addition operates the National.

Number 1 was formerly known as the Diamond No. 1. It is just east of Centerville on the Chicago, Rock Island & Pacific railroad and has also a switch from the Keokuk & Western. The coal lies at a depth of 138 feet and measures as follows in a representative section.

		FEET.	INCHES.
6.	Cap rock limestone	2	6
5.	Clod	1	
4.	Slate		8
3.	Clay		2
2.	Coal, including "the Dutchman"		12
1.	Fire clay		

This mine is particularly well equipped. The plant includes a tail rope system, the usual hoisting plant, and a compressed air plant with a Norwalk 24–20 compressor. In the mine three Harrison and four Legg machines are in use. The machines are used principally on narrow work. The coal lies level except toward the north where a rather heavy dip, presumably local, has been encountered.

Number 2 is located at Numa just west of town. It is a shaft 140 feet deep and was formerly the property of the Diamond Coal Co.

Number 3 was formerly known as the Relay mine and belonged to the Centerville Coal Co. It is a shaft 107 feet deep sunk in the valley of Cooper creek between the Iowa Central and the Keokuk & Western railroads. The company loads on both tracks. The equipment is good. Legg and Harrison machines are used as in No. 1. It was near this mine that the old workings at Talbot's Mill, mentioned by

White, were located. At one time these workings were broken into by the Relay entries. In the Relay mine has been encountered one of the heaviest dips found in the field. In a distance of 1,944 feet the coal rose thirty-six feet.

Number 4 is located at Brazil, opposite the Phœnix. It was formerly known as the Philby mine and is a slope, worked on the semi-longwall plan.

Number 5 was originally known as the Hawkeye mine. Later it passed into the hands of the Walnut Block Coal Co., and eventually came into the possession of the present company. It is a slope on the east side of the K. & W. at Brazil, and lies betwen the Phœnix and the Tipton.

FIG. 68. Mine No. 9, Centerville Block Coal Co. Taken from the rear and showing boiler house, tipple, engine room, etc.

Number 6 was formerly known as the Silknetter mine. It is on the east side of the K. & W., north of the Phœnix.

Number 7 is a slope mine at the K. & W. crossing, north of Brazil. Coal is loaded on the Keokuk & Western railroad. The mine was at one time known as the Enterprise mine, and later as Walnut Block No. 3.

Number 8 (61) is a small mine just south of Number 3. It was formerly known as the Richardson and the Ulrich mine. The shaft is sixty-eight feet deep, starting well down in the valley of a tributary of Manson branch. The fifty-foot rock is exposed in the creek near the mine, and the cap rock, while absent at the shaft, comes in a short distance away.

The coal is hoisted by horse power gin. The mine is now operated by the City Coal Co. on a lease from the Centerville Block Co.

Number 9 is a new mine opened north of Number 3. It is on the Iowa Central railway down in the valley of Cooper creek. The shaft is seventy-two feet deep, the upper twenty-two feet being drift. At the bottom a measured section showed.

		FEET.	INCHES.
11.	Cap rock	1	6
10.	Clod		7
9.	Slate		7
8.	Coal	1	6
7.	Clay		2
6.	Coal		12½
5.	Clay and pyrite; the "Dutchman"		1
4.	Coal		1½
3.	Fire clay	1	2
2.	Bottom rock		10
1.	Shale, soft, sandy		

Farther in the mine the bottom rock is thicker. The fire clay is usually also thicker though in the first south of the west side, it is, at one point, barely a foot thick. Near the air shaft the clod disappears, and the slate is only about eight inches thick. The cap rock is more argillaceous and air-slacks some. The thickness of the coal varies slightly as shown by the following measurements, being taken at various points in the mine.

I.

		FEET.	INCHES.
3.	Coal	1	6
2.	Clay		1–2
1.	Coal; to "Dutchman"	1	2

II.

3.	Coal	1	7
2.	Clay		2
1.	Coal; to "Dutchman"	1	

III.

3.	Coal	1	5
2.	Clay		2
1.	Coal; to "Dutchman"	1	3

IV.

		FEET.	INCHES.
5.	Clod		9
4.	Slate	1	
3.	Coal	1	6
2.	Clay		2
1.	Coal; to "Dutchman"	1	

A short distance from where the last measurement was taken the clod disappears and the slate is only ten inches thick. Faults of great extent have so far not been encountered. A few minor slips do however occur. In one case a thicker bit of "black bat" has been pushed down into the coal. The mine is well arranged and equipped for hoisting a large output. Legg and Harrison machines are in use in driving entries and turning rooms. The shaft is larger than is common in this field, being 7 by 14 instead of 6 by 12, the usual size.

