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THE COAL DEPOSITS OF IOWA

BY

HENRY HINDS

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STATE



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## CONTENTS

	PAGE
Introduction .....	25
PART I. COAL DEPOSITS OF CENTRAL IOWA.	
Humboldt county.....	33
Wright county.....	34
Webster county .....	34
Des Moines valley.....	37
South Lizard valley.....	53
Hamilton county.....	54
Hardin county.....	56
Boone county.....	58
Des Moines valley.....	62
Ogden .....	74
Squaw creek valley.....	76
Angus .....	77
Story county.....	77
Marshall county .....	83
Dallas county .....	85
Des Moines valley.....	87
North Raccoon valley.....	90
Middle Raccoon valley.....	93
South Raccoon valley.....	95
Raccoon valley .....	98
Polk county .....	99
Des Moines valley above Raccoon fork.....	103
Walnut creek valley.....	112
Raccoon river valley.....	117
Des Moines valley below Raccoon forks.....	121
Des Moines Fourmile divide.....	131
Fourmile creek valley.....	138
Highlands east of Fourmile.....	143
Camp creek valley.....	147
Skunk river valley.....	148
Resume .....	149
Jasper county .....	153
PART II. COAL DEPOSITS OF SOUTH-CENTRAL IOWA.	
Madison county .....	167
Warren county .....	168
North river valley.....	174
Middle river valley.....	175
Sandyville district .....	178
Milo district .....	180
Lacona district .....	181
Marion county .....	181
District north of Des Moines river.....	185
District south of Des Moines river.....	189
Mahaska county .....	198
District north of South Skunk river.....	200
District between South Skunk and Des Moines rivers.....	203
District south of Des Moines river.....	212
Union county .....	217
Clarke county .....	217
Lucas county .....	218

	PAGE
Monroe county .....	228
Monroe mines and coal beds.....	230
Ringgold county .....	245
Decatur county .....	246
Wayne county .....	254
Wayne county mines.....	258
Appanoose county .....	261
Appanoose mines .....	268

### PART III. COAL DEPOSITS OF SOUTHEASTERN IOWA.

Keokuk county .....	285
Washington county .....	291
Louisa county .....	292
Wapello county .....	293
Jefferson county .....	306
Henry county .....	316
Davis county .....	319
Van Buren county .....	323
Lee county .....	332
Des Moines county .....	338

### PART IV. COAL DEPOSITS OF EASTERN IOWA.

Grundy county .....	340
Linn county .....	340
Jones county .....	341
Jackson county .....	341
Poweshiek county .....	342
Iowa county .....	343
Johnson county .....	343
Cedar county .....	344
Clinton county .....	345
Muscatine county .....	345
Scott county .....	348

### PART V. COAL DEPOSITS OF WESTERN IOWA.

Pocahontas county .....	355
Plymouth county .....	355
Calhoun county .....	356
Greene county .....	356
Carroll county .....	361
Guthrie county .....	363
North Raccoon drainage .....	365
Middle Raccoon valley .....	367
Brushy Fork valley .....	372
Wichita creek valley .....	373
Raccoon valley .....	373
Beaver creek valley .....	375
Deer creek valley .....	375
Stuart .....	376
Audubon county .....	377
Adair county .....	378
Cass county .....	380

### PART VI. COAL DEPOSITS OF SOUTHWESTERN IOWA.

Taylor county .....	382
Page county .....	385
Fremont county .....	388
Mills county .....	389
Montgomery county .....	390
Adams county .....	391

## CHAPTER I

### THE COAL DEPOSITS OF IOWA

#### INTRODUCTION.

Owing to the irregular lenticular arrangement of the greater part of the coal beds of Iowa and to the heavy deposits of glacial drift which obscure outcrops of beds except along the courses of the major streams, a geological examination of the area under consideration is attended with considerable difficulty, and generalizations as to the location and extent of unprospected fuels are frequently rendered either impossible or extremely uncertain. During the early days of the development of the Iowa coal field, when the nature of the deposits was very imperfectly understood, it was generally considered that two or three persistent coal beds underlay essentially the entire region and that it would be possible to trace certain continuous seams from Fort Dodge to Des Moines and thence to What Cheer, Oskaloosa and other parts of the field. Systematic prospecting, especially in the southern counties, has, however, proved that few coal basins contained over a few thousand acres and that the greater number carry thick coal under no more than 500 or 600 acres. In many cases drill records have shown workable coal at one point and a mere carbonaceous film in the same horizon a few hundred feet distant. It is this lenticular character of the deposits that makes imperative a fairly large outlay of capital for the thorough prospecting of any given field before the installation of expensive mine equipments is undertaken.

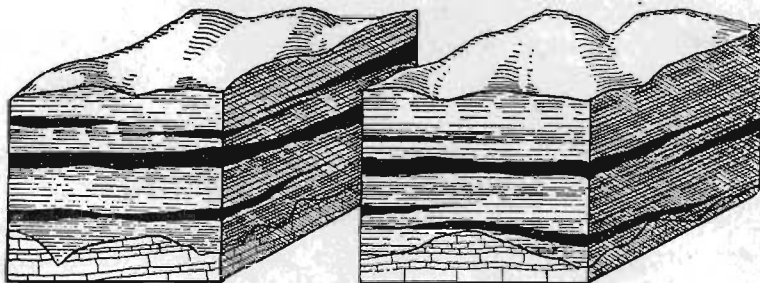


Figure 1. Stratigraphical arrangement of Iowa coal beds.

An exception to the generally inconstant character of Iowa coal seams is furnished by the bed mined in the Appanoose-Wayne field in the south-central part of the state, and by the thin coal mined in the southwestern corner of the state. The latter is a member of the Missouri stage and is described in a special chapter on the stratigraphy of the southwestern counties. The Mystic seam of the Appanoose-Wayne field lies in a section of the Des Moines stage that was deposited under singularly uniform conditions of plant growth and sedimentation. Throughout an area containing at least 275,000 acres in Iowa alone, this bed is present everywhere except where locally removed by old erosion channels, and formerly it extended an unknown distance north and east of its present line of outcrop. The field occupies also a considerable territory in adjacent portions of Missouri. A remarkable feature is the persistency and uniformity of the characteristics of the coal bed: it nowhere varies more than a few inches either way from a thickness of thirty inches, and in Iowa it always bears in its middle portion a clay parting from one-half to two inches in thickness. Microscopic examination of clay from this parting shows that if it were once a soil it has since lost all the characteristics of modern soils. It is difficult to imagine the conditions under which so thin and uniform a parting could have been laid down. Accompanying the Mystic coal are thin limestones which also preserve their character and stratigraphic position over a wide stretch of territory. The Appanoose-Wayne field produces about sixteen per cent of all the coal mined in Iowa.

In by far the greater part of the Iowa field, calcareous strata are conspicuously absent. The beds associated with the coal are chiefly argillaceous and arenaceous shales, with rather thin intercalated sandstones. These deposits, when traced either vertically or horizontally, change places one with the other with startling rapidity, so that drill records from even neighboring localities can be only approximately correlated. In many cases, however, the lenticular coal basins appear to lie in fairly persistent horizons, and where coal is absent in these, strongly bituminous shales are often found occupying stratigraphic positions corresponding with those of neighboring coals.

In almost all cases coal beds are underlain with structureless clays, usually, but often erroneously, termed "fire clays." The roof over the coals is commonly black fissile shale, termed "slate" by the miners, that grades upward into light-colored argillaceous material. A fair amount of timbering is required in mining under such roofs, but "draw slate" is seldom very troublesome. In any drilling, coal horizons are usually numerous, but most of these bear only thin coal or mere indications of coal. Traced laterally, a horizon that is valueless in one locality may become of economic importance in another not far distant.

Aside from irregularities in the coal beds already mentioned, other factors destroy to a limited extent the continuity of some basins. The floor upon which the coal plants grew was often

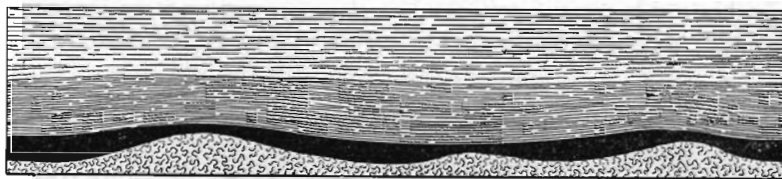


Figure 2. Uneven character of surface upon which coal was deposited.

very uneven, producing undulations in the beds of an amplitude of forty feet or less, and other features, as "horsebacks," etc.

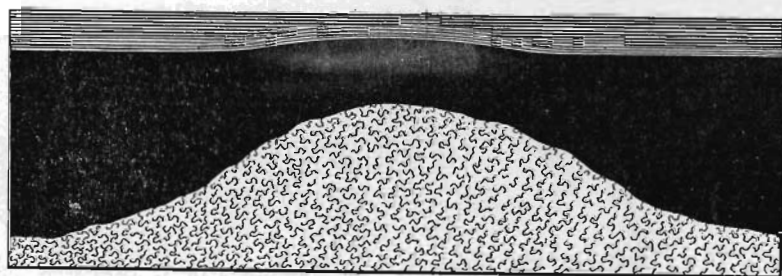


Figure 3. "Horseback" in coal bed.

In mining parlance, the coal usually "thins to the rise" and "thickens in the swamps" (low places). Several types of stream channels have locally effected the removal of all or parts of some beds. Sometimes shifting streams flowing through the

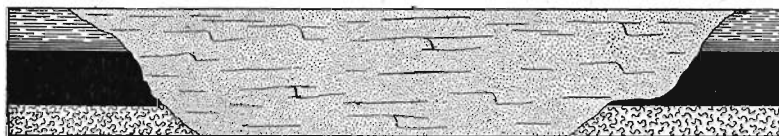


Figure 4. Carboniferous erosion: Sandstone occupying "cutout" in coal seam.

Carboniferous peat bogs, excavated and carried off some of the vegetal material. These channels were subsequently filled with clay and sands that today are found consolidated into shales and sandstones. The so-called "rolls" in the roofs of many mines are usually to be attributed to the partial removal of the coal producing peat by Carboniferous erosion. A second type of channel is the result of stream action during the long period of erosion which existed between the last emergence of the Coal Measures from the sea and the coming of glacial ice from the

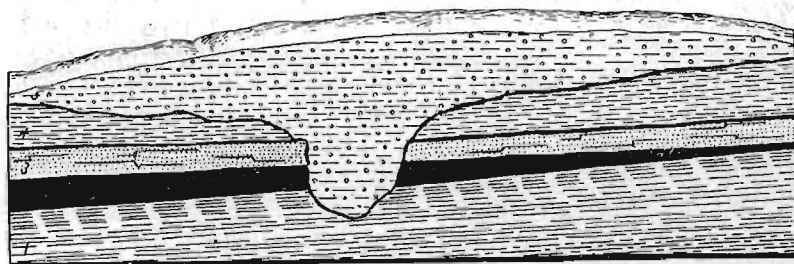


Figure 5. Preglacial erosion: Drift occupying small gorge.

north. These pre-glacial channels were filled with loose, unconsolidated material during the ice age, and sometimes their unexpected appearance gives much trouble in mines. The third type of channel is the work of modern streams acting since glacial time. As only the larger rivers have cut through the drift deposits in much of the Iowa field, and as the result of such action is plainly evident at the surface, post-glacial channels cause little anxiety to the miner. They have, in fact, been of great service in laying open to view the coal beds which now outcrop along their sides.



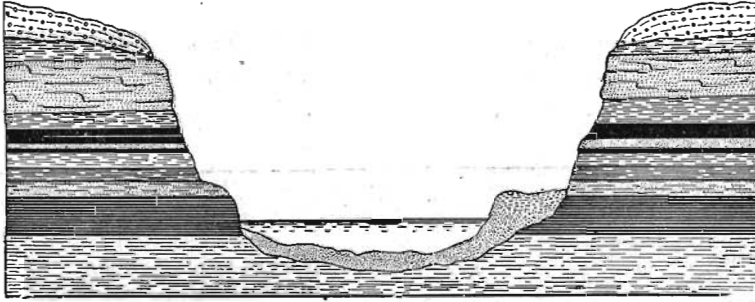


Figure 6. Postglacial erosion: gorge of Des Moines river at city of Des Moines.

Geological faults that affect mining operations at all seriously are extremely rare in Iowa. Where faults or "slips" are known to occur in and above coal beds they are almost always simply the result of the unequal shrinking of the carbonaceous material during the process of its conversion into bituminous coal. The throw of these faults is usually only a few inches or a few feet. Care should be taken to distinguish here geological faults, properly so-called, and the "faults" of mining phraseology. The term "fault" is often used by mining men to designate those portions of a local field in which coal is lacking because of removal by erosion channels or through lack of deposition between closely associated basins.

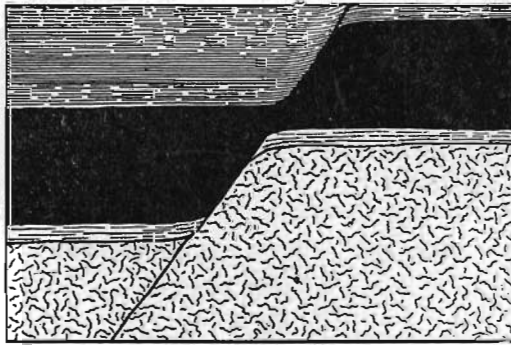


Figure 7. Fault in coal bed.

Other features characteristic of the coal beds are of minor importance and are such as are found in most fields. These characteristics will be more specifically mentioned in the detailed

descriptions of various mining counties. A full treatment of the stratigraphical relationships and lithology of the Pennsylvanian rocks and of the chemical and physical properties of typical coals may be found in other chapters of this volume.

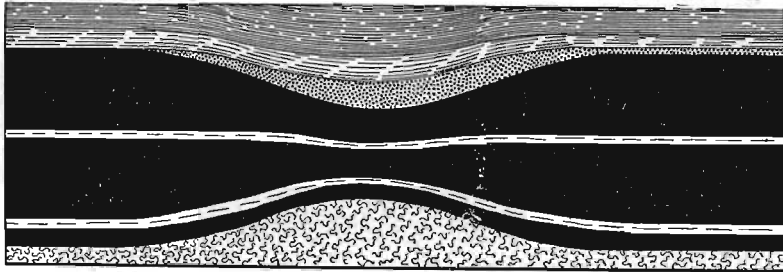


Figure 8. "Pinch" in coal bed.

The Iowa coal field contains about 19,000 square miles, possibly two-thirds of which may in time become productive. These figures do not take into consideration that portion of the most productive formation, the lower Pennsylvanian (Des Moines) which is covered by the Cretaceous and upper Pennsylvanian (Missouri) and which will certainly become in part productive, or of that portion of the Missourian outcrop that is with little doubt barren. Mr. Campbell, of the United States Geological Survey, estimates the original coal supply of Iowa at 29,160,000,000 tons. Subtracting the 141,608,792 tons mined from 1840 to January 1, 1908, from the original supply, we still have left 3,820 times the production of 1907. If the present ratio of a half ton lost for every ton marketed continues, the supply will last 2,550 years at the present rate of production of about 7,500,000 tons a year.\*

In the early days of mining, and indeed even now, operators confined their attention largely to the valleys of the major streams where coals are naturally exposed. The Iowa Geological Survey has insisted for many years that there could be no reason why the valleys should be more productive than the uplands, yet it remains true today that comparatively few mines are situated on the prairie levels. This state of affairs is in large part due to the greater ease of prospecting in the lowlands and to the

\*The production of coal in 1907, Advance Chapter from Mineral Resources of the United States for the Calendar year 1907, p. 125, U. S. G. S., Washington.

heretofore abundant reserves of coal found in such situations. As competition becomes more keen, more of the higher divides will be prospected. Recent attempts to locate profitable basins well back from the larger streams have proved suggestively successful. The thickness of individual coal beds is not great. The thickest coal is perhaps to be found in Marion county, where the Mammoth Vein Coal Company has encountered as much as sixteen feet in local "swamps." Where such thick coal occurs, however, it is often of poor quality and filled with concretions of clay-ironstone and sandstone. The greater part of the mining in the state is in beds from four to six feet in thickness, though the most extensively worked single seam, the Mystic of the Appanoose-Wayne field, shows only thirty inches, and considerable coal is taken from a fourteen to twenty-inch seam in Taylor, Page and Adams counties. Data recently compiled by Mr. Fisher, of the United States Geological Survey, appear to show that fourteen inches is about the minimum thickness for profitable working. Many operators in Missouri mine coal no thicker than this and the Al Russell mine, in Nodaway county, works in twelve inches.\*

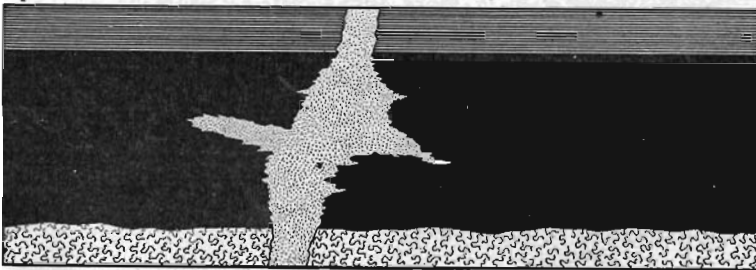


Figure 9. Fissure filled with clay.

The depth at which coal may be profitably mined is a factor that has not yet entered into consideration in Iowa. The deepest mine in the state, No. 3 of the Hocking Coal Company, is only 315 feet in depth. Coal does not occur in any part of the state, even in the Des Moines of the extreme southwestern corner, which lies at too great depth to be profitably mined if other conditions are favorable. The limit of practicable depth in working

\*19th Annual Rept. Bureau of Mines, p. 260, 1905.

was adopted as 4,000 feet by the Royal Commission of Great Britain in 1871 and again in 1905.\* Professor W. Calloway says, "it is probable a depth of 8,000 feet will be attained."† The deepest shaft in England is at the Pendleton colliery, where a bed from two to six feet thick is reached at 3,483 feet. A seam only two feet thick is mined at the Kingswood colliery, in Somerset, at 2,460 feet. In Belgium, there are fourteen mines over 3,000 feet in depth, the deepest being 3,937 feet. In France and Germany are also deep shafts. "The German miner has no doubt that not only is there a possibility, but the greatest likelihood of pushing down to a depth of 1,500 M. (4,921 feet) or more, and of mining coal there at a profitable cost."

In the following pages the details of the present status of the Iowa coal industry are discussed by counties. As each small mining district is a field by itself and the deposits are almost always lenticular, generalizations and correlations of distant beds are dangerous and usually unwarranted. A presentation of facts alone, with but few theorizations, is all that can be safely attempted with strata constituted as are those of the Des Moines stage. This is especially true when, as in Iowa, the coal bearing formations are concealed almost universally by a heavy mantle of drift averaging 100 feet or more in thickness.

\*Digest of Evidence, Royal Commission on Coal Supplies, 1901-05, p. XXXII.

†Trans. Inst. Min. Eng., Vol. 21, 1900-1, p. 87.

‡Dig. of Evi., Roy. Com. on Coal Supplies, 1901-05, pp. 76, 77.

## PART I

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### COAL DEPOSITS OF CENTRAL IOWA

#### HUMBOLDT COUNTY

The greater part of the indurated rocks that lie beneath the heavy drift area of Humboldt county belong to Mississippian limestone formations. During the interval between the deposition of the limestones and the appearance of Coal Measure conditions, the region was a land surface trenched by valleys as at present, and it was in these depressions that most of the Des Moines strata now remaining were laid down. One such erosion valley extends from immediately south of the town of Humboldt nearly to the south county line. Lower Coal Measure strata also outcrop at intervals for a distance of four miles along the east fork of the Des Moines river above its junction with the west fork. The strata represented are chiefly sandstones and shales, the latter being in places so bituminous as to have encouraged prospecting for coal in them. Experimental drifts were started in section 18 (Se. qr.) of Beaver township and section 12 (Sw. qr.) of Corinth, but, aside from a few tons of coal obtained from the latter prospect, little success attended these attempts to obtain fuel. Back from the river valleys a heavy cover of drift effectually conceals the indurated rocks, yet well records and theoretical considerations indicate that the northern extension of the main Iowa coal field reaches interruptedly three to five miles north of the Webster county line. The chances for finding on the southern edge of Humboldt county coal basins of workable extent and with sufficient roof are not particularly bright, yet lie entirely within the range of possibilities.

**WRIGHT COUNTY**

Little is known as to the actual occurrence of Coal Measures in Wright county, for the heavy cover of glacial drift on the uplands conceals the underlying indurated rocks. It seems certain, however, that only a small area is underlain by the fragmentary remnants of the northern extension of the Iowa coal field. Des Moines rocks may be found in the two southern tiers of sections in Wall Lake and Vernon townships and in most of the western half of Troy township. It is not probable that workable beds of coal will be discovered in this county.

**WEBSTER COUNTY**

The surface of the greater part of Webster county is a gently undulating plain or prairie, poorly drained. A large section of country in the southwestern portion of the county is destitute of streams of any consequence, so that no natural outcrops of the indurated rocks beneath the heavy cover of drift may be seen, and prospect records and wells furnish the only clue to the geo-

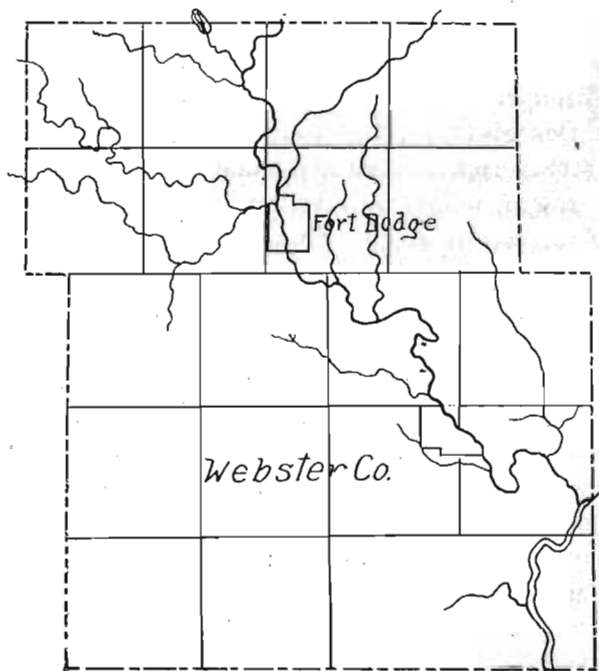


Figure 10. Sketch of Webster county which shows the immature state of drainage.

logical structure of the region. In other parts of the county, however, the Des Moines river and its few important tributaries have cut deep, narrow, sharply V-shaped valleys more than one hundred feet through the surface formations, exposing here and there splendid geological sections which include in places thick coal beds.

It is owing largely to the restriction of natural exposures of the coals to the immediate vicinity of the Des Moines river that the inception and growth of coal mining has been almost entirely confined to points along and near that stream. The finding of coal near Tara, Otho, and Dayton indicates that other coal basins exist at points remote from the main valleys and that only the expense and uncertainty of prospecting operations have prevented their discovery.

Coal Measures of the Des Moines stage underlie the greater part of the county. The underlying Mississippian limestone is exposed in the bottom of the lower portion of Lizard river valley, in the Des Moines valley from Fort Dodge northward to beyond the Humboldt county line, and in small sections of the river bottom above and below Kalo. It lies immediately beneath the drift in several small isolated areas of small importance. Resting unconformably on Mississippian limestones near Fort Dodge and on the Des Moines strata in many other districts are the gypsum-bearing rocks of Permian age. The area underlain by Permian is irregularly oval in shape and extends entirely across the county from northeast to southwest. At its maximum, between Fort Dodge and Kalo and northeast of these points, the area is six miles broad; southwest of Moorland it is not more than one mile in breadth. Coal has been found, although not usually in thick seams, beneath the gypsum in many parts of the area just outlined. The well on the Webster County Poor Farm (Elkhorn Tp., Sec. 3, Sw. qr.) penetrated the drift with its heavy clays, the Permian with its gypsum, the Des Moines with its coals, and stopped in the massive limestone of the Saint Louis. The detailed record of this boring is as follows:

## COAL DEPOSITS OF CENTRAL IOWA

## WELL ON WEBSTER COUNTY POOR FARM.

	FEET.	INCHES.
23. Soil .....	2	
22. Yellow clay.....	13	
21. Blue clay.....	47	
20. Sand .....	1 $\frac{1}{2}$	6
19. Red shale.....	19	4
18. Gypsum .....	17	
17. Blue shale.....	6	2
16. Limestone .....	2	
15. Coal .....		9
14. Fire clay .....	1	6
13. Shale, light colored.....	1	4
12. Coal .....	1	3
11. Sandstone .....	4	
10. Black shale .....	4	2
9. Coal .....		3
8. Fire clay.....	1	
7. Sandstone, white.....	4	6
6. Shale, with limestone bands.....	34	6
5. Shale, light colored.....	5	
4. Shale, blue.....	4	
3. Calcareous shale .....	6	5
2. Shale, blue.....	21	2
1. Limestone (penetrated).....	40	
Total .....	237	10

Because of the great irregularity of the surface of the Saint Louis limestone, it is impossible to give an exact idea of the depth of the base of the Coal Measures in various parts of the county. Roughly speaking, the limestone in the northern third of the county may be said to be at and slightly above the level of the Des Moines river (about 1,000 feet above tide). When allowance is made for the thickness of the mantle of drift under the uplands, it will be seen that the Coal Measures are quite thin in this region and that the chances for finding coal are proportionately small. In the southern half of the county the base of the Des Moines is found at depths of 150 to 250 feet below the prairie level. The drift is from 50 to 150 feet in thickness, leaving in many places 100 feet or more of strata which may include workable coals. Developments in Boone county on the south suggest that prospecting on the uplands of southern Webster county, while somewhat expensive and hazardous, might yield good results.



Owing to its strategical position as the most northerly productive area in Iowa, mining was energetically pursued at an early date and the output soon reached a large figure. In 1862 a production of only 250 bushels was recorded by the State Census. In 1870 the United States Census showed that an output of 34,400 tons had placed Webster fourth in rank among the coal producing counties of the state. In 1880 a production of 126,712 tons made her fifth in rank, while in 1890 she had dropped to twelfth place with a showing of 137,739 tons. The partial exhaustion of the known coal basins has led in recent years to a notable falling off in production. The statistics for the years 1898 to 1906 given below are taken from reports of the Iowa Geological Survey; for 1907 from those of the United States Geological Survey:

YEAR	TONS	YEAR	TONS
1898	137,787	1903	131,698
1899	118,770	1904	134,538
1900	135,661	1905	113,393
1901	127,894	1906	109,522
1902	140,007	1907	80,275

As shown by the report of the State Mine Inspectors, the decline in production was still further accentuated in the early part of 1908, the output for the year ending June 30, 1908, being only 59,031 tons. Eight mines, aside from small country banks, were in operation and 229 men were employed. The average price, per ton at the mines was about \$2.10.

Details in regard to the various mining districts may be found in the following pages.

#### DES MOINES VALLEY.

*Fort Dodge.* The Colburn, the lowest seam found in the Hoday creek area, lies in the upper portion of the Coal Measures present at Fort Dodge and has been mined in a small way in times past by drifts and shallow shafts at and above that point. A little coal is still taken out during the colder months of the year about two miles north of the city, where both the Colburn and a higher coal are found. Just above "the slide" on the west bank of the river (Douglas Tp., Sec. 7, Sw. qr.), the upper bed is shown in the following section:

COAL DEPOSITS OF CENTRAL IOWA

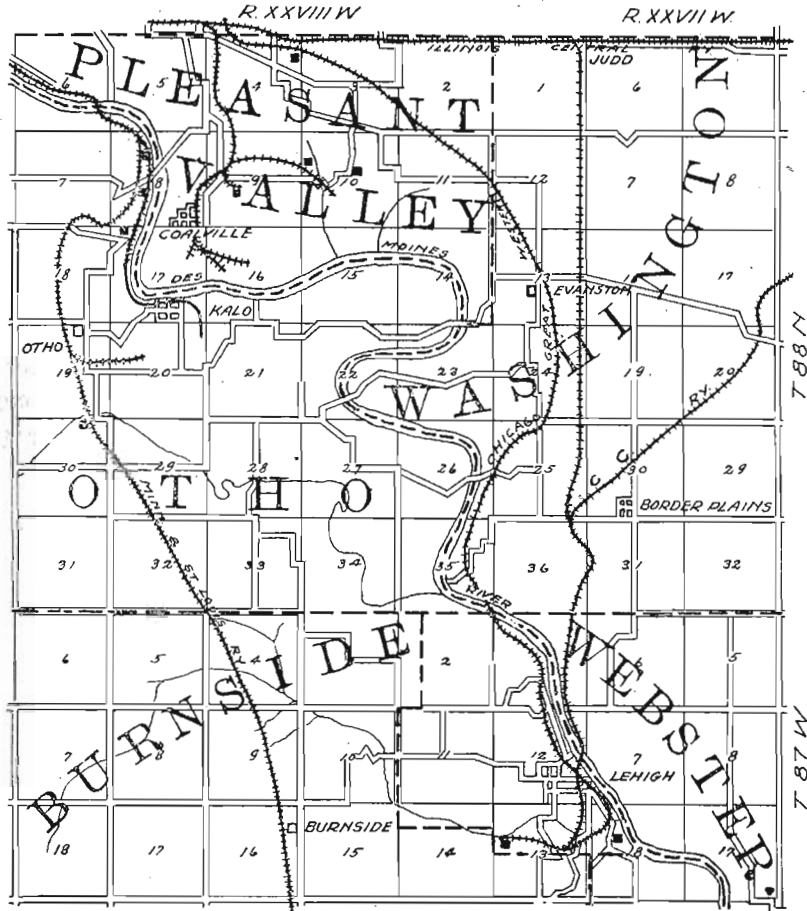


Figure 11. Map showing location of the principal mines in Webster county.

	FEET.
5. Drift .....	8
4. Argillaceous limestone, a single heavy layer.....	2
3. Coal .....	2
2. Shale, fissile, very bituminous.....	44
1. Sandstone, red and white, with fossils of coal plants; to water 6	6

One-fourth mile below this, the same bed is shown at some old mines and what is probably the Colburn seam appears a few feet below in two benches, thus:

	FEET.	INCHES.
3. Coal .....	2	
2. Shale .....	2	
1. Coal .....		6

Coal corresponding to that already mentioned is exposed one mile below the Minneapolis and Saint Louis station, along the railway tracks (Cooper Tp., Sec. 29, Sw. qr.). Numbers 3, 4 and 5 in the section given below probably occupy the Colburn horizon.

	FEET.	INCHES.
8. Limestone, argillaceous, a single, solid layer.....	1	6
7. Coal .....		10
6. Shale and clay.....	3	
5. Coal, impure.....	1	
4. Shale, carbonaceous.....	1	6
3. Coal, fair quality.....	1	6
2. Shale, sandy, yellow; to level of railway track.....	4	
1. Shale, nearly covered with talus to water level.....	25	

*Kalo, Coalville, and Holaday Creek.* For some distance below Fort Dodge outcrops of the Permian gypsum-bearing strata replace those of the Des Moines stage in the valley of the river. Where the river leaves this younger formation and again flows in a valley in which coal-bearing strata are found, many mines have at one time and another been located. Shafts and slopes have dotted the hillsides from Kalo two miles northward, as well as the right side of the valley below that village. The Coalville basin as now known comprises about six square miles, all in Otho and Pleasant Valley townships. Possibly the Otho field once formed part of the Coalville basin and has since been cut off from it by pre-glacial erosion. At any rate, the basin is now limited to sections 16, 17, 8 and 9, the west half of 15, 10 and 3 and the southeast half of 4. Three horizons have been recognized, the lowest the Colburn or "Cannel" seam, the second the "Big" coal, and the highest a thicker seam sometimes termed the "Soft" coal. Considerable difference of opinion exists as to the exact relationship of these beds, owing largely to the irregular character of the "Big" coal.

The Colburn seam, as we have already seen, is not confined to the Colburn basin and has been mined as far north as two miles above Fort Dodge. It is exceedingly variable in level; thus, on Holaday creek it lies about twenty-five feet above the level of the creek bottom or fifty feet above the river level, while in the vicinity of Kalo it is ten feet below the river on the east bank and ten to eighteen feet above the water level on the west side of the

valley. Above Kalo the seam rises rapidly toward the north until it is cut off for a space by the Permian rocks. The bed also undergoes marked lithological variations, there being an increase on the western edge of the basin of the quantity of impurities present and in the percentage of volatile gases. On Holaday creek the bed consists of from four to nine inches of cannel above from one to three feet of bituminous coal; along the river above Kalo the seam bears nearly three feet of cannel in places. While inferior in fuel value to the bituminous coals, the cannel is growing more and more in importance as the other seams become exhausted. The following, published in the *Mining World* by G. H. Ashley, sums up the situation:

“No typical cannel coal has yet been reported from Iowa, though the region near Fort Dodge in Webster county supplies a so-called ‘cannel.’ An examination of its analysis shows it to have 39.04 per cent of volatile matter, 39.22 per cent fixed carbon, and 15.87 per cent ash, giving it a fuel ratio just below one, or on the borderland between cannel and bituminous coals. The coal is low in the coal series, occurring only about fifty feet above the Lower Carboniferous limestone. The seam \* \* \* appears to be somewhat more regular than some of the bituminous seams near it in the series. \* \* \* In its best section the cannel shows thirty inches immediately overlying twelve inches of bituminous coal. Where principally mined it shows sixteen inches of cannel separated by three inches of shale, and twenty-two inches of bituminous coal, the cannel in all cases being above.”

It has often been stated that the so-called “Upper Bituminous” bed and the “Big” coal are distinct seams. This is only in part true. The confusion evidently arises from the presence in several parts of the basin of a higher coal lying not far above the “Big” coal and mined at a few points. This higher seam is the true “Upper Bituminous.” It is of a pockety nature and usually contains coal of a quality much inferior to that of the thicker bed beneath. Much of the coal commonly termed “Upper Bituminous,” however, actually occupies the horizon of the “Big” coal. In his description of the Coalville basin Dr. Wilder says:\*

“A limited portion of this area contains coal varying in thickness from six to eight feet. This is known as the ‘Big coal.’

\**Geology of Webster County, Iowa Geol. Surv., Vol. XII. p. 90: Des Moines, 1902.*

The Big coal is confined to a curiously narrow and contorted strip. It is rarely over 300 feet wide and often only 200 feet. Its center lies twenty-five feet below the rest of the upper bituminous horizon. Its edges rise rapidly, however, and all of the upper bituminous coal forms with it a continuous seam. Because it lies below the rest of the seam and is of better quality, it is often regarded as a distinct seam. The coal in this horizon outside of the Big coal varies in thickness from three feet to five feet. It is generally uniform in quality and some of it is of value only as steam coal. It lies fifty feet below the prairie level, is horizontal in position and free from fault. The Big coal ranks with the best coal produced in the county.

"The Coalville basin seems to be part of the trough of an ancient river. The Big coal was formed in the stream channel, while the rest of the seam represents the bottom lands. The Big coal is too pure to admit the belief that water was flowing through the channel when the coal was deposited, and that the vegetable matter was drift material. The fact that as yet it has not been possible to connect the tortuous sections of the Big coal, also leads to the belief that the hollow in which the Big coal lies represents portions of a deserted channel, which in places was filled in and consequently is at times barren. The Big coal has an excellent shale roof and is worked very economically."

Three mines are now working on Holaday creek, cleaning up the odds and ends left from former operations. Little coal is now left in workable shape in any part of the Coalville basin. The most northerly of these mines is the Rogers and Collins shaft (Pleasant Valley Tp., Sec. 4, Ne. qr., Se.  $\frac{1}{4}$ ). The shaft, situated on the right bank of the creek, is forty-seven feet deep and takes coal from the "middle vein" where it is from four to eight feet thick. It is probable that this coal forms part of the "Big" seam, though it does not appear to lie in a basin which is continuous with other parts of that bed. The seam is extremely irregular; "horsebacks" and "rolls" are rather common. Northeast of the shaft is a remarkably large "boulder," ten feet thick in the center and gradually tapering towards the ends. As nearly as can be determined at present, it occupies an area of nearly ten acres. The coal divides as this body is approached, half passing above and half below it. Above the central or thicker part of the rock the coal thins notably. Evidently at this point a quantity of sediment borne by a shifting

stream gained admittance to a temporarily deserted channel, burying beneath itself the mass of vegetation which had already gained a footing there. After the disturbing influence had been withdrawn, swamp conditions again prevailed. At this mine the roof is firm, black "slate." The bottom is a sandstone and less frequently a fire clay. Entries have been driven 800 feet from the shaft. A single-cylinder hoisting engine is used. The product is shipped over the Chicago Great Western Railroad and is also sold to the local wagon trade.

Half a mile southwest of the Rogers and Collins (Sec. 4, Se. qr.), the test-hole record given below shows a section similar to that near the mine. Both the hole and the shaft are located on the southern edge of the Permian gypsum area. Drift, Permian and Des Moines strata may be distinguished in the record.

	FEET.	INCHES.
9. Soil .....	3	
8. Yellow clay .....	16	
7. Blue clay .....	30	
6. Red shale .....	4	
5. Shales .....	30	
4. Rock .....	1	10
3. Shale .....	9	
2. Coal .....	2	7
1. Black jack .....		8

Farther down Holaday creek, just above its junction with Miracle creek, is the Minn and Scott bank (Sec. 10, Nw. qr., Sw.  $\frac{1}{4}$ ). This is a slope to the "Big" seam, supplying a local trade, from the bluff on the west side of Holaday creek. Forty acres have been leased and the company is working 400 feet back from the slope mouth in six feet six inches of coal. The roof is a black "slate" which requires only ordinary timbering; the bottom is sandstone. Here an upper seam is present about twenty feet above the "Big" coal, a series of shales filling the interval between them. The Colburn, only a short distance below the "Big" coal, consists of from two to two and a half feet of bituminous coal capped by five inches of cannel.

A little below, on the opposite side of Holaday creek, is another local mine, that of J. E. Martin (Sec. 10, Sw. qr., Ne.  $\frac{1}{4}$ ). Three seams are worked here by separate drifts. The

upper is reached by a steep but short incline over which cars are hauled by a cable wound on a small drum and operated on the double pull-rope system. The middle seam is the one from which the greatest amount of coal is now taken. It is the "Big" seam, with coal from two to nine feet in thickness, thinning to the east. In this vicinity the "Big" coal lies in a basin 300 feet wide, running northwest and southeast. At this mine this bed lies fifteen feet or less beneath the upper seam and has a sandstone bottom. The lower, or Colburn seam has only recently been opened by Mr. Martin by a drift a short distance down the creek. It shows from one to three feet of bituminous coal overlain by from four to eight inches of cannel.

The following section is typical for the district. The drilling was headed on high ground. The "Big" seam, always very variable in level, was penetrated at one of its highest points, while the upper seam, if it ever existed at this point, has been removed by pre-glacial erosion and its place taken by drift.

DRILLING IN PLEASANT VALLEY TOWNSHIP, SEC. 9, SE. QR.

	FEET.	INCHES.	
16. Mixed clay.....	18		
15. Blue clay .....	32		
14. Sand and gravel.....	4	3	
13. Sandstone .....		5	
12. Sand, black .....	1	8	
11. "Slate," black .....		4	
10. Coal, soft ("Big" coal).....	4	5	
9. Sandstone, white, compact.....	1	6	
8. Fire clay .....	9	1	
7. Sandstone, white .....	35	6	
6. "Slate," black .....		4	
5. Coal, cannel	} Colburn seam)	{ 1	
4. Coal, hard			11
3. Black jack			4
2. Sandstone .....		5	
1. Fire clay .....	1	9	
Total .....	112	2	

The Gleason Coal Company is just beginning to drive entries in a new mine on the prairie level (Pleasant Valley Tp., Sec. 9, Sw. qr., Nw. 1/4). A steam hoist has been installed and a shipping business is to be done. In sinking the shaft, the following section was revealed:

## COAL DEPOSITS OF CENTRAL IOWA

	FEET.	INCHES.
3. Yellow and blue clay.....	.65	
2. Black "slate" .....	.15	
1. Coal ("Big" seam).....	4	2
Total .....	.84	2

Mr. Gleason reports that while prospecting they drilled 150 feet without finding more than the one coal. The Colburn horizon is, therefore, barren at this point. The coal found varies in thickness from one inch to four feet and a half. Other mines have recently worked this seam on the south, but 500 feet east of this shaft it is said to "go to the rise" and disappear.

In the valley bottom of the Des Moines river above Kalo, three mines are taking coal from the Cannel seam. On the southern border of the gypsum area is the Johnson mine (Otho Tp., Sec. 8, Nw. qr., Ne.  $\frac{1}{4}$ ). Although the mouth of the slope is at the side of the tracks of the Kalo switch, no coal is shipped, all being used at the adjacent plant of the Johnson Brothers Clay Works. As in other parts of the Cannel seam the sulphur content is often disagreeably large. Both cancell and bituminous coal are taken out. The section here is as follows:

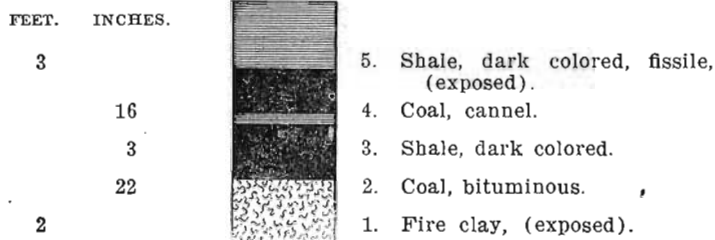


Figure 12. Cannel and bituminous veins at the Johnson mine. Kalo.

A quarter mile south, beside the tracks of the same switch, is the Irvine slope (Sec. 8, Nw. qr., Se.  $\frac{1}{4}$ ). The Cannel seam is reached at an elevation ten feet lower than that of the tracks of the switch. The seam is about twenty-eight inches thick at this point. The bottom is fire clay and sandstone. During the summer of 1908 attention was devoted chiefly to making roads through old workings. In the early autumn of the same year, some coal was being supplied to the Central Brick and Tile Company, whose yards are close at hand.



A half mile farther south on the same switch is the shipping mine of the Craig and Dawson Coal Company (Sec. 17, Nw. qr., Nw.  $\frac{1}{4}$ ). The shaft is fifty feet deep to the Cannel seam, showing that a southerly dip of about 100 feet to the mile prevails between this mine and those farther north. An upright double engine hoists the coal. The seam is from thirty-three to forty inches thick. The relationships of the strata near the seam are well shown in the following typical section found in a drilling near the mine:

## DRILLING IN SECTION 17, NW. QR.

	FEET.	INCHES.
9. Surface .....	8	
8. "Slate" .....	3	4
7. Rock .....	3	8
6. "Slate" .....	9	4
5. Coal (Cannel seam).....	3	6
4. Black jack .....		6
3. Fire clay .....	14	
2. Limestone (St. Louis).....	21	1
1. Sandstone .....	19	1

The Foster bank is a small affair in the side of a ravine at Kalo. The "Big" or "Upper Bituminous" horizon normally contains a coal bed from three to four feet thick at this place, but the present drift is taking coal from under a large "roll" which has reduced the thickness of the seam to two feet. The bottom is a very argillaceous sandrock; the roof a black bituminous shale.

For a distance of over a mile below Kalo, mining was at one time in active progress. At present only one small local mine is in operation. The Hewitt bank, a fourth mile southeast of Kalo, is a drift high on the side of a ravine in which several shipping mines were formerly located. The seam lies in the "Upper Bituminous" coal horizon and shows an average thickness of four feet at the Hewitt. "Horsebacks" and "rolls" are fairly common, though seldom of large size. Vertical "clay slips," usually about one inch thick, occur about one foot from the top. When the coal is of normal thickness a one-inch band of "bone" lies in the seam. The entry runs 1,000 feet into the bluffs, exposing a fire clay beneath the seam and a soft blue-

black shale above. The coal mined is rather soft, yielding a large proportion of slack and nut. Near the bottom of the ravine, forty feet below the drift mouth, the Colburn horizon is occupied by a bed of coal eighteen inches thick. Five to seven feet above the coal mined an upper seam, two feet and less in thickness, is found in isolated patches. The following drilling made on the L. W. Hart land, near the Hewitt bank, shows the "Upper Bituminous," or "Big" coal horizon above and the Colburn below.

	FEET.	INCHES.
11. Surface .....	24	6
10. Fire clay .....	4	9
9. Coal .....	4	2
8. Fire clay .....	5	
7. Sandstone .....	1	6
6. Fire clay .....	6	6
5. Rock, hard .....	2	
4. Sandstone .....	22	6
3. "Slate" .....	4	
2. Coal .....	2	4
1. Fire clay .....	3	
Total .....	80	3

*Otho.* A new field has been opened south of Otho by the Craig and Dawson Coal Company (Otho Tp., Sec. 30, Ne. qr., Ne.  $\frac{1}{4}$ ). By means of a ninety-foot shaft a seam three to four feet thick has been reached. Entries have been driven only 200 feet from the pit bottom and hoisting is done by a small single-cylinder engine and boiler which are to be replaced soon by larger ones. Shipping facilities can be easily procured when the development of the mine reaches a more advanced stage. The seam worked has a fire clay bottom and a black "slate" roof. An upper seam lies from ten to twenty feet above the other, but is not being developed at present. It is from two to three feet in thickness, has a fire clay bottom and, near the shaft, a roof of sandy shale which grades laterally into a black "slate." The upper seam is perhaps the cleaner of the two.

If this field were ever connected with the Coalville basin it has since been cut off by pre-glacial erosion. In some places the coal is cut out entirely and in others it becomes very thin. The

upper seam may be tentatively assigned to the so-called "Upper Bituminous" horizon of the Kalo-Coalville area. The lower seam does not fall naturally into a position corresponding with any coal previously discovered, though it may possibly represent the Colburn horizon at a point where it approaches closely the upper coal.

In as heterogeneous a collection of strata as the Des Moines stage comprises, two horizons cannot be expected to preserve the same relations to one another, even in adjacent areas, nor can a horizon be expected to bear good coal in more than a small portion of its extent. The following is a record of a drilling made on the Doushack land (Sec. 30, Ne. qr., Ne. 1/4), near the Craig and Dawson shaft.

	FEET.	INCHES.
11. Soil and gravel.....	5	
10. Yellow and blue clay.....	49	
9. Sandy shale.....	15	
8. "Slate".....	3	
7. Coal (at 72 feet).....	1	11
6. Fire clay.....	2	
5. Sandstone.....	1	
4. Fire clay.....	4	7
3. "Slate".....	1	8
2. Coal, good quality (at 83 1-6 feet).....	3	
1. Fire clay.....	1	
	-----	-----
Total.....	87	2

In section 18, north of Otho, attempts have been made from time to time to mine a thick seam of coal. Much of the bed has, however, been cut out by erosion and that which remains usually lacks sufficient cover. Below is given a section from the Bensing land, near the Minneapolis and Saint Louis railroad.

	FEET.	INCHES.
17. Surface.....	43	1
16. "Slate".....	1	6
15. Fire clay.....	1	4
14. "Slate".....	2	
13. Coal.....	4	8
12. "Slate".....	3	3
11. Fire clay.....	1	3
10. Sandstone.....	5	6
9. Sandy "slate".....	12	6

## COAL DEPOSITS OF CENTRAL IOWA

8. Fire clay .....	1	4
7. Sandstone .....	6	6
6. Fire clay .....	2	
5. "Slate" .....	15	
4. Hard blue rock.....	1	
3. Fire clay .....	1	4
2. Black "slate" .....	13	
1. Fire clay .....	1	4
	113	6
Total .....	113	6

Within a mile south and southeast of the Craig and Dawson shaft pre-glacial erosion appears to have either cut out the coal itself or to have removed so much of the cover as to render mining hazardous. The two drill records shown below (Sec. 32, Ne. qr., Ne.  $\frac{1}{4}$ ) furnish typical sections for the district. It is possible that if drilling No. 2 had been carried farther down, a second seam would have been found and that No. 1 passed through an old channel which had removed the upper coal. The drillings do not, therefore, prove that two seams were not deposited in this district.

## DRILLING NO. 1.

	FEET.	INCHES.
8. Soil .....	2	6
7. Yellow clay .....	13	
6. Blue clay .....	55	6
5. "Slate" .....	8	6
4. Boulder ("Hard band").....		6
3. "Slate," coal, and calcite with hard band.....	5	
2. Fire clay .....	12	
1. Sandstone .....	49	
	146	
Total .....	146	

## DRILLING NO. 2.

	FEET.	INCHES.
5. Soil .....	2	6
4. Yellow and blue clay.....	67	6
3. Black "slate" .....	1	5
2. Coal .....	1	7
1. Fire clay .....		7
	73	7
Total .....	73	7

*Lehigh.* Of former vigorous mining in the lower valley of Crooked creek and along the river near Lehigh little remains. Clay plants, using the Carboniferous shales exposed in the valleys, have largely superseded the coal mines. In October, 1908, only two mines were in operation and a revival of the activity of the past seemed unlikely. No new light has been thrown on the geology of the basin since the following description of it was written by Wilder:\*

“The Lehigh coal belt is not more than two-thirds of a mile wide and extends from northeast to southwest across section 7, Webster township, and section 13, Burnside township. It is crossed nearly in the center by the Des Moines river. On the west side of the river Crooked creek cuts through it, and coal is mined on this creek two miles from its mouth. On the east side of the creek the prospect holes of the Crooked Creek Railroad and Mining Company have found coal a mile back from the river. All of the mining has been done along the river and Crooked creek. The coal lies in four seams, one above the other, so that prospect holes often pass through more than one seam. The seams vary considerably at different points. All of the seams have produced coal, but the coal from the Tyson seam is regarded as the best and this seam up to date has been most extensively worked. The Harper seam is thirty feet above the water of the river; the Tyson is twenty feet above water level; the Pretty seam is ten to twenty feet below water level, while the Big is forty feet below the Pretty seam. The two seams above water level have been worked by drifting into the banks of the river, the banks of Crooked creek, and the sides of the numerous ravines in the vicinity. The Pretty seam and the Big seam are reached by shafts. The Big seam is said to lie at a uniform level, but the other seams are not so regular. The Tyson seam is never more than fifteen hundred feet wide, and it dips uniformly towards the center.

“The following is a composite section through the Lehigh coal seams:

	FEET.
9. Drift .....	120
8. Shale .....	20
7. Coal, slate, six inches, Harper vein.....	0-2½
6. Sandstone and shale.....	15
5. Coal, Tyson seam .....	4
4. Sandstone and shale.....	40
3. Coal, Pretty seam.....	2-3
2. Sandstone and shale.....	30
1. Coal, Big seam, four inches bone in center.....	3½-4½

\**Geology of Webster County, Iowa Geol. Surv., Vol. XII, p. 88; Des Moines, 1902.*

Both mines at present operating in the district are using the Pretty seam. In the valley of Crooked creek, a mile and a half above its mouth (Sumner Tp., Sec. 13, Nw. qr., Sw.  $\frac{1}{4}$ ), is the mine of the McClure Coal Company. The shaft is seventy-five feet in depth. The mine employs steam power and does a shipping business. The Pretty seam, which is from two and a half to three feet thick at this point, is the only one now being developed, though attention will be turned to the Tyson in the near future. Under the coal is a six-inch band of a very carbonaceous and compact clay underlain by at least two feet of soft sandstone. The roof is a light gray shale containing numerous bands of iron pyrites near the coal. The long wall method of development is used, mining being done in the clay band. Work has been carried 1,300 feet north and 1,800 feet south of the shaft. The north side is now abandoned. Electric mining machines were used until the working face became so short that the time consumed in moving the machines rendered them unprofitable.

The Crooked Creek shaft Number 9 is located near the mouth of Crooked creek (Sec. 18, Nw. qr., Se.  $\frac{1}{4}$ ). The product is hoisted by steam power and loaded on cars for shipment. The main entry runs 525 feet S. 10° E. with a cross road 675 feet to the west. "Rolls" and "horsebacks" are found, though small, and a fault with a throw of about three feet has given some trouble. The disturbance attending this dislocation of strata was not sufficiently strong to impair the value of the coal near the fault plane. The Pretty seam, where mined from this shaft, is from two feet to twenty-eight inches thick and lies about thirty-five feet beneath the surface. Often, though not always, present beneath the coal is a thin seam of fire clay. Where the clay is lacking a soft argillaceous sandstone forms the floor of the coal. The roof is a compact bluish gray shale which stands well with only a moderate amount of timbering.

Near the river, three miles below Lehigh, coal has been mined for a local trade in the valley of a small creek. A little farther down (Yell Tp., Sec. 21, Sw. qr., Sw.  $\frac{1}{4}$ ) coal is exposed on the river bank.

	FEET.	INCHES.
5. Limestone .....	1	
4. Coal .....	1	2
3. Shale .....		10
2. Coal .....	2	
1. Fire clay (exposed to water level).....	6	

*Linnburg.* At the mouth of Skiller creek, four miles east of Dayton, at least two seams are present. An upper seam which lies about five feet above the level of the creek bed has been reached by drifts and shafts. The bed is strongly undulatory. Only a bit over two feet of coal is shown. An attempt was made to work a lower coal here for shipping purposes, but it did not prove profitable and was soon abandoned. On the east side of the Des Moines river, opposite the mouth of Skiller creek, the Sunnyside Coal Company is now taking coal of good quality from an eighty-foot shaft (Sec. 16, Se. qr., Se.  $\frac{1}{4}$ ). A small double engine is used for hoisting and a local trade is supplied. The bed lies forty feet below the level of low water in the river and varies between twenty-four and thirty inches in thickness. Although the mine has been opened only a short distance, there are indications that the seam is rather undulatory and has a slight general dip to the southeast. Under the coal is three feet of fire clay; above is a band of iron pyrites from one to ten inches thick. Over the "sulphur band" is a one-foot layer of "bone," a very carbonaceous shale, which is taken down only over the roads; it is capped by a black "slate" bearing *Lingula* and other brachiopod shells in abundance. Forty-five feet above the lower seam is an upper bed perhaps corresponding to the upper coal mined on Skiller creek. At the shaft the upper bed is quite thin, owing probably to the removal of much of the coal by the erosive action of the Des Moines at earlier periods. Locally these two coals are known as the Pretty and the Tyson, yet any attempt to correlate on but little evidence the beds of two such widely separated areas as the Lehigh and Linnburg basins seems unwarranted.

Another local mine—that of the Stratford Coal Company—is situated one mile below the Sunnyside. The seam, which is fifty feet below low water level, has an average thickness of two feet seven inches and occupies the horizon of the lower seam

found opposite Skiller creek. Here the dip is to the southwest and the under-cutting is done in a layer of "bone" which lies beneath the coal, instead of above it as at the Sunnyside mine. About three acres have been mined out. In the greater part of the mine the roof is a compact, variegated sandstone, often quite argillaceous. Where this sandstone is lacking a tough fossiliferous shale takes its place and the upper portion of the coal bed becomes "bony," reproducing the conditions prevailing at the Sunnyside.

Workable coal was located near Dayton several years ago. The two sections given below, cited on the authority of the Craig Coal Company of Fort Dodge, appear to indicate a field the possibilities of which have been overlooked. The first drilling was made two miles east of Dayton (Dayton Tp., Sec. 18, Nw.  $\frac{1}{4}$ ).

	FEET.	INCHES.
19. Drift .....	92	8
18. Sandstone .....	11	4
17. Gray shale .....	5	
16. Sandstone .....	4	3
15. Shale .....	1	
14. Rock (undet.) .....		4
13. Gray shale .....	1	4
12. Black shale .....	1	3
11. Rock (undet.) .....	4	3
10. Gray shale .....	18	5
9. Hard rock (undet.) .....	8	
8. White clay .....		4
7. Hard shale .....		2
6. Gray shale .....	1	5
5. Gray shale .....	26	10
4. Black shale .....		11
3. Coal .....	3	6
2. Fire clay .....		7
1. Rock (undet.) .....	5	3
Total .....	186	10

One mile northeast of Dayton the Craig Coal Company obtained the following section:

	FEET.	INCHES.
9. Drift .....	129	1
8. Shale .....	1	10
7. Coal .....	3	6



6. Fire clay .....	1	
5. Shale .....	4	9
4. Rock .....	8	11
3. Shale .....	1	7
2. Shale and black jack.....	41	9
1. Coal .....	4	
Total .....	196	5

SOUTH LIZARD VALLEY.

*Tara.* The Tara coal basin lies on the northwestern border of the Permian area, on South Lizard river about four miles southwest of Fort Dodge. A fairly level and apparently quite persistent seam bearing five feet and less of coal lies at a depth of 130 feet below the prairie level. For many years small mines supplying a country trade have operated here during at least the colder months, but when the region was visited by the author no coal was being taken out. The coal is of good quality. The floor is a fire clay and the roof a blue-black shale which does not always prove satisfactory. The limits of the basin have not been exactly determined, but it is known to include at least sections 33, 34 and 35 of Douglas township and section 6 of Elkhorn township. Where coal has been mined (Elkhorn Tp., Sec. 6, Ne. qr.; Douglas Tp., Sec. 33, Sw. qr. and Se. qr.; Sec. 34, Sw. qr.) the seam was from four to five feet in thickness. In adjacent territory drillings passed through coal which was not always of workable thickness. In Douglas township (Sec. 34, Se. ¼), five prospect holes were sunk and coal found in each case at about the same depth and under the same general conditions. A record of one of these holes is given below.

	FEET.	INCHES.
11. Soil and drift .....	75	
10. Shale .....	3	
9. Blue clay .....	8	4
8. Coal .....	1	6
7. Clay ironstone ? .....	2	10
6. Fire clay .....	4	6
5. Sandstone .....	8	9
4. Red clay .....	3	2
3. Sandstone .....	7	4
2. Red clay .....	2	4
1. Rock (undet.) .....	4	

In section 35, Douglas township, Sw.  $\frac{1}{4}$ , the following record reveals three coal horizons; two of them bearing seams of workable thickness.

	FEET.	INCHES.
13. Soil .....	2	
12. Drift .....	76	6
11. Sandstone .....	4	
10. Shale .....	8	6
9. Coal .....	2	3
8. Sandstone .....	2	
7. Shale .....	2	2
6. Coal .....		6
5. Fire clay .....	3	3
4. Shale .....	2	1
3. Coal .....	2	2
2. Fire clay .....	8	9
1. Red clay .....	21	6

#### HAMILTON COUNTY

By far the greater part of Hamilton county is underlain by coal-bearing strata of Des Moines age, although the northern limit of this stage lies but a few miles beyond the northern boundary of the county. The Boone river and White Fox creek have cut down to the Mississippian limestone from the north to below Webster City and the Coal Measures are lacking also under a small area in the northeastern corner of the county. By far the greater part of the region is a gently undulating prairie, poorly drained, without outcrops, and unexplored by coal men. In the only district in which there is opportunity offered for coal beds, if such there be, to appear at the surface—namely, along Boone river below Webster City—seams are known to occur. Under the heavy cover of drift on the uplands back from the river, and especially in the southern townships, there are doubtless other basins where future wealth lies undisturbed. Prospecting to be successful must be thorough; since large sums may be expended in vain before the coveted fields are finally located. Seams have been more or less extensively worked not far from Hamilton county, in Webster on the west and in Boone and Story on the south.

Before the coming of the railroads brought cheap coal from other districts, considerable mining for local trade was in prog-

ress in the Boone river valley. Some coal is still taken out during the winter months. Old strippings, dumps, and drift openings may be seen near the river from five miles below Webster City nearly to the Webster county line. At least three horizons are known, some coal having been taken from each. Only one is considered of great importance; it lies at an average elevation of forty feet above the river level, though its altitude varies considerably at different points. Whether the coal is continuous under the entire district cannot be definitely stated from present knowledge, but the probabilities are more in favor of a number of nearly contiguous basins.

So far as known the most northerly point at which mining has been undertaken was at the Brockshink mine (Freedom Tp., Sec. 25, Sw. qr., Sw.  $\frac{1}{4}$ ), a short distance west of the river, where three feet of coal was capped by sandstone and underlain by fire clay. One mile south (Sec. 36, Sw. qr., Ne.  $\frac{1}{4}$ ), a small quantity of coal is occasionally worked by drifts on Mr. Silvers' farm. A short ravine on this place shows vestiges of extensive stripping, about two acres of surface having been removed in this way from the "upper vein." A second two-foot seam, separated from the first by three feet of shale and five of heavily-bedded sandstone, outcrops farther down the ravine. Still lower is a third bed, eighteen inches thick at the outcrop, bearing a tenacious, easily combustible coal known locally as cannel. East of Silvers', along the river, much stripping was done in former years—notably on the land of John Claffin on the west side of the river and on the Houck place opposite. The average thickness of the seam is reported to have been two feet and its elevation above low-water level about forty feet.

On the west side of the river, farther down (Webster Tp., Sec. 1), on land now belonging to Robert Lewis, coal has been removed for a distance of a fourth of a mile by stripping and at one place from a shaft. The seam worked here is from two to three feet in thickness. Two miles below, the river winds about a sharp horseshoe bend, impinging at the extremity of the curve against a steep bluff. On the brow of this declivity a shaft seventy feet deep was sunk years ago. It is said that the men worked in four feet of coal just before the caving of the

shaft stopped operations. Two miles west of the bend were the most important mines of the district, the Stockdale drifts (Webster Tp., Sec. 10, S.  $\frac{1}{2}$ ). Openings have been made in both sides of the ravine through which the wagon road leads to the north. The thickness of the bed worked ranged from two to four feet, with an average of forty inches. Entries penetrated the hill for nearly half a mile, revealing a gentle dip to the west. The roof was seven feet of slate overlain by white sandstone. A sump seven feet deep failed to pass through the fire clay underlying the coal. At one time farmers came from long distances to procure this coal, but the entrance of considerable water into the mine caused operations to be discontinued about six years ago. Still farther down the river, near Bell's mill (Sec. 16, Sw. qr.), small openings have been made at various times. Nothing has been done here for several years.

Some prospecting was undertaken a short distance back from the river at several places north of the Stockdale mines and west of Silvers'. Since the results have never been made public, we have now only negative evidence derived from the fact that no shafts were sunk where the investigations were made.

The annual production of Hamilton has always been small. In 1862 it was 850 bushels; in 1880, 3,000 tons. In 1885 the total fell to 918 tons and has since shown a gradual decline.

#### HARDIN COUNTY

Although Hardin lies on the eastern margin of the Iowa coal field, the superficial indurated rocks beneath two-thirds of its surface may be classed as Coal Measures. The areas where Des Moines strata have not been identified form part of the northern townships and of the extreme southeastern corner of the county. Almost the only natural exposures of the Upper Carboniferous are along the Iowa river from Xenia to Steamboat Rock. At Eldora, ninety feet of Coal Measure rocks, chiefly sandstones, are exposed. The Des Moines does not possess great thickness in any part of the county. The elevation of its base is 950 feet above tide at Eldora and 970 at Steamboat Rock; farther west this altitude probably decreases somewhat. Toward the west the elevation of the surface increases by 100 to 200

feet, but a corresponding increase in the depth to which the superficial deposits extend allows no increment in the thickness of the coal-bearing rocks. The average thickness of the drift is about 100 feet for the entire county and 150 feet or more for the western tier of townships. In several localities a maximum of 300 feet and more has been recorded.

Twenty-five years ago Hardin was a producer of coal; now no mining of importance is being undertaken. In 1860 the tonnage was reported to be 262. In 1866 the production had increased to 30,000 bushels. The Census of Iowa for 1875 places the production at 7,193 tons and the U. S. Census of 1880 at 3,135 tons. A further decrease soon brought the total output to less than four figures and no recovery has since been evidenced.

Until the completion of the railroad south to Oskaloosa brought Hardin county coal into direct competition with the fields of southern Iowa, Eldora was the center of a flourishing mining industry. As many as four coal horizons have been recognized yet only one has been considered worthy of much development work. A drill record from section five of Eldora township shows this sequence of strata:

	FEET.	INCHES.
12. Surface deposits .....	5	
11. Sandstone, ferruginous .....	2	
10. Coal .....	1	2
9. Fire clay .....		6
8. Shale .....		18
7. Coal .....		11
6. Fire clay .....	1	
5. Shale .....	12	
4. Coal .....	4	
3. Fire clay .....	4	
2. Coal .....		8
1. Shale .....	5	

Number 11 of this section is the base of a thick series of sandstones through which the Iowa river has hewn its way. The coal occurs in small pockets, five feet six inches thick at the maximum. The majority of the mines were situated in sections 5 and 6 of Eldora township and section 32 of Clay township. Where mined, the seam lies above the level of low water in the river, but a dip to the southeast carries it below the river in that direction.

An abundance of water forced attempts to follow the seam down the dip to be relinquished at the river level, so that considerable thick coal was left as unworkable at the lower elevations. The coal was somewhat "soft," and contained much sulphur in the form of bands of iron pyrites. The bed thins rapidly to the west and disappears beneath the river on the east. No coal has been encountered in wells at Eldora on the south, although some is reported from the vicinity of the State Industrial School, one mile west of Eldora.

Well drillers report coal from various parts of the county, yet little reliance can be placed on their somewhat conflicting statements. No systematic search for coal has yet been undertaken. The fact that a good field was discovered on the line of the only notable Des Moines outcrop within the limits of the county leads one to infer that prospecting in the unexplored strata beneath the prairies might reveal other basins and pockets of importance.

#### BOONE COUNTY

The coal bearing strata of the Des Moines stage everywhere underlie Boone county to a depth of between 400 and 500 feet below the highland level. In almost all cases, however, the upper hundred or two hundred feet penetrated in drilling from points on the plain consist of drift clays, sands, and gravels. Drillings at several points furnish data for an approximate determination of the depth of the Saint Louis limestone, or in other words, of the base of the Coal Measures, beneath the Des Moines valley region. The deep well at Boone penetrated 200 feet of drift and 260 of Des Moines strata; a drilling at Moingona reached the limestone about 200 feet below the level of the station at that village; a drilling at the Driscoll Brothers slope below Moingona encountered a cherty limestone at 125 feet beneath the river level. These determinations indicate that the base of the Coal Measures may be expected to be reached at an altitude approaching 700 feet above sea level. The usual variations in the level of the top of the limestone due to its very irregular surface must, however, be taken into consideration. Toward the east the limestone rapidly rises on the side of an anticlinal

## BOONE COUNTY

arch and comes to the surface a short distance beyond the Story county line. The strata found within 200 feet above the Saint Louis comprise the lower part of the Des Moines stage, and

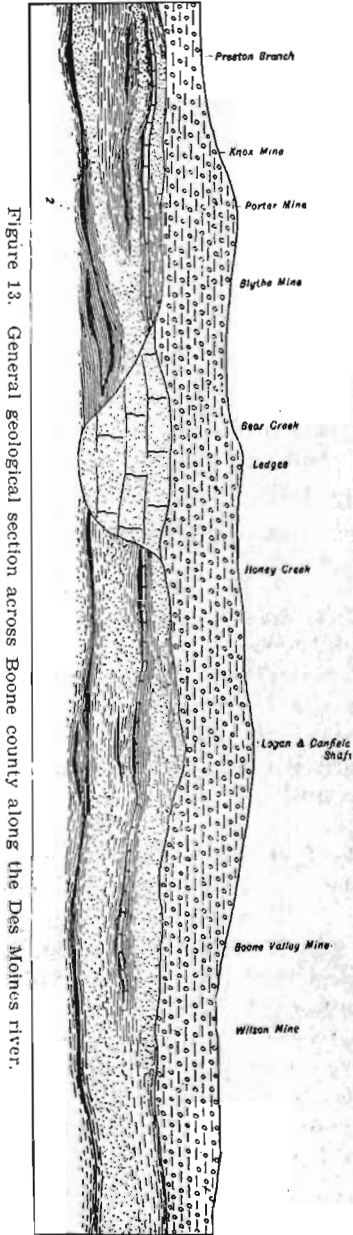


Figure 13. General geological section across Boone county along the Des Moines river.

therefore belong to the richest portion of the Iowa coal bearing rocks. Stratigraphically they correspond to the beds which include the coal seams of Polk county and the country to the southeast.

The Des Moines river has cut for itself a deep, narrow valley, bisecting the county from north to south and exposing along its course a magnificent geological section. The coal outcropping along the bluffs soon attracted the attention of the first pioneers, so that mining began in this region during the early stages of settlement. Even in 1849 Owen noted that blacksmiths obtained their coal along Honey creek, and the building of a railroad into the district in 1866 gave a great impetus to the coal industry. The production recorded in 1860 by the Eighth Census was 630 tons, value \$1,200. In 1870 the output had increased to 42,143 tons. The State Census of 1875 shows only 955 tons, but the Tenth United States Census (1880) gives 140,000 as the figure and the Eleventh (1890) 174,392. Boone now ranks eighth among the counties of the state as a producer. According to the reports of this Survey, the tonnage for the past ten years has been as follows:

## COAL DEPOSITS OF CENTRAL IOWA

YEAR.	TONS.	YEAR.	TONS.
1898	331,543	1903	291,321
1899	262,632	1904	285,157
1900	288,742	1905	292,659
1901	257,033	1906	233,110
1902	264,524	1907	208,150

During recent years the output suffered a slight decrease, but with the opening of new fields back from the river the outlook for the future is bright. The State Mine Inspectors' report for the year ending June 30, 1908, is:

Number of tons of all kinds produced.....	218,491
Total number of employes.....	864
Number of mines .....	12

At \$2.00 per ton, the value of this product at the mines becomes \$436,982.

Several coal horizons were distinguished by Beyer in the Des Moines river valley as a result of his study of the outcrops of strata and of the mining being done in 1895. Only three coal horizons were known at that time and these are described as follows in the Geology of Boone county.\*

“The first has an elevation of from fifty to seventy feet above the water in the Des Moines river and is the bed operated at the Knox and Porter slopes in the southern portion of the county, and the drifts along Honey creek in the central area. This horizon is usually overlain by a ‘caprock’ of hard, brittle, calcareous shale which contains in abundance the remains of a marine fauna—*Rhynchonella*, *Discina* and *Productus* are the more common genera represented.

“The second horizon occurs some fifty feet below the first and is the most persistent seam in the county. It is currently known as the ‘upper vein,’ or ‘black jack.’ The former name is in contradistinction to a lower vein which sometimes accompanies it; the latter name is often applied to it on account of its semi-lustrous jet-black color and somewhat bony character. This seam is operated at the Blythe [Driscoll] mine and in the Moingona, Boonesboro, Milford and Fraser areas. It is usually provided with a good roof and carries its thickness well—two essentials to profitable mining. The roof shale often contains well preserved specimens of the genus *Lingula*.

\*Beyer, Iowa Geol. Surv., Vol. V, p. 218; Des Moines, 1896.



“The third horizon occurs from four to twelve feet below the second and is usually denominated the “lower vein.” The distribution of coal in this seam is somewhat anomalous; the coal usually occurs in lens-shaped masses (pockets) of limited extent. The roof is fairly good, but often contains numerous septarian nodules and clay ironstone concretions, which render mining somewhat hazardous unless due precautions are observed. The product of this vein is much sought for furnace and domestic use and commands the highest market price. At the present time the production of this coal is almost wholly limited to the Boonesboro-Milford area.”

Since the above was written mining operations have tended to show that the “black jack vein,” although the most persistent of any, is far from being continuous between the points at which the horizon has been recognized. In most other parts of the state, also, the most strongly marked coal horizons of the Des Moines stage contain workable coal only in basins of limited extent separated by areas in which the coal is thin or completely lacking. To the three horizons recognized by Beyer must now be added a fourth which lies between fifty and eighty feet below the level of the Milford-Boonesboro coal. It has been found at several points during prospecting operations, but as the parties interested are not yet ready to make public their discoveries, nothing very definite can be stated at this time. The Ogden mine, north of Ogden, has opened up this coal and it has been reported from the Milford and Moingona districts as well as from fields south of Fraser, south of Ogden, and near the Driscoll slope. Like the hird horizon, it possesses coal of good quality and is “pockety.” It is not probable that any of the districts just mentioned are connected uninterruptedly by workable coal. Possibly the Scandia-High Bridge coal lies in this horizon.

The outlook for further discoveries of coal in Boone county is decidedly good. Drilling from the highlands, back from the river bluffs, has only recently been attempted in a determined manner and results have justified the effort. Coal is most likely to be found between depths of 200 and 300 feet below the upland; above and below these levels it may occur, though not in the same abundance. Prospectors must expect to find no coal in many of their test holes, but a continued display of energy

should bring its reward. Detailed mention of the present state of our knowledge in regard to various localities in the county, so far as it can now be made public, will be given in the following pages.

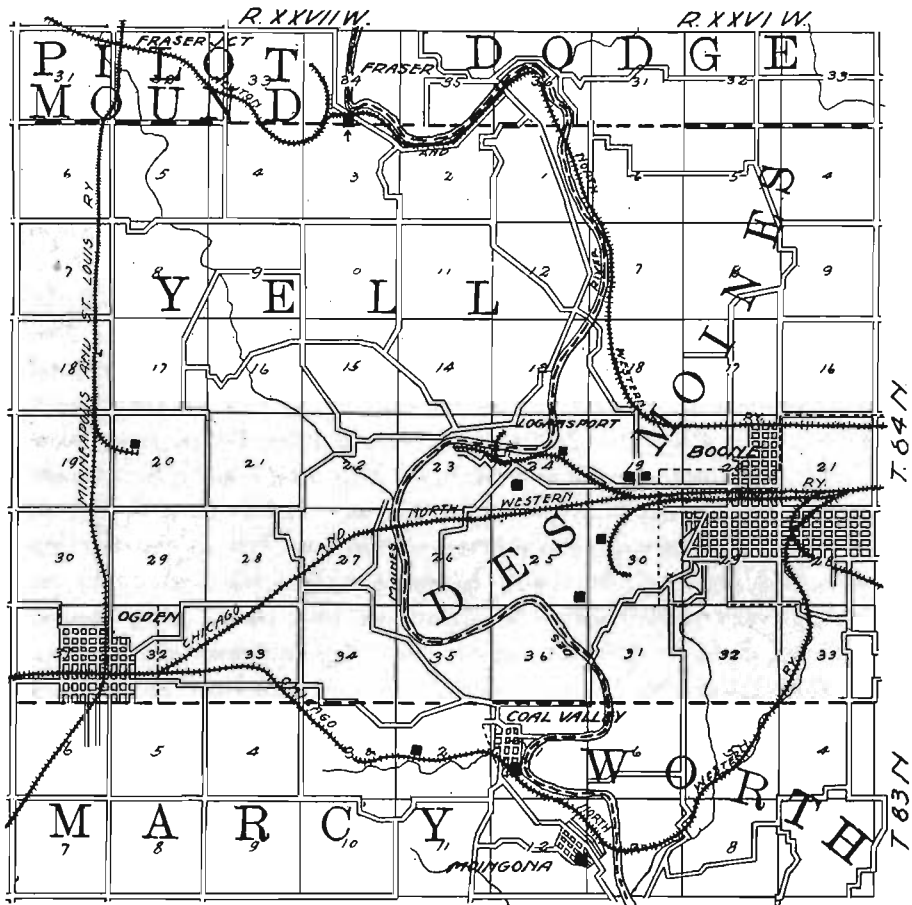


Figure 14. Map giving location of principal mines in Boone county.

#### DES MOINES VALLEY.

*Fraser.* For more than thirteen years the town of Fraser has been the center of an important mining industry which has only recently begun to show a decline. At present only one mine is in operation, but another will soon be ready for business and the output of the district may again reach an important figure.

Mine No. 5 of the Boone Coal and Mining Company loads on the tracks of the Newton and Northwestern Railway, directly behind the Fraser depot, on the west side of the river (T. 85, R. 27, Sec. 34, Se. qr., Sw.  $\frac{1}{4}$ ). The equipment on top is modern and includes Canty self-dumping cages, tubular boilers and a geared, double hoisting engine. Two workable coal seams are found here. At the shaft the upper bed is thirty-eight feet below the surface, or about at the river level, but this elevation suffers changes of twelve feet or less because of the undulatory character of the seam. This upper coal varies in thickness between two feet six inches and four feet, thickening usually in the "swamps" and "thinning to the rise." "Sulphur balls" and "dirt bands" are irregularly distributed through the coal and calcite occurs sparingly in thin films along cleavage faces. The floor of the seam is a sandstone from six to eight feet thick. The roof is a thin cap rock of variable thickness, overlain by black fissile shale. A thin "wild cat" seam, from one inch to one foot thick, is sometimes encountered fifteen feet above the heavier bed, but is as often lacking. At a distance of 400 yards from the bottom of the shaft a slope has been driven from the upper to the lower seam and cars are soon to be hauled up the incline by an electric motor. During the six years the mine has been under development, work has been carried back 3,800 feet from the river. The two seams are now yielding nearly equal amounts of coal, although the upper was opened and developed first. The distance separating the two may be as much as eighteen feet or as little as two inches, a difference due to the fact that the upper is undulatory and the lower is practically level. Where they are most widely separated, a two-foot "bowl-der," or clay-ironstone, roof overlies the lower seam. The thickness of the lower bed is quite uniformly three feet six inches. It contains some of the best coal found in the mine. The underlying stratum is a fire clay. At the recently abandoned No. 3 mine of the same company, a half mile distant, the lower bed was not found.

The Boone Coal and Mining Company have recently done considerable prospecting in the Fraser district and as a result are now sinking a shaft southeast of No. 5, near the center of

section 2 of Yell township. A spur track is to be run up from Fraser. They have already worked out the coal beneath much of section 34 and the eastern part of section 33, Pilot Mound township. Prospecting has shown at least one workable bed under sections 1, 2 and 3 of Yell township, the eastern half of 4, and parts of 10. The seam probably underlies much of sections 11 and 12 and extends into sections 13, 14 and 15, the territory worked by the old Milford mine. Near Fraser, in Dodge township, seventy-five feet below the bottom lands, a bed has been found which is six feet thick in places and unworkable in others. The company reports that they have been unsuccessful in finding coal in any drill hole they have placed farther from the river than one and a half miles.

The following section illustrates the character of the strata in part of the Fraser field. Since the elevations of the heads of the bores differ greatly, the depths given for the thick coal are not uniform in the different records. Hole A was drilled from the upland, three-fourths mile west of mine No. 5. If the thick seam sought for had been present it would have been found at a depth of about 250 feet. Hole B, one-fourth mile east and the same distance south of mine No. 5, penetrated both beds that have been mined at Fraser. Hole C, put down not far from mine No. 3, penetrated only one thick coal. It may be observed from a study of the sections that several thin seams appear in some parts of the field and are absent in others.

## FRASER SECTIONS.

## HOLE "A."

	FEET.	INCHES.
17. Soil and clay .....	15	
16. Drift, gray, hard bands, sand and gravel.....	211	
15. Shale, pink .....	1	
14. Shale, light-colored .....	1	
13. Rock, dark .....	1	
12. Coal .....		6
11. Fire clay .....	1	6
10. Shale, gray .....	1	
9. "Slate" .....	10	
8. Shale, gray .....	1	
7. Shale, light-colored .....	4	
6. Shale, gray .....	4	
5. Shale, light-colored .....	12	

BOONE COUNTY

65

4. Shale, gray .....	21	
3. Shale, light-colored .....	15	
2. "Slate," dark .....	10	
1. Shale, light-colored .....	10	9
Total .....	319	9

HOLE "B."