(13) NATIONAL FUEL CO.

The National mine is one of the older mines of the district and was formerly known as the Watson. It is now operated by the Centerville Block Coal Co. The shaft is 147 feet deep and is located on the C., R. I. & P. railway a short distance south of the station. The mine is well equipped with new topworks replacing those burned in 1892. The coal is regular and of the usual thickness. In working north and west a fault was encountered which cut off the coal.

(12) STANDARD COAL CO.

The Standard mine is located in the southeast quarter of Centerville. The coal averages about thirty to thirty-two inches clean, and lies 135 feet below the surface. The cap rock and other overlying beds are found in place. The coal is brought to the foot of the shaft by a tail rope operated from the surface. The hoisting plant is of the usual character. The company loads upon both the C., R. I. & P. and K. & W. railways.

(11) RAVEN COAL CO.

The Raven mine is a new shaft, located a mile east of Centerville, on the C., R. I. & P. railroad. In sinking the shaft

rather more than the usual thickness of drift was encountered, ninety feet being found in the main shaft. The first shaft was sunk a short distance east of the present location, but was abandoned at a depth of seventy-two feet because of the water which came from a sand layer in the drift. The coal lies at a depth of 150 feet. The regular sequence of strata is present in normal thickness, with the exception of the cap rock, which is, at the shaft, only one foot thick. The bottom rock is also thinner than usual, and below it is found sandstone.

ANCHOR COAL CO.

The Anchor Coal Co. operates two mines, No. 1 (9) being located in the southwest quarter of Centerville, on the K. & W. railway, and No. 2 (10) being two and a half miles south on

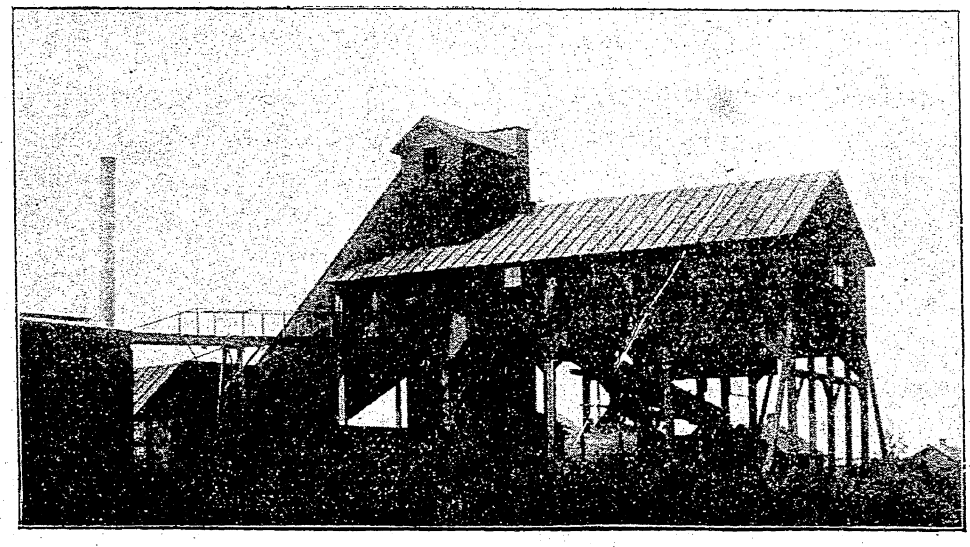


FIG. 69. Eldon mine No. 2, the usual type of top works seen in the region.

the C., R. I. & P. (Tp. 68 N., R. XVIII W., Sec. 13, Ne. qr., Nw. $\frac{1}{4}$). No. 1 is in the valley of Manson branch and reaches the coal at seventy feet. No. 2 is on the open plain, lying southwest of Centerville, the coal being found at 155 feet. The coal in each is of the usual character, and no faults of especial importance have so far been encountered. The section of the drift as found in sinking No. 2 has already been given.

(45) ELDON COAL CO.

The Eldon Coal Co. of Ottumwa has two mines; No. 1 is in Davis county, near Laddsdale, and No. 2 is in Appanoose, about three miles southwest of Centerville, on the C., R. I. & P. railroad. The latter mine is located on the high prairie, and reaches the coal at 145 feet. The drift extends in the air shaft down to the fifty-foot rock, which was struck at a depth of ninety feet. The little rock is twenty feet above the coal, and is only one and one-half feet thick. The coal has a slight general dip to the west.

(14) SCANDINAVIAN COAL CO.

The Scandinavian mine is located in the southwestern portion of Centerville, on the K. &. W. railroad. The mine has been operated under different names for about fourteen years, and in that time about 120 acres have been exhausted. The coal lies 100 feet below the K. & W. track, with the usual limestone rocks above. In the creek bed, near the mine, the fifty-foot rock and some of the underlying shales are exposed. The coal within the mine does not vary greatly, except in the vicinity of the fault which has been already described.

LOCAL COAL CO.

The Local Coal Co. is composed of representatives of the separate companies which mine coal for the local market at Centerville. It is not a mining company, but sells the output of the individual mines. The companies represented in it are the Monitor, Rock Valley, Star, Scandinavian, North Hill, Happy, and City.

(56) MONITOR COAL CO

The Monitor mine is a gin shaft, located within the town limits, a short distance northeast of the postoffice. The company has only a small lease, less than five acres, and hoists coal for the local trade. The coal runs level and lies at a depth of 140 feet, the mouth of the shaft being but little below the general level of the plateau upon which that portion of the city is built. The shaft is the usual size, having two hoisting compartments, which measure 4x4 in the clear.

(57) HAPPY COAL CO.

The Happy mine is a small shaft worked for the local trade. The lease includes twenty acres surrouded on three sides by the Scandinavian land, and on the west joining that of the Anchor No. 1. The shaft is 106 feet deep to the bottom of the coal. The workings have been cut through to connect with those of the Scandinavian.

(58) NORTH HILL COAL CO.

The mine operated by the North Hill Coal Co. is a shaft opened in 1893, and at one time was known as the Frisby mine. It is located in the northwestern quarter of Centerville. The lease covers six and three-fourths acres, and the coal is reached at 120 feet, starting some distance below the level of the public square. The coal near the bottom of the shaft measures as follows:

		FEET.	INCHES.
9.	Cap rock		
8.	Clod		4
7.	Slate		8
6.	Coal	1	8
5.	Clay		2
4.	Coal		11
3.	Clay		½
2.	Coal		1½
1.	Fire clay		

The middle clay parting (No. 5) is at one place barely a half inch thick, but a short distance down the entry it has its normal thickness. The coal is hoisted by gin and goes to the local market.

(59) ROCK VALLEY COAL CO.

The Rock Valley mine is a gin shaft eighty feet deep. The shaft is a little larger than usual in local mines. It is divided into three compartments measuring in the clear 5′x4′ 8″, 5′x4′ 8″ and 5′x2′ 4″. The smaller compartment is used as an air shaft. The company operates on a lease of thirty-three acres and the coal runs from 28 to 32 inches in thickness. The mouth of the shaft is located on the hillside. In the bed of

the ravine near by the fifty-foot limestone is well exposed. The strata penetrated in sinking the shaft were as follows.

		FEET.	INCHES.
11.	Drift	20	
10.	Fifty-foot limestone	10	
9.	Shale, in part blue argillaceous, and in part sandy	28	
8.	Seventeen-foot limestone	4	
7.	Black argillaceous shale	10	
6.	Cap rock, gray, argillaceous limestone	4	
5.	Clod and slate	1	3
4.	Coal	1	6
3.	Clay		2
2.	Coal, including the "Dutchman"	1	
1.	Fire clay		

It will be noticed that the seventeen-foot rock is quite well developed and lies eighteen feet above the coal. Both the fifty-foot and the cap rocks are fossiliferous. The coal lies level and is free from faults.

(60) STAR COAL CO.

The Star mine is just inside the east city line of Centerville. It is a gin shaft, hoisting coal for the city trade. The coal land consists of a small tract of less than five acres. The coal is reached at a depth of seventy-four feet and is about thirty-two inches thick. The normal succession of strata occurs.

WALNUT BLOCK COAL ASSOCIATION.

This association was formed in 1895 by the various mines in Appanoose county loading on the C., M. & St. P. railway. It is not a mining company, but controls the output of all but three of the mines. The general offices of the association are located at Mystic. The mines represented are as follows: The Superior Block Coal Co., the Darby Block Coal Co. and the American Coal Co. of Darby; the Star Coal Co. at Rathbun; Clark & Sons, Orr Bros., the Iowa Block Coal Co., the Lodwick Brothers, the Iowa and Missouri Coal Co., the Peerless Coal Co., C. L. Arnot, Brown & Bowers, the Mystic Fuel Co., the Lone Star Coal Co., the Walnut Creek Coal Co., the

Herl Coal Co., the Columbia Coal Co. and the Hazelton Coal Co. of Mystic; with the Gladstone Coal Co. and the Big Four Coal Co. at Jerome. The Carlton Coal Co., west of Mystic, while independent, sells some coal through the association. The Twin Coal Mining Co. and the Co-operative Coal Co. are the only ones who market their own output.