	FEET.	INCHES.
14. Soil and sandy clay.....	10	
13. Drift, mixed gray and yellow clay.....	132	
12. Red shale.....	7	
11. Shale, sandy, light-colored.....	1	
10. Sandstone .....	2	
9. Shale, light-colored .....	8	
8. Shale, dark .....	3	
7. Shale, sandy, light-colored.....	11	
6. Shale, gray .....	15	
5. Coal .....	3	6
4. Sandstone .....	3	
3. Shale, light-colored .....	3	
2. "Slate," black .....	10	
1. Coal .....	3	6
Total .....	212	

HOLE "C."

	FEET.	INCHES.
21. Soil and sandy clay.....	19	
20. Drift, gray .....	30	
19. Shale, mixed .....	32	
18. "Slate," dark .....	2	
17. Coal .....		6
16. Shale, light-colored .....	1	6
15. "Slate," dark .....	10	
14. Coal .....	1	
13. Shale, sandy, blue .....	1	
12. Coal .....	1	4
11. Sandstone .....	4	8
10. Shale, gray .....	3	
9. Rock and coal .....	1	
8. Coal, pure .....	1	
7. Shale, light-colored .....	5	
6. Shale, gray .....	26	
5. Sandstone .....	2	
4. Rock, white .....	2	
3. "Slate," dark .....	4	
2. Coal .....	4	
1. "Slate," sandy .....	1	6
Total .....	152	6

*Milford.* An important mining locality for a number of years was Milford, on the west side of the river, south of Fraser and west of Boone. A long coal spur was run from Boone across the Des Moines to provide transportation for this field. Operations were continued until the district was considered worked out and was finally abandoned. Mining was done in an extravagant and wasteful manner in many cases, so that much coal is still left untouched and in such condition that it is worthless. Two coal beds were recognized in mining practice: a lower seam averaging three and one-half feet in thickness, and an upper ten feet and more above it. The latter seam was slightly thinner than the former, but was more uniform and persistent. The lower seam thickened and thinned with apparent irregularity. There was a third seam about forty feet below the "lower" coal. The "lower" seam is shown in the following section at the old Milford mine, the shaft of which, located at the base of the bluff, was 100 feet deep.

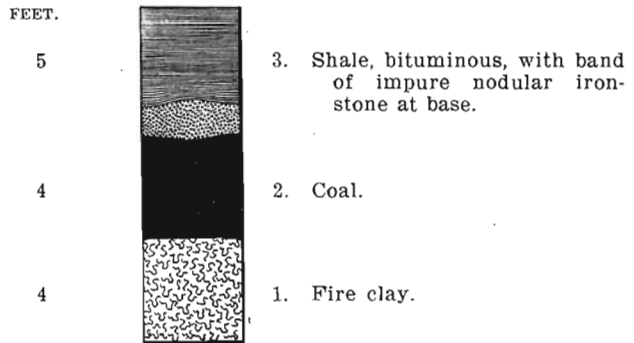


Figure 15. Bottom of shaft, Milford mine, Boonesboro.

*Boonesboro.* After the cessation of mining at Milford, the center of the coal industry of the Boone area was transferred to Boonesboro, on the opposite side of the river. A number of important mines have shipped coal from this district, yet recently there has been a falling off in the production of the field. At present there are five shafts on the highland, all shipping mines with steam hoists and worked long wall. The two seams developed in the Milford district are present also on the east side of the Des Moines, although the "lower" is workable for

only a short distance back from the river. Details of the strata at the various mines will be found below.

The shaft farthest east is that of the Rogers Coal Company (T. 84, R. 27, Sec. 24, Sw. qr., S. 1/2). It is 200 feet deep, reaching a bed uniformly three feet thick. Aside from a gradual dip to the south, the level of the seam varies only a few inches in different parts of the mine. Strips and "boulders" of rock, predominantly sandstone, are found only occasionally in the seam. Entries have been run in all four of the cardinal directions and forty acres have already been mined out. The coal is underlain by fire clay and overlain by "cap rock."

A half mile northeast (Sec. 24, Ne. qr., Sw. 1/4) is the oldest shaft in the county, No. 2 of the W. D. Johnson Coal Company. It has been operated almost continuously for more than forty-three years and by the present management for over thirty-eight. Much difficulty has been experienced with an underground fire which has been burning for ten years and has finally been brought under control by the construction of a solid brick wall around it. In the early days entries were driven rapidly away from the shaft and only the best coal was taken; now work is being carried back towards the shaft to obtain the coal formerly left. Rope haulage, which was necessary when the haul was longer, is not now in use. At present the coal mined is from three to three and a half feet in thickness, with a two-inch band of black jack at the base. This is the "upper vein"; the "lower" was followed back from the river until it became too thin for profitable mining. The strata found in excavating the shaft are listed below, the lithological identifications having been made from small samples obtained by the foreman at the time of sinking.

## W. D. JOHNSON SHAFT.

	FEET.
29. Soil .....	5
28. Clay, yellowish .....	20
27. Clay, bluish, with considerable grit.....	40
26. Clay, yellowish brown .....	40
25. Shale, bluish, massive, dark below.....	9
24. Sandstone, light-colored, shaly.....	9
23. Shale, gray-blue .....	3
22. Shale, with iron-stone concretions.....	3

## COAL DEPOSITS OF CENTRAL IOWA

21. Sandstone, fine-grained, friable.....	12
20. Shale, bluish and drab.....	6
19. Sandstone, ash colored.....	12
18. Shale, compact, massive.....	7
17. Shale, light-colored ("soapstone").....	5
16. Sandstone, whitish, argillaceous.....	13
15. Sandstone, compact, somewhat coarse in texture.....	8
14. Shale, black, bituminous, fissile below.....	3
13. Fire clay and light-colored shale.....	9
12. Shale, hard, blue-black.....	5
11. Fire clay .....	1
10. Shale, dark, highly bituminous, brittle, compact.....	3
9. Coal .....	½
8. Shale, variegated .....	1
7. Coal, "upper vein".....	4
6. Fire clay .....	3
5. Shale, with irregular iron-stone concretions.....	4
4. Coal, "lower vein".....	4
3. Fire clay .....	3
2. Shale, light-colored .....	3
1. Shale, dark, bituminous.....	2
Total .....	237½

Shaft No. 3 of the W. D. Johnson Coal Company (T. 84, R. 26, Sec. 19, Sw. qr., Ne. ¼) was sunk seven years ago to avoid the long hauls then being made to No. 2 shaft. The two mines are connected underground, but both possess quarter-shafts and may be ventilated independently. The "upper vein" and its overlying strata are the same at both openings, except that there are more "bowlders" in the coal at No. 3 and a heavier cover of drift. The "bowlders" are bituminous sandstones, very hard and compact and with a lime cement. They may be as much as twenty feet in length by four in diameter, and occur usually in the top coal, next the roof. Mine No. 1 of the same company was on lower land, near the river.

The Smiley and Heaps shaft is on the east side of the wagon road, opposite the Johnson No. 3. It is 240 feet deep. The company are working east, north, and south, one main entry running east and the other northeast. The strata near the coal, which is the "upper vein," show a few minor variations in character and thickness on opposite sides of the shaft. The small seam which is shown a foot above the "upper vein" in the Johnson shaft section, has increased to a thickness of ten



inches on the north side of the shaft, although it is only six inches on the south side. The bed worked is three feet thick.

A bit over three-fourths mile southeast (Tp. 84, R. 26, Sec. 30, Nw. qr., Sw. 1/4), the Eagle Coal Company is operating a shaft 230 feet deep. As shown in the accompanying figure, the strata near the coal differ but little from those found with the "upper vein" farther north.

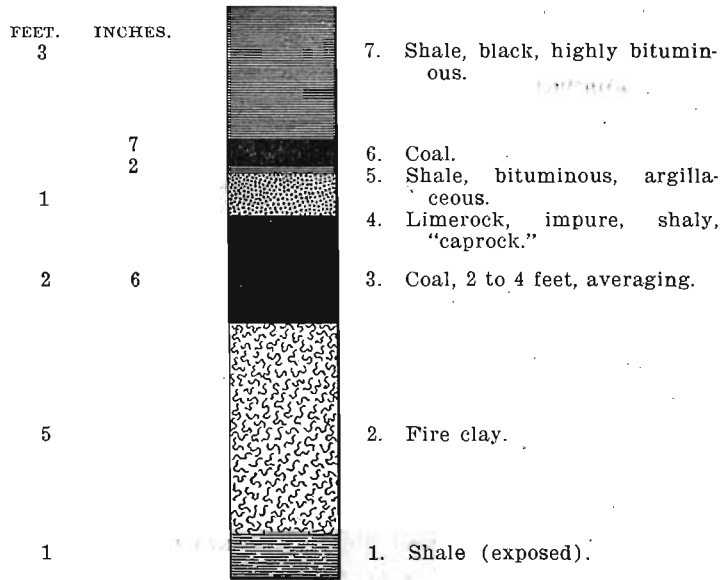


Figure 16. Section in Eagle shaft, Boonesboro.

Where the seam is thin the coal is quite free from impurities, but wherever it thickens a two-inch band of black jack appears at its base and another occasionally finds a place in the top coal. The latter band is sometimes six inches thick, yet gives little trouble as it seldom persists continuously for more than fifteen feet horizontally. No "bowlders" are reported. The "lower vein" of the Johnson shaft section is present at this point as a fourteen-inch bed about eleven feet below the "upper vein." At from seven to seventeen feet above the latter is a thin coal between four and fourteen inches thick. It is not very persistent in this field.

There are two local mines south of the Boone field proper and on lower land. The Black Diamond mine is a small shaft

located in a deep gulch on the east side of the river (T. 84, R. 27, Sec. 25, Se. qr., Se.  $\frac{1}{4}$ ). The shaft is forty-eight feet deep, the coal being a little above the river level at low water. The seam is two feet six inches thick, fairly uniform and level. The thin roof of "cap rock," with a little black shale and a four-inch coal bed above it, preserves the characteristics of the "upper vein" of the main Boonesboro area. Another seam, one foot thick, twenty feet above the bed worked, also has its representative at the Eagle mine. In the bottom coal there is a streak of black jack about one and a half inches thick and at varying distances from the base of the coal seam. In mining long wall, the coal splits as it comes down, the bottom coal being ten inches thick and the top coal constituting the remainder of the seam.

On the west side of the river (T. 84, R. 27, Sec. 35), is the Pestotnik slope. It supplies a large country trade, as there is a good demand for this coal among the surrounding farmers. Mr. Pestotnik has just completed sinking a new shaft two miles northwest of Moingona (Marcy Tp., Sec. 2, Sw. qr., Nw.  $\frac{1}{4}$ ), on what was formerly the main line of the Chicago and North Western Railroad. The shaft is ninety-five feet deep. Tracks are now being laid for a coal switch and hoisting machinery is being shipped.

*Moingona.* Many years ago Moingona was the seat of a flourishing mining industry and mines were turning out coal both at the town and also north and south of it, near the river. Today there are but two small mines open, aside from the new Pestotnik shaft already mentioned. At the junction of Wall and High streets in Moingona, is the shaft, 104 feet deep, of the Big Five Coal Company. Coal is shipped, although hoisting is done by horse and gin and the output does not reach a large figure. The seam worked shows an average of thirty inches of coal. A little black jack is known, but the bed as a whole is a clean one. There is just sufficient fire clay beneath the seam to mine in. The clay is underlain by about four feet of sandstone, that in turn by black "slate," and the latter by the so-called "lower vein." When present, the "lower" coal is variable in thickness and lies about twelve feet below the "upper." It is not, however, at all persistent in this field. The

“lower vein” is undulatory, while the “upper” is practically level.

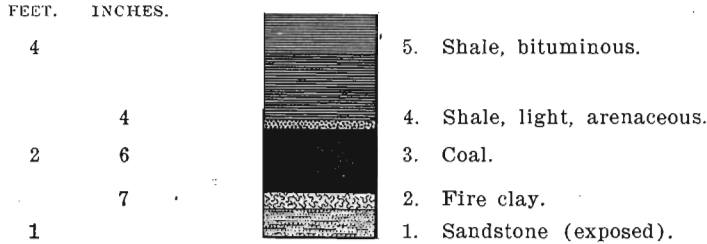


Figure 17. Vein at Big Five mine. Moingona.

One mile northwest of Moingona, beside the Chicago and North Western tracks, is the John Birmingham mine, now operated by the Coal Valley Coal Company. (T. 83, R. 27, Sec. 1, Sw. qr., Nw. ¼). The shaft, which is ninety-three feet deep, was sunk several years ago, but development has taken place slowly. Coal is hoisted by steam power and shipped to points in Boone and neighboring counties. The strata present but slight differences from those at the Big Five mine, except, perhaps, that the seam contains a greater amount of black jack. Between this shaft and Moingona, the following section is exposed along the railway:

	FEET.
11. Drift, extends about fifteen feet below the road bed.....	50
10. Sandstone, shaly, alternating with sandy shales.....	12
9. Shale, blue .....	4
8. Sandstone, both shaly and compact.....	4
7. Shale, black .....	2
6. Coal .....	¼
5. Fire clay and shale.....	7
4. Shale, containing ferruginous concretions and stems of Lepidodendra .....	4
3. Shale, blue-black, containing <i>Lingula umbonata</i> Cox.....	2
2. Coal .....	2
1. Fire clay, exposed.....	2

Some deep prospecting has been done at Moingona, but detailed records could not be obtained. According to the best information procurable, the Mississippian limestone lies at a depth of about 200 feet below the level of the Moingona station. This places the base of the Coal Measures here at about 700 feet

A. T., as compared with 680 at Boone, and perhaps 720 seven miles down river at the Driscoll bank. A coal three feet six inches in thickness, about seventy-five feet below the seam now worked, is reported as struck in at least one hole.

*Moingona to Madrid.* Many years ago some important mines were opened along the river below Moingona in the same seams as were mined at that town. Nothing is being done in the district now. Still farther down the river, in the neighborhood of Bear and Peese creek, the Ledge sandstone, a massive arenaceous formation sometimes more than 100 feet thick, displaces the series of shales, thin sandstones, and coal beds which outcrops elsewhere along the Des Moines. This ancient channel is well shown in the geological section across Boone county already figured. Some distance below it, mines are often opened during the fall and winter for the local trade. One of the more important of these is the York bank on the east side of the stream; it was not in operation when the region was visited by the author. Two local coal banks had, however, been opened for the winter on the west side of the river and a brief description of the conditions at each of these may be taken as typical for the region.

The Driscoll Brothers mine is at the base of a steep bluff about half way between Moingona and the Dallas county line (T. 82, R. 26, Sec. 5, Se. qr., Sw.  $\frac{1}{4}$ ). Since the mouth of the slope is near the water level, it is necessary to raise the loaded cars along an inclined tramway from it to the top of the bluff, two hundred feet or more above the river. A small engine and boiler perform this duty. The coal is well exposed twenty feet above the river, then dips very rapidly down stream until the seam disappears beneath the water. At the present workings a slope 100 feet long reaches the coal below the water level where its average thickness is three feet. The bottom is solid arenaceous rock, the roof a firm blue "slate." Old entries have taken coal from as far back as 700 feet from the face of the bluff. Below the slope mouth the strong dip down stream ceases, so that the bed may be traced in shallow test holes as a fairly level seam for three-fourths of a mile; it then appears to thin out and disappear. Above the slope the seam persists for 300 yards and perhaps more.

Driscoll Brothers, boring from the level of low water near the entrance to their mine, encountered at a depth of 125 feet a cherty limestone which in all likelihood lies just below the base of the Coal Measures. A two-foot coal was found forty-six feet below the seam in their mine and also an eight-inch bed at greater depth; otherwise the test is remarkably barren. The detailed record follows:

	FEET.	INCHES.
22. Mud .....	1	
21. Coal .....	3	
20. Shale and clay .....	44	6
19. Rock, very hard .....	1	6
18. Coal .....	2	
17. Fire clay .....	2	6
16. Shale and clay .....	13	6
15. Rock, hard .....	2	6
14. "Slate" .....	3	4
13. Coal .....		8
12. Fire clay .....	4	6
11. Sandstone .....	9	
10. Rock, very hard .....		4
9. Sandy shale and sandstone.....	6	
8. "Slate," black .....	6	
7. Fire clay .....	1	9
6. Sandstone, dark, compact.....	12	
5. "Slate," black .....	7	
4. Fire clay .....	1	7
3. "Slate," black .....	1	8
2. Fire clay .....		10
1. Limestone, cherty .....		3+
Total .....	125	5

The Wisecup bank is a mile below the Driscoll (Sec. 9, Sw. qr., Ne.  $\frac{1}{4}$ ). It is a drift which has been driven into the bluff for 300 feet through an average of two feet of coal. Here, too, the loaded cars are hauled up an inclined tramway to the top of the bluffs by means of a pull rope, but in this case the motive power is furnished by two horses attached to a gin. The mouth of the drift is forty-five feet above the river. What appears to be a fairly persistent horizon is indicated at the Driscoll air shaft by a thin coal twenty-five feet above the bed mined at that point. Possibly the Wisecup coal may lie in this same horizon. In this drift, sandstone and sandy shale underlie the seam, while the

roof is a black "slate" bearing below a thin layer of bluish shale containing sandy streaks and bands. The layer last mentioned is taken down with the coal in mining. The dip is to the west. A lower coal, which has not been opened near this point, appears at low-water level. At the old Knox bank, less than a mile below, a seam twenty-six inches thick has been drifted into at a height of about seventy feet above the river. Where it outcrops in the side of a ravine it has a good roof and bears coal of fair quality.

Some recent prospecting has been undertaken on the uplands on both sides of the river near Madrid. Workable coal is reported, but more tests must be made before the existence of a large field can be verified. A thick seam is reported from the vicinity of Luther, but this information is also somewhat vague.

#### OGDEN.

A new field which will become one of the most important in the county has recently been opened by the Ogden Coal Company.\* Their shaft is located two miles north of Ogden (T. 84, R. 27, Sec. 20, Nw. qr., Sw.  $\frac{1}{4}$ ), and loads on a spur from the Minneapolis and Saint Louis railroad. The mine is not fully developed yet, but already turns out a large daily output which is shipped to the north and west. A large double hoisting engine is now in place and Goodman electric motors, mining machines, and automatic cages are planned for the near future. The seam has a height of from four to five feet, and dips slightly to the west. The coal is of excellent quality, being noticeably free from pyrites. Lenses of a compact, highly bituminous sandstone are occasionally found in the coal about four inches from the top of the bed, and a few clay-ironstone "bowlders" of small size may be seen in the roof. The bottom is a fire clay one to three feet thick. Above the bed worked is an upper coal bed which is sometimes three feet thick and sometimes quite thin. The bed worked lies at a depth of 270 feet and is known to be of workable thickness under all of the 1,000 acres controlled by the company.

In sinking the city well at Ogden, the Ogden mine horizon was

\*Since the above was written a controlling interest in the Ogden Coal Co. has been purchased by the Fort Dodge, Des Moines & Southern Ry. Co.

penetrated at a point where there was apparently too little coal to warrant putting in a shaft. The section, as published many years ago in the reports of this survey, is:

## OGDEN WELL.

	THICKNESS FEET.	DEPTH OF SAMPLE FEET.
8. Soil and drift clays.....	108	108
7. Sand and gravel, water bearing.....	2	110
6. Shale, light-colored, sandy.....	7	117
5. Shale, black, with some coal at base.....	8	125
4. Fire clay .....	2	127
3. Shale, bituminous .....		228
2. Shale and sandstone mixed.....		256
1. Coal, penetrated at .....		270

In Marcy township, not far south of Ogden, recent prospecting has proved a field two miles long from east to west by one and one-half miles north and south. A representative section from this territory follows:

	FEET.
23. Soil and drift .....	120
22. Shale, light-colored .....	6
21. Shale, gray .....	5
20. Sandstone, gray .....	3
19. Shale, gray, sandy .....	2
18. Shale, light-colored .....	16
17. Shale, variegated .....	18
16. Shale, light-colored, sandy, with rock bands.....	13
15. Shale, gray .....	7
14. "Slate," dark .....	5½
13. Coal .....	1
12. Shale, light-colored .....	6½
11. "Slate," dark .....	1
10. Shale, light-colored .....	4
9. Rock, dark .....	3
8. Shale, gray .....	2
7. "Slate," dark .....	5
6. Iron pyrites, in bands .....	1
5. "Slate," dark .....	4
4. Coal .....	3½
3. "False bottom" .....	½
2. Shale, gray .....	1
1. Fire clay .....	2
Total .....	230

SQUAW CREEK VALLEY.

At Zenorsville, near the eastern edge of the county, mining was once carried on, but no coal has been taken out for a number of years. At the Hutchinson No. 1 shaft (T. 84, R. 25, Sec. 12, Se. qr., Nw.  $\frac{1}{4}$ ), the section was as follows:

	FEET.
11. Soil, gray and sandy.....	1
10. Joint clay .....	40
9. Shale, bluish .....	53
8. Shale, light-colored .....	1
7. Shale, bituminous, fissile below.....	2
6. Coal .....	2
5. Fire clay .....	3
4. Sandstone, rather soft and friable.....	2
3. Shale, light-colored .....	4
2. Shale, dark, bituminous.....	3
1. Coal .....	1½
<b>Total .....</b>	<b>112</b>

Hutchinson shaft No. 2, located 300 yards northward, was on lower ground and only 105 feet in depth. At the base of the shaft were two coals, only one of which was worked. They are shown in the figure.

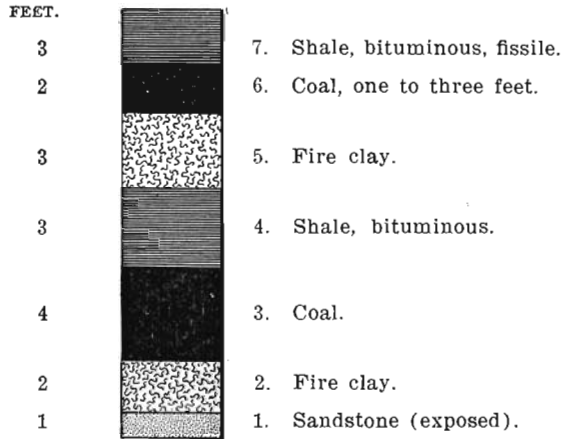


Figure 18. Coal bed in Hutchinson mine No. 2, near Squaw creek, Zenorsville.



## ANGUS.

Some large mines were once in operation in Boone county near Angus. Since the only mining being done in this district at present is just over the line in Greene, the various coals of the area will be discussed in the chapter on that county.

**STORY COUNTY**

The Skunk river anticline brings the Mississippian limestone to the surface in the west-central portion of Story county, along Skunk river and Squaw creek and the country between. From this area the strata dip rapidly in all directions. Coal Measures of the Des Moines stage underlie the drift of the entire eastern half of the county, of practically all of La Fayette, Palestine, Grant, and Union townships, of most of Howard, Milford and Washington, and of the north-central third of Franklin. Nowhere, nevertheless, do the coal bearing strata attain any great thickness. The upper surface of the Saint Louis limestone has been found at an elevation of 900 feet above the sea level at Story City, 738 at Nevada, and 700 at Maxwell and Collins. The difference between the altitude of the surface and that of the limestone can by no means be taken, however, as a measure of the thickness of the Des Moines; for the drift commonly extends to a depth of 100 to 200 feet below the prairie level and proportionately less below the lowlands. For example, the drift is 101 feet in thickness at Nevada and the Des Moines 166 feet; at Maxwell the latter is reduced to fifty feet at some points but attains at least 150 at others not far distant.

It will be seen that the Coal Measures, while attenuated in some localities, are often present in sufficient abundance to encourage search for coal. The greater part of the surface of the county is a prairie which yields no natural outcrops; yet, in spite of this, coal has been already located in many widely separated districts by means of borings and wells. Indeed, the chief reason that Story is now producing no coal seems to rest more in the difficulties attending development work than in any lack of thick coals. Wherever mining has been attempted, the roof has proved unsatisfactory, an eventuality very probable in a region of this type. The surface is so poorly drained that

large quantities of water sink beneath it and flow slowly through the heterogeneous drift deposits until from some deep-lying pockets of the latter they obtain entrance to all parts of the Coal Measures themselves. It is this water which is largely responsible for unsatisfactory characteristics of bottoms and roofs. There are, nevertheless, undoubtedly places in Story county where good coal will some day be found and where mining conditions will be excellent. Little prospecting has been done in the eastern and northeastern townships, both promising districts. The best results may be expected where the drift is thin, since in some parts of the county pre-glacial channels have cut so deeply into the indurated rocks as to largely destroy the value of what were once splendid coal basins.

The production of Story has never been noteworthy. The largest output was 12,000 tons in 1897, a tonnage which dropped to 7,885 in 1898, to 3,200 in 1900, and to 300 in 1901. Since 1902 almost no coal has been mined. Prospect records and other data may be found in the following pages. The report of Dr. S. W. Beyer on the *Geology of Story County*\* has been of considerable assistance to the writer.

*Summit.* Early in 1893 a shaft was sunk at Summit (LaFayette Tp., Sec. 21, Sw. qr.) and mining operations were conducted for a number of years. Part of the product was shipped over a short spur from the Chicago & North Western railroad. Nothing has been done at this point for some time. The coal was only of fair quality, while the roof was very poor in places and water entered in inconvenient quantities. Trouble was always experienced from the tendency of the underlying fire clay to "creep." The seam lies quite level and is uniform in thickness. In sinking the shaft no less than five coals were revealed.

SHAFT AT SUMMIT.

Surface altitude about 1,050 feet A. T.

	THICKNESS IN FEET.	DEPTH IN FEET.
20. Soil .....	3	3
19. Clay, yellow, gravelly.....	20	23
18. Clay, blue .....	5	28
17. Sand, bluish .....	1	29

\*Iowa Geol. Surv., Vol. IX, pp. 155-245; Des Moines, 1899.

16. Sea-mud (loess ?) .....	40	69
15. Sand and gravel (till?) .....	26	95
14. Rock, hard .....	1	96
13. Clay, sandy .....	3	99
12. Coal "blossom" .....	1-3	99 1-3
11. Fire clay .....	1	100 1-3
10. Coal .....	1-3	100 2-3
9. Fire clay, bluish .....	11	111 2-3
8. Coal .....	1-3	112
7. Fire clay .....	7½	119½
6. Coal, good .....	2	121½
5. Fire clay, bluish .....	4	125½
4. Shale, hard .....	3	128½
3. Shale, blue .....	6	134½
2. Coal .....	4½	139
1. Fire clay, exposed .....	3	142

A well record from this vicinity shows the following sequence, including still another coal, below number 2 of the above record.

	FEET.
Fire clay .....	3
Rock (sandstone?) .....	1½
Fire clay .....	18
Coal .....	1
Fire clay .....	38
Shale, black .....	5

The Summit coal is, according to Beyer, an eastward extension of the Sugar creek basin near Zenorsville, Boone county. The altitudes and stratigraphic relationships of the two basins closely correspond. The seam worked has been reported to extend at least one mile east of the shaft, but its range toward the northeast is known to be limited. Prospecting east and south of Story City failed to locate promising coal horizons.

*McCallsburg.* Two miles south of McCallsburg two local mines were at one time established to supply winter trade. The seam worked was only eighteen inches in thickness, yet mining conditions were sufficiently favorable to maintain a profit. A three-foot coal is said to lie seventy-five feet below the upper seam and this report, if verified, may lead to future development.

*Cambridge.* In section 10 of Union township, northeast of Cambridge, a six-foot coal bed was claimed and a shaft was sunk. The latter filled with water, and positive data in regard to the

coal are now difficult to obtain. Considerable prospecting has been done in and near the valley of Skunk river between Cambridge and Ames, with variable success. One or two coals were penetrated in each hole, yet usually these were under two feet in thickness. Where more promising seams were discovered they commonly thinned rapidly in all directions; yet the presence of numerous coal horizons seems so firmly established that the outlook for the future is far from discouraging. The following records of holes drilled by J. A. McElhaney, of Lovilia, give a fair idea of the stratigraphy of the district.

## HOLE "A."

Grant Tp., Sec. 30, Nw. qr.

	FEET.
11. Drift .....	93
10. Shale, black .....	1
9. Sandstone, blue .....	3
8. Shale, gray .....	5
7. Limestone, gray .....	½
6. Shale, bituminous .....	½
5. Coal .....	4
4. Fire clay .....	2
3. Shale, sandy .....	8
2. Coal, impure .....	1½
1. Shale, gray .....	16
Total .....	134½

## HOLE "B."

Grant Tp., Sec. 18, Ne. qr., Nw. ¼.

	FEET.
14. Drift .....	95
13. Shale .....	1
12. Coal .....	½
11. Sandstone .....	2½
10. Coal .....	¾
9. Shale, sandy .....	1½
8. Shale, argillaceous .....	2
7. "Sand," blue .....	11
6. Coal .....	1
5. Sandstone .....	16
4. Shale, blue .....	6
3. Shale, black .....	4
2. Sandstone .....	2
1. Shale, blue .....	8½
Total .....	151¾

STORY COUNTY

91

HOLE "C."

Grant Tp., Sec. 17, Sw. qr., Ne. ¼.

	FEET.	INCHES.
14. Drift .....	99	8
13. Shale, black .....	3	
12. Coal .....		9
11. Fire clay .....	3	
10. Shale, black .....	11	9
9. Coal .....	1	11
8. Fire clay .....	1	4
7. Sandstone .....	4	8
6. Shale, sandy .....	13	11
5. Rock .....	2	
4. Shale, black .....	4	2
3. Coal .....	1	11
2. Fire clay .....		4
1. Rock .....		2
Total .....	148	7

HOLE "D."

Union Tp., Sec. 6, Ne. qr.

	FEET.
13. Drift .....	78
12. Shale, black .....	2
11. Coal .....	1½
10. Rock (boulder?) .....	1
9. Coal .....	2
8. Sandstone .....	7½
7. Shale, sandy .....	2½
6. Shale, blue .....	3
5. Coal .....	2½
4. Shale, gray .....	5½
3. Shale, blue .....	11½
2. Shale, gray .....	4½
1. Sandstone .....	14½
Total .....	136

*Maxwell.* The town of Maxwell recently drilled five holes on either side of Indian creek. Some coal was found in each drilling, but the cover over the thicker coal was not considered sufficiently good to warrant sinking a shaft. The drill logs of two of the holes are shown below.

## COAL DEPOSITS OF CENTRAL IOWA

## HOLE "A."

Tp. 32, R. 22, Sec. 28, Ne. qr., Sw.  $\frac{1}{4}$ .

	FEET.
12. Drift .....	9½
11. Shale, black .....	50
10. "Slate," black .....	5
9. Coal .....	1
8. Fire clay .....	5
7. "Slate" .....	11
6. Coal .....	1½
5. "Slate" .....	30½
4. Coal .....	2
3. Clay .....	10
2. Soapstone .....	27
1. Limestone .....	..
Total .....	152½

## HOLE "B."

Tp. 32, R. 22, Sec. 27, Sw. qr.

	FEET.
11. Drift .....	75
10. Sandstone, and "keel" .....	10
9. "Slate" .....	10½
8. Coal .....	4½
7. Fire clay .....	2
6. Sandstone .....	2
5. Coal .....	¼
4. "Slate" .....	15
3. Sand .....	10
2. Soapstone .....	10
1. Limestone .....	..
Total .....	139¼

Eighty rods east of hole "B," the heavy seam is represented by three feet of coal which, however, is separated from the overlying drift by only two feet of "slate" and is therefore unworkable at that point. Eighty rods south of hole "B," the drill apparently penetrated an old channel from which the coal had been removed. South of hole "A" (Sec. 33, Nw. qr., S.  $\frac{1}{2}$ ), only six inches of coal was shown. In all five prospects the driller reported limestone at a depth of approximately 150 feet. If his identifications are correct, the surface of the Saint Louis lies at about 700 feet A. T. and the thickness of Coal Measures beneath the drift is in places as little as fifty feet.

A well near the clay pit of the Maxwell Brick and Tile Works, one mile east of Maxwell, passed through six feet of soil and drift and 142 feet of Des Moines strata, including three coal "blossoms" less than one foot in thickness. Although the coal found at Maxwell lies at nearly the same level as that mined at Enterprise, in Polk county, it undoubtedly represents a lower horizon.

*Collins.* Three miles south of Collins (Collins Tp., Sec. 34, Sw. qr., Ne.  $\frac{1}{4}$ ), a shaft was sunk in the bottom land along Wolf creek. The coal taken out had a ready sale. The seam is known to extend some distance east and south of the shaft, but the roof is not dependable. The sequence of strata at the shaft is about as follows:

	FEET.
5. Drift .....	70
4. Coal Measure shales and clays.....	60
3. Coal .....	2
2. Fire clay and shale.....	7
1. Coal .....	3½
	<hr/>
Total .....	142½

#### MARSHALL COUNTY

Marshall lies on the eastern border of the Coal Measure area of Iowa. Des Moines strata underlie the whole of the western half of the county with the exception of small areas at and southwest of Liscomb and above Marietta. The Des Moines also occupies all of Iowa and Jefferson townships and the divides of the western half of Timber Creek township. The youngest indurated rocks of the remainder of the county have been classified with the Kinderhook stage of the Mississippian series. On its eastern margin the Des Moines is extremely attenuated, while farther back towards the west outcrops are few and the drift on the uplands possesses an average thickness of about 200 feet. It is, perhaps, due to this concealment of the coal-bearing strata that so little coal has been found along the western border of the county. The great thickness of the drift which must be pierced in order to reach a comparatively thin series of Coal Measures renders prospecting precarious. For

a full discussion of the general geology of the county the reader is referred to Beyer\* ✓

Practically the only place where mining has been carried on is near Mormon Ridge, three miles northwest of Albion (Tp. 85, R. 19, Sec. 34, Sw. qr., Se.  $\frac{1}{4}$ ). A shaft fifty feet deep was sunk through the following sequence of strata:

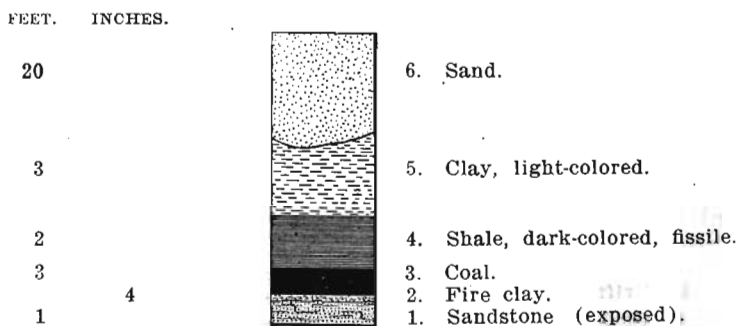


Figure 19. Bed at Mormon Ridge mine, near Albion.

Only a few feet of shale intervened between the coal and a stratum of water-bearing sand, so that work was abandoned after not more than 100 tons of coal had been excavated. Later another company endeavored to reopen the mine, but water again interfered with progress. Nothing has been done here for a long period. A quarter of a mile north of this shaft, on the north side of Mormon Ridge, some coal was taken out many years ago. A drilling one mile northwest of the Mormon Ridge shaft (Sec. 28, Sw. qr., Sw.  $\frac{1}{4}$ ) penetrated at a depth of 118 feet a bed of black shale with some coal. The seam was reported to be several feet in thickness and to be underlain with a thin stratum of fire clay.

At one time a shaft was sunk on Minerva creek, five miles west of Bangor (Liberty Tp., Sec. 9, Se. qr., Se.  $\frac{1}{4}$ ). Just how much coal has been found here is not now definitely known. Traces of coal have been encountered in wells at various points in the western part of the county. Coal basins of local importance will undoubtedly be located in the future, but Marshall will never rank among the chief coal-counties as a producer.

\**Geology of Marshall County, Iowa Geol. Surv., Vol. VII, pp. 199-262; Des Moines, 1897.*



**DALLAS COUNTY**

With the exception of a small area in the southwestern corner of the county, the indurated rocks which outcrop immediately below the loose surface cover of soil and drift belong to the Des Moines stage, the lower and more productive member of the Coal Measures of Iowa. In the southern half of Union township and the southwestern quarter of Adams, the Des Moines strata are covered by those of the Missouri, the upper member of the Coal Measures, which, however, is so thin that Bear creek and most of its tributaries have cut through it so as to expose the underlying Des Moines in the bottoms of their valleys. Few coal beds have been found in the Missouri rocks and those that do occur are thin; but workable seams are plentiful in the Des Moines. Unfortunately for Dallas, a large part of the county is a high, level plain upon which there are no exposures of the solid strata; while those rocks which are to be seen in the valleys of the Des Moines river and the Raccoon and its main branches, belong to an upper section of the Des Moines which apparently contains few thick coals. Strata lower down should, however, contain coal basins at many points. Very little deep prospecting has been undertaken, yet that which has been done has in most cases yielded good results. At Van Meter and southwest of De Soto, deep coals are known to be present; while others are now being exploited in the valley of the Des Moines. The fact that a few tests holes reveal no coal should not discourage the prospector; for undoubtedly the lower seams in this county lie in basins of rather limited extent, as they do in other parts of the state, and not in beds which are continuous over whole townships or even over many sections. The future of the coal industry in Dallas lies in the hands of those who are willing to risk considerable capital in systematic prospecting.

The depth to which it would be necessary to go in order to reach the bottom of the Coal Measures varies considerably at different points. The depth is definitely known at only a few places, but may be closely estimated at others. In the valley of the Raccoon, two miles west of Commerce, the St. Louis has been found at a depth of 250 feet or at about 600 above tide. At Van Meter, the lower coal mined lies at an altitude of 590 A. T., making the base of the Coal Measures at least 430 feet

below the adjacent highlands. Near De Soto, a well 321 feet deep failed to penetrate the Saint Louis. At Redfield the Saint Louis limestone was reached at about 300 feet, or at an altitude of a little more than 600 feet A. T. North of Dexter, on the South Racoon, 175 feet of Coal Measures and twenty-five of drift overlie the Mississippian. In the northeastern corner of the county coal is mined at a depth of 220 feet from a shaft situated well down in the deep valley of the Des Moines river. The thickness of the Coal Measures under the highland farther west must be at least 350 feet and is probably much more.

Dallas has never ranked as one of the leading producers of the state, but the recent developments in the Des Moines valley have caused a decided increase in its production. A still greater output may be expected in the immediate future, even though no new mines are started. In earlier years the tonnage showed considerable fluctuations. The state census of 1862 reported only 170 bushels mined in the county, but this had increased to 1,700 in 1865 and to 13,200 tons in 1880. The output increased more or less steadily until 1889, one of the banner years, for which the Eleventh United States Census reports 67,055 tons at a value of \$111,472. The tonnage did not remain long at this figure, however, for in 1893 it had declined to 33,800 tons and later years witnessed a still greater fall. The statistics for the last ten years are given below; those from 1898 to 1902 are from reports of the Iowa Geological Survey, from 1902 to 1907 from those of the U. S. Geological Survey.

YEAR.	TONS.	YEAR.	TONS.
1898.....	8,859	1903.....	15,467
1899.....	10,813	1904.....	13,086
1900.....	16,521	1905.....	5,000
1901.....	16,988	1906.....	5,522
1902.....	18,845	1907.....	70,042

Though the figures given for 1905 and 1906 are probably too low, a great contrast between 1906 and 1907 is nevertheless an actuality. That the activity of the industry has continued is evident from the following extracts from the report of the State Mine Inspectors for the year ending June 30, 1908:

Number of mines.....	3
Tons of coal of all grades produced.....	108,700
Total number of employes.....	277

A number of small local mines which spring up in the winter months are not included in the above enumeration, but it is not probable that their total output now exceeds three thousand tons. Two of the three mines listed are near the Des Moines river; the third is a smaller mine west of Dawson. A small local mine was in operation on Panther creek during the early fall of 1907 and a few others were worked for short periods during the winter and late autumn. In the detailed discussion which follows the author has drawn freely upon previous reports of this Survey\*.