(16) THE SUPERIOR BLOCK COAL CO.

The Superior Block slopes are at present the extreme easterly mines of the group working along Walnut creek. The coal lies near the surface and is reached by two slopes, loading on the C., M. & St. P. railway.

(17) THE DARBY BLOCK COAL CO.

The Darby mine is a shaft fifty feet deep located at Darby, south and west of the Superior Block. The coal is loaded on the C., M. & St. P. railway.

(18) AMERICAN COAL CO.

The mine operated by the American Coal Co. was opened by the Evans Coal Co., and is known as the Evans mine. It is a shallow shaft mine, having a switch from the C., M. & St. P. railway, and lying to the north of the track, about half way between Darby and Rathbun. The coal is hoisted by a horse-power gin, and the bed is of the usual thickness. The cap rock and the little rock may be seen in the air shaft.

(19) STAR COAL CO.

The Star Coal Co. of Streator, Ill., operate the mine located at Rathbun. The shaft is eighty-two feet deep, and the coal is worked on the longwall plan.

(20) CLARK & SON.

Clark & Son operate a mine at a place called Clarksdale lying about two miles east of Mystic, on the C., M. & St. P. railway. The coal is reached at a depth of seventy feet. It is hoisted by a horse-power gin. Near the mine are good exposures of limestone along the railway track.

ORR BROTHERS.

Orr Brothers operate two mines. Number 1 (26) is a small slope lying on the south side of Walnut creek at Mystic, and loading on the Turkey river switch. Only a small tract of about fifteen acres is controlled here and the area is almost entirely mined out. Number 2 (21) is a shaft mine immediately west of Clarksdale and lying on the north side of the

FIG. 70. Floating rock near Clarksdale.

railway track. A large tract of land is under lease at this point. The coal is reached at seventy feet.

(22) THE IOWA BLOCK COAL CO.

The Iowa Block Coal Co. has a good territory under development on the south side of the railway west of Orrs' mine and east of Mystic. The coal is reached by a double track slope timbered with 8 by 8 timber and divided into two compartments each five and one-half feet wide at the top.

The double track continues into the mine about 500 feet. The coal is brought out by an endless rope driven by an Ottumwa engine. As a rule three cars are brought out in a trip, being attached by means of a Leavenworth grip. No conductor is required and a trip comes out in about three minutes. The cars are carried on a trestle over the creek to the tipple, where the coal is loaded on a switch from the main line of the Chicago, Milwaukee & St. Paul railway.

(23) LODWICK BROTHERS.

The Lodwick Brothers Coal & Mining Co. operate two slopes in the eastern edge of Mystic, loading on the reservoir switch. Coal is taken from both the east and the west side of the ravine. Recently a very carefully driven slope had been opened on the east side and it is proposed to connect both mines with this and load all the coal from one tipple. The slope is six feet high, ten feet wide at the top and twelve feet at the bottom, measured in the clear. At the mouth it is timbered for thirty yards with 8 by 8 stuff backed with two inch lumber. The next sixty yards merely requires a row of props in the middle, while beyond that, there is no timber of any kind. The slope is driven due north and carries two tracks. The cost was about $7 per yard for the first thirty yards, $3.75 for the following sixty, and $3.50 for the remainder.

The slope is an excellent piece of work and can be used to handle a very large output. Ultimately steam haulage will be put in. The coal is mined by the modified longwall plan. A face is being driven to the east from the main entry.

In working this mine a preglacial channel, now filled with drift, has been encountered and traced some distance in a northeasterly direction. It seems probable that it is the same that was encountered in working the old Sandbar mine toward the northwest. If so the channel would be about 1,200 feet wide. In certain parts of the mine the drift has been encountered where it does not cut down into the coal.

(46) IOWA & MISSOURI COAL CO.

The Iowa & Missouri Coal Co. operate a large slope mine immediately east of the Mystic railway station. The main entry is driven north. The slope is single track and the coal is brought out by a tail rope.

(25) C. L. ARNOT.

Starting southeast from the depot and running along the east side of Walnut creek is what is known as the Turkey river switch of the C., M. & St. P. railway. There are three mines, loading on this track. The first, from the depot, is the Orr slope already described, the second is the Arnot mine, and the third the Peerless. The Arnot mine is a small slope working about seventy acres on the modified longwall plan.

(26) PEERLESS COAL CO.

The Peerless Coal Co. is at present operating only one mine, though other land is held by the company. The mine from which they now load coal is the farthest east of those on Turkey river switch. West of it and near the Arnot mine is a second slope from which coal was formerly loaded. The output of this latter mine is now handled through the eastern slope. The Peerless mine was originally opened as the Henrietta and passed through several hands before being purchased by the present owners. The mouth of the slope has been recently retimbered, and a neat brick engine room has been built. The coal lies nearly level, the dip, which is northward, being four and one-half inches to the hundred feet. The mine is worked on the longwall plan by machinery. The machine in use was invented by Messrs. Lee, the proprietors, and has proven quite efficient. It is driven by a Thompson-Houston dynamo. For the present, mule haulage alone is used in the mine. A box car loader of a new pattern is under development.

(29) CO-OPERATIVE COAL CO.

Running west from near Mystic depot is a track known as the Catfish switch. There are three mines loading on this

track. The first is now known as the Co-operative and was formerly worked by the Peerless Co. It is a slope mine, on the north side of the track.

(28) BROWN & BOWERS.

The Brown & Bowers mine is a small slope, nearly opposite the Co-operative, and like it loading on the Catfish switch. West of the Brown & Bowers is a tract of undeveloped land held by the Peerless Co.

(29) MYSTIC FUEL CO.

The Mystic Fuel Co. controls a considerable area lying at the end of the Catfish switch. They load by means of a tramway running from the slopes down to the tipple on the railway track. This company now has the property formerly held by the Blackrod Coal Co.

(27) LONE STAR COAL CO.

The Lone Star mine is almost directly opposite the depot at Mystic. The coal is brought out through a drift on the south side of Walnut creek and carried over the creek on a

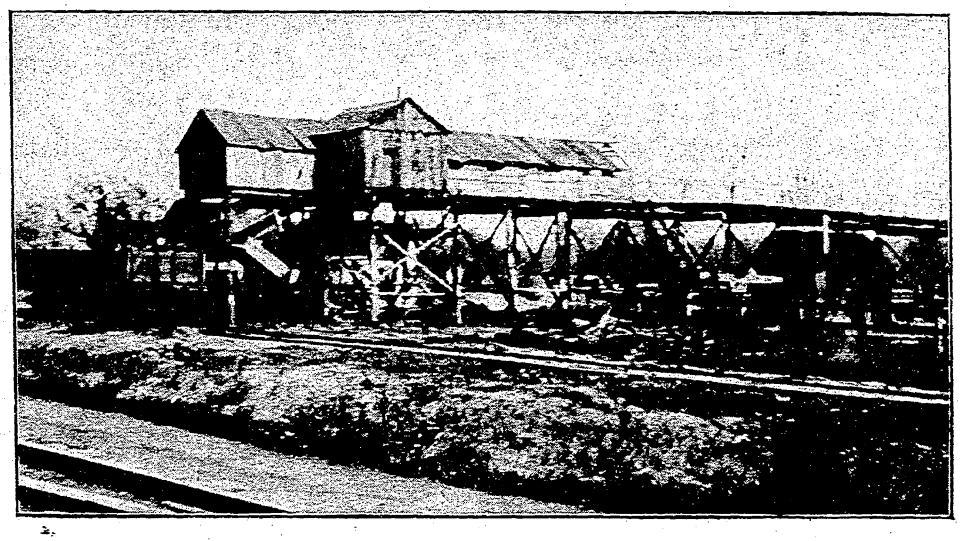


FIG. 71. Tipple at the Lone Star mine; representative of the smaller mines.

trestle to the tipple. A section of the coal as exposed near here has been already given.

(31) WALNUT CREEK COAL CO.

The Walnut Creek Coal Co. has recently obtained, and now operates, the Stormfeldt & De France mine. It is a slope, located on the south side of the C., M. & St. P. railway, about half way between Mystic and the K. & W. crossing.

(32) TWIN COAL MINING CO.

The Twin Coal Mining Co. operate what are known as the Twin mines, and which formerly belonged to the Peerless Coal Co. The mines are two shafts sunk a short distance apart and having underground connection. They have a switch from the C., M. & St. P. railway and are located near the K. & W. crossing. The coal is reached at a depth of forty feet.

(33) HERL COAL CO.

The Herl Coal mine is a shaft thirty feet deep lying just west of the Twin mines and formerly known as the Peerless No. 4. It loads on the C., M. & St. P. railway.

(34) CARLTON COAL CO.