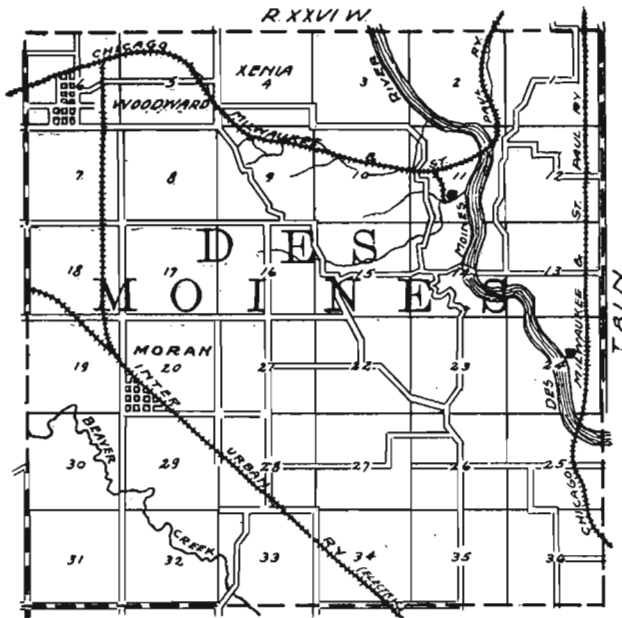


Figure 20. Map showing shipping mines of Dallas county.

#### DES MOINES VALLEY.

It has been known for a number of years that there are at least four thin beds of coal, two and a half feet or less in thickness, in the northeastern corner of the county, where the Des Moines river has cut for itself a deep valley through the drift and indurated rocks. Two of the seams outcrop above the water level and one is especially well shown in an exposure on the west side of the valley, just above High Bridge (Figure 21).

\*Keyes: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 253-267; 1894. Leonard: *Geology of Dallas County*, Iowa Geol. Surv., Vol. VIII, pp. 51-118; 1898.

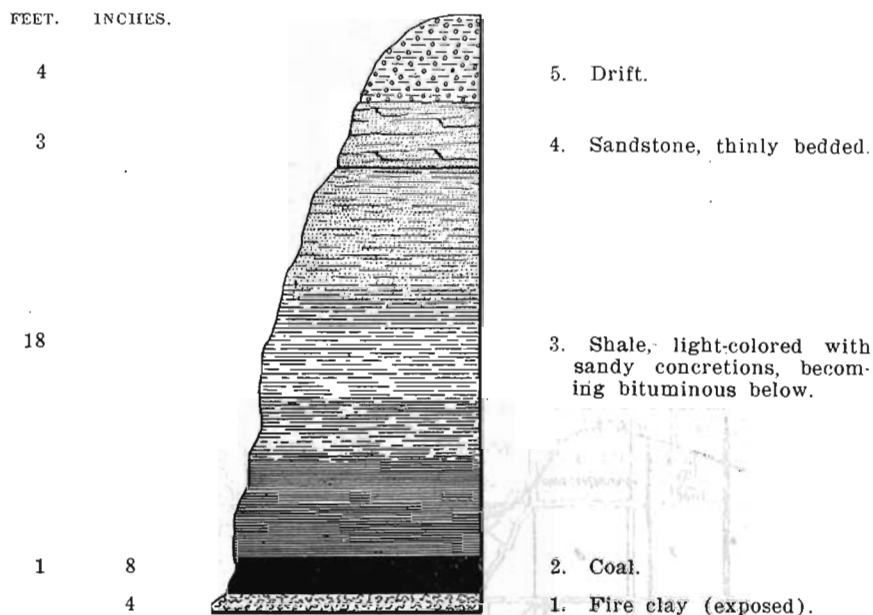


Figure 21. Bluff near old Pritchard drift, High Bridge.

The third seam, and to a less extent the fourth, were opened by shallow shafts and worked on the longwall method to supply a purely local demand. In spite of the fact that attention had been called by this Survey to the discovery of a four foot coal bed at greater depth than that to which prospecting was usually carried, no attempt was made to develop it until quite recently. The coal horizons in the strata near the present Scandia mine were published in 1897\* and again in 1898† as follows:

DEPTH OF COAL.	THICKNESS.
1. 16 feet .....	12 to 14 inches
2. 40 feet .....	20 inches
3. 87 feet .....	28 inches
4. 109 feet .....	2 feet
5. 171 feet .....	4 feet

Coals 3 and 4 of this list were worked at the old Chestnut Valley mine (T. 81, R. 26, Sec. 14, Nw. qr., Nw.  $\frac{1}{4}$ ) until the Scandia Coal Company was organized to sink to the lower seam in the same neighborhood. Afterward the High Bridge Coal Company sank farther down the river and the outlook for new mines in the near future is very bright.

\*Iowa Geol. Surv., Vol. VII, p. 324; Des Moines.

†*Idem.* Vol. VIII, p. 100.

The shaft of the Scandia Coal Company, 166 feet deep, is situated near the middle point of the south line of section eleven, Des Moines township, on the west side of the river. A spur track has been laid to the mine from the Chicago, Milwaukee and Saint Paul railroad, a half mile to the north. Although development was not begun until the summer of 1906, a large daily output is now (1907) being shipped and sold to the local trade. The hoisting engine is of the double, direct-connected type with 14x30 cylinders and with a four-foot drum. There are two tubular boilers, one 16 ft. x 60 in., of 80 horsepower, and the other 16 ft. by 66 in., of 100 horsepower. It was the original intention to use electric mining machines and a dynamo was purchased for that purpose, but so far the plan has not been put into operation. The coal remains fairly constant at a thickness of three feet eight inches and lies fairly level at an altitude of about 700 A. T. Sometimes rolls in the roof cut out all the coal, but more often these interfere with only the upper foot or two of the seam. The company owns the coal rights of 1,400 acres of land in a basin which is elongated from the northeast to the southwest but the extent of which is not known. It is possible that another shaft may be sunk by the company on the opposite side of the river near the tracks of the Boone branch of the Chicago, Milwaukee and Saint Paul Railroad. A drilling done in that locality (Se. qr. of Sec. 12) penetrated at least three coal horizons at a considerable depth. The upper coal, as reported by the company, is sixteen inches thick, with a three foot seam forty-six feet below it and a five inch "blossom" lower down. Between the two lower horizons is a compact sandstone twenty feet thick.

Farther down the river than the Scandia mine, at High Bridge on the east bank, the High Bridge Coal Company sank a shaft 220 feet during the summer of 1907. In September of that year they had driven entries only 300 feet, but were rapidly pushing the development of the mine and preparing to install an equipment capable of handling the large output which they expect to ship over the Boone branch of the Chicago, Milwaukee and Saint Paul Railroad. The company has leased a large territory and believes most of it to be underlain with workable

coal. As far as opened up the vein has proved to be about four feet thick and without noticeable dip. Sandstones and sandy shales are very common in the drill records and as many as three thin coals are sometimes found above the thick seam. Whether the latter belongs to the same coal horizon as the seam worked at the Scandia is not determinable from the data now available, yet the probabilities point strongly to such a connection.

#### NORTH RACCOON VALLEY.

*Dawson.* Dawson was for a short time the center of a fairly active mining industry. Shafts were sunk on all sides of the town, to continue in operation, however, no great length of time. Six coal horizons have been reported; yet only three are generally recognized as workable. Two of the latter were shown in the old shaft of the Chicago Coal Company, one-half mile east of Dawson.

#### DAWSON SECTION.

	FEET.	INCHES.
11. Soil .....	3	
10. Yellow clay.....	13	
9. Blue clay .....	.64	6
8. "Slate," gray .....	2	6
7. Coal (at 83 feet).....	1	10
6. Fire clay .....	4	
5. Sandstone .....	8	
4. "Slate," gray .....	10	
3. "Slate," black, oily.....	13	
2. Coal (at 120 feet).....	3	
1. Fire clay .....	4	

Number 2 was the bed worked at this point and also at the old Tudor shaft at the foot of the bluff north of Dawson. This coal

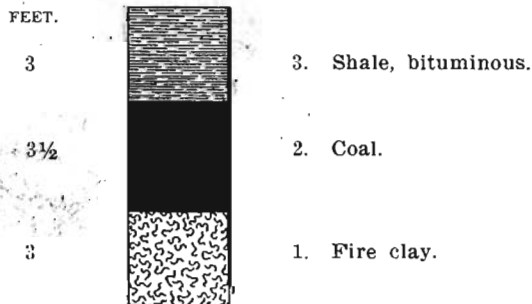


Figure 22. Coal seam at old Tudor shaft, Dawson.

did not prove suitable for a locomotive fuel because of a tendency to clinker, due probably to the iron pyrites included in the seam. Forty-five feet below number 2 is a coal bed which varies in thickness from three and a half to four feet. On the Dixon farm, two miles south of Dawson, the strata found in a shaft from which a little coal was taken are reported to be as follows:

	FEET.	INCHES.
4. Drift .....	72	
3. Shale and "slate".....	38	
2. Coal .....	1	7
1. Fire clay .....	10+	

The shaft was unfortunately situated, reaching the coal near the top of a "rise" on the edge of the basin. Toward the southeast, the direction of a strong dip, the bed thickened gradually up to the point at which work was abandoned.

A short distance west of Dawson the two upper seams become slightly thinner than at the Dawson shaft and the other strata undergo a few changes, as shown in the following drill record (Dallas Tp., Sec. 9, Ne. qr., Se.  $\frac{1}{4}$ ):

	FEET.	INCHES.
12. Soil .....	3	9
11. Clay, yellow .....	14	6
10. Clay, blue .....	26	
9. Clay, light .....	14	
8. Sandstone .....	12	
7. "Slate" .....	12	
6. Coal .....	1	2
5. Fire clay .....	3	
4. Sand rock .....	26	
3. "Slate" .....	10	
2. Coal .....	2	2
1. Fire clay .....	1	5
Total .....	126	

The only mining done at present in northwestern Dallas county is by the Hutchinson Brothers Coal Company, one and a fourth miles west of Dawson (Dallas Tp., Sec. 8, Ne. qr.). Coal is elevated 110 feet by steam power from a seam three feet to three feet six inches thick. The company controls 204 acres on the north side of the railroad. In the summer months only suf-

ficient work is done to keep the mine in good condition, but in the winter a fairly large local trade is supplied and some coal is hauled to Dawson to be loaded for shipment. The seam is extremely undulatory, differences in level of twenty feet or more occurring at points not greatly distant from one another. Where coal is now being excavated, only a few irregularities are found in the roof and coal; though on the "rises" at what are supposed to be the edges of the basin, "rolls" in the roof and other "troubles" become more numerous. It is probable that this seam is the representative of the "second vein" at Dawson.

*Minburn.* Three miles southwest of Minburn, in section 24 of Washington township, a seam outcrops about fifty feet above the Raccoon, in the valley of a small tributary. The coal has a dip to the east and lies in two benches separated by a foot of fire clay, the upper bench varying from eighteen to twenty-four inches and the lower from twelve to thirteen inches in thickness. A roof of firm shale covers a coal of good quality, but attempts to mine it have been of a desultory character only.

*Adel.* Three miles north and a little west of Adel, a thin bed of coal, eighteen inches thick, outcrops in a small creek which crosses the Chaney farm (Colfax Tp., Sec. 12, Se. qr.). For many years this seam has been drifted into and mined intermittently. At the present time a little coal is obtained by stripping for the winter use of one or two families. East of the Chaney farm this bed again outcrops as a coal seventeen inches thick. Near this point well drillers report having penetrated a thicker seam sixty-six feet below this horizon. They were unable to determine its exact thickness, however.

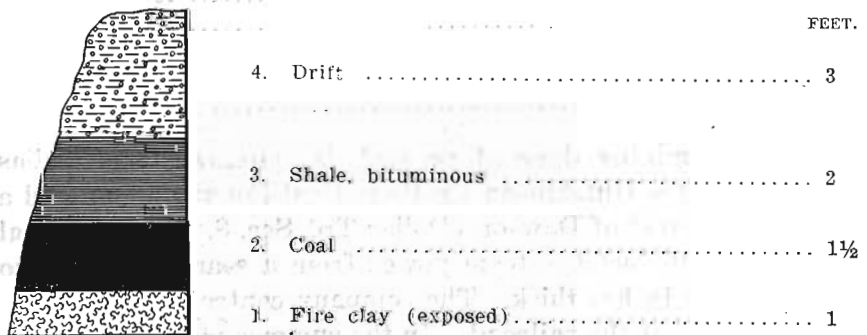


Figure 23. Section at Chaney drift. Three miles north of Adel.



A company has been formed to search for coal near Adel and several test holes have been drilled. Up to date, results have not been of an encouraging nature.

MIDDLE RACCOON VALLEY.

*Redfield.* In following the valley of the Middle Raccoon from the Guthrie county line to Redfield, the vestiges of numerous abandoned drifts may be seen in the slopes bordering the river and its tributary creeks. Several coals outcrop above the water level in this territory, but nothing has been found which exceeds two feet in thickness and many of the seams in which development has been attempted can scarcely be said to have returned a fair reward for the labor expended upon them. Little has been done during recent years and no coal was being taken out when the region was visited during the early autumn of 1907.

The Keeler and Topping banks have at one time and another taken coal from a tripartite seam about two miles south of Linden (Linn Tp., Sec. 31, Ne. qr.). The three benches, which together yield only eighteen inches of coal, are shown with the roof and bottom in the section given below.

	FEET.	INCHES.
3. Sandstone (exposed) .....	1	
2. Coal, 8, 4 and 6 inches, separated by thin clay partings	1	11
1. Fire clay .....		6

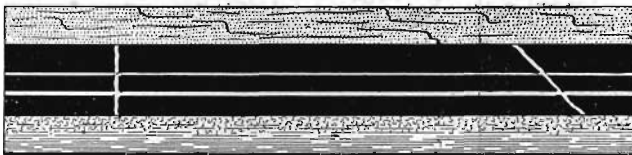


Figure 24. Clay seams in Topping mine, south of Linden.

Less than a mile down stream, two seams are known, one about ten feet above the level of the river and the other sixty-five feet higher. The upper bed is the thicker, being twenty inches at its best, so that most of the mining done here has been in this seam. Still farther down the river, a small creek empties into it from the north in the eastern portion of section 32, Linn township. An eighteen-inch bed which is perhaps the

equivalent of one of the coals just mentioned has been drifted into from the valley of this tributary and the following section has been measured at one of the old mines:

	FEET.	INCHES.
4. Drift .....	3	
3. Clay shale, compact .....	3	6
2. Coal .....	1	6
1. Fire clay .....	1	10

Along the valley of the Middle Raccoon between this point and Redfield and in that of Mosquito creek just above its junction with the Raccoon, thin veins similar to those mentioned above have been drifted into in the past and a few may be opened up in the future to supply a very local demand during the winter months. They are hardly worthy of detailed mention. Some drilling of rather a crude character has been attempted north and west of Redfield. North of the town a four-foot bed was reported and west of it one twenty-seven inches thick, overlain by eighteen inches of black jack. These reports need verification and amplification; though the discovery of good coal basins in this county would undoubtedly follow deep prospecting pursued on a large scale.

South of Redfield, in a bluff opposite the picnic grounds, a massive sandstone forms a steep escarpment known as "Hang-

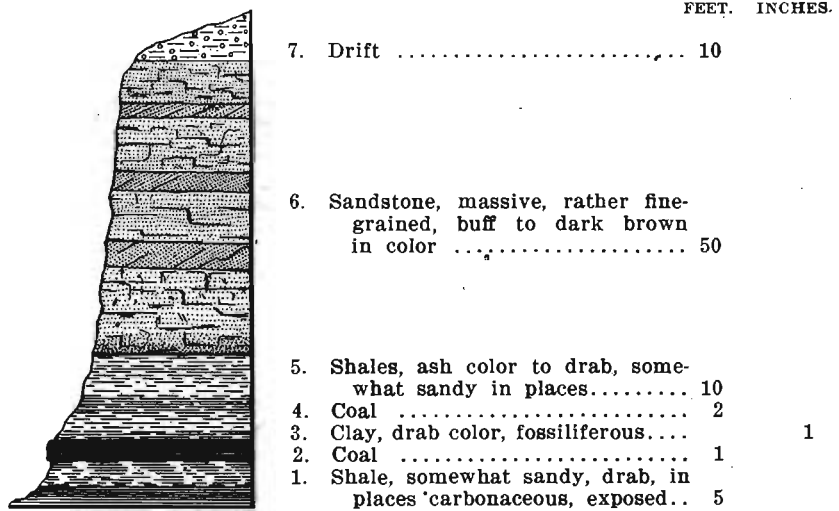


Figure 25. "Hanging Rock" section. Redfield.

ing Rock." Twelve feet lower is a three-foot bed from which coal has been taken in the past by slopes, drifts and shafts. The section at this point is shown in figure 25. The seam is separated into two and sometimes three benches by thin argillaceous partings. One of these partings is one inch thick and always present, while the other is one-fourth inch thick and appears only occasionally. The seam has an unreliable clay roof in places. Traces of a coal seam of unknown thickness are said to have been found here at greater depths. The old Leeper mine near Redfield had a shaft sixty-five feet deep which was operated more than twenty years. The characteristics of the seam at that point are shown in the following figure.

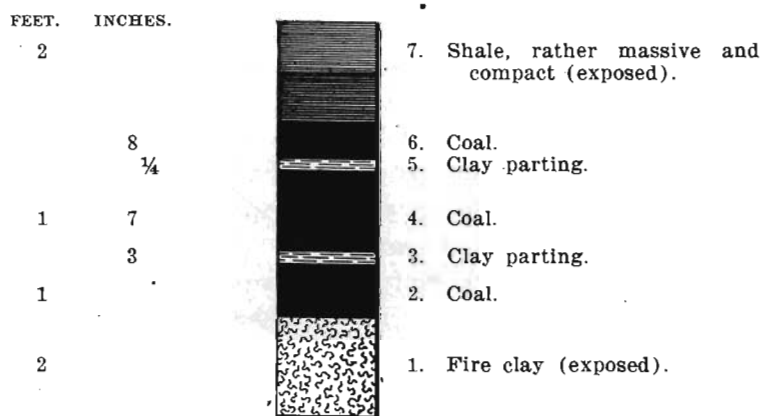


Figure 26. Bed of old Leeper mine, Redfield.

#### SOUTH RACCOON VALLEY.

*Union Township.* As along the Middle Raccoon, small mines have intermittently taken coal from thin veins at various points along the South Raccoon. Considerable coal has been removed on both sides of the river in section 12, Union township. On the land belonging to E. Woods, drifting into a twenty-inch seam had been begun as long as twenty-five years ago, and the old Dawson drift employed at times as many as sixteen men. Nothing has been done here during the last three years. On the opposite side of the river (Sec. 12, Ne. qr., Nw.  $\frac{1}{4}$ ) Oliver Cave's mine has supplied a considerable country trade for ten years or

more. The seam is the same as on the south side of the river, and the thickness is from fourteen to twenty inches. A shaft which was sunk here at one time furnished the following section:

	FEET.	INCHES.
10. Drift .....	25	
9. Shale, gray .....	4	
8. Limestone, blue, compact.....	1	
7. Clay .....		6
6. Limestone, blue, fossiliferous.....		10
5. Shale, black, bituminous; "black jack".....	8	
4. Limestone, blue .....		10
3. Slate, black .....	2	6
2. Coal .....		20
1. Fire clay .....		..

This shaft is no longer used but coal was removed by means of drifts during the winter of 1906-1907 and some of these may be reopened for winter trade. The coal thins to the south and west until it disappears altogether within a distance of a mile. To the southeast it thickens and dips so rapidly as to be carried below the river a short distance from Cave's mine. Attempts to work it beyond this have been frustrated by the amount of water which entered the seam.

*Panther Creek.* The only mine being worked in the southwestern part of the county in September, 1907, was the Thomas Bott bank on Panther creek, about two miles and a half above its mouth. The mine is a drift which has been driven into the hill about 300 feet through two feet to two feet ten inches of coal. Since the opening is in the bottom of a deep, steep-sided ravine, much difficulty is experienced in hauling the coal to the level of the surrounding country. One digger and two wheelers are employed in the fall and about seven men in the winter. During the remainder of the year the mine is closed. The seam dips to the south and thins to the north. Above is a good roof of a very fossiliferous shaly limestone which when fresh is hard and firm. An eighteen-inch coal is reported above the one worked, though the surface indications are a mere "blossom."

*Bulger Creek.* A little drifting for coal has been done on the lower part of Bulger creek. The seams are very thin and nothing has been taken from them for a long time. An interesting record is that given below of a deep well drilled one mile south-

west of De Soto in section 25, Adams township. At a depth of 321 feet the base of the Coal Measures had not been reached. Four seams of coal were penetrated, one foot at a depth of 98 feet, two feet at 239 feet, eighteen inches at 255 and three feet at 350.

## DE SOTO SECTION.

	FEET.
82. Soil and subsoil.....	8
81. Yellow clay .....	37
80. Blue clay .....	12
79. Clays and shales, red and yellow.....	7
78. Soft rock .....	1
77. Clay, red and blue.....	28
76. Limestone .....	3
75. Slate .....	2
74. Coal .....	1
73. Fire clay .....	4
72. Shale, with marly partings.....	3
71. Limestone, gray .....	3
70. Shale .....	1
69. Limestone, coarse grained.....	1
68. Shale, with marly partings.....	4
67. Sandstone .....	2
66. Shale and clay .....	5
65. "Coal roofing" (slate?).....	1
64. Sandstone .....	2
63. Calcareous rock, hard, gray.....	4
62. Rock, hard .....	6
61. Shales and clays, red and blue.....	10
60. Sandstone, gray .....	6
59. Limestone .....	5
58. Sandstone .....	4
57. Shale, with thin layers of rock.....	5
56. Sandstone, gray, flinty .....	5
55. Clay and shale.....	6
54. Limestone .....	10
53. Clay .....	5
52. Limestone .....	3
51. Shale .....	3
50. Sandstone .....	4
49. Shale .....	2
48. Limestone, gray .....	3
47. Shales, very hard.....	2
46. "Rock," hard .....	4
45. Shale .....	4
44. Sandstone .....	2
43. "Rock," hard, white.....	19

## COAL DEPOSITS OF CENTRAL IOWA

42.	Slate, black	2
41.	Coal	2
40.	Fire clay	1
39.	"Rock"	7
38.	Clay	1
37.	"Rock," hard, light-colored	4
36.	Slate	1½
35.	Coal	1½
34.	Fire clay	2
33.	Shale, gray	7
32.	"Rock"	1
31.	Shale	1
30.	"Rock"	1
29.	Shale, gray	3
28.	Rock	1
27.	Shale	5
26.	"Rock," gray	8
25.	Shale	1
24.	"Rock"	2
23.	Shale	3
22.	"Rock"	10
21.	Shale	4
20.	Sandstone	3
19.	Shale	1
18.	Sandstone	8
17.	Clay, red	1
16.	Sandstone	18
15.	Shale, blue	3
14.	"Rock," gray	5
13.	Shale	2
12.	"Rock"	6
11.	Shale	2
10.	Sandstone	3
9.	Shale	3
8.	Coal	3
7.	Fire clay	1
6.	Shale, dark	1
5.	Sandstone	9
4.	Shale	7
3.	Sandstone	4
2.	Shale	1
1.	Sandstone	2

## RACCOON VALLEY.

*Van Meter.* Below the junction of the north and south branches of the Raccoon river, abandoned drifts with their accompanying dumps may be seen at several points, but none of these have been used for a long time and the seams are in all

cases very thin. The bluffs near Van Meter were the field of operations for most of the attempts to obtain fuel. Van Meter is best known for its deeper coals, however, for it was at this town that the only shipping mine in the southern half of Dallas county produced coal for many years. A shaft was sunk in the western portion of the town from a surface altitude of 878 feet A. T. to a depth of 305 feet. At the bottom of the shaft is the three-foot bed shown in figure 27. This coal was worked out at this point before being abandoned. Twenty feet higher is the middle seam, to which work was chiefly confined, the bed ranging from eighteen inches to four feet in thickness, with an average of three feet. Overlying the middle seam is from three to eight feet of fire clay which was taken out and used in the manufacture of brick. Above the clay is a thin coal, eighteen inches thick at its maximum, and thinning out entirely in places. No coal has been mined here in recent years.

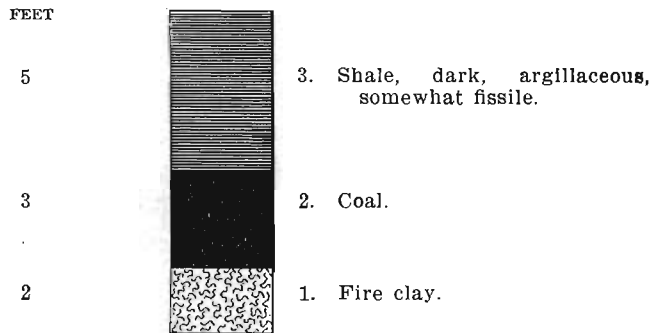


Figure 27. Bed of Van Meter and Chicago mine, Van Meter.

### POLK COUNTY

The fact that the Des Moines river, which crosses Polk county, had cut down through the overlying mantle of drift and exposed Coal Measures beneath, led to the discovery at an early date of coal by explorers ascending that stream, while the establishment of an army post and the growth of a large city at the mouth of the Raccoon encouraged attempts to mine the seams exposed.

Summaries of the early history of the coal industry, which was largely confined to the neighborhood of Des Moines, will

be found in previous reports of the present Survey.\* Today the larger mines have withdrawn to new fields farther from the city, yet all are contained within an ellipse bounded by a line passing through Ankeny, Commerce, Fort Des Moines, Avon, Altoona, and Enterprise. With the exception of the Commerce and Avon shafts, and those near Des Moines which supply the city trade, all the mines have railroad connections and ship much coal to the west and north. The equipments both above and below ground are in general very good and all but the Avon Coal Company employ steam power for hoisting. Underground haulage is in most cases by mules, though some of the larger mines have tail-rope or motor systems in the main entries. Blasting from the solid is the common practice; the room and pillar method of working is in use at all except the Commerce mine. Mining machines do not seem to be very popular, though there is seldom anything in the nature of the coal to prevent their use. The quality of the coal differs but little from the average for the Iowa field. Block coals are uncommon, but comparatively little slack is produced and what there is finds a ready market in the city as a boiler fuel.

The growth of the industry has been steady and consistent, increasing from 600 tons in 1856 to 1,358,397 tons in the fiscal year 1907-1908. The number of mines has not increased so rapidly, however, for the tendency has been toward a concentration of capital and effort at a few points and the suppression of small banks through the competition of large mines. An illustration of this tendency is furnished by the fact that in 1908 thirty-three mines were producing four times as much as did twenty-three in 1895.

In the following table the statistics for the years 1856-74 are taken from state and federal census reports, for 1881-95 from the reports of the State Mine Inspectors and from 1896-1907 from the reports of the Iowa Geological Survey and the United States Geological Survey.

\*Keyes: Iowa Geol. Surv., Vol. II, p. 267; Des Moines, 1894. Bain: *idem*, Vol. VII, p. 352, 1897.



## POLK COUNTY

101

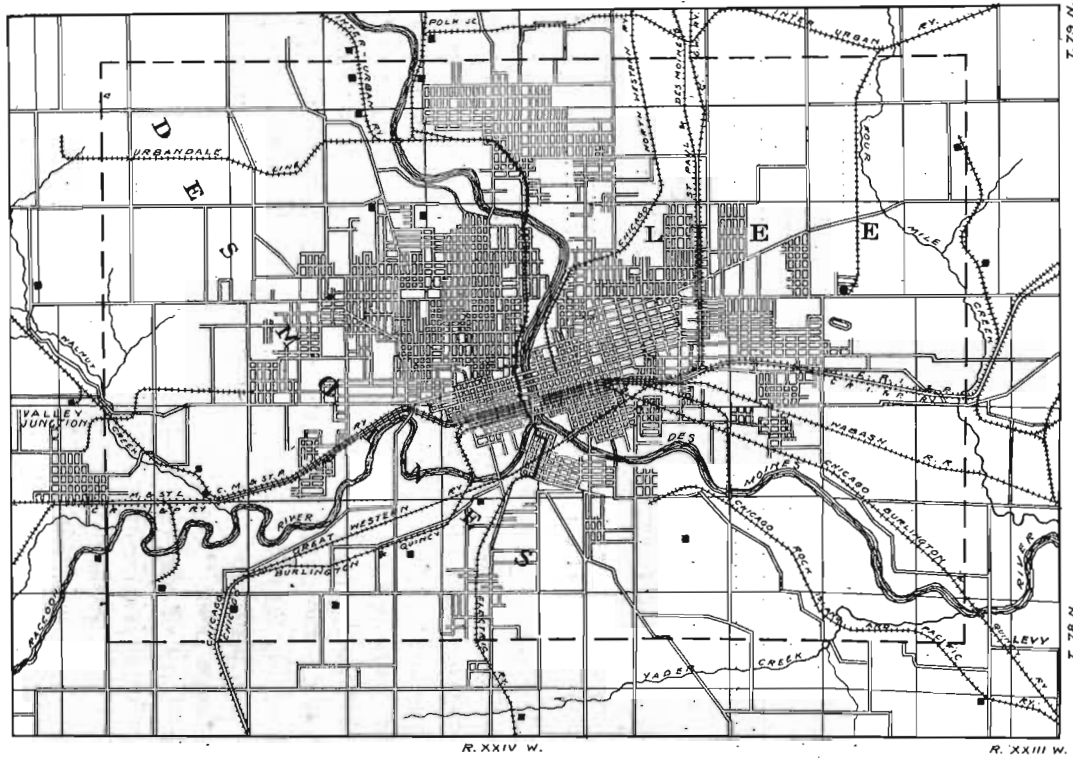
YEAR.	TONNAGE.	YEAR.	TONNAGE.
1856.....	600	1891.....	397,833
1860.....	1,858	1892.....	371,389
1862.....	1,418	1893.....	466,408
1865.....	1,116	1894.....	355,000
1866.....	13,310	1895.....	334,881
1869.....	27,796	1896.....	546,051
1874.....	69,327	1897.....	489,136
1881.....	473,893	1898.....	635,606
1882.....	327,819	1899.....	691,989
1883.....	558,821	1900.....	851,667
1884.....	619,921	1901.....	954,112
1885.....	462,895	1902.....	1,007,860
1886.....	337,964	1903.....	1,032,165
1887.....	305,094	1904.....	1,130,668
1888.....	386,321	1905.....	1,205,317
1889.....	356,039	1906.....	1,369,506
1890.....	408,149	1907.....	1,460,203

The following figures from the report of the State Mine Inspectors are for the year ending June 30, 1908:

Tons of coal of all kinds produced.....	1,358,097
Total number of employes.....	3,249

Taking the average price per ton as \$1.73 at the mines, the value of the product for the fiscal year 1908 becomes \$2,332,508. This represents a slight decline from the previous year due to the abandoning of a number of mines, but shafts have been sunk in new fields and the output will certainly increase in the future as it has in the past. For over ten years Polk has ranked second among the counties of the state, producing during recent years nearly 20 per cent of the total. In round numbers, about 22,000,000 tons have been mined in this county and nearly 7,000 acres have been "mined out." In spite of this, however, the possibilities of the region are as yet scarcely realized.

The following description of the present status of the industry is from data gathered during the summer of 1908. The mining districts are somewhat arbitrarily grouped along the drainage lines and on the high divides and the situation of most of the mines is shown on the accompanying maps.



Map showing location of mines in the Des Moines district.

## DES MOINES RIVER VALLEY ABOVE THE RACCOON FORK.

*Polk City.* Between High Bridge and the immediate vicinity of Des Moines little mining of importance has been done near the Des Moines river. At one time coal was taken from a depth of 238 feet at Polk City by a shipping mine with a good equipment. There were three and one-half feet of coal in two benches separated by an eight-inch band of calcareous shale, but as the basin proved to be of limited extent nothing has been done there in recent years. In an effort to locate more coal in a place so favorably situated as regards market and shipping facilities, several companies prospected in the district. Always an exceptionally large number of thin seams were found, but none of workable thickness have been reported. About a mile north and northeast of the town, several drillings penetrated as many as seven coal beds. Unfortunately the thickest of these was a twenty-two inch seam. Another company drilled a hole 325 feet deep near Polk City and encountered ten seams, the thickest only nineteen inches. A third company tried a deep prospect southeast of Polk City Junction (Lincoln Tp., Sec. 30, Sw. qr., Sw.  $\frac{1}{4}$ ). They record the following strata beneath the upland level:

	FEET.	INCHES.
37. Clay and sand .....	10	
36. Drift .....	113	
35. Mixed shale .....	46	
34. Sandy shale .....	7	
33. Dark shale .....	2	6
32. Coal (No. 1).....		7
31. Dark shale .....	2	
30. Sandstone .....	6	5
29. Gray shale .....	3	
28. Coal (No. 2).....		6
27. Gray shale .....	3	3
26. Dirty coal (No. 3).....		5
25. Light shale .....	8	
24. Gray shale .....	10	3
23. Coal (No. 4).....		7
22. Gray shale .....	1	7
21. Coal (No. 5).....		3
20. Light shale .....	4	6
19. Gray shale .....	11	2
18. Coal (No. 6).....		9
17. Light shale .....	4	

## COAL DEPOSITS OF CENTRAL IOWA

16. Sandstone .....	4	9
15. Gray shale .....	13	
14. Coal (No. 7).....		7
13. Light shale .....	2	9
12. Coal (No. 8).....		7
11. Light shale .....	3	
10. Shale, dark, "slate".....	4	
9. Coal (No. 9).....		6
8. Light shale .....	3	6
7. Gray shale .....	6	6
6. Sandstone .....	2	9
5. Coal (No. 10) .....	1	4
4. Light shale .....	2	6
3. Sandstone .....	6	8
2. Gray shale .....	7	
1. Light shale .....	5	
Total .....	300	2

Another prospect northwest of Polk City, in the valley of Big creek (Sw. qr., Sec. 26, Madison Tp.) brings to light several other thin coals:

	FEET.	INCHES.
32. Clay and sand.....	22	
31. Drift .....	31	
30. Mixed shale .....	7	5
29. Sandrock .....	6	
28. Gray shale .....	7	8
27. Coal (No. 1).....		7
26. Gray shale .....	4	10
25. Coal (No. 2).....		3
24. Light shale .....	11	8
23. Dark shale .....	7	10
22. Coal (No. 3).....		6
21. Light shale .....	3	7
20. Gray shale .....	4	
19. Light shale .....	5	
18. Gray shale .....	3	2
17. Coal (No. 4).....		5
16. Light shale .....	2	
15. Gray shale .....	13	7
14. Light shale .....	1	6
13. Dark shale .....		8
12. Dirty coal (No. 5).....		7
11. Light shale .....	2	
10. Dark shale .....	2	2
9. Coal (No. 6).....		4
8. Light shale .....	7	
7. Sandstone .....	14	4
6. Dirty coal (No. 7).....	1	5

5. Light shale .....	4	
4. Sandstone .....	5	
3. Gray shale .....	10	5
2. Coal (No. 8).....		2
1. Light shale .....	9	2
Total .....	190	3

These two records show that frequent, though slight, oscillations of the level of the land relative to that of the sea prevailed in this district during Des Moines time. Conditions were often favorable for the formation of coal-producing swamps, yet did not remain so sufficiently long to yield deposits which would become of economic value.

Near Andrews, on the west side of the Des Moines river, the appended drill log of a hole in the southeast corner of the Jas. Stoner land again shows several coals. They are somewhat thicker than those found near Polk City. Four other drillings in this vicinity showed the variations of strata usual in the Des Moines stage; but no thicker coals were found. Prospecting farther back from the river might give better results.

	FEET.	INCHES.
31. Soil and clay.....	6	
30. Sand and gravel.....	3	
29. Yellow clay .....	21	
28. Mixed shale .....	23	
27. Black shale ("slate").....	1	
26. Coal (at 54 feet).....	1	
25. Light shale .....	14	
24. Dark shale .....	7	
23. Coal (at 76 feet).....	1	8
22. Light shale .....	10	4
21. Sandy shale .....	17	
20. Dark "slate" .....	16	
19. Coal (at 121 feet).....		8
18. Dark shale ("slate").....	3	4
17. Coal (at 125 feet).....	1	
16. Fire clay .....	2	
15. Dark shale ("slate").....	15	10
14. Coal (at 143 feet).....	2	7
13. Fire clay .....	4	7
12. Dark slate .....	2	
11. Coal (at 151 feet).....	1	
10. Dark shale .....	4	
9. Light shale .....	4	
8. Dark shale .....	7	
7. Light shale .....	4	

6. Gray shale .....	32
5. Light shale .....	16
4. Dark shale .....	4
3. Light shale .....	10
2. Gray sandstone .....	6
1. Light sandy shale .....	8
Total .....	249

*North Des Moines District.* Between Polk City and the corporation limits of the city of Des Moines mining has been confined to thin veins opened at a few places by drifts and slopes in the lowlands. Old Saylor may appear to form an exception to this statement, but it lies well back from the river on the edge of the upland and will be discussed later.

A mile and a half below the mouth of Beaver creek is the shaft of the West Riverside Coal Company. It lies at the foot of the bluffs near the corporation line and ships over the Perry and Des Moines Electric railway, beside whose tracks it is situated. About fifty feet down in the shaft is a fifteen-inch seam, still lower is one twelve inches thick, while at a depth of 160 feet lies the bed worked. This latter seam is known as the "third vein," and varies in thickness from three feet six inches to five feet. The coal shoots well off the solid, contains comparatively little pyrites, and only infrequent "bowlders." While irregularities and impurities are uncommon in the coal itself, small "slips," running down to the coal, appear in the thick black shale ("slate") which forms the roof. The development of this mine has extended over a period of only three years and at present only a small engine is utilized for hoisting. The elevation of the seam worked is about 660 feet A. T., but varies considerably because of undulations.

One-half mile south, beside the tracks of the same electric railroad, is a mine of the Blount-Evans Coal Company. The shaft is 135 feet deep. The seam worked lies slightly higher here than at the West Riverside and presents somewhat different characters, yet there is little doubt that the coal of one mine is identical with that of the other. It varies in thickness from three feet to four feet six inches, and cannot be successfully shot from the solid by hand labor, as it breaks down into dust and fine fragments when such a method is employed. With the

use of mining machines, however, the yield of lump is as high as ninety per cent. During the winter of 1906-07 three Ingersoll punching machines, driven by compressed air, were in operation. The freedom of the coal from impurities allowed them to do good work, so that it is the intention of the operators to install two more. After the holes are drilled two and a half feet deep, a very small charge of explosive is sufficient to bring down the coal. Ventilation is effected by means of a twelve-foot fan and hoisting by a double engine driven by steam from one boiler of eighty horsepower. A second boiler will shortly be put in position. Above the coal is a considerable thickness of the good roofing "slate" common to the district. Little difficulty is experienced in supporting it, even where it becomes quite sandy next the coal, as it does in places. A so-called "second vein" was found about 110 feet down in the shaft, where it is not sufficiently thick to be of importance. The "first vein" is present, but is also thin.