The Carlton mine is a shaft fifty feet deep lying on the north side of the C., M. & St. P. railway, about a mile west of the K. & W. crossing. It is sometimes called the Diamond mine. For some time electric mining machines were used here. The mine is now operated by the Tipton Coal Co. and is on the same land that is worked by their mine Number 2.

(35) COLUMBIA COAL CO.

The Columbia mine is a slope on the south side of the railway track a short distance southwest of the Carlton mine.

(36) HAZLETON COAL CO.

The Hazelton mine is on the south side of the track about a mile west of the Columbia mine. The coal is reached by a slope as well as by a shaft seventy feet deep.

GLADSTONE COAL CO.

The Gladstone Coal Co. operate two mines, Number 1 (38) lying east of Jerome and Number 2 (39) west. The

former is 100 feet deep. In sinking it the upper limestones were not found in the regular shaft, though present in the air shaft. Their absence in the one case is probably due to preglacial erosion. Mine Number 2, west of town, was sunk in 1893 and is a well equipped shaft mine.

(37) BIG FOUR COAL CO.

The Big Four mine is at the eastern edge of Jerome, and is a shaft 125 feet deep. It loads on the C., M. & St. P. railway from the north side of the track.

TIPTON COAL CO.

The Tipton Coal Co. operates two mines at Brazil. No. 1 (40) is a drift located on the east side of the K. & W. railway, immediately south of the Centerville Block No. 5. It has been open for some years. No. 2 (41) is a slope located at the crossing of the K. & W. and the C., M. & St. P. railways, and was opened up by the Philips Fuel Co. of Ottumwa.

(42) BRAZIL COAL CO.

The Brazil mine is a slope lying west of the K. & W. railway. It has been open for a number of years and has passed under a number of different names. The territory belonging to the company is itself limited, but they have a lease of eighty acres from the Centerville Block Coal Co.

(43) PHŒNIX COAL CO.

The Phœnix is one of the older mines, located at Brazil. It is a drift, and lies between the Centerville Block mines 5 and 6. The company has recently leased additional land, so that the available territory is sufficient for some time to come.

(44) LANE COAL CO.

The mine of the Lane Coal Co. is located on the K. & W., at a place called Laneville, between Brazil and Centerville. It is a shaft mine and reaches the coal at a depth of seventy-five feet. Robert Campbell (62) and E. Stern (63) operate small mines for the local trade at Brazil.

(76) COAL VALLEY COAL CO.

At Numa, in addition to the Centerville Block Co.'s mine No. 2, is the shaft of the Coal Valley Coal Co. This mine is located south of town and sells largely to the local trade.

(49) APPANOOSE COAL CO.

At Cincinnati, in the southern part of the county, and on the C., B. & K. C. railway, there are a number of mines. In the eastern portion of the town is the Appanoose mine. The shaft is 180 feet deep, and the coal shows the normal thickness.

(47) THISTLE COAL CO.

The Thistle mine is east of Cincinnati, beyond the Appanoose shaft and on the north side of the railway. The shaft is 110 feet deep, and the coal is of the usual thickness. No faults of any economic import have been encountered, but a number of small slips of scientific interest occur in the mine.

(48) MERCHANTS COAL CO.

The Merchants, or, as it is locally known, the Hyatt shaft, lies south of the Thistle, and has an outlet over a spur from the C., B. & K. C. railway. The mine is a new one, opened in 1893, and is well equipped.

(50) ALBERT COAL CO.

The Albert shaft is south of Cincinnati and on the west side of the railroad. A section of the strata at the shaft has already been given.

(51) STREATOR BLOCK COAL CO.

The Streator mine lies south of the Albert, and the shaft is on the east side of the track. At this point it is eighty-six feet to the coal, the mouth of the shaft being thirteen feet above the track.

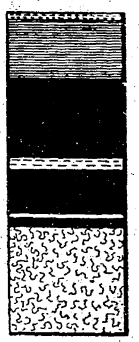
(52) CINCINNATI COAL CO.

The Cincinnati mine is a shaft sixty feet deep lying in the northern portion of the town. It, with the Kansas City (53)

and Hocking Valley (75) mines south of town, is worked mainly for local trade, though some coal is wagoned to the cars and shipped by each.

(74) PEARL CITY COAL CO.

The Pearl City mine is located very near the state line. It is a small shaft about twenty feet deep and shows the following strata as measured by Mr. A. C. Spencer.



		FEET.	INCHES.
8.	Shale, drab, clayey (exposed)		2
7.	Shale, black, highly bituminous	1	2
6.	Coal	1	6
5.	Clay parting		3
4.	Coal		10
3.	Clay parting		1
2.	Coal		2
1.	Fire clay (exposed)	2	

FIG. 72. Coal bed in Pearl City mine. Four miles south of Cincinnati.

(54) ROYAL COAL CO.

Near Exline there are two mines in operation. The larger is the Royal, located about two miles east of the station and loading coal on to the C., B. & K. C. railway. The mine is a drift and the coal is brought to the railway, by means of a tail rope. The second mine is the White Oak (55), a small shaft worked almost exclusively for the local trade, and located about three-fourths of a mile northwest of the station.

(15) WHITEBREAST FUEL CO. MINE 19.

The Whitebreast Fuel Co. own a large tract of land north of Centerville. Their mine No. 19 is located upon this land about four miles from the town mentioned, at a place called Forbush. The mine is large and well equipped and ships over the Iowa Central railway. Many details of the work at this place have already been given.

LOCAL MINES.

In addition to the mines listed above there are several important local plants. Near Hilltown in the southeastern

part of the county mining is quite extensively carried on for the country trade. The principal openings are the two Dickson mines (70), the Heim (71), and the Troublesome or Thompson mine (72). At Livingston in the southwestern part of the county the Parker mine (65), a shaft 110 feet deep, has been operated for some years. Northwest of Jerome is the Houser mine (64), near Plano is the Knight (77), and near Milledgeville are quite a number. Among the latter are the Fenton (66), Gurnsey (68), Mosby (69), and Young (67) mines. Northeast of Forbush there is a group of small mines along the Chariton, among which may be mentioned the Stevens (75) drift.

CLAYS.

There are two series of clays within the county which may be used in the manufacture of brick and other clay products. The first is the loess-silt and the second includes the shales of the coal measures.

The loess-silt is well adapted to manufacturing purposes. It is homogeneous, plastic, widely distributed, easily mixed and burns to a good color. In many important particulars it is resembled by the alluvium, though the loess-silt is usually a heavier clay. The alluvium itself is easily worked up into hand made brick, but is not at present used within the county.

The coal measure shales and fire clays are found throughout the county. They are readily obtained and adapted to a wide variety of treatment. Pavers, building brick, face brick and tile are among the products which may be made from these shales. Within the county the shales are interbedded with limestones and frequently contain a large lime content which greatly decreases their value. Where, as is usual, the lime occurs as separate nodules, it may be readily separated from the clay. Important beds may be found which are almost entirely free from lime.

In working the coal seams it is necessary to move a large amount of the underlying fire clay. This material is usually hoisted and dumped. It is quite probable that it could, to a

large extent at least, be utilized. Mr. B. Parker, at Livingston, at one time experimented with the clay and found that it shrinks badly in burning. This could be remedied by proper admixture with the loess-silt or by changing the method of treatment. There is a good opening in the region for a combined brick plant and coal mine, and such plants will probably at no distant day, form an important industrial feature throughout the region.

Of the plants now in operation only one utilizes the coal measures shales. The remainder depend upon the loess-silt.

CENTERVILLE.

The Centerville Brick and Tile Co. have a plant in the southwestern portion of the city, located on the K. & W. railway. The brick works are on the territory worked by the Scandinavian mine, and a figure of the pit, showing the disturbed condition of the shales has already been given (see figure 65). The pit is located south of the Scandinavian shaft. The shale comes from above the fifty-foot limestone, and twenty or more feet of gray to greenish shale is exposed. The upper portion is weathered some and should be mixed with the loess.

Over the shale is about four to twelve feet of boulder clay, which must be stripped off. Formerly the loess-silt was used, being obtained nearer the kilns, but now the shale is taken alone. A combination of the two would probably be advantageous.

The clay is hauled by tail-rope from the pit to the plant, a distance of about 150 yards. It is run through a Frost dry-pan and a Fate and Freese Ohio machine. The product is in part dried in the open air and in part upon a furnace-heated floor. Three up draft kilns and one permanent open kiln are used in burning. It requires usually from five to seven days for the burning. Building brick and sidewalk blocks are made.

E. Ramsey has been making brick by hand in the northwestern part of Centerville for some years. The loess-silt

from the crest of an upland ridge is used. The brick command a ready sale.

LIVINGSTON.

Brick have been made at Livingston by B. Parker, and later by Chivare and Lomberger, since 1880. The surface soil is used, being made up by hand and burned in a down draft kiln.

UNIONVILLE.