The Madison Coal Company has a mine at Twenty-third street and Hickman avenue, one mile south of the Blount-Evans, in the valley of a short tributary of the Des Moines river. About forty acres have already been worked out. At 165 feet the coal, which is at an elevation of 655 feet A. T., is reached, and although this bed is nearly twenty-five feet lower here than at the Blount-Evans, it is considered with reason that the horizon remains the same. The thickness worked remains quite constant at a little over four feet, except on the south where the coal thins to a few inches along an east and west line. The decrease takes place at some points with surprising suddenness, the normal thickness being reduced to practically nothing within a distance of eight or ten feet. Whether the "fault" is due to an erosion channel or to the natural thinning of the bed at the limit of the basin cannot be stated with certainty from the evidence now obtainable. Rolls in the roof sometimes extend down to the underlying clay. Small slips, or faults, are common in some portions of the mine, but their distribution is quite irregular. The coal is markedly, but not sharply, undulatory, there being a difference of four or five feet between the crests of the rises and the bottoms of the "swamps." Especially in the "swamps," bands of cannel coal appear and reach a thickness

of eight inches or less. Above this bed there are known to be several thin coals, besides one which is thicker than the seam now being worked. Attempts to mine it would probably prove unsatisfactory because of the inconstancy of its thick coal.

One-half mile southeast, near the western boundary of the Chautauqua grounds, is the new shaft of the Eagle Coal Company. The coal bed is continuous from the Madison to the Eagle and thickens locally, being from four to seven feet thick at the Eagle. West of the shaft, which is 170 feet deep, is a low "swamp" into which entries are now being driven and where the best coal lies. Its axis lies northwest and southeast. Elsewhere, also, the seam is strongly undulatory. The roof is a good bituminous shale ("slate") of varying thickness, with only occasional areas where draw slate appears. In places a layer of black jack makes its appearance at the top of the coal. All the coal produced at this mine is hauled in wagons to be sold to the city trade. A steam hoisting equipment is in use and a large output is expected during the coming winter.

Following is the drill log of a prospect hole at the shaft. Its accuracy was afterward ascertained during the excavation of the shaft.

	FEET.	INCHES.
33. Soil and clay .....	3	
32. Shale, mixed .....	19	
31. Sandstone .....	1	
30. Shale, dark .....	6	
29. Shale, sandy, light-colored.....	14	
28. Shale, mixed .....	3	
27. Shale, sandy, light-colored.....	18	
26. Shale, gray .....	2	
25. Shale, light-colored .....	1	
24. Shale, gray .....	2	
23. Coal (at 69 feet).....		6
22. Shale, gray .....		6
21. Coal (at 70 feet).....	1	
20. Shale, light-colored .....	1	
19. Shale, dark .....	17	
18. Shale, light-colored .....	19	
17. Sandstone .....	1	
16. Shale, sandy, light-colored.....	7	
15. Shale, gray .....	2	
14. Shale, light-colored .....	8	
13. Sandstone, compact .....	5	



12. Shale, gray .....	2	
11. Shale, dark .....	9	
10. Sandstone .....	1	
9. Shale, sandy, gray.....	1	
8. Shale, dark .....	5	6
7. Coal (at 149 feet).....	1	
6. Shale, light-colored .....	4	
5. Shale, dark .....	13	
4. Coal, bony (at 167 feet).....	1	
3. Coal, good .....	4	5
2. Shale, gray .....	7	
1. Fire clay .....		
Total .....	179	11

In the bluffs on the east side of the river, opposite the West Riverside, two mines are now in operation, both controlled by the Flint Brick and Coal Company. Shaft No. 2 is situated on the side of the bluff behind the clay plant of the same company. Steam for the hoisting engine is obtained from the clay plant and much of the coal mined is used by it, the remainder being either shipped or retailed in the city. All work underground is now to the west, on the opposite side of the river. The shaft



Figure 28. Ironstone nodules in roof of coal bed.

is 180 feet deep and the elevation of the seam at the shaft 675 feet. A. T. The thickness of the coal varies between three and five and one-half feet, although as much as seven feet has been found in local thickenings in "swamps." The seam thins to the west as the workings of the mines on the west side of the river are approached, while it was abandoned within a short distance east of the shaft, where its height decreases to eighteen inches. Part of the seam furnishes a good shooting coal; the remainder tends to cleave horizontally, so that great difficulty is experienced in attempting to shoot it down. Pyrite is fairly common, especially near the roof and the bottom of the vein. "Bowlders" also occur; some in the top coal are as much as

fourteen feet long by three feet in diameter. Those in the coal are so compact that dynamite is employed to break them up, while those in the roof usually split easily. Ironstone concretions, locally termed "snakes" because of their great length in proportion to their other dimensions, are embedded in the clay which usually forms the floor of the coal. The seam is strongly rolling, parts of it differing as much as twenty-five feet in level in this one mine.

One-half mile north of No. 2, at Polk Junction, is shaft No. 3, more familiarly known as the Oak Park. It ships over the Des Moines & Colfax Electric railway. Eighteen feet down in the shaft is the so-called "first vein," over three feet thick but filled with clay seams. It has been reached at about the level of low water in the Des Moines river by several slopes in the neighborhood, but has not been touched in recent years. At a lower level is an eighteen-inch seam. At 130 feet below the surface lies the bed worked, four feet thick at the shaft but as high as six feet in local thickenings where work is now being prosecuted. The coal presents the same characteristics as that of the Flint No. 2. It is perfectly clean in some parts but irregularities and impurities become more conspicuous towards the thin edges of the basin on the southeast. In all of the rooms now open, the coal shows a good vertical cleavage and is shot down without difficulty. The roof is good, being both sandstone and black shale. The bottom is a fire clay, except where a shale with minute intercalated layers of coal makes its appearance. Mining is now being done

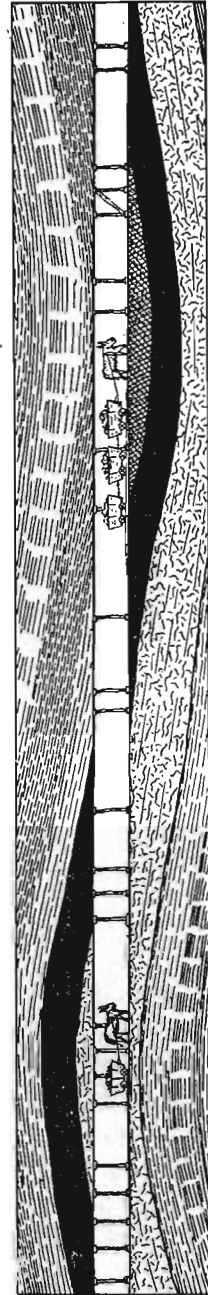


Figure 29. Section showing undulatory character of the coal seam in the Flint mine No. 2.

northwest of the shaft. The workings are connected with those of Mine No. 2 and considerable territory has already been worked out in a strip running north and south on both sides of the river.

The North Des Moines district, as now known, embraces an area of four square miles. Two seams appear in most parts of it with reasonable persistency, while a third, lying between the others, is found less frequently and is of very variable thickness. The lower, or "third vein," in which all of the mining on a large scale has been conducted, has nearly reached the limit of its productiveness. There are undoubtedly parts of the upper coals which will repay development in the near future. Prospecting both east and west of the present mines has revealed little of encouragement; although, so far as known, investigations have not been carried west farther than a mile and a half from the river. Little coal has been found under the higher land of Highland Park; but under the lower land of the pre-glacial valley bounding it on the north and east, mining has often proved profitable from Saylor southeast to the Fair Grounds.

It must not be understood that the "third vein" is a continuous bed underlying every part of the North Des Moines district. On the contrary several "faults" are well known to the miners. On the west side of the Blount-Evans shaft is a large "fault," 400 or 500 feet wide. This feature continues to the southeast and the same or a very similar "fault" was found east of the new Eagle mine, where it is more than 300 feet in width. Near the latter mine signs of disturbance can be traced in the pit of the Shackleford Brick Company, but the exposures were very unsatisfactory at the time this was visited. The "fault" was penetrated from the southwest by an entry of the new Eagle and from the northeast by one from the former Bloomfield. In both cases rolls in the roof of the coal became more frequent as the feature was approached. A similar "fault" disturbed mining operations east of the West Riverside shaft. It proved to be 303 feet wide and the entry which was driven through it encountered sandstone, slate, and a little fire clay in succession. The coal seam, when again found on the eastern side, soon attained a thickness of five feet, although when first reached it

was only six inches in height. This "fault" runs southwest and northeast, perhaps joining the one first mentioned at right angles. Somewhat similar phenomena separate the Oak Park and Saylor fields, as also those of the Oak Park and the recently abandoned O. K. mine which lay a half mile east of it.

It is altogether probable that these disturbing features are not true faults in the geological sense. That they are not pre-glacial erosion channels seems likely from the absence in them of a drift filling. It is not at all clear, however, whether they are valleys eroded and refilled during the Pennsylvanian period or whether they simply mark the limits of small productive areas in a coal horizon. The latter explanation is applicable to the "faults" in which the coal thins gradually until it disappears altogether, often rising as it thins. Where the coal is abruptly cut off, it is more likely that stream erosion has removed it. Both types of "faults" may, therefore, be considered to be represented in this district.

#### WALNUT CREEK VALLEY.

*Clive.* A new field has been discovered a mile east of Clive and was opened during the summer of 1908 by the sinking of the Gibson shaft No. 5 (Walnut Tp., Sec. 35, Se. qr., Se.  $\frac{1}{4}$ ). A spur track is to be laid from the Chicago, Milwaukee and St. Paul railroad. Neat top works, protected from fire by galvanized iron sheathing have been built and an Ottumwa first-motion engine, cylinders 16x32, installed for hoisting purposes. Danville self-dumping cages are employed. Entries have not been driven far, but the coal promises to be of good quality and to preserve a thickness of at least four feet. The shaft is 160 feet deep, and the altitude of the coal at the shaft is about 675 feet above tide. Systematic prospecting by the company has revealed considerable variation in the depth of the coal from point to point: west of the shaft the bed drops ten feet in a distance of 125 feet. East of the shaft at least three coals are present above the one worked, while south of it there are probably four.

POLK COUNTY

HOLE 150 FEET EAST OF GIBSON NO. 5.

	FEET.	INCHES.
21. Fill .....	42	
20. Sand .....	9	
19. Soapstone .....	2	
18. Rock .....	2	9
17. Soapstone and fire clay.....	29	3
16. Shale, .....	2	
15. Coal (at .87 feet).....	3	8
14. Fire clay .....	9	4
13. Shale, gray .....	4	
12. Shale, black .....	23	7
11. Coal (at 127 feet).....	3	5
10. Fire clay .....	3	
9. Soapstone .....	6	
8. Shale, gray .....	2	
7. Sandstone .....	1	
6. Shale, black .....	1	6
5. Coal (at 144 feet).....	2	
4. Fire clay .....	1	6
3. Shale, gray .....	3	
2. Shale, black .....	9	6
1. Coal (at 160 feet).....	4	6

HOLE SOUTH OF GIBSON NO. 5.

	FEET.	INCHES.
25. Soil .....	2	
24. Sand and gravel.....	10	
23. Blue clay .....	20	
22. Sand .....	10	
21. Fire clay and soapstone.....	9	
20. Sandstone .....	5	
19. Fire clay .....	8	
18. Shale, gray .....	2	
17. Coal (at 66 feet).....	3	6
16. Fire clay .....	4	
15. Sandstone .....	8	6
14. Shale, gray .....	8	
13. Shale, black .....	5	
12. Rock, compact .....	1	
11. Shale, black .....	3	
10. Coal (at 99 feet).....	1	7
9. Sandstone .....	1	
8. Fire clay .....	7	5
7. Sandstone .....	7	
6. Shale, gray .....	6	
5. Shale, black .....	5	
4. Coal (at 127 feet).....	2	2
3. Fire clay .....	2	
2. Shale, black .....	11	8
1. Coal (at 143 feet).....	2	8

It seems probable that the last drilling did not reach the horizon of the coal mined at the shaft and that numbers 1, 4 and 10 of the second section correspond respectively with 5, 11, and 15 of the first. Number 17 of the second may have been cut out of the first section by erosion. These suggestions are only tentative, however, since all the strata, including the coals, are so changeable both in their vertical dimensions and lithographic characters that exact correlations are made extremely difficult.

*Valley Junction.* Another new mine is that of the Keystone Coal Company, north of Valley Junction (Walnut Tp., Sec. 11, Nw. qr., Ne.  $\frac{1}{4}$ ). When visited during the summer of 1908 entries were just being started and a double, geared hoisting engine had but recently been set up. The section at the shaft is:

	FEET.	INCHES
26. Soil and clay.....	12	6
25. Sand .....	12	
24. Shale, light-colored .....	6	9
23. Sandstone (water bearing) .....	1	
22. Shale, light-colored .....	9	
21. Shale, dark .....	3	
20. Coal (at 44 $\frac{1}{4}$ feet).....		7
19. Fire clay .....	1	2
18. Shale, light-colored .....	24	
17. Shale, dark .....	2	
16. Shale, black .....	5	
15. Coal (at 77 feet).....	3	
14. Fire clay .....	3	
13. Shale, light-colored .....	7	
12. Shale, dark .....	10	
11. Hard rock band.....		6
10. Shale, dark .....	8	6
9. "Boulder" .....	1	8
8. Shale, black .....	4	
7. "Boulder" .....	1	
6. "Slate," black .....	7	6
5. Coal (at 121 1-6 feet).....	4	4
4. Fire clay .....	1	8
3. Coal (at 127 1-6 feet).....	1	
2. "Slate," black .....	19	6
1. Coal (at 147 2-3 feet).....	5	

The coal horizons shown here agree very well with those found at the Gibson mine near Clive. The altitude of No. 1, the seam worked, is about 676 feet A. T. It may be seen that a

field rich in possibilities is being newly developed along Walnut creek. Considerable prospecting has recently been conducted between Valley Junction and Commerce, and new mines may be expected in that district some time in the near future. It is not to be understood, however, that the coal lies in continuous beds, even between points where the seams are evidently closely related, as are those at the Gibson and the Keystone. Under the lands prospected by the Keystone Coal Company, for instance, number 5 of their shaft section is not very persistent, and number 1 appears to be confined to a basin which is elongated from southwest to northeast. The lower seam was only eighteen inches thick in test holes drilled one mile west and two miles northwest of the shaft.

*Mouth of Walnut Creek.* Two mines are in operation about one-fourth mile above the mouth of Walnut creek beside the tracks of the Chicago, Milwaukee and St. Paul railroad. On the east side of the tracks is the shaft of the Walnut Creek Coal Company, which is working the "third vein." The maximum thickness of the seam is four feet, but it thins so as to become unworkable north and northeast of the mine workings. Another coal, eighty feet and more above the lower, is workable over part of the company's land, though it is only six inches thick at the shaft. Most of the coal has been taken from the east side of the shaft, but the work is now to the west.

## DRILLING NEAR SHAFT OF WALNUT CREEK MINE.

Surface Altitude 818 feet A. T.

	FEET.
20. Fill .....	22
19. Soapstone shale .....	19
18. Rock .....	2
17. Fire clay .....	10
16. Soapstone shale .....	11
15. Shale .....	4
14. Fire clay .....	5
13. Coal .....	½
12. Soapstone shale .....	7
11. Fire clay .....	14
10. Shale .....	9
9. Coal .....	1
8. Soapstone shale .....	14½
7. Rock .....	1½

## COAL DEPOSITS OF CENTRAL IOWA

6. Fire clay .....	8
5. Shale, black .....	10
4. Coal .....	2
3. Fire clay .....	4½
2. Shale, black .....	9
1. Coal .....	3½
Total .....	157½

DRILLING 2,000 FEET NORTHEAST OF WALNUT CREEK SHAFT.

Surface Altitude 890 feet A. T.

	FEET.	INCHES.
26. Soil .....	3	
25. Yellow clay .....	30	
24. Sandstone .....	2	
23. Soapstone shale .....	6	
22. Sandstone .....	3	
21. Soapstone shale .....	6	
20. Sandstone .....	1	
19. Soapstone shale, blue.....	8	
18. Coal .....	2	3
17. Soapstone shale, sandy .....	4	
16. Sandstone .....	4	
15. Soapstone shale .....	8	
14. Sandstone .....	4	
13. Soapstone shale .....	16	
12. Coal .....	1	3
11. Soapstone shale .....	42	5
10. Coal .....	2	9
9. Soapstone shale .....	12	
8. Sandstone .....	4	
7. Soapstone shale .....	50	
6. Shale, black .....	9	4
5. Coal .....	1	4
4. Shale, black .....	18	10
3. Coal .....	2	2
2. Fire clay .....	7	
1. Shale, black .....	34	2
Total .....	282	6

The mine of the Coaldale Fuel Company is on the opposite side of the tracks, a short distance south. Both of the two lower seams found at the Walnut Creek shaft are here much thicker, the lower varying between three and one-half and five and one-half feet, the upper being five feet three inches and lying fourteen feet above the lower. Both these seams are now worked from the same shaft. Both contain quite clean coal with very lit-



tle dirt, no "clay slips," and with the "sulphur" confined chiefly to the roof. The roof is in part black "slate" and in part a clay ironstone ("boulder") which requires little timbering. Entries have been extended three-fourths mile to the south, in which direction there is a gentle dip, and the main haulage is by Goodman electric motors.

#### RACCOON RIVER VALLEY.

*Commerce.* Coal has long been known at Commerce and has been worked by small shafts at both the western and eastern edges of the town. Only one mine is in operation now, a gin shaft supplying local trade only. It is on the land of Dr. Hulme, just east of Commerce (Tp. 78, R. 25, Sec. 28, Nw. qr., Nw.  $\frac{1}{4}$ ). A number of coal seams are known at this point. Twenty feet below the surface is the first seam, ten inches thick and with a good "slate" roof and fire clay bottom. The second seam is the one which has been chiefly worked. It lies seventy-five feet below the uppermost coal, at an altitude of about 755 A. T. and with a dip to the northwest. Its thickness is variable, but the average may be taken as three feet. The roof is so firm that the coal can be worked longwall. The third seam, three feet three inches thick, is thirty feet farther down and has a sandy soapstone shale roof. Two and one-half feet below the third is a twenty-inch coal, while other thinner seams are known at still greater depths. Where mining has been carried on just west of Commerce, the succession of coals is much the same. The second seam, however, is only twenty inches thick and a third two and a half feet.

*Valley Junction.* The Valley Union Coal Company is operating a new mine at the foot of the bluffs on the south side of the Raccoon near the Valley Junction bridge. At a depth of 150 feet, at an altitude of about 680 A. T., a four-foot coal bed is reached; while seventeen feet above it a two-foot coal is reported and forty-three feet still higher is a two and a half foot seam. The mine supplies a local trade in Valley Junction and the country districts on the south. Entries running east, west and south, have been driven a total distance of 1,700 feet. The roof of the lower coal is a tough bituminous shale. Hoisting is done by a small single engine.

*Park Avenue and Vicinity.* In the southwest corner of Section 13, three-fourths mile southeast of the Valley Union mine, is the shaft of the Hollingsworth Coal Company. Hoisting is effected by a double, geared engine with 10x18-inch cylinders. The product is shipped over a spur from the Minneapolis and St. Louis railroad. The seam mined lies 150 feet below the surface, at an altitude of about 670 feet A. T. The coal bed is slightly undulatory, without noticeable dip in any particular direction and the average thickness of the coal is four feet. Entries extend from the shaft in all four of the cardinal directions, the main entries being north and south. At present the work is about half way between the shaft and the Raccoon river. In general, the coal may be said to be clean; a few dirty streaks and irregularly placed bands of iron pyrites give little trouble. The roof is alternately "slate" and sandstone, one giving place to the other without apparent regularity. The presence of a thick bed of coal below the one now being developed, as well as of one above it, is shown by the following section:

## SECTION 992 FT. S. AND 25 FT. E. OF HOLLINGSWORTH SHAFT.

Surface altitude about 840 A. T.

THICKNESS.			DEPTH OF BASE.	
FEET.	INCHES.		FEET.	INCHES.
20	..	Clay .....	20	..
5	..	Shale, light-colored .....	25	..
2	9	Shale, dark .....	27	9
..	10	Coal .....	28	7
29	4	Shale, light-colored.....	57	11
1	..	Shale, dark .....	58	11
..	9	Coal .....	59	8
62	1	Shale, light-colored .....	121	9
2	11	Coal .....	124	8
6	7	Shale .....	131	3
..	11	Coal .....	132	2
8	8	Shale, light-colored .....	140	10
8	6	Sandstone .....	149	4
34	8	Shale, dark .....	184	..
3	2	Coal .....	187	2
1	6	Shale, light-colored .....	188	8
2	..	Shale, dark .....	190	8
3	4	Shale, light-colored .....	194	..
8	8	Shale, dark .....	202	8
5	..	Coal .....	207	8
8	..	Shale, light-colored .....	215	8
42	4	Sandstone .....	258	..
2	..	Shale, sandy .....	260	..

Three-fourths mile east and a little south of the Hollingsworth, beside the Chicago, Burlington & Quincy tracks, is the Iowa mine (T. 78, R. 25, Sec. 24, Ne. qr., Nw. ¼). The shaft is 150 feet deep to a coal bed which varies in thickness between four and four and a half feet and lies at an altitude of about 690 feet A. T. This seam is reported to be present under all of the 300 acres controlled by the company. At first entries were driven under the railroad tracks toward the west, then attention was turned toward the north. For 400 feet from the shaft the coal dips to the west, then lies level for a short distance until it begins to rise toward its initial level. A thin band of black jack and pyrites is quite generally present about eighteen inches below the roof of the coal. Immediately above the seam is a "dirt band" between one-half and two feet in thickness, and lying on it a foot or less of coal. The latter is seldom removed during mining operations, being left to render notable service as a roof. A lower seam, perhaps identical with the one shown in the Hollingsworth section, is reported; but information on this subject is somewhat vague.

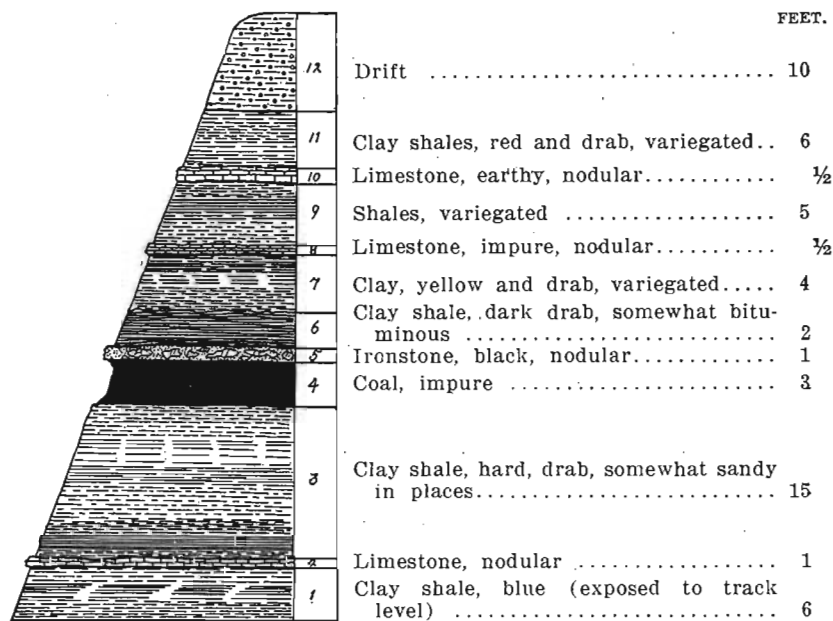


Figure 30. Railroad cutting near Rose Hill mine, four miles west of Des Moines.

The Midway Coal Company is now operating the Shaw mine, one mile east of the Iowa (T. 78, R. 24, Sec. 19, Ne. qr., Ne.  $\frac{1}{4}$ ). The shaft cuts two seams at this point, but it is not the intention of the operators to mine in the lower coal for some time to come. The lower seam is 180 feet below the surface at the shaft and is four feet eight inches thick at that point. The coal now being excavated lies forty feet higher, at an altitude of about 700 feet A. T. Its thickness varies between four and six feet. There is a small general dip to the west, though it is somewhat obscured by the local grades due to the undulatory character of the seam. A single-cylinder, geared engine is utilized for hoisting. There are no shipping facilities here, yet a considerable trade is supplied locally and in Des Moines.

One mile northeast is the Bennett (T. 78, R. 24, Sec. 17, Se. qr., Nw.  $\frac{1}{4}$ ), another mine which, although without railroad connections, is able to market a large daily output in Des Moines. Steam power is used. The shaft is 125 feet deep to a level, clean coal bed which varies irregularly in thickness between three and a half and five feet. The seam is known to the miners as the "third vein," though its altitude of about 715 feet A. T. and its relation to the limestone bands to be mentioned later seems to indicate a probable correspondence with the "second vein" of the territory farther east. The "second vein" is absent; but the "first vein," 100 feet above the third at this point, is workable in places. It has a poor roof, however, and is largely cut into by pre-glacial channels. No coal was found in the first fifty feet of shales and thin sandstones which lie below the so-called "third vein."

The Johns Coal Co. opened a new mine in the autumn of 1907 about one mile northeast of the Bennett, at the base of the bluffs near the brick plant (T. 78, R. 24, Sec. 16, Nw. qr., Ne.  $\frac{1}{4}$ ). Two tubular boilers, one 60-in. x 18-ft. and the other 40-in. x 16-ft., furnish steam to a single-cylinder hoisting engine. Although the mine lies close to the Chicago Great Western railroad tracks, no coal is shipped. Various manufacturing industries in Des Moines consume the entire product. The seam mined belongs in the same horizon as the lower coal at the Bennett and is four feet thick.

## DES MOINES VALLEY BELOW THE RACCOON FORK

*South Des Moines.* Owing to the strategical position of a field so close to the business center of a large city, mining was energetically prosecuted in the South Des Moines district at an early date and was continued until the complete exhaustion of the known supply was in sight. Three horizons at which coal has been found are generally recognized, the first a little above the river level, the second about seventy feet lower, and the third, from 120 to 150 feet below the bottom lands. Coal does not always exist at all three of these horizons at any given point, nor are the horizons always separated by exactly the same intervals. Changes in level of a coal bed from place to place may be due to "rolling" of the coal seam, to a dip common to all the strata, or to a thickening or thinning of certain strata below the coal. Nor are the three horizons of which mention has been made the only ones known, though they are perhaps the most persistent. A general idea of the relations of the strata in the district may be gained from the following shaft record of the old Clifton mine, which was situated a short distance south of the West Ninth street bridge.

## CLIFTON SHAFT RECORD.

Elevation of Surface About 890 Feet A. T.

	FEET.	INCHES.
42. Drift .....	11	
41. Sandstone, soft .....	2	
40. Shale, argillaceous .....	9	
39. Limestone .....		8
38. Shale, argillaceous .....	8	
37. Limestone .....		9
36. Shale, argillaceous .....	5	
35. Shale, black .....	2	
34. Coal .....		10
33. Fire clay .....	2	
32. Sandstone, compact .....	3	
31. Sandstone, soft .....	3	
30. Fire clay .....	3	
29. Shale, argillaceous .....	12	
28. Shale, black .....	6	
27. Coal .....	2	
26. Fire clay .....	6	
25. Sandstone .....	9	
24. Fire clay .....	6	

23. Shale, brown .....	2	
22. Coal .....	1	11
21. Fire clay .....	16	
20. Sandstone, compact .....	6	
19. Fire clay .....	8	
18. Shale, argillaceous .....	4	
17. Coal .....	6	
16. Fire clay .....	13	
15. Shale, black .....	10	
14. Limestone .....		10
13. Shale, black .....	3	
12. Coal, impure .....	3	
11. Rock .....		3
10. Coal .....	2	3
9. Fire clay .....	8	
8. Sandstone .....	2	
7. Shale, black .....	5	
6. Sandstone .....	3	
5. Shale, black .....	5	
4. Coal .....	1	8
3. Fire clay .....	4	
2. Shale, black .....	10	
1. Coal .....	5	6

Very little mining is done today in the South Des Moines district. The only mine now in operation between the West Ninth street bridge and Levey is that of the Beck Coal Company at Sevastopol. The present shaft of that company opens to a new mine situated near the center of section 14, range 24, township 78. Hoisting is done by steam. There are no railroad connections. Work is being done in the "third vein," which is here quite level and roofed by a firm bituminous shale. Scattered ironstone segregations may be seen here and there in the coal, but clay seams and small faults, often numerous in the "first" and "second" veins, are lacking. Not more than two or three acres have been worked out.

*Fort Des Moines.* Several attempts have been made to locate fields near the army post, but so far the only successful one appears to have been that of the Blount-Evans Co. They have recently sunk 218 feet near the crossing of the Fort Des Moines electric line over Yader creek, about a mile north of the Fort. This coal appears to be in an isolated pocket of 200 acres, with the long axis lying northeast-southwest. Although the company drilled seventeen holes on the 360 acres owned by them,

the remainder of the tract proved barren. A test hole near the present shaft shows:

	FEET.
16. Soil and clay .....	12
15. Sand and gravel .....	3
14. Yellow clay .....	3
13. Gray rock .....	3
12. Hard, dry sand .....	96
11. Shale, sandy, gray .....	9
10. Shale, sandy, light-colored.....	7
9. Sandstone, gray .....	15
8. Shale, sandy, light-colored .....	13
7. Sandstone, gray .....	3
6. Shale, light-colored .....	4
5. Shale, mixed .....	3
4. Shale, dark .....	7
3. Coal (altitude about 647 A. T.).....	4½
2. "False bottom" .....	½
1. Shale, light-colored .....	24½
<b>Total .....</b>	<b>207½</b>

Other prospects in the vicinity show that there is a barren succession of shales and sandstones for a considerable distance below the bottom of the shaft. There is a marked predominance of sandstones, some bearing highly mineralized waters, among the superficial strata for a radius of a mile from Fort Des Moines.

*East Des Moines.* Like South Des Moines, the district east and northeast of the Capitol became the scene of extensive mining early in the history of the industry. Three coal seams of encouraging size—the "first," "second" and "third"—became in succession the foci of operations in various mines; then as the fields near the centers of congestion were exhausted, new shafts were opened farther and farther to the north and to the east until the present locations were reached. The stratigraphical relations of the coal horizons are illustrated by the accompanying section from the shaft of the old Giant No. 1, which was a short distance east of the Capitol.

At the present day the only mining being done in East Des Moines is by the Glenwood Coal Company, whose shaft No. 3 was sunk on the north side of the State Fair Grounds. At a depth of 110 feet they found four feet six inches of coal, increas-

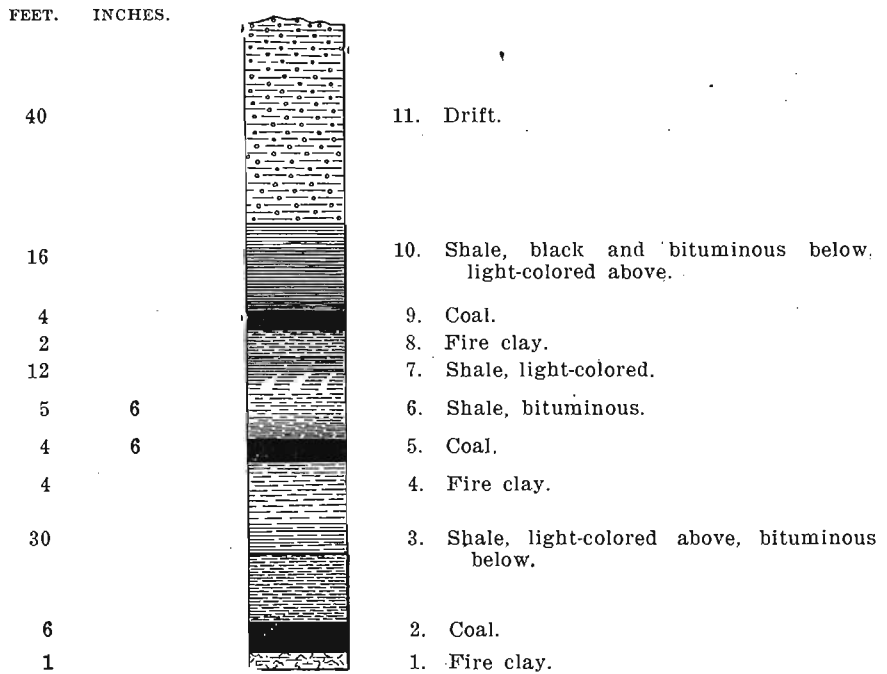


Figure 31. Shaft of Giant number 1, East Des Moines.

ing to six feet in a few spots and overlain by a tolerably firm calcareous shale. Near the shaft there is a slight grade, but as a rule the entries are quite level. Of the 200 acres leased by the company, fifteen have been worked out, and during the summer of 1908 entries were being driven east and north in a little less than five feet of coal. Steam for hoisting is furnished by two tubular boilers capable of producing a total of 160 horsepower. The product is hauled by wagon into the city.

It is difficult to connect the Glenwood coal with any of the seams found near the Capitol. Perhaps it may best be correlated with the "third vein" of the Giant section and with the coal now worked at the Economy mine in Four Mile valley, and the conception advanced that it lies near the crest of a very low anticline.

*Carbondale.* For more than twenty years mining was prosecuted at Carbondale, until the last mine to continue was closed during the summer of 1908 because of the numerous pre-glacial and Pennsylvanian erosion channels encountered on the edges



POLK COUNTY

of the workings. The following section of the strata at old Carbondale No. 2 (Tp. 78, R. 23, Sec. 9) is taken from Bain's "Geology of Polk County,"\* which has been freely drawn upon for material relating to mining districts which are no longer active.

CARBONDALE NO. 2.

	FEET.	INCHES.
21. Soil .....	2	
20. Marly clay .....	17	22'
19. Sand and clay .....	3	
18. Shale, gray .....	39	5
17. Sandrock and shale.....	3	9
16. Limestone, white, brittle.....	1	10
15. Shale, light blue .....	1	6
14. Shale, sandy .....	8	4
13. Shale, light blue .....	1	4
12. Sandstone .....	1	6
11. Shale, gray .....	2	
10. Sandstone .....	3	4
9. Shale, sandy .....	12	9
8. Shale, gray .....	5	5
7. Coal and black jack.....	1	2
6. Fire clay .....	1	8
5. Shale, gray .....	1	1
4. Rock, hard, gray .....		7
3. Rock, hard, blue .....	3	8
2. Shale, black .....	3	
1. Coal .....	4	4

A record from section 10, farther east, is as follows:

	FEET.	INCHES.
30. Soil .....	4	
29. Clay and sand .....	42	40'
28. Gray soapstone shale .....	5	
27. Blue clay .....	39	
26. Shale, black .....	3	
25. Sandstone .....	2	
24. Shale, gray .....	6	
23. "Slate," black .....	1	6
22. Coal .....		8
21. Fire clay .....	3	
20. Soapstone shale, gray .....	4	
19. Shale, black .....	22	
18. Coal .....	4	
17. Pyrites .....		6
16. Fire clay .....	3	
15. Sandstone, soft .....	1	
14. Shale, clayey, white .....	6	

\*Iowa Geol. Surv., Vol. VII; Des Moines, 1897.

## COAL DEPOSITS OF CENTRAL IOWA

13. Sandstone .....	1	6
12. Shale, clayey, brown .....	2	6
11. Shale, black .....	10	6
10. Sandstone .....	1	6
9. Shale, white .....	1	
8. Sandstone, hard, gray .....	3	7
7. Pyrites .....		1
6. Shale, gray .....	19	
5. Sandstone, hard .....	6	
4. Shale, gray .....	13	
3. Rock, hard .....	1	6
2. Shale, black .....	4	9
1. Coal .....	4	9½

The correspondence of the last two sections is only approximate. Numbers 18 and 22 of the last are not represented in the first, and number 7 of the first is not found in the last. The thick coal at the base of both sections represents the same horizon and lies at an altitude of a little over 700 feet A. T. The horizon of number 22 of the last section yields thicker coal in other places, notably in the northwest quarter of the northeast quarter of section 9, where a boring started on the upland found a five-foot bed at sixty feet. The Saint Louis limestone has been found only eighty-four feet below the horizon worked at Carbondale, and so far no coal has been reported from the strata between the limestone and this horizon.

A mile northwest of Carbondale several mines were formerly located near the tracks of the Chicago, Rock Island and Pacific railroad. The record of a drilling near old Gibson No. 2 (Sec. 5, Ne. qr.) is as follows:

	FEET.
13. Soil .....	2
12. Red sand .....	12
11. Blue clay .....	32
10. Soft clay and sand .....	10
9. Shale, black .....	32
8. Coal .....	3½
7. Fire clay .....	4
6. Sandstone, soft .....	5
5. Shale, black .....	15
4. Cap rock .....	1
3. Coal .....	4½
2. Fire clay .....	2½
1. Sandstone .....	7
Total .....	130½

Number 8 of the above section probably lies in the horizon of the coal mined at Carbondale (No. 1 of both Carbondale sections). The coal is not particularly persistent in the neighborhood, but in many cases its absence in drill records is due to removal by pre-glacial erosion, which reached to a great depth in the valley of Fourmile creek. Number 3 of the section was located over a considerable area.

*Ross Junction.* Coal which corresponds in position with that mined at Carbondale was formerly developed at Hastie (Ross Junction) by several companies. The shaft of the Wabash mine was 100 feet deep. One mile southeast of this point the Iowa Coal and Mining Company once operated a shipping mine (Fourmile Tp., Sec. 15, Se. qr., Ne.  $\frac{1}{4}$ ). Four coal horizons have been recognized here. The upper coal, mined by drifting, is shown in the accompanying section and sketch of a near-by railroad cut.

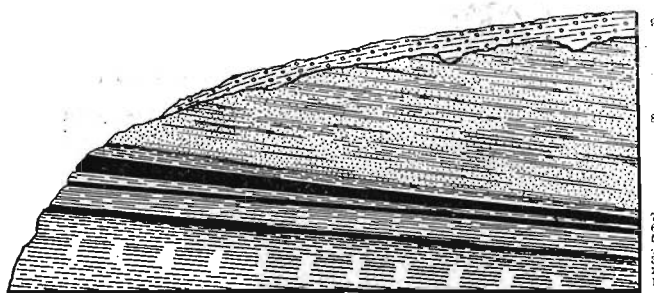


Figure 32. Railroad cut one mile east of Hastie.

	FEET.
9. Drift .....	4
8. Shale, sandy, yellow .....	30
7. Shale, bituminous .....	3
6. Coal .....	3
5. Clay, white and ash-colored .....	2
4. Coal, impure .....	$\frac{1}{2}$
3. Shale, yellow and white.....	4
2. Coal, impure .....	2-3
1. Shale, dark, drab (exposed).....	6

As shown in the old Iowa shaft there are about thirty-five feet below this horizon a three-foot seam, twenty-five feet lower one three feet eight inches thick, and fifty-four feet still farther down a three-inch representative of the coal at Hastie.

*Levey.* On the south side of the Des Moines river, one-half mile south of Levey station, the small gin shaft of the Avon Coal Company is supplying a local trade. Although it is only 300 feet from the Winterset branch of the Chicago, Rock Island and Pacific Railroad, no railroad facilities are utilized. The shaft is thirty-four feet deep to the top of the coal, which is three feet eight inches thick and lies at an altitude of about 770 feet A. T. The strata in the shaft are said to be practically the same as those occurring three-fourths mile northwest at the old Manbeck mine and shown in the accompanying figure.

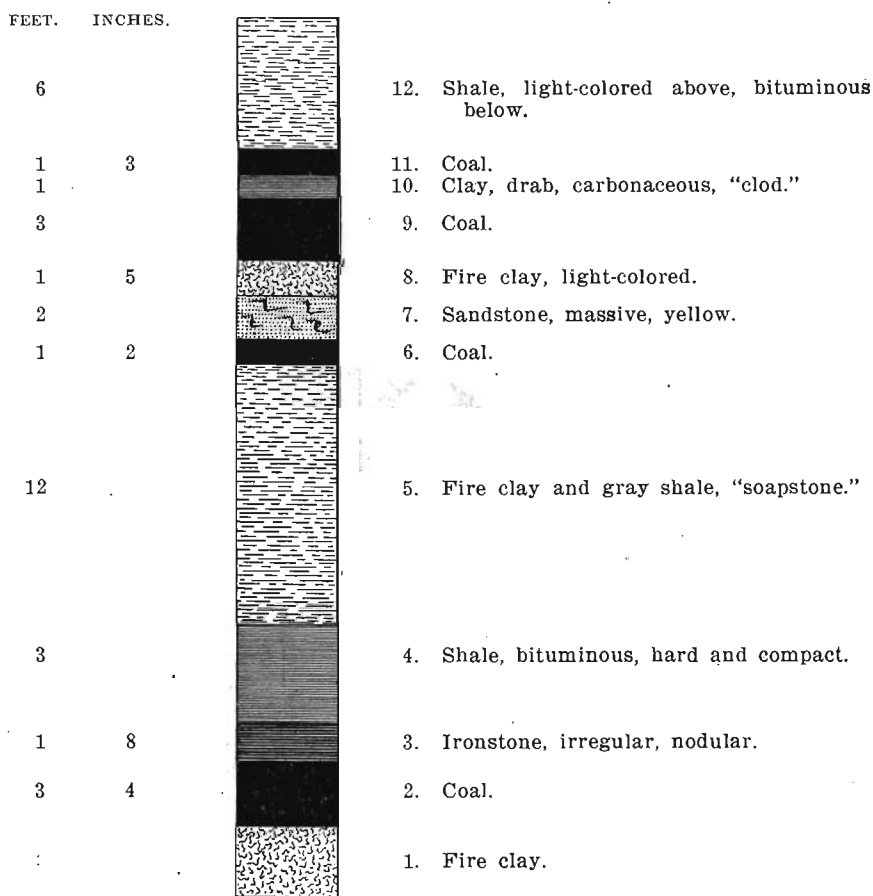


Figure 33. Part of shaft of Manbeck mine, north of Avon.

The coals numbered 11, 9, and 6 in the figure correspond to the tripartite seam mentioned as exposed in the railroad cut near the old Iowa mine on the opposite side of the river, so that number 2 falls into a position corresponding with that of the upper seam in the Iowa shaft. The two upper benches of this tripartite coal found in the Manbeck shaft have been mined by drifts at numerous points to the southeast, along the Winter-set branch of the Chicago, Rock Island and Pacific Railroad. In an attempt to discover workable horizons below those already known, a drill rig was set up in the bottom of the Avon Coal Company shaft, and the following sequence of strata recorded:

## DRILLING IN AVON MINE.

	FEET.	INCHES.
Depth of shaft .....	34	
41. Coal at bottom of shaft.....	3	8
40. Clay .....	3	
39. Shale, bituminous .....	30	
38. Coal .....	1	
37. Clay .....	2	
36. Rock .....	2	
35. Fire clay .....	3	
34. Rock .....	2	
33. Clay, sandy .....	2	
32. Shale, sandy .....	5	
31. Rock .....	3	
30. Clay .....	3	
29. Sandstone .....	10	7
28. Rock, hard .....	3	6
27. Shale, black .....	5	
26. Clay .....	1	
25. Shale, sandy .....	30	
24. Sandstone .....	2	
23. Limestone .....	1	
22. Clay .....	1	
21. Rock .....		10
20. Shale, sandy .....	3	
19. Shale, black .....	1	6
18. Sandstone .....	2	
17. Shale, carbonaceous .....	1	6
16. Clay, compact, brown .....	1	
15. Coal, black jack .....	3	
14. Shale, black .....	1	
13. Clay, cream-colored .....		6
12. Shale, black .....		4
11. Coal .....		3

10. Shale, bituminous .....	1	
9. Coal .....		3
8. Clay, blue, sandy .....	1	
7. Shale, black .....	17	
6. Cap rock .....	2	3
5. Shale, black .....	6	
4. Rock .....		9
3. Shale, carbonaceous .....	4	6
2. Fire clay .....	2	6
1. Sandstone (?) .....		10
Total .....	198	9

It will be seen that no workable coal was found in this prospect. Number 38 may be correlated with the second coal seam found in the old Iowa shaft, on the opposite side of the river; but the Carbondale-Hastie horizon cannot be recognized. There was some dispute among the drillers as to the proper identification of number 1; it may, perhaps, be the Saint Louis limestone.

*Runnells.* The upper coal horizon (numbers 6 to 11 of the Manbeck mine section) outcrops at many points in the bluffs on both sides of the river. At Ford it is well exposed and drift mines working it will be discussed in the chapter on Warren county. At Runnells and for some distance east and west of the town, the same seam has been worked by drifts and slopes, as well as by shafts located a short distance back from the bottom lands. Figure 34 illustrates a section measured in a cut on the Wabash railroad, about a mile east of Runnells.

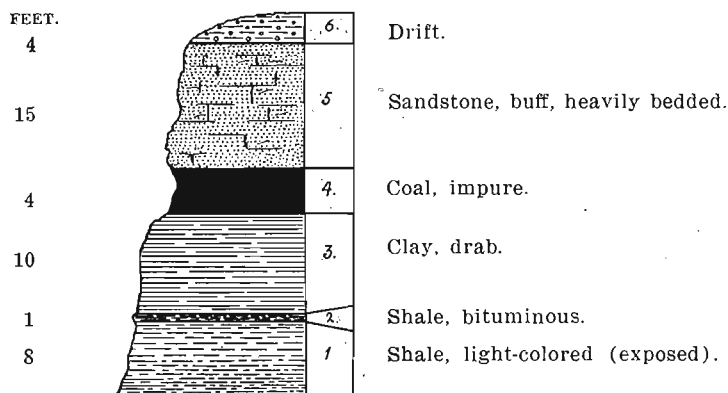


Figure 34. Railroad cutting near east county line, below Runnells.

The Ford-Runnells coal horizon may usually be recognized by the heavy sandstone, known as the Ford sandstone, which often overlies it. This is best shown at Ford, but is also represented by sandstones and sandy shales on the north side of the river. A stratum of clay shale, often bituminous, sometimes intervenes between the sandy layers and the coal, but it is erratic in appearance and variable in thickness. Prospecting four miles north of Runnells failed to reveal the Ford horizon in a convincing manner.

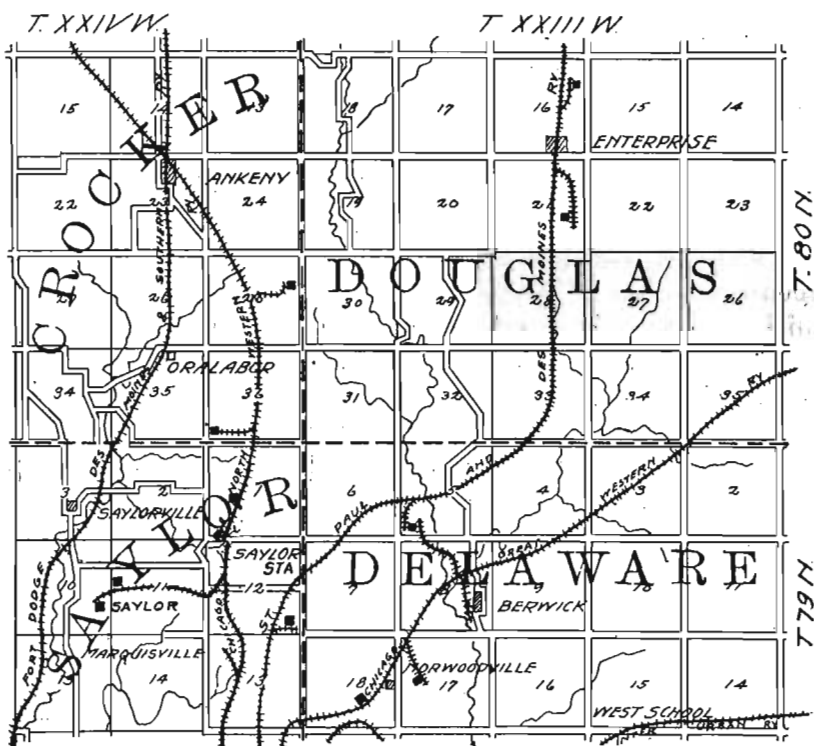


Figure 35. Map showing location of principal Polk county mines outside of the Des Moines district.

THE DES MOINES—FOURMILE DIVIDE.

For many years mining operations have been conducted in the neighborhood of Marquisville, but it was not until recently that attention was turned to the upland district on the north. Today a very respectable portion of the coal produced in Polk county is

taken from the prairie region lying between Ankeny and Marquisville, while indications point to the continuance and probable extension of the present industry for many years to come.

*Ankeny.* Two miles southeast of Ankeny (Crocker Tp., Sec. 25, Ne. qr.), the Anderson Coal Company sank a shaft early in 1908 to a thick bed of coal. The main entry has been driven 500 feet due south and development work has advanced far enough to promise a large production during the coming winter. The product is loaded on a spur of the Chicago and North Western railway, over which most of it is shipped north. Three tubular boilers of eighty horsepower each furnish steam for the Eagle first-motion hoisting engine. Hopper scales and Olson automatic cages form part of a modern equipment. The tippie is arranged so that three cars may be loaded simultaneously. The coal seam, which lies at an elevation of 675 feet A. T., has so far proved to be a clean one. The field, so far as prospected by this company, consists of 700 acres. The 285-foot shaft lies in about the center of the field. The drift is as much as 100 feet thick at this point, yet four small seams, ranging from six to eighteen inches in thickness, occur between it and the bed worked.

*Carney.* The new mining camp, Carney, is three miles south of Ankeny. Shaft No. 2 of the Saylor Coal Company is located here (Crocker Tp., Sec. 36, Sw. qr., Sw.  $\frac{1}{4}$ ) and, although but two years old, the mine already ranks as the largest producer in the county. Houses for the new camp have been moved over from old Saylor. The hoisting is done by a first-motion Eagle Iron Works engine, cylinders 18x36, drum six feet. Five boilers, one two-flue and four tubular, of about 100 horsepower each, supply the power. The tower and other top works are modern and well equipped. The tippie is so arranged that loading may be done on all or any of three tracks which join to form a short spur to the Chicago and North Western railway. Automatic cages and hopper scales facilitate loading. A large part of the interior of the mine is lighted by electricity, while the same power is also employed for the main haulage, which is done by two Goodman haulage motors. Three cutting machines, driven by two air compressors, are in use in the mine. The coal seam



is quite uniformly four feet thick and is practically free of "boulders." It sometimes is slightly rolling, yet it runs for long distances with little change of altitude. In spite of small clay seams in the roof and coal, as well as the usual amount of "sulphur," the bed may be ranked as a clean one. The following is the record of a drilling made near the shaft.

## DRILLING AT CARNEY.

	FEET.	INCHES.
17. Clay .....	10	
16. Drift .....	84	
15. Shale, light-colored .....	64	7
14. Shale, black .....	10	7
13. Coal .....		8
12. Shale, light-colored .....	7	7
11. Sandstone .....	8	6
10. Shale, light-colored .....	9	
9. Sandstone .....	4	
8. Shale, dark .....	7	1
7. Coal .....		6
6. Shale, dark .....	4	7
5. Coal .....		5
4. Shale, light-colored .....	3	6
3. Shale, drab .....	17	4
2. Coal .....	4	2
1. Shale, light-colored .....	1	1
Total .....	237	7

One-half mile south of Saylor No. 2, beside the tracks of the Chicago and North Western railway, over which it ships (Saylor Tp., Sec. 1, Nw. qr., Sw.  $\frac{1}{4}$ ), is the present mine of the Bloomfield Coal Company. The output is quite large and is shipped north chiefly, only a comparatively small amount going to Des Moines. The equipment is of the type commonly seen in Polk county mines of the better class. Three boilers of seventy-five horse power each furnish steam to the hoisting engine, which has two 18x32 cylinders and is directly connected to the six-foot drum. Hopper scales and Olson self-dumping cages are employed. There are two workable coals at this mine. The shaft extends to the upper seam, which lies 271 feet below the surface of the ground. This bed was mined successfully until the roof became troublesome. The coal was found to be four to four and a half feet thick. A slope was run from the upper to the lower

seam, fifteen feet below, and an engine was placed under ground to haul loaded cars up the incline by means of a pull-rope. The roof of the lower bed is good, while the thickness of the coal is satisfactory (three feet eight inches to five feet). The work at present is to the west and south. The company controls about 600 acres. What the miners describe as a "fault" coming in from the north and going off toward the southeast checked operations on the east side of the workings. The so-called "fault" appears, however, to mark simply the limit of the coal basin, for the coal thins gradually toward it until the overlying shale and the underlying fire clay meet. Toward the west the upper seam appears to split into two thin veins, if the record of a prospect hole one-fourth mile west of the shaft be taken as accurate. The strata at this point may be easily correlated with those at Saylor No. 2, the lower coal at the Bloomfield being the same as the bed worked at Carney.

## HOLE WEST OF BLOOMFIELD SHAFT.

Surface Altitude About 935 Feet A. T.

	DEPTH.
28. Soil and drift .....	
27. Soapstone shale at.....	135
26. Red shale at.....	139
25. Soapstone shale at.....	144
24. Hard rock (undet.) at.....	151
23. Sandstone at .....	153
22. Soapstone shale at.....	160
21. Red shale at .....	165
20. Soapstone shale at.....	166
19. Black shale ("slate") at.....	170
18. Black jack at.....	176
17. Coal at .....	176-6
16. Black shale ("slate") at.....	177-6
15. Coal at .....	178
14. Fire clay at .....	178-4
13. Sandstone at .....	179
12. Soapstone shale at .....	183
11. Sandstone at .....	191
10. Bituminous shale ("slate").....	194
9. Coal at .....	219-6
8. Fire clay at .....	222-7
7. Black shale ("slate") at.....	226
6. Coal at .....	230
5. Black shale ("slate") at.....	230-3
4. Coal at .....	237

3. Black shale ("slate") at.....	237-4
2. Coal at .....	258
1. Fire clay at .....	261-2

*Saylor.* At the old mining camp of Saylor, at the end of a spur track which runs one mile due west from Saylor Station, is the mine of the Western Coal Company, formerly known as Saylor No. 1. During its ten years of service this mine has produced a large amount of coal and has enjoyed at times a larger output than any of its contemporaries. At the present time, pillars are being pulled and preparations made to abandon the mine in the course of one or two years. Since little water enters the workings and mining has always been conducted in a scientific manner by the old company, the coal found in the pillars is still in good condition in many places. Two tubular boilers and a first motion Ottumwa engine are used for hoisting purposes. Two cars are loaded simultaneously and the screens are usually arranged to sort the coal into three grades. The elevation of the bed, 216 feet below the surface at the shaft, is about 680 feet A. T. The coal averages four feet in thickness and is fairly clean. The roof of bituminous shale ("slate") stands well.

*Marquisville.* For a long time Marquisville was the center of an important mining industry. The Des Moines Coal Company operated a shaft in section 13 (Nw. qr.) until a fire caused the mine to be abandoned in October, 1907. The coal is said to have been removed from nearly 600 acres and an upper seam to have been worked out under the Poor Farm, farther north. An old record of the Des Moines shaft shows that this coal occupied a higher horizon than does that of the mines previously described. The altitude of number 3 of the following section is about 720 feet A. T., the surface at the shaft being about 900 feet A. T. Numbers 3, 9 and 11 occupy the same horizons as numbers 9, 15 and 17, respectively, of the Bloomfield section.

## DES MOINES SHAFT, MARQUISVILLE.

	FEET.
24. Drift .....	49
23. Sandstone, soft .....	6
22. Shale, black .....	12
21. Fire clay .....	12

## COAL DEPOSITS OF CENTRAL IOWA

20. Rock .....	1
19. Fire clay .....	3
18. Shale, black .....	5
17. Fire clay .....	4
16. Sandstone .....	3
15. Fire clay and sandstone.....	22
14. Rock, hard .....	1
13. Fire clay .....	6
12. Shale, gray .....	4
11. Coal .....	2½
10. Fire clay .....	2
9. Shale ("slate"), black .....	2
8. Rock, hard .....	1
7. Shale, black, with some coal.....	4
6. Fire clay .....	2
5. Rock, hard .....	3
4. Shale, gray .....	31
3. Coal .....	4½
2. Fire clay .....	1½
1. Sandstone .....	3
Total .....	184½

Coal has been known for some time to exist east of this territory, and during the summer of 1908 a shaft was sunk by the Swanwood Coal Company near the tracks of the St. Paul and Des Moines Railway (Saylor Tp., Sec. 12, Se. qr., Se. ¼). About 200 feet of entries have been driven and the intention is to push the development of the mine rapidly until a large production is assured. The elevation of the seam worked is a little below 700 feet A. T., and a record of the strata shows several thin coals.

## SWANWOOD SHAFT SECTION.

	FEET.	INCHES.
20. Soil and drift .....	94	2
19. Shale .....	4	
18. Rock .....	4	6
17. Shale, mixed .....	4	
16. Shale, sandy .....	4	6
15. Shale, mixed .....	33	5
14. Shale, gray .....	6	2
13. Coal, dirty .....	1	6
12. Shale, light-colored .....	1	
11. Sandstone .....	3	
10. Shale, light-colored .....	9	6
9. Shale, dark .....	12	

8. Coal, dirty .....	1	5
7. Shale, light-colored .....	1	
6. Sandstone .....	28	3
5. Shale, gray .....	5	
4. Coal, soft .....		8
3. Shale, light-colored .....	3	8
2. "Slate" .....	15	
1. Coal .....	4	2
	236	11
Total .....	236	11

The company has determined by prospecting that at least 300 acres are underlain with workable coal. The greatest thickness found was four feet ten inches; while the seam thins toward the edges of the property. The record cited below of a drilling made 1,500 feet east of the Swanwood shaft shows how rapid are the lithological variations in the Des Moines stage when strata are traced either laterally or vertically. Number 18 of the following record may be correlated with number 13 of the Swanwood shaft section, 10 with 8, 7 with 4, and 3 with 1.

DRILLING EAST OF SWANWOOD SHAFT.

	FEET.	INCHES.
28. Drift .....	130	
27. Shale, light-colored .....	6	
26. Rock, light-colored .....	1	
25. Shale, gray .....	5	
24. Shale, black .....	4	
23. Shale, gray .....	5	
22. Shale, pink .....	10	
21. Rock, gray .....	1	
20. Shale, mixed .....	23	
19. Shale ("slate"), black .....	8	
18. Coal .....	1	
17. Shale, sandy, light-colored .....	2	
16. Rock, light-colored .....	1	
15. Shale, light-colored .....	8	
14. Coal .....	1	6
13. "False bottom" .....		6
12. Shale, light-colored .....	2	
11. Shale, black .....	2	
10. Coal .....		6
9. Shale, sandy, light-colored .....	22	6
8. Shale, black .....	6	
7. Coal .....	1	
6. Shale, black .....	5	
5. Shale, light-colored .....	4	

4. Shale, black .....	15	
3. Coal .....	3	11
2. "False bottom" .....		6
1. Shale, light-colored .....	1	
		5
Total .....	270	

South of the Swanwood (E  $\frac{1}{2}$  of Sec. 24, Saylor Tp.; the Sw.  $\frac{1}{4}$  of Sec. 19, and the N.  $\frac{1}{2}$  of Sec. 30, Lee Tp.) a group of mines worked out a higher seam where the coal was three to four feet thick. This horizon may perhaps be represented in the Swanwood sections by one of the thin coals found above the seam that is workable at that point.

#### FOURMILE CREEK VALLEY.

*Berwick District.* The Delaware Coal Company sank a 170 foot shaft northwest of Berwick a few years ago (Delaware Tp., Sec. 5, Sw. qr., Sw.  $\frac{1}{4}$ ). Ordinarily the seam is three and one-half to four feet thick, sometimes running locally to higher figures, and all the coal is of good quality, with few "bowlders" or clay seams. The roof is "slate" and an ironstone "cap rock." Most of the section of land in which the mine is located has been proved to be underlain with workable coal. The seam is practically level so far as now known, though as only ten or fifteen acres have been mined out this statement is not of wide application. The seam, lying at an elevation of 708 feet A. T., can best be correlated with the horizon of number 4 of the Swanwood shaft record and with one of the coals mined at Marquisville. Eighteen feet higher is another four-foot seam, containing good coal, but possessing a poor roof which renders mining in it difficult. A spur runs to the mine from the St. Paul and Des Moines tracks on the north. Most of the product is shipped either north or east, some going even as far as Milwaukee.

One mile north and east of the Delaware, just east of the intersection of the Douglas-Delaware township line and Fourmile creek, a prospect record shows the succession of strata given below. The elevation of the surface is uncertain, yet the coal may reasonably be supposed to lie in the horizon of that at the Delaware mine.

	DEPTH IN FEET.
7. Soapstone shale .....	112
6. Black shale .....	150
5. White soapstone .....	152
4. Hard rock .....	165
3. Black "slate" .....	169½
2. Coal .....	183½
1. Fire clay .....	186

*Norwoodville.* Norwoodville, a coal camp, is situated two miles due south of the Delaware mine. Mining has been carried on in a desultory fashion at this point for a number of years, but it was not until recently that the present large production was attained. The company now in charge of operations has met all difficulties in a determined and scientific manner.

The Norwood-White shaft No. 1, commonly known as Klondike No. 1, lies on the north side of the Chicago Great Western tracks, near the camp (Delaware Tp., Sec. 18, Se. qr., Ne. ¼). The shaft, which is 215 feet deep, reaches, at an altitude of 715 feet A. T., a coal seam which averages four feet in thickness, varying between three and five feet in the various parts of the mine. The mine is fully developed and entries have been carried a considerable distance. Trains of cars going north are hauled 2,700 feet by tail-rope; those going west are drawn 3,300 feet by the same method. What appears at first sight to be too small an engine for the depth of the shaft and the amount of mine run produced is reported capable of hoisting five cars in two minutes during the regular course of a day's work. The coal bed follows a succession of "swamps" and "rises." Small clay seams and veins of calcite may be seen running through the coal, while others appear only in the roof. A mile north of the shaft the coal bed is beginning to pinch out as the workings are carried forward. This is true toward the east also, where the presence of an erosion channel is thought to be the cause of the decrease in the size of the seam. There is not much "draw-slate" in the roof, yet the latter is rather uncertain. "Slate" lies immediately above the coal in part; while those portions of the mine in which the "slate" is replaced by sandstone have usually been abandoned because of an influx of water.

A short distance east of No. 1, in section 17, is shaft No. 2 of the same company. Loading is done on a short spur running south from the Chicago Great Western railway. Steam is supplied to a first-motion double hoisting engine by a 150 horse power marine boiler and a 100 horse power horizontal boiler. Hopper scales and self-dumping cages add to the efficiency of the equipment. Not over forty acres have been mined out. The nature of the coal bed is much the same as in Mine No. 1, except that the thickness of the seam is more variable (two to five feet) and the bed is more level. Lying in the top of the coal are occasional "bowlders," sometimes as much as twelve feet in their largest dimensions. Water gives so much trouble that entries have to be abandoned now and then.

## DRILL LOG TAKEN NEAR NORWOOD-WHITE NO. 2.

	FEET.	INCHES.
14. Soil and clay.....	112	
13. Shale, gray, sandy .....	4	
12. Sandstone, gray .....	9	
11. Shale, light-colored .....	14	
10. Coal .....		4
9. Shale, gray, sandy .....	5	8
8. Shale, dark .....	1	
7. Shale, sandy, with rock.....	7	
6. Shale, gray, sandy .....	6	
5. Shale, light-colored .....	2	
4. Shale, dark, sandy .....	3	8
3. Coal (at about 715 A. T.).....	3	8
2. "Brown bottom" .....		4
1. Rock, light-colored .....		4
Total .....	169	

*Lower Fourmile Valley.* On the eastern slope of Fourmile valley, at the end of a long spur extending to the north from the Chicago, Rock Island and Pacific railway, is the Maple Block shaft (Tp. 79 N., R. XXIII W., Sec. 28, Se. qr., Nw.  $\frac{1}{4}$ ). The depth of the shaft is 168 feet and the elevation of the bed worked 702 feet A. T. This mine, with its well equipped top works and conveniently arranged underground workings, ranks as one of the largest producers of the county. Hoisting is effected with a first-motion engine with two cylinders, each 18x36. Loading is done on three tracks. The coal bed is fairly level, undulating



gently. In some of the "swamps" seven-foot coal is found; but this maximum thickness is quite local and on the "rises" the bed thins sometimes to as little as three feet six inches. The average thickness of the seam where it has been mined may be taken at a little under five feet. "Bowlders" and other impurities are not conspicuous, although a few clay-ironstone masses are found in the main dips. The bottom is a hard fire clay which shows little tendency to heave. Only a little "draw-slate" is found above the coal, the roof being in general a fairly firm bituminous shale. The seam worked here is known to underlie at least 1,200 acres. The Maple Block Coal Company controls 900 acres, all well prospected. The long axis of the coal basin lies southwest-northeast, with one end about one-half mile south of the shaft and the other two miles or more northeast of it. An attempt has been made to mine another vein which lies not far above the one already described. In places it is found to be of workable thickness, but it is not constant in its appearance. In the following record of a hole drilled one-fourth mile west of the Maple Block shaft, this upper seam is shown to have split into thin beds divided by shale.

## HOLE WEST OF MAPLE BLOCK SHAFT.

	FEET.	INCHES.
21. Yellow sand .....	23	
20. Drift .....	24	
19. Shale .....	32	4
18. Coal .....		7
17. Shale, light-colored .....	21	1
16. Sandstone .....	3	
15. Shale, light-colored .....	8	
14. Sandstone .....	9	7
13. Shale, light-colored .....	4	
12. Sandstone .....	10	4
11. Shale, dark .....	3	10
10. Coal .....	1	8
9. Shale, dark .....	5	8
8. Coal .....		8
7. Shale, light-colored .....	3	6
6. Shale, dark .....	8	
5. Rock .....	1	6
4. Shale, dark .....	2	9
3. Rock .....		11
2. Coal .....	4	
1. Fire clay .....		10
Total .....	169	3

The mine of the Economy Coal Company loads on the same spur, a little more than a mile farther south (Tp. 79, R. XXIII W., Sec. 33, Se. qr., Ne.  $\frac{1}{4}$ ). At the pit bottom, 110 feet below the surface, the coal lies at practically the same elevation above sea level as at the Maple Block shaft and it undoubtedly lies in the same coal horizon. Between the territories of the mines, however, a "fault," encountered 1,500 feet south of the Maple Block shaft, intervenes. This seems to extend from northeast to southwest; but whether it is an old erosion channel which has cut out the coal, or simply the barren measures between adjacent coal basins is not determinable from the present condition of the mine workings. At the Economy the seam varies in thickness from three and a half to five and a half feet, with five-foot coal where the miners are at present employed. When the mine was new, difficulty was experienced from the wet shaft and numerous "bowlders" in the coal, but these conditions have steadily improved. A thick bituminous shale forms the roof. Eight to ten inches of "draw-slate" which, however, does not fall if properly and promptly supported, usually tops the coal.

The company has leased 1,000 acres, much of it known to be underlain by this seam. Here, as at the Maple Block, an upper coal is found twenty feet above the one worked. A half mile southwest of the shaft it is four feet thick; a fourth mile east it shows only twenty inches.

*Altoona.* The Gibson Coal Company operate their No. 4 mine one mile southwest of Altoona, near the upper portion of one of the chief tributaries of Fourmile creek (Clay Tp., Sec. 23, Ne. qr., Sw.  $\frac{1}{4}$ ). At a depth of 186 feet lies a four-foot bed of good coal that probably forms part of the basin already mentioned in connection with the Maple Block seam. Except where rolls in the roof cut out part of the coal, sometimes rendering it unworkable, the thickness of the bed is uniform. The roof is, in general, either a black "slate" or a compact siliceous "boulder" formation. No regular "draw slate" has been encountered, but the operators are forced to leave the coal in a narrow strip in the midst of the main workings where the roof is a soft, sandy shale. Southeast of the shaft pre-glacial erosion has cut out the strata above the coal along a line parallel to the long

axis of the coal basin (northeast-southwest), rendering further operations in that direction impossible because of the filling of drift, sand and clay immediately over the seam. About 100 acres have been worked out, chiefly to the west and south, and the limit of coal available from the present shaft has been almost reached.\* Another shaft may be sunk on the opposite side of the pre-glacial channel cited.

What is probably a continuation of the same seam was worked from a shaft 215 feet deep near the Altoona station, until an influx of water forced a cessation of operations. The seam thinned east and west of the shaft and thickened to the south, the direction of the main dip. Fig. 36 gives the characteristics of the strata at this point.

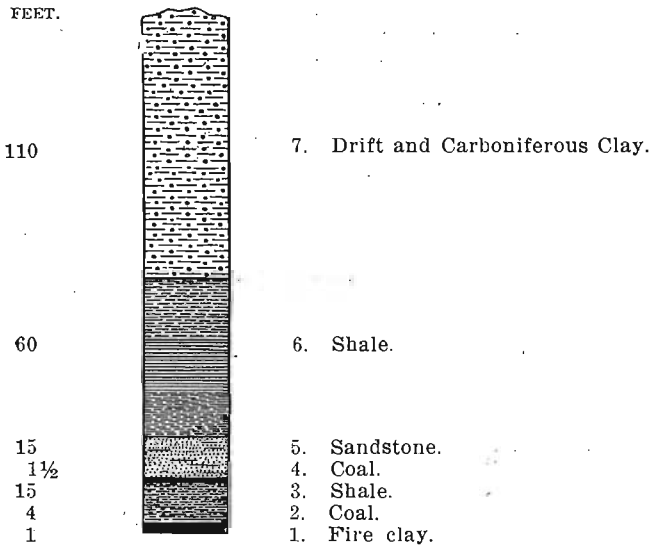


Figure 36. Shaft of mine near Altoona.

#### THE HIGHLANDS EAST OF FOURMILE CREEK.

*Enterprise.* Shaft No. 1 of the Enterprise Coal Company is located a half mile north of Enterprise, near the tracks of the St. Paul and Des Moines Railway and reaches the coal at a depth of 212 feet. The mine has been in operation about five years and may be ranked as one of the best equipped in the central

\*This shaft was abandoned May 1, 1909.

part of the state. The buildings constituting the top works are protected from fire by galvanized iron sheathing. Hoisting is done by a double, first-motion, Eagle Iron Works engine with 13x38 cylinders and a six-foot drum. There is one boiler of 125 horse power and two of 100 horse power. The tower is sixty feet high from the surface to the sheave wheels. Olson automatic cages are employed. Loading is done on two tracks and is facilitated by the use of a Christy box-car loader. A small amount of coal may be stored in an elevator into which it is carried by an endless chain conveyer. The main haulage underground is by Goodman electric motor, trolley system, on 3,500 feet of track, each train consisting of from fifteen to twenty cars. One Goodman cutting machine is being tried as an experiment.

Shaft No. 2 of the same company was sunk during the summer of 1907 in the southeast quarter of section 21, Douglas township. A short spur track leads from it to the main line near Enterprise. The depth of the shaft and the character of the equipment are essentially the same as at mine No. 1, although No. 2 is as yet too young to employ electric haulage to advantage. Entries are being driven from the shaft in all of the cardinal directions. The east entry, at present the longest, has been driven 300 feet.

The Enterprise seam exhibits many of the characteristics of the so-called "second vein" of the Des Moines district. Especially in mine No. 1 are "clay slips" numerous. In most cases the fissures are filled with a soft white clay; yet a few contain an argillaceous sandstone which is significant because totally unlike the material underlying the coal. The thickness of the seams averages two inches and their lateral extension is often considerable. Individual streaks have been followed for long distances during the progress of mining operations. They intersect the shale of the roof at a high angle and extend downward into the coal bed; but they almost always thin out and disappear at some point above the floor of the coal. Thus it is evident that they have no genetic relationship with the fire clay underlying the coal. They may be simple or branching, and either curved, zigzag, or strictly vertical. The Enterprise coal shoots

well off the solid, except where these "slips" are so numerous that their yielding qualities have a deadening effect on the force of the explosives.

In both of the Enterprise mines a band of black jack, usually slightly exceeding one inch in thickness, is found near the middle of the seam. This black jack is a feebly combustible mixture of "slate" and coal, often with abundant inclusions of iron pyrites. The stratum above the coal bed is in most places a shale which requires close timbering. Occasionally a layer of more tenaceous shale, known as "slate," makes its appearance next the coal and forms a firm roof over small areas.

The Enterprise Coal Company has proved by prospecting the presence of good coal under more than 1,100 acres; while it is probable that about 300 acres more should be included in the same field. From north to south the workable basin is at least two and one-half miles long, with a width from east to west of one-half to three-fourths of a mile. The thick coal lies at an elevation of about 765 feet A. T. and is four feet thick at Enterprise No. 1. At No. 2 the thickness varies from two to six feet, but nothing under four feet is utilized for room work. One mile northwest of No. 1 the company sank a shaft to three feet eight inches of coal, but soon abandoned the mine because of trouble with a roof of white clay and shale. Thirty feet above this seam is a thinner coal which is fairly persistent. The relationships of the strata in this district are shown by the sections given below.

## DRILLING ONE MILE DUE WEST OF ENTERPRISE NO. 1.

	DEPTH IN FEET.
19. Soil and drift.....	
18. Shale, red, at.....	60
17. Soapstone shale at.....	80
16. Shale, black, at.....	85
15. Soapstone shale at.....	86
14. Shale, black, at.....	104
13. Coal at.....	110½
12. Fire clay at.....	111½
11. Soapstone shale at.....	118
10. Sandrock at.....	127
9. Soapstone shale at.....	128
8. Sandrock, soft, at.....	129
7. Soapstone shale at.....	132

6. Sandrock at .....	142
5. "Slate, black, at.....	153
4. Coal at .....	156
3. "Slate" at .....	157
2. Coal at .....	160
1. Fire clay at .....	161

This test did not extend to the Enterprise coal horizon, but no workable coal has been reported from deeper holes in the vicinity.

## PROSPECT NEAR ENTERPRISE NO. 2 SHAFT.

(Douglas Tp., Sec. 21, Center of Se.  $\frac{1}{4}$ .)

	FEET.	INCHES.
23. Soil and drift .....	100	
22. Shale, mixed .....	15	
21. Limestone .....		6
20. Shale, mixed .....	4	6
19. Limestone .....	1	
18. Shale, gray .....	11	
17. Shale, blue .....	15	
16. Limestone .....		3
15. Shale, light-colored .....	3	9
14. Limestone .....		9
13. Shale, blue .....	10	3
12. Shale, mixed .....	6	
11. Shale, dark .....	6	
10. Coal (at 174 feet).....		8
9. Shale, light-colored .....	3	4
8. Limestone .....	-2	
7. Shale, light-colored .....	5	
6. Shale, dark .....	1	
5. Shale, light-colored .....	6	
4. Shale, dark .....	8	6
3. Coal (at 200 $\frac{1}{2}$ feet).....	4	6
2. Shale, brown, sandy .....	2	
1. Shale, blue .....	1	
Total .....	208	

The limestones cited in the above section are stratigraphically important if correctly identified. Samples for inspection could not be obtained by the author. The record given below is of a hole made by another driller in the same section of land, but on the west side of the St. Paul and Des Moines tracks. No limestones are reported.

	DEPTH IN FEET.
Clay, sand and gravel.....	
17. Soapstone shale at.....	101
16. Soapstone shale, red, at.....	108
15. Soapstone shale, white, at.....	112
14. Rock, hard, at.....	116
13. Soapstone shale at.....	117
12. Shale, blue, at.....	151
11. Soapstone shale at.....	157
10. "Slate," black, at.....	166
9. Coal at.....	172½
8. Fire clay at.....	173½
7. Sandstone at.....	175
6. Soapstone shale at.....	179
5. Shale, black, at.....	192
4. Soapstone shale at.....	196
3. Rock at.....	201
2. Coal at.....	202
1. Shale at.....	206½

Two miles south of Enterprise the Enterprise coal is still in evidence, as shown below. Thicker coal is present in the same horizon in neighboring drillings.

	DEPTH IN FEET.
8. Clay at.....	50
7. Gravel and sand at.....	60
6. Blue clay and boulder at.....	80
5. Gravel and sand at.....	108
4. Soapstone shale at.....	138
3. Slate, black, at.....	154
2. Coal at.....	179
1. Fire clay at.....	180¾

*Bondurant.* It is claimed that good coal has been found in workable thickness near Bondurant. Nothing definite could be ascertained in regard to this report.

#### CAMP CREEK VALLEY.

*Lower Camp Creek Valley.* A systematic attempt to locate a profitable field was made in sections 11, 12, 13 and 14 of Camp township. In most of the test holes only two feet or less of good coal was found. The record of one of the deeper holes (Camp Tp., Sec. 14, Nw. qr., Sw. ¼) is as follows:

## COAL DEPOSITS OF CENTRAL IOWA

	FEET.	INCHES.
26. Clay and sand .....	33	
25. Shale, mixed .....	24	
24. Shale, dark .....	6	1
23. Coal .....	1	2
22. Shale, light-colored .....	3	
21. Sandstone .....	6	
20. Shale, light-colored .....	16	9
19. Shale, dark .....	10	
18. Sandstone .....	2	10
17. Shale, light-colored .....	8	
16. Shale, dark .....	8	2
15. Shale, gray .....	6	5
14. Coal .....	1	5
13. Sandstone, light-colored .....	12	
12. Shale, dark .....	7	6
11. Shale, light-colored .....	10	4
10. Sandstone .....	2	
9. Shale, dark .....	16	8
8. Shale, light-colored .....	5	
7. Shale, dark .....	29	1
6. Rock .....	2	10
5. Shale, dark .....	15	10
4. Rock .....	2	
3. Shale, dark .....	10	
2. Rock .....	1	4
1. Shale, dark .....	9	11
Total .....	251	4

One of the holes (Camp Tp., Sec. 14, Ne. qr., Se.  $\frac{1}{4}$ ), which penetrated somewhat thicker coal than is common in this district, is as follows:

	FEET.	INCHES.
6. Clay .....	28	
5. Shale, gray .....	32	2
4. Coal .....		1
3. Pyrite .....		2
2. Coal .....	3	1
1. Shale, light-colored .....	9	9
Total .....	73	3

## SKUNK RIVER VALLEY.

*Santiago.* Some prospecting has been done in Franklin and Washington townships. Several holes drilled near Santiago failed to bring to light coal in paying quantities. One of these



prospects, although carried 100 feet, did not reach the solid strata below the drift. Another which was continued to twice this depth did, however, penetrate the surface formations. Extensive mining has been carried on near the Skunk in Jasper county, a few miles beyond the county line.

#### Resume

The coal bearing strata of Polk county belong exclusively to the Des Moines stage of the Pennsylvanian or Upper Carboniferous series. No other rocks outcrop below the heavy mantle of drift within the limits of the county; for the Saint Louis limestone, the stage immediately underlying the Pennsylvanian, lies 200 feet and more below the bottom lands of the Des Moines and Raccoon rivers. The contact of the Saint Louis and the Des Moines is by no means, however, a plane surface, a fact elaborated in another portion of this volume. At Mitchellville the limestone lies 224 feet below the surface, or at an altitude of about 764 feet A. T.\*; at Greenwood Park it is 498 feet down at an altitude of 374; while at Carbondale it lies 200 feet below the bottom lands at an altitude of 600. One interpretation of the Avon mine boring would place the Saint Louis at the same level near Levey as on the north side of the river at Carbondale. Some interesting results have been obtained in the southwestern part of the county, indicating the presence of a deep and remarkably steep sided post-Mississippian valley at Commerce. A mile and a half south of Commerce, south of Millman, and at Valley Junction, the altitude of the top of the Mississippian is 565 feet or more above sea level. A boring made by Dr. Hulme at Commerce passed through a series of shales, sandstones, and thin coals, characteristic of the Des Moines strata, to a depth of 500 feet or an altitude of 320 feet A. T. Two miles west of Commerce the surface of the Saint Louis is found to have regained a level of about 250 feet higher.