At Unionville there are two brickyards, both turning out a hand-made product, which is derived from the loess-silt and burned in cased kilns. The Miller & Calkins yard is about three-quarters of a mile west of town, and the Knight Brothers is nearly two miles northwest.

BUILDING STONES.

The limestones of the Appanoose beds furnish excellent material for the rougher grades of masonry. At many places along the streams of the area underlain by these beds are ledges which may be readily quarried. Near the Scandinavian mine, at Centerville, the fifty-foot rock is quarried. Near Milledgeville, Messrs. D. S. Fenton, R. I. Prenty, and N. J. Elam each operate small quarries to supply the local trade. The ledges occurring are nowhere of sufficient thickness to warrant the investment of capital in any extensive quarry enterprise. The rock is of good quality and stands the weather well. In the foundation of Mr. Elam's house, stone cut in 1866 shows the tool marks quite distinctly. The quality of rock available at any one quarry site is entirely too limited, however, to make the industry profitable.

The rock has been burned for lime at a few points and yields a good material; but the same factors which prevent the growth of a large quarry industry will be equally potent in discouraging any attempts towards lime burning on a large scale.

The Chariton conglomerate has been quarried a little on the farm of Mr. Wm. Duval, near Moravia, as also near Hilton,

in Monroe county. The stone does well enough for rougher foundation work, though it is not usually as good as the limestone of the Appanoose beds. It is easily obtained and occurs in thick ledges, but will never support a large quarry industry.

WATER SUPPLIES.

The drainage system of Appanoose county is quite well developed. The streams have pushed out their lateral branches till the whole area is, as compared with regions in the northern portion of the state, covered with a network of waterways. These creeks and rivulets afford a generous supply of water for ordinary farm and stock purposes. Springs are rare, as is common in drift covered regions. The drift is made up of unconsolidated beds of boulder clays, sands and gravels. The latter are irregularly distributed in small patches, which form natural basins for the reception and storage of water. The larger number of wells throughout the county derive their water supply from these drift basins. The water is almost always of good quality and of sufficient quantity to meet ordinary demands.

At Centerville, water for the city supply is obtained from a deeper horizon. Two wells have been put down here. The first* was carried to a depth of 2,495 feet and encountered water at several horizons. This supply was not utilized. In 1895 a second well was put down and an abundant supply was struck at 1,439 feet. The water is of excellent quality and is pumped at the rate of 350 gallons per minute. It probably comes from the sandstone which Norton* has referred to the Upper Silurian.

ACKNOWLEDGMENTS.

In the preparation of this report the writer has received important aid from very many people. It is impossible to name all, but among those who have been particularly helpful may be mentioned Messrs. Clarke & Peatman, Hon. J. T.

*See Norton: Iowa Geol. Surv., III, 205-210. Des Moines, 1895.

*Op. cit., 209.

Connor and Hon. D. W. Bryan, of Centerville, Hon. J. E. Gault, of Cincinnati, and the officers of the various coal companies. Among the latter, Messrs. Drake, Oliver and Dargavle of the Centerville Block Coal Co., Messrs. Lee of the Peerless, Merritt of the Standard; Johnson of the Scandinavian, Lodwick at Mystic and Denny at Cincinnati have been particularly helpful. To these and to many others not mentioned the larger portion of the facts presented in this report are due.

The field work upon which this report is based was carried on mainly in the summer of 1895. Since that time there have been numerous changes in the ownership and management of the various mines, so that the list as published is only correct up to August, 1895.

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF APPANOOSE COUNTY, IOWA.

BY

H. FOSTER BAIN

1896.

R. XIX W. R. XVIII W. R. XVII W. R. XVI W.

Tp. 70 N.

Tp. 69 N.

Tp. 68 N.

Tp. 67 N.

CHARITON INDEPENDENCE TAYLOR UNION DOUGLAS WALNUT UDELL JOHNSON BELLAIR SHARON WASHINGTON VERMILLION LINCOLN PLEASANT WELLS CALDWELL FRANKLIN

Iconium MORAVIA Milledgeville Griffinsville Trask Moine Walnut City Rathbun Derby Dennis Mystic Garfield Fosbush Udell Unionville Plano Brazil Jerome CENTERVILLE Indina Ribbsville Exline Cincinnati Livingston Sedan Dean MOULTON Hiltown

LEGEND

GEOLOGICAL FORMATIONS

DES MOINES (Coal Measures)

APPANOOSE BEDS

INDUSTRIES

QUARRIES

COAL MINES

CLAY WORKS

IOWA PRINTING CO. DES MOINES, IA.

DRAWN BY F. C. TATE