From the above it will be seen that the Saint Louis furnishes no datum plane upon which the geologist may base his conclusions. Even though it were conformable beneath the coal bearing strata, it would still be of little assistance, since coal

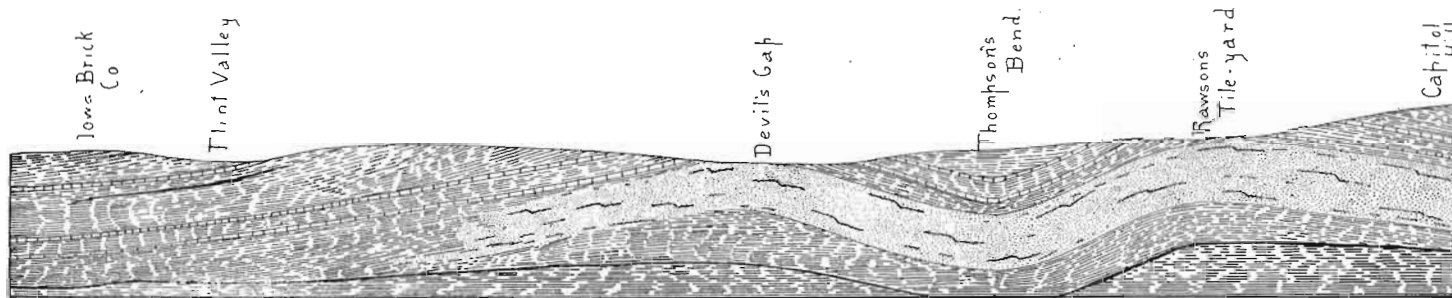
\*This altitude is based upon data received from the Chicago, Rock Island & Pacific Railway, which places Mitchellville station 988 feet above sea level, Cairo datum.

companies seldom carry their test holes below horizons which lie at least 100 feet above the base of the Des Moines beds. Nor is much aid given to stratigraphical research by the lithological characters of the Des Moines strata themselves; as already explained in a previous chapter, few strata have any considerable lateral extent or vertical thickness. A study of the records of shaft borings and prospect holes cited in this report reveals the difficulties attending an attempt to correlate the coals found in even adjacent situations and these difficulties are by no means alleviated by the carelessness exhibited by drillers in identifying strata.

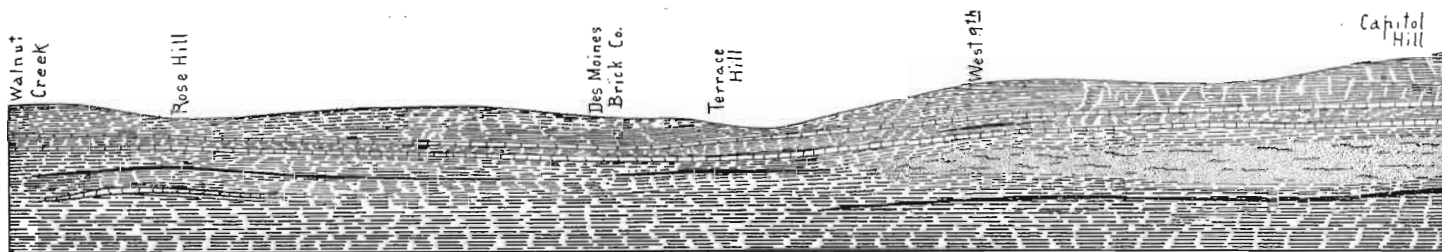
Argillaceous shales of many hues are predominant among the Des Moines strata of Polk county and with them may be included the black bituminous "shales" so eagerly sought by prospectors as possible indications of coal. The white structureless clays, commonly, though often improperly, termed "fire clays," are found in thin beds under most of the important coals. Sandy shales are not uncommon, but true sandstones are rare and lie in thin beds of limited lateral extent, except in the southern part of the county where the Ford sandstone appears. Limestones are exceedingly rare and are always thin, but when present are a great help to the stratigrapher. Three thin bands found in the vicinity of Des Moines enabled Bain to construct the two cross-sections shown in Plate III. Those interested in the data upon which these sections are based are referred to his "Geology of Polk County."\*

An interesting and significant fact in connection with the coal seams at present being developed within the county is that, with the exception of the beds at Commerce, Fort Des Moines, Levey and Enterprise, all lie at an altitude between 675 and 720 feet above sea level. Two possible explanations present themselves: (1) many of the coal basins lie in the same coal horizon and the general dip to the southwest prevalent throughout much of the Iowa field flattens out in the central portion of the county, or (2) the basins lie in several horizons separated by no great vertical interval. Of these explanations the first appeals most strongly to the writer, the term "horizon" being applied in its

\*Iowa Geol. Surv., Vol. VII., pp. 302-310; Des Moines, 1897.



A. Geological section from Capitol Hill to the mouth of Beaver creek.



B. Geological section from Capitol Hill to Walnut creek.

broadest sense. The "rolling" common in some basins accounts satisfactorily for differences of elevation of twenty feet or less between related coals.

There seems little doubt that the basins utilized by the Anderson, Saylor No. 2, Bloomfield and Western mines occupy the same horizon and are separated from one another by rather limited barren areas of irregular shape. There is a considerable gap between the fields of the Western and the Oak Park, yet there is a strong suggestion that the "third vein" in which the North Des Moines mines are working may be correlated with the coal under the highlands farther north. Stratigraphic studies of exposures along the Des Moines river seem to establish the equivalence of the "third veins" of the North and East Des Moines districts. The "first vein" on the East side is probably the "second" of South Des Moines. The "third veins" of East and South Des Moines may possibly be equivalent; but the nature of the coal and the material immediately overlying it does not bear out this supposition. The seams now worked at the Johns, Bennett, Midway, and Iowa mines, south of the Raccoon river, apparently lie slightly above the "third vein" horizon of East Des Moines, though those at the Hollingsworth, Walnut Creek and Coaldale may be tentatively correlated with the lower coal of the east side. Possibly the Valley Union, Keystone and Gibson No. 5 shafts of the Valley Junction district, reach coal which may be assigned to the horizon of the Iowa-Johns basins. The Commerce mine is developing a basin which is stratigraphically higher than any other now worked in the county. The thick coals of the Marquisville, Berwick, and Norwoodville fields belong to slightly higher levels than those worked between Marquisville and Ankeny. The Enterprise seam cannot well be connected with any other, though the characteristics of the bed are reported by experienced mining men to be surprisingly like those of the "second vein" of East Des Moines. The relationships of the beds in the southeastern corner of the county have already been sketched. With the coal once worked near Youngstown by the Christy and Gibson No. 2 mines may perhaps be correlated the "third vein" of East Des Moines and the coal of the Economy, Maple Block, Gibson No. 4, and old Altoona mines.

The visible supply of coal in this county appears to be more than adequate for many years to come, and there are undoubtedly undiscovered basins more than equal in aggregate magnitude to those already known. Less than eight per cent of the county has been prospected; while even in the prospected lands a lower series of Coal Measures from 100 to 200 feet thick has been left uninvestigated. The results of the few holes carried all the way to the Saint Louis limestone have not been encouraging, yet it should be remembered that a certain number of fruitless prospects are often drilled in the midst of valuable coal territory and that the strata lying immediately above the Saint Louis are known to be exceedingly prolific in other parts of the state.

#### JASPER COUNTY

With the exception of the extreme northeastern corner of the county, constituting about half of Hickory Grove township, Jasper is underlain by strata classified with the Des Moines stage. The formations underlying the Des Moines, and the latter itself at many points, have a moderate general dip to the southwest. The geological structure along a line running from southwest to northeast across the county is illustrated diagrammatically in the accompanying sketch. The drawing is on a vertical scale of 350 feet to one inch.

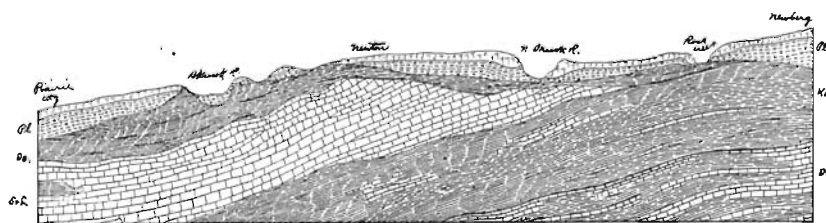


Figure 37. Geological section from Prairie City to Newberg (Williams).  
 Pl. Pleistocene. St. L. Saint Louis. Ds. Des Moines.  
 Kd. Kinderhook. Dv. Devonian.

Owing to their irregular basement and to the varying degrees of erosion which they underwent before the invasion of the ice sheet, the Coal Measures vary in thickness within wide limits. The underlying limestones and calcareous shales of Mississip-

pian age have been doubtfully identified in drillings at a number of localities, but the accuracy of none of these determinations can be vouched for by the author. It seems certain, however, that there is a notable thinning of the Des Moines in the eastern and northeastern sections of the county, while the figures given below for the central and west central portions have about them the elements of probability. At Mitchellville, just over the Polk county line, the base of the Coal Measures was reached at a depth of 224 feet, making its altitude about 764 feet above tide.\* In drillings in the Oswalt coal-field, a limestone, possibly the St. Louis, was reached at a depth about eighty feet below the level of Skunk river. The altitude of the Mississippian at this point is, if the above assumption be correct, about 730 feet A. T.; but unfortunately the data obtained for the district are not such as can be fully relied upon. Considerable difference of opinion exists as to the thickness of the Coal Measures at Colfax. Norton refers the aquifer, which is reached in the majority of the wells at about 300 feet, to the St. Louis.† Basing his deductions on a somewhat generalized record furnished from memory by one who had to do with the sinking of several of the wells, Williams gives the thickness of the drift as eighty feet and of the Des Moines as 217 feet, placing the base of the latter at about 544 feet A. T.‡ This furnishes rather a surprisingly low altitude for the top of the St. Louis, although it is not at all an impossible one. Dr. T. D. Hulme of Commerce, who has had a wide range of experience in drilling deep wells in various parts of the state, considers the Coal Measures to extend downward only 100 feet in a hole headed on lower ground at the old Hotel Sanitarium. He describes the following generalized section from memory:

	FEET.
Drift, shale, sandstones, limestones, thin coal beds.....	100
Heavy beds of cherty, fossiliferous limestone, containing large cavities; also one or two beds of sandstone and thin beds of calcareous soapstone .....	100
Soft sandstone bearing artesian waters.....	6
Heavy beds black shales with beds of limestone; no coal.....	300

It is, perhaps, dangerous to base any conclusion upon records given from memory of holes sunk so many years ago. Just east

\* cf. p. 149 of the chapter on Polk county.

†*Report on Artesian Wells*, Iowa Geol. Surv., Vol. VI, p. 293; Des Moines, 1897.

‡*Geology of Jasper County*, Iowa Geol. Surv., Vol. XV, p. 307; Des Moines, 1905.

of the Chicago, Rock Island and Pacific railroad bridge over Cherry creek, a limestone has been reached which, if referred to the St. Louis, would place the base of the Coal Measures a very moderate depth below the creek bottom, at about 725 feet A. T. The log of a hole put down in the southeast corner of Newton, if the record has been correctly given, places the top of the St. Louis at about the same altitude there. The basement limestone was struck at depths between 117 and 161 feet in a series of drillings in sections 28, 31 and 32 of Independence township. Just above it, from one to five feet of coal was encountered.

As in so many other sections of the Iowa field, mining in Jasper county has been largely confined to the valleys of the main streams where coal has been seen to outcrop or where it may be easily traced in test holes of shallow depth. The future will reveal lucrative basins in other parts of the county, where only systematic prospecting can hope to locate them. The workable seams lie in basins of limited extent, distributed along a number of horizons, and there appear to be two groups of such horizons separated by a short stratigraphic interval. Present knowledge of the conditions is not, however, sufficiently definite to permit of correlating the coals of the different fields. The southwestern portion of the county contains much undeveloped coal; it is the logical field for thorough exploration. The northeastern portion is not so promising, both because the Coal Measures are thinner there and because the strata present were deposited contemporaneously with those which have not so far yielded abundant coal in neighboring counties on the west and north. There are strong possibilities, nevertheless, in even the northeastern townships.

Coal mining began at an early date in Jasper and increased steadily. In 1860 the production was 2,336 tons; in 1870, 20,720; in 1880, 74,462; in 1890, 192,152, and in 1892, 293,255. The annual output for the past ten years has been:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	151,816	1903.....	270,804
1899.....	214,677	1904.....	258,098
1900.....	100,256	1905.....	306,164
1901.....	183,500	1906.....	388,582
1902.....	235,390	1907.....	397,297

Jasper now ranks fifth among the coal counties of the state. According to the report of the State Mine Inspectors, the production for the year ending June 30, 1908, was 467,552 tons. Ten mines employed 836 men.

The occurrence of coal in various parts of the county and the mines in operation in September, 1907, are described below. Mr. Ira Williams ably described the status of the Jasper coal industry as recently as 1905.\* In order to avoid duplication of work, his report has been freely drawn upon for material.

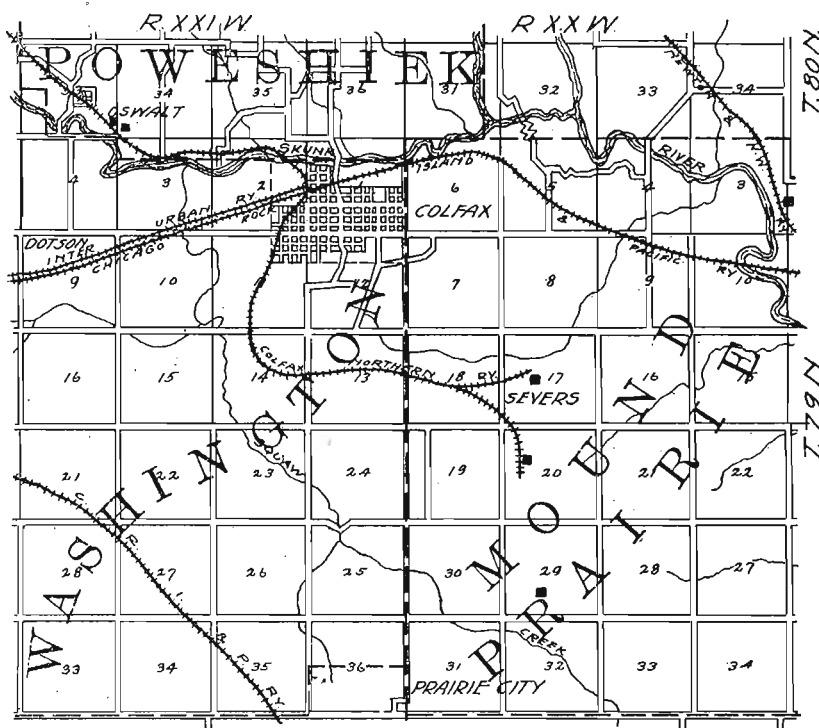


Figure 37a. Map showing the principal mines of Jasper county.

*Oswalt.* Along the northern side of Skunk river valley from Valeria to Colfax, extensive mining was undertaken many years ago. The Jasper County Coal and Mining Company removed the coal from much of a thick bed, ranging in thickness from three to six and a half feet, which lies twenty-five feet below the level of the river. This one company mined out as much as 500

\**Geology of Jasper County, Iowa Geol. Surv., Vol. XV, pp. 335-348.*



acres in sections 34 and 35 of Poweshiek township, while others sank shafts to the same seam in adjacent territory, notably the Valeria and the Diagonal companies, whose shafts were a short distance from Oswalt. Throughout the field, the roof of black "slate" occasionally becomes so attenuated that the drift comes dangerously near the coal, allowing quantities of water to enter the mines. The dip is, in general, to the west. A lower coal, somewhat thinner than the first seam, lies from thirty to forty feet below the one chiefly exploited. A generalized section for the region is:

OSWALT FIELD.

	FEET.
13. Soil and drift .....	70
12. Coal .....	1
11. "Slate," black .....	0-35
10. Coal .....	3-6½
9. Fire clay .....	½-10
8. Sandstone .....	15-20
7. "Slate" .....	1-10
6. Coal .....	2½-3½
5. Fire clay .....	0-3
4. Sandstone .....	15-30
3. Shale, bituminous .....	8
2. Fire clay .....	¼
1. "Rock" .....	

Number 1 of this section was found in a few other drillings and may possibly be the St. Louis limestone. Its altitude is slightly lower than that of the limestone encountered at Mitchellville, in Polk county.

Two small mines are now working the "upper vein" in this district. Both supply an important country trade and haul some coal to a neighboring switch for shipment. The Warrick mine (Poweshiek Tp., Sec. 34, Sw. qr.) is entered by a slope 210 feet long with a grade of one foot in three. Cars are hauled to the surface by steam power. Four hours' pumping daily is required to remove the water entering the mine. The seam is undulatory and shows an average thickness of four feet. Thirty feet and more of shale intervene between this bed and a higher one, thirteen inches thick. The Adams mine, operating a gin shaft, is situated a short distance west. In sinking the shaft, thirty feet

of surface material and thirty-five of "slate" were encountered. The coal is said to average five feet in these workings.

Southwest of Oswalt, number 10 of the Oswalt section given above apparently becomes attenuated, although it does not disappear; the lower coal, number 6, thickens slightly and remains of economic importance; while the thin bed, number 12, persists essentially unchanged. On the south side of Skunk valley, southwest of Oswalt, the Burris and Davis shaft reached a four-foot seam at a level about fifty-five feet above that of the water in the river. Two thin beds were penetrated at elevations of about fifty and eighty feet, respectively, above the thick coal. Near the old Cook shaft, east of Mitchellville (Washington Tp., Sec. 6, Se. qr., Se.  $\frac{1}{4}$ ), the three Oswalt horizons may be recognized, as shown in the following section.

OLD COOK MINE, EAST OF MITCHELLVILLE.

	FEET.
8. Surface .....	27
7. "Slate" .....	3
6. Coal .....	1
5. "Slate" and soapstone .....	.45
4. Coal .....	2-3
3. "Slate," with a band of soapstone.....	16
2. Coal .....	4
1. Fire clay .....	

The lower coal "pinches out" to the north. In a well on the farm of A. W. MacDonald, southeast of the Cook shaft (Washington Tp., Sec. 8, Sw. qr.) two seams, possibly corresponding to numbers 2 and 4 of the Cook section, were associated with the following sequence of strata.

	FEET.	INCHES.
10. Yellow bowlder clay.....	100	
9. Rock, hard .....	1	
8. "Slate" and coal .....	40	
7. Coal .....	2	
6. Fire clay .....	2	6
5. "Slate" .....	18	
4. Coal .....	2	6
3. Fire clay .....	4	
2. Sandstone, gray, magnetic.....	8	
1. Rock, brown .....	62	6

*Colfax.* Colfax is now the main center of the Jasper county coal industry. The first mining in the county was done at the

Slaughter bank, one and a half miles east of Colfax (Sherman Tp., Sec. 32, Sw. qr.). A six-foot seam has been removed from about thirty acres of land by means of drifts slightly above low water in the Skunk river. The roof is a "slate" of fair stability and the seam dips to the south one foot in 216. Drilling on the south, between the Slaughter bank and the railroad, failed to find the coal in some cases; while in others little or no roof was present. No coal was found in an interval of sixty-five feet below this bed. About the same conditions were met in drillings just south and west of Colfax. The Slaughter coal appears to occupy the horizon of the principal bed of the Oswalt district.

The largest mines in the county are located southeast of Colfax near Severs, a mining camp. Two shafts, shipping over the coal spur of the Colfax Northern Railroad, are being operated by the Colfax Consolidated Coal Company. The company control about 1,000 acres of coal rights in Mound Prairie and eastern Washington townships. The whole has been thoroughly prospected and workable coal found to underlie considerable areas. Their mine No. 7 (Mound Prairie Tp., Sec. 17, Sw. qr., Ne.  $\frac{1}{4}$ ) is developing coal three feet six inches to six feet in thickness at a depth of fifty-five feet. The seam is undulatory. The roof is a bituminous shale, bearing in places thin streaks of limestone which weaken it to some extent. Hoisting is done by a geared, two-cylinder Ottumwa engine, supplied with steam by five boilers, one of 100 horsepower and four of forty horsepower each. The haulage engine, situated above ground, is a four-drum, double Ottumwa tail-rope engine, ninety horsepower at eighty pounds pressure. Coal is supplied to the engine room by an endless chain purveyor. Jackson "half dump," automatic cages are in use and chutes are arranged so that three freight cars may be loaded simultaneously. Workings are planned on the room and pillar, double entry method. Tail-rope haulage is extensively employed.

Mine No. 8 of the same company is one mile south of No. 7 (Sec. 20, Nw. qr.). The shaft is 164 feet deep. The tippie is excellently well arranged to handle a large output. From the automatic cages the coal descends over a somewhat complicated system of screens. Five cars may be loaded at once, three with

various grades of large coal and two with pea and slack. The two-cylinder hoisting engine is direct-connected and is supplied by three boilers of 100 horsepower each and one of 150 horsepower, fed by two Penworthy injectors. A McEwen high-speed engine and a Goodman multipolar generator furnish the electric power used in the mine for illumination and for the recently installed Goodman haulage motor. The coal at No. 8 exhibits the same variations in thickness as does that at No. 7 and is connected with it at one point at least. As in many other portions of the Iowa field, however, the thick coal here lies in adjacent basins separated by areas where the bed becomes attenuated or fails completely. The seam at No. 8 is strongly undulatory and possesses a "slate" roof which requires much timbering. In parts of the workings, iron pyrite is found freely distributed in irregularly placed bands and nodules. Running north and south near the shaft is an ancient channel of erosion, which has cut out some of the coal. Rolls in the roof are occasionally found, but give little trouble.

Following is a section in a drill hole put down on high ground near shaft No. 8. The churn drill is used by this company in all of its prospecting. Essentially the same sequence was found also one-half mile east.

	FEET.	INCHES.
17. Soil .....	4	
16. Clay .....	26	
15. Sea mud .....	13	
14. Sand .....	4	
13. Sandy shale .....	3	
12. Blue clay .....	16	
11. Soapstone .....	3	
10. Sand rock .....	4	
9. Soapstone .....	7	
8. Slate .....	10	
7. Coal blossom .....		6
6. Slate .....	11	6
5. Coal .....	1	
4. Soapstone .....	7	
3. Slate .....	58	
2. Light slate .....	3	
1. Coal .....	5	
	0	—
Total .....	176	

A mile and a half south of No. 8 is the Shorten bank (Mound Prairie Tp., Sec. 29, Sw. qr., Se. ¼), reopened during the summer after an idleness caused by the burning of the shaft. A four-foot coal bed is reached at a depth of 100 feet. Impurities, especially "sulphur," are common in the seam. This is a local mine, hoisting with a twenty-horsepower double engine. Less than one acre has been worked out.

*Metz.* Local mines have operated intermittently in the vicinity of Metz. Northwest of Metz (Mound Prairie Tp., Secs. 1 and 2) two seams, both outcropping in the vicinity, have been worked. The lower seam is eighteen inches to four feet thick and lies at about the water level in Skunk river. The upper bed lies just below the drift, thirty-nine feet above the river, and varies in thickness between fourteen inches and three feet. The lower coal is the one usually developed. It has a good roof of sandstone, beneath which "boulders" and masses of calcareous ironstone sometimes appear, replacing all or part of the coal. In the edge of the Skunk river flood plain, a twenty-two inch coal was found at a depth of twenty-five feet below water level. Some mining has also been undertaken in a small way southwest of Metz (Mound Prairie Tp., Sec. 15, Se. ¼). On the land of Dexter Fowles, coal of good quality was taken from a shaft fifty-seven feet deep. The seam is four feet six inches thick and has a roof of firm "slate."

*Newton.* For many years coal has been mined south and southwest of Newton, chiefly for local use. Four coal banks are now in operation during part of the year in the district lying about three miles southwest of Newton, in Palo Alto township. The field, which includes all or parts of sections 5, 8, 9, 10, 3, 15 and 16 and small portions of adjoining sections, bears two seams separated by a short interval. The following section may be taken as typical for the district:

	FEET.
7. Soil and drift .....	20
6. Sandstone or "slate" .....	6-20
5. Coal .....	½-4
4. Fire clay .....	0-6
3. "Slate" .....	3-20
2. Coal .....	½-5
1. Fire clay .....	

The strata exhibit even more pronounced variations in thickness than is indicated in the above section and their lithological characters are not at all constant. Where one coal is well developed the other is apt to be thin or lacking, while throughout the field there are barren areas in which neither seam is found. True faults of small throw, known locally as slips, are common, especially in the lower seam. Drillings on both sides of the railroad in the northern part of section 8, Palo Alto township, are said to have stopped in a stratum of limestone about fifty feet below the level of the track. It is possible, though by no means certain that this is the St. Louis limestone at the base of the Coal Measures.

Mr. Lister, who has operated several mines in this field, is now working a small slope on section 10 (Nw. qr., Ne.  $\frac{1}{4}$ ). The opening penetrates the hill for about seventy yards through coal that is from eighteen inches to two feet thick. Old workings not far distant show four feet of coal in the same seam and the present slope is being excavated in the hope of finding a similar thickness at this point. In ascending order, the strata above the coal are: "slate," 3 feet; fire clay, 4 feet; coal, 8 inches; soft sandstone, 8 feet.

The McAllaster bank is a new mine (Sec. 9, Ne. qr., Sw.  $\frac{1}{4}$ ) with a shaft thirty-four feet in depth. The "upper seam" is the one worked; the "lower" has been found also. On the west side of this forty-acre tract, drillings are said to reveal a thickness of four feet or more for the "upper" bed. Entries have been driven a short distance. A twenty-horsepower engine is used for hoisting.

Carson Brothers Coal Company have a forty-foot gin shaft not far from the McAllaster (Sec. 9, Sw. qr.). The seam is four and one-half to five feet thick with a slight general dip to the west. Over the coal is a fairly firm roof made by thirteen to eighteen feet of fissile shale or "slate." The bottom is a fire clay, occasionally replaced by white argillaceous shale.

French Brothers sank seventy feet to a five-foot coal southeast of the Carson (Sec. 16, Se. qr., Nw.  $\frac{1}{4}$ ). Hoisting is done with a twenty-two horsepower engine. As the "slate" and soapstone roof proved dangerous, six inches of coal is now left up and gives

ample warning before a fall occurs. Under the three feet of fire clay that underlies the bed worked another coal, which, however, is only three inches thick, occurs. Fifteen feet and less above the principal seam is a nine-inch coal.

Some of the earliest mining in the state was inaugurated on Cherry creek (Newton Tp., Sec. 32, W.  $\frac{1}{2}$ ), where there are two seams bearing a close relationship to the field just described. The lower coal is about at the creek level and is one foot in thickness. The upper lies close to the drift, twenty feet higher and is eighteen inches to two feet thick. The interval between the two is bridged by shale. Deeper drilling revealed no other seams. Four miles southeast of Newton, near the Iowa Central tracks (Buena Vista Tp., Sec. 7), several drifts have been operated on the land of A. C. Davis. The seam is eighteen inches to two feet in thickness. Water caused considerable trouble.

*Vandalia.* At the village of Vandalia, two seams have been utilized. The Cavitt shaft, sixty-five feet deep, reached the lower bed, which is four feet in thickness. The Pulver slope mined from a three-foot coal twenty-five feet higher. A drilling in the town brought to light a third horizon, thirty feet below the second and bearing coal eighteen inches thick. In the northeast corner of section 30, a seam twenty-two inches thick has been drifted into to some extent. Wells near Vandalia seldom fail to penetrate coal beds at moderate depths. On Walnut creek (Des Moines Tp., Sec. 34, Ne.  $\frac{1}{4}$ ) coal was taken from a thirty-inch seam until trouble with water and a poor roof caused it to be abandoned. Two miles to the north, coal is still taken out by two local mines during the fall and winter months. The White mine is west of Walnut creek (Sec. 22, Nw. qr.) and drifts into a seam four feet thick, twenty-eight feet above the creek level. Two feet of "slate" above the coal is overlain by an eighteen-inch limestone "caprock." There is a gradual dip to the southeast. The Norris drift (Sec. 22, Ne. qr., Se.  $\frac{1}{4}$ ) has been in operation on the opposite side of the creek for more than twenty-five years, and about thirty-three acres have been mined out. It is now worked by Charles Calvert. A "sulphur band" of black jack and iron pyrites, two inches in thickness,

occurs persistently in this coal. The bed is very similar to that mined on the west side of the creek.

*Prairie City.* Coal northeast of Prairie City has already been described in connection with the Colfax district. One-half mile east of Prairie City, at the north edge of section 1, a drill hole 185 feet deep penetrated three and one-half feet of coal at the bottom. Mining was not undertaken on account of water.

*Monroe.* On Calhoun creek, four miles west of Monroe, drifts were at one time run into a four-foot coal which outcrops in the hillsides (Des Moines Tp., Sec. 32). Water and a poor roof have prevented mining here during the last twenty-three years.

Four miles east of Monroe are a group of local mines working in a district which was once one of the most active in the county. An important mining camp named Draper was established and operations were undertaken on a large scale by the Jasper County Coal and Mining Company and others. At present only a few small mines are in existence. There are two coals in this district, a lower four feet thick and an upper sometimes slightly thinner. The two beds are separated by from ten to forty feet of shale and sandstone. The larger mines worked both beds; but at present only the upper is being developed. Considerable coal is still to be won from the area, but many of the property owners are reserving their coal rights for future sale.

Wm. Marshall is hoisting coal from a shaft fifty-six feet deep by means of horse and gin (Fairview Tp., Sec. 33, Ne. qr.). The upper seam is from three to four feet in thickness. The second seam, about twenty feet below, is a "shooting" coal and is not worked. Long wall mining in the upper bed is rendered peculiarly easy by the presence of a clay band, from eight inches to one foot in thickness, separating the coal into two benches. Upon the removal of the clay band, the top coal wedges down by its own weight, while the bottom coal may be pried up with bars. This mine is quite new.

A fourth mile northeast of the Marshall is the Shaw mine, entered by a slope ninety feet in length with a grade of one in twelve. The upper seam is three feet eight inches thick at this point and is split into two divisions by a clay band; fourteen inches in thickness on an average. In one part of the workings



this band is only six inches thick; while at the other end of the breast, only 300 feet distant, it has increased to three feet. The lower seam is found as at the Marshall and was formerly worked. The present slope is a new opening into old workings. The old Shaw slope, a short distance south (Sec. 33, Ne. qr., Ne.  $\frac{1}{4}$ ), had removed the upper seam from under more than eighteen acres.

The Gray slope and Sheeler Brothers shaft are adjacent mines working on the northern border of the old Gilchrist workings (Sec. 34, Sw. qr., Nw.  $\frac{1}{4}$ ). A layer of impure coal about one foot in thickness lies in the middle of the seam here. The coal is three feet six inches thick. It lies so close to the surface that water gives much trouble after heavy rains.

The McConoghey mine is situated northeast of the ones previously mentioned, near the Skunk river (Sec. 26, Ne. qr., Sw.  $\frac{1}{4}$ ). A slope enters a four-foot seam, which is capped by arenaceous limestone, a rather common occurrence in this field. The dip is to the southwest. An unusual feature for the district is a well defined fault which occurs here. A displacement of two feet has been measured; the fault plane is nearly vertical and strikes northwest-southeast. A lower bed, penetrated in a well at a depth of forty-five feet, is reported to be eight feet in thickness. Southwest of the McConoghey, in the same section, the lower seam is known to be thirteen feet below the upper. The latter shows the thin clay band characteristic of it farther west. In the southwest part of section 36, the coal occurs in the hills bordering the Skunk river flood-plain, and a small amount of mining has been done here.

*Lynnville.* Considerable coal has been found north and west of Lynnville along North Skunk river and its tributaries. In section 3 of Lynn Grove township, two seams outcrop above river level. Farther north, in sections 33 and 34 of Richland township, three seams are known. Only the upper bed, which varies between one and four feet in thickness and lies about twenty-five feet above the river flood-plain, has been mined. Under quite a large area here, at least one workable seam may commonly be found at any given point not too near the river bottoms. A general idea of the sequence of strata in the district may be gained from

the shaft record of the old Black Oak mine (Sec. 34, Se. qr., Nw. 1/4):

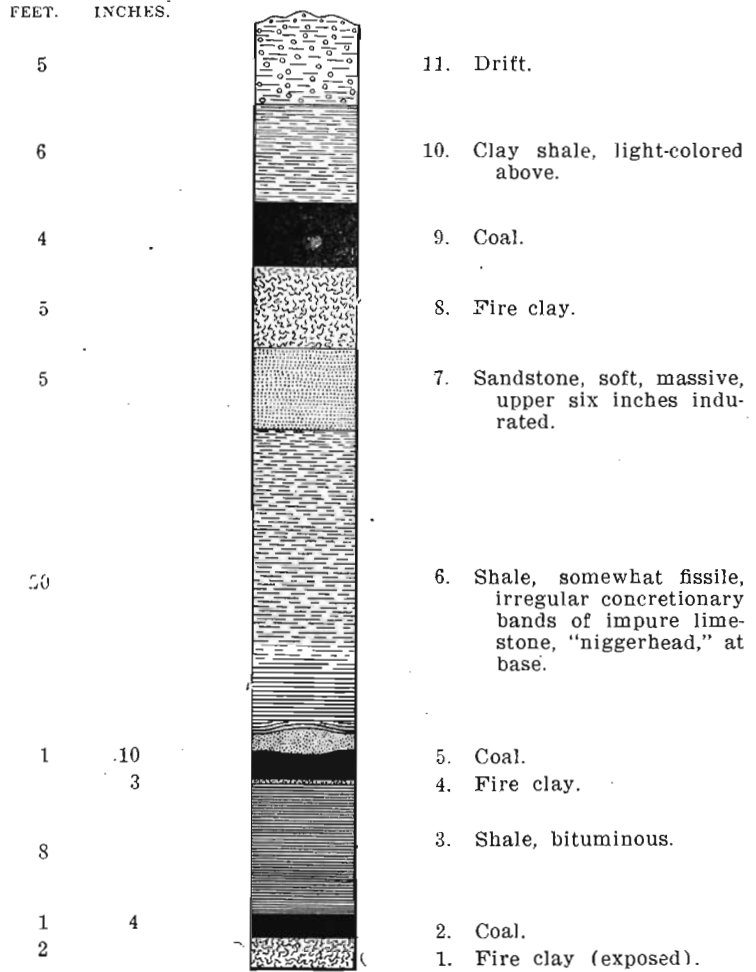


Figure 38. Shaft of old Black Oak mine, Lynnville.

## PART II

### COAL DEPOSITS OF SOUTH CENTRAL IOWA

#### MADISON COUNTY

The southwesterly dip of the Des Moines strata carries them under the Missouri in Madison county. Des Moines rocks are the highest of the indurated series in the northeastern section of the county and in long re-entrants running far up all the main valleys; but in other parts of the region the barren lower section of the Missouri stage lies over and conceals the more freely coal-bearing members of the Pennsylvanian. Outcrops of the Des Moines are of that upper portion which preserves its characteristics more persistently than do the more heterogeneous strata below it, as has been more fully described in the section on Guthrie county. It is probable that the three coal horizons found along the Raccoon river in Guthrie are represented also in Madison. For example, what is probably the Panora coal appears on Bulger creek in Jefferson township and the Lonsdale and Marshall in Madison township (section 25). Coal is also found on Cedar creek (Crawford Tp., Secs. 17 and 18), southwest of Bevington (Sec. 36), near St. Charles, and along Clanton creek and Middle river. All these seams are, however, quite feebly developed and hardly of even local importance.\*

The heaviest of these coals, where they approximate a thickness of two feet, have been mined for local consumption during the fall and winter months. Less of this is done now than a decade or more back. A two-foot bed has been drifted along Middle river near Patterson and near North river in Madison township (Sec. 25, Nw. qr.). There are probably basins of good coal underlying Madison county; but it will be necessary to drill

\*This. *et seq.*, is taken largely from Tilton and Bain: *Geology of Madison County*, Iowa Geol. Surv., Vol. VII, pp. 537-539; Des Moines, 1897. Recent developments are practically negligible.

200 or 300 feet in order to reach the horizons which have yielded the best coal in other parts of the state. Thick coal was found at Van Meter in Dallas county at a depth of 285 feet in a shaft the mouth of which had an elevation above sea level of 878 feet.

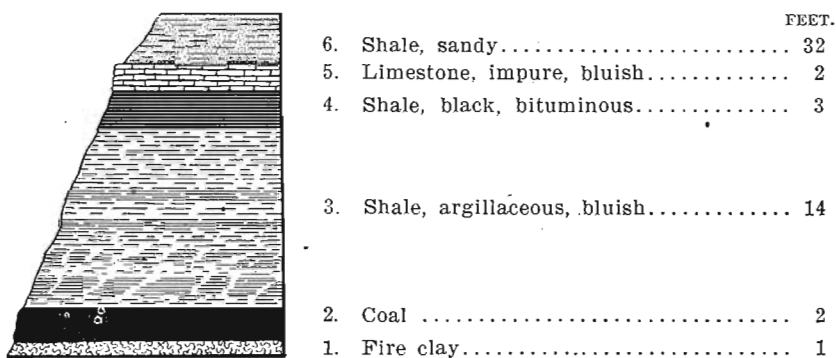


Figure 39. Coal on North river (Madison Tp., Sec. 25).

At Lucas, in Lucas county, four to five feet of coal is found at a depth of about 290 feet, with another thick seam slightly lower. Conditions at Lucas should be very similar to those in the lowlands of northeastern Madison county. Rumors have been circulated of discoveries made in deep drillings near Peru, but nothing at all definite could be learned. Thinner, but still profitable, seams may be expected nearer the surface. Such beds are found in Dallas, Warren, and Lucas counties. Southwest of Norwalk, about four miles east of the Madison county line, a thirty-two inch seam lies at an altitude of about 890 feet A. T., and is reached by a shaft sixty-five feet deep.

#### WARREN COUNTY

In no other county in the state, apparently, are the possibilities of finding hitherto undiscovered coal so bright as in Warren. In Polk on the north, Marion on the east, and Lucas on the southeast, strata corresponding stratigraphically with those underlying Warren are known to include coals in abundance. Owing to the fact that numerous thin coals outcrop in the many deep valleys into which the surface of the county is carved, the temptation has always been to neglect search for deeper seams and to confine attention to those already in sight. Even the lat-

ter, however, are worthy of development on a much larger scale than they have received. A serious check on attempts to establish shipping mines within the confines of the county has been the poor transportation facilities at hand and the difficulty of constructing new lines in so rough a country. This is a drawback which will be obviated in the course of time.

As in other sections of the Iowa field, the coals of Warren lie in more or less isolated basins that are surrounded by areas in which the seams are either attenuated or absent. These basins exhibit a certain amount of regularity in their arrangement along stratigraphic horizons or groups of horizons, as has been carefully worked out by Tilton and described by him several years ago in the following paragraphs:\*

*Coal Seams of the Lower Group.* In this line of strike the borings at Milo and southeast of Palmyra are the only ones, having accessible records, that have pierced the Saint Louis formation below the Coal Measures. The "Carbonaceous shale" at Milo, at a depth of about 328 feet from the surface or 609 feet above sea level, marks the lowest horizon at which there is now any evidence of coal in the county. It might be regarded as the lowest possible horizon were it not that the floor on which the Coal Measures rest is so irregular. Southeast of Palmyra (Tp. 76 N., R. 22 W., Sec. 5) the Saint Louis is 329 feet below the uplands or 546 feet above sea level.

The strata are nearly horizontal, the dip rarely reaching as much as two degrees southwest, but because of the slight dip to the southwest and the slope of the surface to the northeast, the several strata gradually approach the surface toward the northeast and recede farther and farther from it toward the southwest. Southeast and northwest the old Saint Louis surface lies as nearly horizontal as any surface carved into ridges and valleys by erosion may be expected to lie.

About sixty-eight feet above the lowest horizon are unsatisfactory indications of a second horizon; while a marked third horizon lies 712 feet above sea level, or 225 feet below the upland surface at Milo. This latter horizon is the upper one in the two groups found at and below the altitude of 725 feet above sea level, and marks the upper part of the group of strata in

\**Geology of Warren County, Iowa Geol. Surv., Vol. V, pp. 344-347; Des Moines, 1896.* Immediately after the panic of 1893, there were a large number of farmers' mines taking coal from thin seams. The number of these has steadily decreased; while all of the mines now in operation, with one unimportant exception are working coals known for many years. Professor Tilton's account takes cognizance, therefore, of all information obtainable at the present time.

which coal has been formed of greatest thickness near Des Moines on the north and Lucas on the south. At this same level lies the lowest coal penetrated by Earle Brothers, in section 9, southeast of Spring Hill. At this same level also lies Caldwell and Cassidy's mine in section 31, just west of Summerset; and in section 28, east of Summerset, Jones and Benham have mines where there is a local thickening of the coal, if not an independent basin. To a continuance of this same horizon belongs the seam of coal in the bluff at Ford. This particular horizon, then, is marked by evidence of coal so widespread and of such thickness (two and a half to three feet) that the horizon may be considered as one especially rich in coal.

*Coal Seams of the Upper Group.* All seams, evidences of which have been found above the horizon last described, outcrop along ravines at different points in the county. The first of these, the lowest of the group, is to be found in the central part of the county, at and above a level of 800 feet. It lies at the level of Middle river east of Spring Hill, in section 2, and at the level of North river in sections 19 and 20, Greenfield township. On South river it is about on a level with the river bed south of Indianola, but it dies out before reaching Milo. Another seam, a few feet below the position of the one last mentioned, is at Summerset, about the level of the railway tracks. East of Summerset it is frequently drifted as a surface seam. Another seam on this same horizon appears at the level of Whitebreast creek, in section 35 of Whitebreast township.

These upper seams mark quite an important coal horizon. The coal, under favorable conditions, is quite uniformly eighteen to thirty inches thick.

Above this horizon, in the west-central part of the county, two others exist over quite an area, the first about thirty-five feet above it, the second forty-five still higher up. The lower of these two seams furnishes an easily accessible supply of coal in Jefferson township, the upper seam appearing only at the higher points along the divides. The horizons of these two seams are also marked in White Oak, Otter and Liberty townships by indications of coal. The upper seam is drifted in a few places while the lower of the two horizons is drifted in the vicinity of Milo and in the south-central part of Belmont township. Both horizons appear in the ravine of section 26, southeast of Lacona, and the lower of the two is mined a mile north of Lacona.

*Intermediate Coal Seams.* Between these two groups of seams, one at and below a level of 725 feet in the central part of the county, and the other at and above 800 feet—belong the

seams outcropping along the ravines in southern Richland, Palmyra and Union townships, where they are often drifted for local use. These latter seams frequently present a thickness of eighteen inches of good coal, and are more nearly related to the upper of the two groups of seams in the central part of the county than to the lower group.

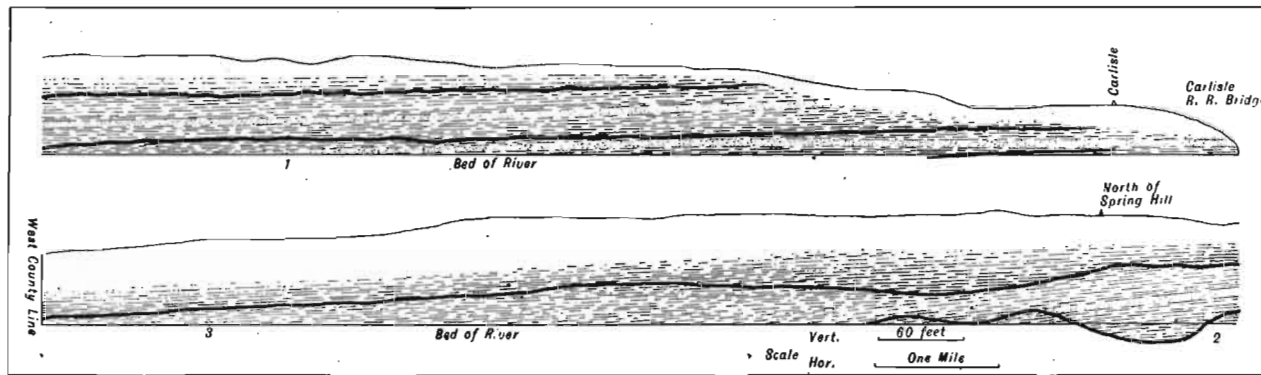
The carbonaceous material found in the well at Milo at a depth of 150 feet from the surface, or at an elevation of 775 feet, suggests, together with the position of coal in Palmyra and Union townships, a coal horizon that may be looked for at a corresponding level in the southern part of the county.

In the southwestern part of the county the single coal seam that exists will not afford very profitable mining, nor are there local indications that there are seams to be reached by shafts of moderate depths. The nearest coal seam to the northeast would, if extended beneath Virginia township, lie about thirty feet beneath the river bed at the mouth of Limestone creek. To the east of Limestone creek, nothing but sandstone appears till the vicinity of Squaw creek is reached.

All of the mines in operation in this county are small local affairs, using man and car haulage, and if shafts, primitive methods of hoisting. The more important banks are near Lacona, Milo, Summerset, Carlyle and Norwalk. They will be mentioned more minutely below. Practically all of the county's production has been consumed within its own borders. The annual output has never been considerable; but, on the other hand, it has seldom dropped as low as 1,000 tons. Commonly, Warren has mined between 5,000 and 25,000 tons per year. In 1900, one of the banner years, the tonnage published by the Iowa Geological Survey was 27,824. Since that year the output has gradually declined; for the year ending June 30, 1908, the State Mine Inspectors report a production of 5,950 tons. These figures do not, however, include coal taken out by small country banks, working only two or three men for part of the year. The six principal mines of the county employ only thirty-seven men.

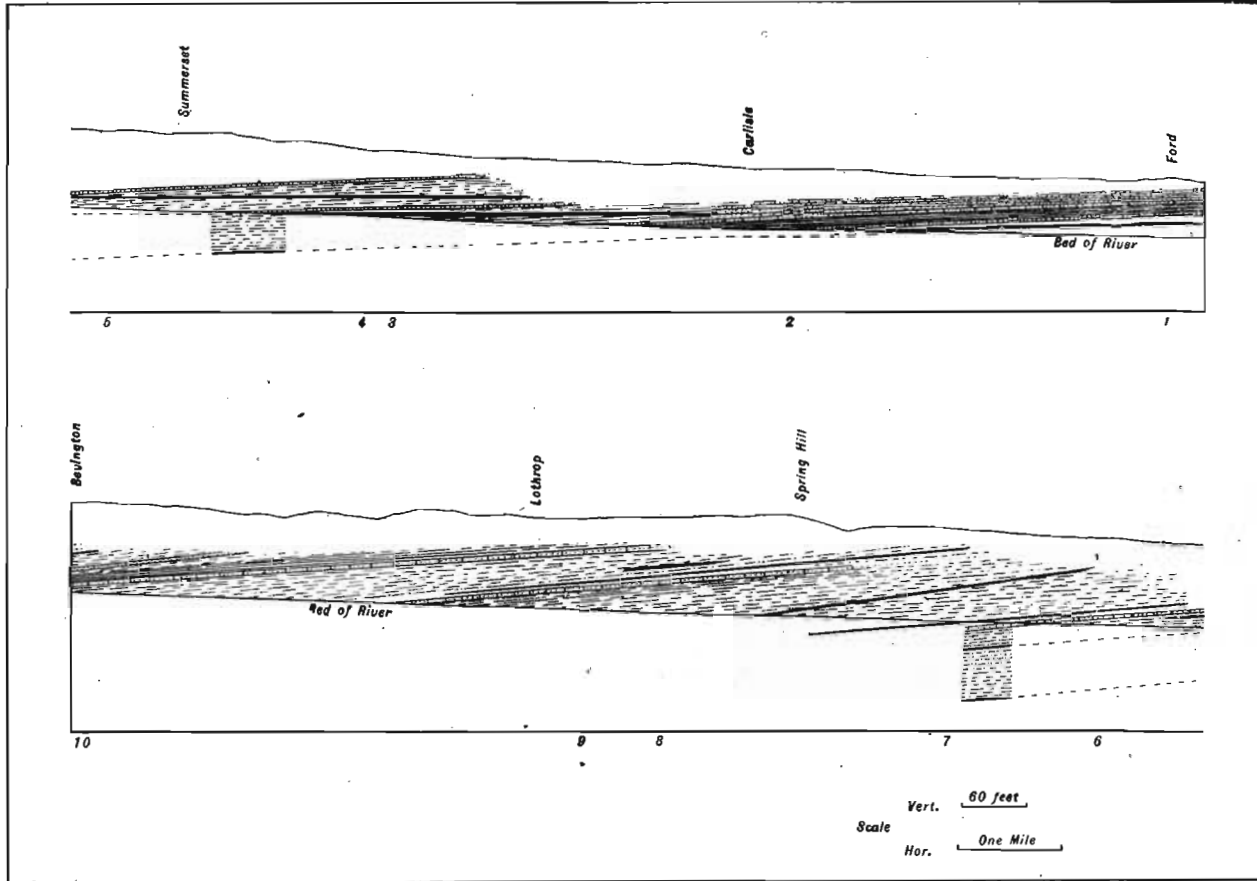
IOWA GEOLOGICAL SURVEY.

PLATE IV.



Geological Section along North river in Warren county.





Geological cross-section along Middle river in Warren county.

## NORTH RIVER VALLEY.

Descending North river from the west county line, an exposure of good coal is met with a little over a mile down stream (Linn Tp., Sec. 32, Sw. qr., Se.  $\frac{1}{4}$ ). As measured by Tilton, the section is:

	FEET.	INCHES.
8. Sandstone, gray, easily decomposed.....	1	6
7. Shale, clayey, blue, jointed.....	5	
6. Sandstone, very fossiliferous.....		7
5. Shale, clayey, blue, jointed; sandy above.....		6
4. Shale, clayey, black.....		4
3. Sandstone, nodular, reddish.....		3
2. Coal, very good .....	3	6
1. Fire clay, exposed.....		4

Two miles northeast of this exposure (Sec. 34, Ne. qr.), a forty-foot shaft was sunk to what is probably the same seam. At this point the bed is three feet in thickness.

Two miles southwest of Norwalk and a half mile north of the river (Sec. 23, Nw. qr., Se.  $\frac{1}{4}$ ) is the local mine of the Hartshorn and Son Coal Company. The shaft is sixty-five feet deep to a seam thirty-two inches thick. Hoisting is effected by a traction engine attached to a drum. The seam exhibits a dip of one foot in sixty to the north. The roof is an argillaceous shale which requires considerable timbering; the floor is a fire clay that shows some tendency to heave. Two miles southeast of Norwalk, a coal lying a few feet above water level has been reached by shafts and slopes at various points along North river (Secs. 19, 20, 21 and 29, Greenfield Tp.). The seam varies from two to three feet in thickness. The Hawkeye mine now supplies a good grade of coal to the surrounding farmers. Down river (Sec. 22), the coal is found sufficiently far above the river to be reached by drifts.

A few miles southwest of Carlisle, drifts and shafts have reached a thirty-inch coal from the south side of North river valley (Allen Tp., Sec. 8). A bit more than half a mile south of the river three mines are now supplying a local trade. They are located in the upper portions of the valleys of small tributaries to North river, at an elevation of from forty to fifty feet above the level of the river. The seam varies in thickness from

thirty inches to three feet. A fairly constant characteristic of the bed is a "sulphur band" of black jack and iron pyrites about one inch thick, which lies near the middle of the coal. The roof is a "slate" of fair stability, although weak in places. The John Gross mine formerly worked a twenty-four foot shaft, but a slope has recently been opened (Allen Tp., Sec. 8, Sw. qr., Sw.  $\frac{1}{4}$ ). The coal may be seen outcropping here in a ditch near the slope mouth. A few hundred feet southwest is the new Peterson coal bank, a slope 180 feet in length to the coal. A half mile east is the Myers and Farrel shaft, thirty feet in depth (Sec. 8, Se. qr., Nw.  $\frac{1}{4}$ ). Hoisting is done with horse and gin. Work has been chiefly south and west of the shaft. For 300 feet from the shaft the dip is southwest, then ceases, and finally becomes slightly reversed.

## MIDDLE RIVER VALLEY.

Along the upper course of Middle river, in Warren, little mining has been attempted and a large part of the coal used is taken from beds less than fifteen inches in thickness. There are, however, several places where workable seams are known. Southeast of Spring Hill, a boring made by Earle Brothers near their old shaft furnished the suggestive record given below (Tp. 76 N., R. 24 W., Sec. 9, Nw. qr., Se.  $\frac{1}{4}$ ). The top of this drilling is twenty-eight feet above the river bed, so that the first seam mentioned in this record is that which is found to pass beneath the river bed close by.

	FEET.
17. Soil and clay .....	8
16. Shale, clayey, blue .....	6
15. Sandstone .....	1
14. Shale, clayey, dark .....	1
13. Coal .....	1
12. Fire clay .....	2
11. Shale, sandy, hard .....	13
10. Shale, clayey .....	4
9. Sandstone .....	1 $\frac{1}{4}$
8. Shale, clayey .....	12
7. Shale, clayey, black .....	5
6. Coal .....	2 $\frac{1}{2}$
5. Shale, sandy, hard .....	21
4. Shale, clayey, red and blue.....	34
3. Sandstone, dense .....	1 $\frac{1}{2}$
2. Shale, clayey, black .....	5
1. Coal .....	4

According to Professor Tilton's geological cross-section along Middle river, number 1 of the above record occupies the same horizon as the coal mined at Ford, on the Des Moines river.

Between Earle Brothers' shaft and Summerset, only thin coals have been reported. At Summerset, shafts were sunk sixty to 100 feet to the so-called "third vein," which was four feet in thickness. Nothing has been done at this point for some years, but two miles northeast is a group of local mines working in a seam which lies from fifteen to thirty feet above the low water level of North river. This bed varies in thickness from thirty inches to three feet where worked, and shows persistently, about one foot above its base, an inch or less of iron pyrites. In this, as in its altitude, the seam corresponds closely with the coal worked near Carlisle. It has a slight dip to the south. The roof is a thin layer of black "slate" overlain by a thin arenaceous limestone which renders the whole secure, except where the base of the drift approaches perilously near the coal. Sixty feet above the seam now worked is a fifteen-inch bed which has been mined a little. From sixty to forty feet below the seam now worked is a heavier bed, said to be as much as four feet thick in places. Between the two lower seams a thin bed, known locally as the "lost vein," is sometimes present and sometimes absent. Two mines are now supplying a local trade from the seam first described. The Overton mine (Tp. 77 N., R. 23 W., Sec. 33, Nw. qr., Ne.  $\frac{1}{4}$ ) is taking coal from a shaft recently sunk 125 feet. The Buchanan mine operates a shaft thirty feet deep on lower ground, one mile north (Sec. 28, Nw. qr., Se.  $\frac{1}{4}$ ). The lower seam was also worked in this vicinity formerly. The accompanying figure illustrates the sequence of strata above the lower coal, which probably lies in the Ford horizon.

Three small mines are now working at and near Ford. Considerable coal has been taken out in the past from a seam which outcrops along the base of the bluff until it comes to an end as it reaches the water level of Middle river, one-fourth mile east of the Clarkson bridge. The stratigraphic relationships of the Ford coal with other seams along the Des Moines river have already been discussed in the chapter on Polk county.

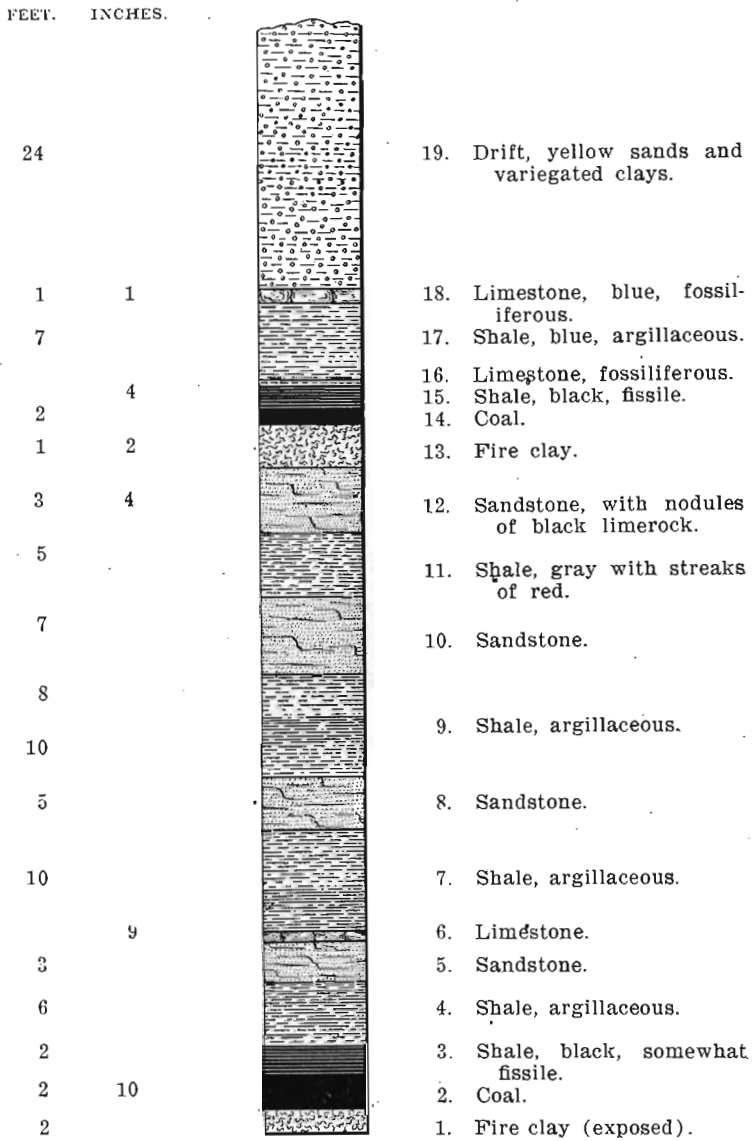


Figure 40. Section of shaft at Bennum mine. Summerset.

The Locust Grove Coal Company have a thirty-foot shaft a little less than a mile southwest of Ford (Richland Tp., Sec. 9, Sw. qr., Sw. 1/4). Hoisting is by horse-gin; pumping by traction engine. The seam is level and shows a thickness of four feet

four inches. A constant feature in it here is the inclusion of a band of black jack about eighteen inches above the base of the coal. The thickness of the band, from eight to eighteen inches, is included in that of the seam as given above. Above the coal is fourteen feet of slate; next higher, six feet of the massive Ford sandstone.

A slope, sometimes called the Red Diamond, is taking out a large pillar left by the old Fordville company in their workings opposite the store at Ford. The roof over this particular piece of coal is not good. The "dirt band" found at the Locust Grove is practically lacking at this point; but more sulphur is present. The old workings are said to extend back nearly a mile from the face of the bluff.

Another slope is being operated opposite the Ford station, where the seam is from three feet to fifty inches in thickness, and shows only a one-inch "dirt band," near the base of the coal. There are no "slips." Rolls in the roof occasionally cut out all or part of the coal. The roof is an infirm black "slate," which may be as much as twelve feet or as little as six inches in thickness, and is capped by the heavy Ford sandstone. The present company, having run 350 feet into the bluff, is heading off part of the old Fordville workings.

#### SANDYVILLE DISTRICT.

In the southwestern quarter of the county, very little coal has been found and only thin coals have been worked along South river above Ackworth. In the vicinity of Sandyville, east of Ackworth, some two and three-foot coal is known. One mile west of the village, two feet of good coal has been reached by drifts (Union Tp., Sec. 20, Ne. qr., Ne.  $\frac{1}{4}$ ). Three miles north of the town three coals are shown in the following exposure (Union Tp., Sec. 3, Se. qr., Nw.  $\frac{1}{4}$ ):

	FEET.	INCHES.
10. Drift .....	15	
9. Shale, clayey, black .....	2	
8. Coal .....	1	
7. Shale, clayey, gray .....	4	
6. Limestone, gray, arenaceous, fossiliferous.....	2	
5. Shale, clayey, gray .....	8	
4. Coal .....	3	7

3. Shale, gray .....	34	
2. Coal .....	1	1
1. Shale, clayey (exposed to South river).....	2	6

A mile south of this exposure, in the valley of a small creek, a three-foot seam was reached by a shaft twenty-four feet deep (Sec. 10, Se. qr., Nw. ¼). A mile northeast of the exposure, a coal from three to three and a half feet in thickness was entered by drifts (Richland Tp., Sec. 35, Nw. qr., Se. ¼). It will be seen that there is considerable workable coal near South river in this region, and it has been left practically untouched. On the north side of South river valley, in Palmyra township (Sec. 5, Sw. qr.), two drillings were carried to the base of the Coal Measures. Only one of these, begun on higher ground than the other, showed coal. The drill record of the latter test is given in full below:

	FEET.	INCHES.
35. Soil .....	4	
34. Clay, yellow, with gravel below.....	20	
33. Sandstone, yellowish .....	11	
32. Shale, blue .....	3	
31. Limestone, fossiliferous .....	4	
30. Shale, black .....	4	
29. Coal .....	1	8
28. Fire clay .....	8	
27. Sandstone .....	4	
26. Shale, gray .....	12	
25. Shale, clayey, black .....	2	
24. Coal .....	1	
23. Fire clay .....	3	
22. Shale, clayey .....	16	
21. Shale, clayey, red running to brown, bed of South river .....	26	
20. Shale, brown, sandy below.....	19	
19. Shale, bituminous .....	2	
18. Shale, clayey .....	14	
17. Shale, clayey, black .....	6	
16. Coal .....	3	8
15. Fire clay .....	4	
14. Shale, gray with hard bands.....	10	
13. Shale, soft, blue, with bands of gravel.....	27	
12. Shale, sandy .....	11	
11. Sandstone, compact .....	6	
10. Shale, bright, with ironstone bands.....	17	
9. Shale, clayey, red, blue, and brown.....	26	
8. Sandstone, fine-grained .....	4	

7. Shale, light above, dark below, hard.....	23	
6. Coal .....	1	10
5. Fire clay .....	2	
4. Shale, clayey, black .....	16	
3. Shale, light, with hard bands.....	7	
2. Shale, gray, very hard and sandy.....	12	
1. Saint Louis limestone .....	38	
Total .....	367	2

South and southeast of Sandyville, along Coal and Fly creeks and their tributary branches, numerous drifts and slopes have taken coal from thin beds. In almost all cases these seams show thicknesses of less than two feet. Heavier coal could probably be found by drilling.

#### MILO DISTRICT.

Three miles southeast of Milo, on Flank creek, is a field showing a basin of coal from thirty to forty inches in thickness. The coal is of medium grade, thin bands of pyrite being interspersed through its substance. Two other seams are found at slightly higher levels; they are commonly thin, yet occasionally show as much as two feet of coal. The lower bed is tapped during the colder months by shafts, slopes, and drifts at several points in sections 28, 29, 32 and 33 of Belmont township and in the northern portions of sections 3 and 4, Whitebreast township. The most important of these small mines at the present time is, perhaps, the Heinen drift (Belmont Tp., Sec. 33, Ne. qr., Ne.  $\frac{1}{4}$ ), where the bed lies at an altitude of 835 feet above sea level. Mr. Heinen is now pulling pillars and preparing to move to a new location not far up Flank creek, where three feet of coal has been found in a well.

On Otter creek and its tributaries west and southwest of Milo, is a group of small local mines. One mile west of Milo (Otter Tp., Sec. 13, Sw. qr., Sw.  $\frac{1}{4}$ ), is the Hollingsworth bank, reached by a shallow shaft. The seam is eighteen inches thick. This mine has been idle for two years, but may be reopened. One mile southwest (Sec. 23, Nw. qr.), Joe Mitchell works intermittently a slope for the local trade. This coal is also thin. The principal mine of the district is the Bayles bank, one mile and a



half southwest of Milo. A slope is now being driven in from the valley of a small "ditch" (Sec. 26, Ne. qr., Ne.  $\frac{1}{4}$ ), it being planned to use the old shaft as an air course. A seam has been worked by numerous openings in this neighborhood since 1870. It is a fairly clean coal, showing a thickness of from twenty-one to twenty-seven inches. It grows thinner to the west and extends but a short distance east into section 25. In sections 32, 33, and 34 of Otter township and in 5 and 8 of Liberty township thin coals have been feebly exploited at numerous points along the streams.

The coal beds of the Bayles area appear to lie in fairly definite horizons and have, accordingly, been termed by the miners the "first," "second" and "third" veins. The coals, however, are not continuous, but lie in basins of limited extent at levels which approximately correspond. The altitude of the bed chiefly worked at present is about 870 above tide. About thirty feet below and fifteen feet above are other horizons which have yielded only thin coals.

#### LACONA DISTRICT.

One mile north of Lacona, the Jones mine is operated during a portion of the year. A bed two and a half feet in thickness is reached by a shallow shaft. Farther north, on Wolf creek, and southeast near Whitebreast creek thin beds have been reached at one or two points. Southwest of Liberty Center (Liberty Tp., Sec. 29) a little coal is still taken from a sixteen inch bed during the winter months.

#### MARION COUNTY

Marion county embraces the northwestern portion of what has proved the most prolific section of the Iowa coal field, and includes some of the best coal basins in the state. Topographically, the greater part of the county is rough, as the result of the excavation of valleys by several important streams, chief among which is the Des Moines river. The topography has affected the coal industry in two ways: it has favored it by affording an easy means of locating and reaching coal beds exposed in the valleys beneath the drift, while it has hindered it by check-

ing the building of railroads excepting along a few rather circumscribed lines of travel. A number of railroads do traverse the county; yet their courses are such that they can carry Marion coal only into territory already supplied by fields enjoying the advantage of a shorter haul to the centers of consumption. This is a defect that will be remedied in the course of time.

In the eastern half of the county the base of the Coal Measures lies at no great depth beneath the surface of the county. In fact, the larger streams have cut completely through the Des Moines beds in the lower portions of their courses so as to expose the Saint Louis limestone in the lowlands. Thus, the Des Moines river flows over the limestone as far up the valley as Howell and over an isolated exposure of it just below Rousseau; English creek leaves the Coal Measures just below Flagler; South Skunk river and Thunder, Walnut, and Cedar creeks also uncover the Saint Louis for several miles above the points at which their waters enter Mahaska county on the east. The Coal Measures, therefore, are not very thick in the eastern half of the county, although above depressions in the very uneven surface of the Saint Louis limestone, coal may be found below the level of the basement formation at the outcrops mentioned. Owing to the general dip of the strata to the southwest, the Coal Measures of the southwestern part of the county attain greater depth than do those in the eastern. Few deep drillings have been made in this area, so that only a general idea of the average depth of the surface of the Saint Louis may be offered. At Milo, a few miles from Marion county in Warren, the base of the Coal Measures was reached at a depth of 328 feet, making its elevation above sea level about 609 feet. Borings in Lucas county, on the south, place the Saint Louis at about the same average level in that quarter. Results obtained by borings farther north in Warren county and in Polk do not deviate materially from the figures already given. It is probable, then, that the thickness of the Coal Measures in southwestern Marion seldom exceeds 400 feet and more often approximates 300 feet or less.

Marion county contains in local "swamps" some of the thickest coal in the state. Vertical heights of as much as sixteen feet have been reported from more than one mine, but in such cases

the value of the coal is often decreased by the presence of considerable foreign substance or by weakness in the overlying stratum forming the roof. Coal appears to be abundant in all parts of the county; very rarely is a test hole sunk without encountering at least one seam. Nevertheless, the discovery of thick coal in one pocket by no means indicates the presence of a workable field in the neighborhood. The coal lies in isolated basins of lenticular shape, many of them small, and it has been known to thicken and thin with startling rapidity when followed short distances laterally. It is not safe to sink a shaft to any seam until its extent has been accurately determined by a free use of the drill. Such prospecting operations have been actively carried on within the limits of the county and coal rights covering large tracts of land have been reserved by companies now operating in neighboring counties on the east and south-east. When the fields in which these companies are now working approach exhaustion, it is reasonable to suppose that they will turn their attention to Marion. Large sections in the southwestern corner of the county have been neglected, and yet this is the most promising territory of all, since under it the Coal Measures are presumably thickest. The building of a railroad through this area would be followed by rapid coal development.

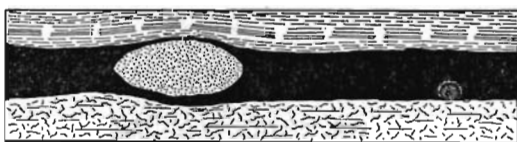


Figure 41. Ironstone mass in coal bed.

Difficulties attendant on mining in Marion are little, if any, greater than in other sections, yet some trouble is experienced from the more than usually large number of "bowlders" often encountered. These "bowlders" are sometimes sandstone concretions, yet much more frequently they are of impure carbonaceous limestone, black on freshly broken surfaces, but whitening after exposure to the atmosphere. "Bowlders" are commonly oval or lenticular in shape and lie with their long axes parallel to the bedding planes of the strata. They often occur

in aggregations, leaving large areas perfectly clear. Their favorite position is in the top of the coal, next the roof, and they are apt to be most numerous where the coal is abnormally thick.

Marion has always been an important producer and has shown a steady and consistent gain in output, aside from temporary setbacks. The annual production for 1860 is given in the federal census reports as 1,548 tons; for 1870 as 4,313; for 1880 as 72,550; and for 1890 as 145,180. The output of the last ten years as given in reports of the Iowa and United States Geological Surveys is as follows:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	127,293	1903.....	324,859
1899.....	232,351	1904.....	314,908
1900.....	209,223	1905.....	338,812
1901.....	149,917	1906.....	372,750
1902.....	269,724	1907.....	346,999

The report of the State Mine Inspectors for the year ending June 30, 1908, shows a slight falling off.

Number of mines .....	20
Number of tons of all grades produced.....	327,745
Number of men employed .....	693

Marion now holds sixth place among the coal counties of the state, having recently yielded fifth place to Jasper. The price per ton at the mines is lower here than in other parts of the state, being only about \$1.40.

Mining is now most actively carried on in Liberty township. Flagler still ships considerable coal; while smaller mines may be found near Pella, Harvey, Dunreath, Knoxville, and Coalport, and on Whitebreast creek. In the following account brief mention is made of the mines found in operation in September, 1907. Material has been freely taken from earlier reports of this Survey.\*

No attempt has been made to correlate the various coal basins, for no regularity in their stratigraphic position has as yet been deciphered. The roughness of the county renders extremely uncertain attempts to assign any particular relationship to coals geographically separated; while the inconsistency in character

\*Keyes, Iowa Geol. Surv., Vol. II, pp. 317-340; Des Moines, 1894. Miller, Vol. XI, pp. 169-182; Des Moines, 1901.

of the lower Des Moines strata makes the advisability of such attempts doubtful. The forthcoming publication of detailed topographic maps of the Knoxville and Pella quadrangles by the United States Geological Survey may, perhaps, aid in determining the possible value of future correlation work on a large scale.

#### DISTRICT NORTH OF THE DES MOINES RIVER.

*Morgan Valley.* In the northwestern corner of the county two seams, separated by a vertical distance of ten feet, outcrop just above the level of the Wabash tracks. The upper seam, four feet or less in thickness, is capped by a massive sandstone that reveals its close relationship with the Ford horizon. The lower is one foot or less in thickness. Up a ravine near Morgan Valley, a switch track was laid for a distance of three-fourths of a mile from the main line and coal was shipped over it from a mine situated at its extremity. The shaft was forty-five feet deep to a four-foot coal which possesses also the heavy sandstone roof. This mine has been idle for several years. One-fourth mile south (Perry Tp., Sec. 4, Sw. qr., Sw.  $\frac{1}{4}$ ), beside the tracks of the same switch, brick and tile is being made from Carboniferous clay underlying a twenty-inch seam of coal. The seam outcrops near the bottom of the valley. A compact sandstone roof makes it possible to excavate the clay in broad rooms, with an entry fifteen feet wide at the foot of the short slope. Only the upper ten or twelve feet of clay is utilized, the coal being at first left up for a roof. As the working face advances, the coal is removed and used at the plant.

Along the river, below Morgan Valley, several outcropping seams have been drifted from the sides of the bluffs. These coals are either thin or of limited lateral extent. At Dunreath, however, extensive mining was carried on many years ago. Miller\* recognizes the existence of four horizons near this village: the first forty-five feet above river level, the second fifteen feet lower; the third twenty feet beneath the second, and the fourth at low-water level in the bed of the river. All four horizons do not bear coal at any one point. The coal in the lower

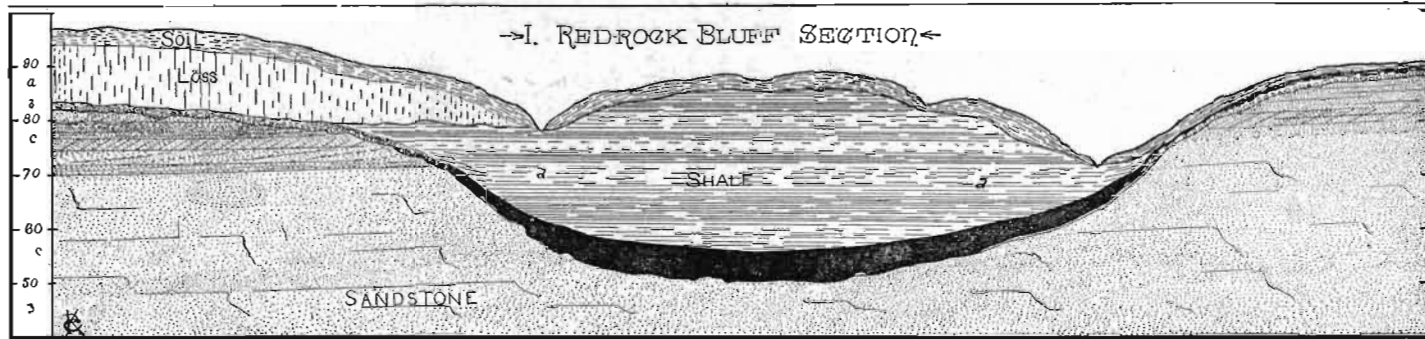
\*Iowa Geol. Surv., Vol. XI, p. 176; Des Moines, 1901.

two horizons is thin in most cases. The second seam is the one from which the larger mines of the district obtained their supply, and may be correlated with the coal found occupying a depression in the Red Rock sandstone in the quarry near Red Rock. At Dunreath, the seam is from four to seven feet in thickness. The Black Diamond mine (Red Oak Tp., Sec. 26, Sw. qr., Nw.  $\frac{1}{4}$ ) removed the coal from about seventy acres; the Success (Sec. 27, Nw. qr., Sw.  $\frac{1}{4}$ ), from approximately forty acres. The upper horizon shows a thickness of two and a half feet where it has been drifted to some extent at its outcrop in the hill south of Dunreath.

The New Dunreath Coal Co., northeast of the village, plans to reopen its shipping mine during the coming winter (Sec. 22, Ne. qr.). With the exception of a few months, this shaft has been idle for two years because of trouble with accumulating water. The shaft, fifty feet deep, reaches what is probably the second Dunreath horizon, in which the coal is here four and one-half feet in thickness. A short spur has been built from the main line of the Wabash railroad. Hoisting is done with a double, geared engine with cylinders 14x20 inches.

Two miles northeast of Dunreath a group of small, local mines have operated intermittently. At the present time Le Grande coal bank is the only producer (Red Rock Tp., Sec. 13, Nw. qr., Sw.  $\frac{1}{4}$ ). This is a slope 200 feet long, with a maximum grade of one in three. In excavating the air shaft, six feet of surface material, a small coal "blossom," three feet of fire clay, and forty feet of shale were successively encountered before the thick coal was reached. The seam worked is four feet in thickness and, so far as now known, dips toward the south. Ironstone "bowlders" are freely dispersed through the coal and contingent portions of the roof and underlying fire clay. A "sulphur band," two inches or less thick, occupies a central position in the coal. Whether the seam worked here and those sometimes exploited in neighboring mines are identical is difficult to determine; for a network of small streams has cut deeply into the horizon on every hand.

At the Red Rock quarry, southeast of Dunreath, is the small coal basin already mentioned, and illustrated in the accompany-



Coal bed shown in Red Rock quarry (Miller).

ing sketch. At its point of maximum thickness, this seam shows six feet of coal.

*Otley.* One mile southwest of Otley is a basin containing coal from four to seven feet in thickness, with an average of five feet. At one time the Otley Coal Company did a shipping business in this field; but now only local mines are operated. The Yukon, or Vriezelaar, mine (Summit Tp., Sec. 21, Se. qr., Se.  $\frac{1}{4}$ ) has enjoyed a long continuance. The main entry runs east and southeast for a considerable distance, showing at its extremity a slight dip to the east. The roof is a fairly firm shale, showing, as does the coal itself, occasional streaks of pyrites. The mine is entered by a gentle slope 125 feet long, over which cars are hauled by means of a pull-rope attached to a small single engine. About twelve men are employed during the winter. A short space northeast, on the same forty acres of land, is the small Hollingsworth & Rickabaugh slope to the same seam.

*Pella.* Pella itself lies on a rather level divide on which, over a limited area, the surface drainage is poor. The water sinking through the porous soil has tended to destroy the value of what coal lies immediately under the city; so that all mines now working are situated a few miles from the corporation limits. These mines do no shipping and are not large affairs; yet they do an important wagon trade. Two miles northwest of Pella (Lake Prairie Tp., Sec. 32, Ne. qr., Se.  $\frac{1}{4}$ ) is the Buwalda mine, where coal is taken from a seam which varies in thickness from three and a half to five feet. In places six feet of coal has been encountered, but in such cases the condition of the overlying "draw slate" made mining impracticable. The shaft was sunk 112 feet, chiefly through sandstone, and is most fortunately placed at the lowest point of the basin. Sandstone forms the roof, except where slate somewhat erratically intervenes between it and the coal. The same coal was mined from a shaft situated one-fourth mile east. It is estimated that this coal pocket contains about 200 acres, less than half of which has been worked out.

The Dieleman Coal Company has a shaft to a seam of similar thickness one mile south of the Buwalda (Sec. 5, Ne. qr., N.  $\frac{1}{2}$ ). In this shaft, which is 104 feet deep, less sandstone and more shale were penetrated. The main entries extend 100 yards



north and 150 feet south of the shaft. The seam is undulatory, as is usually the fact in this region.

In the rough country on the border of the Des Moines river valley, south of Pella, seams outcropping in the ravines are occasionally drifted for local use. Several basins containing coal three feet or more in thickness have been located; but very little prospecting has been done and little is known about the nature and extent of the workable coal.

#### DISTRICT SOUTH OF DES MOINES RIVER.

*Swan.* Several shipping mines have operated at Swan, in the Des Moines valley near the Marion county line. The town is situated in the midst of a considerable coal field, not yet completely mined out, but abandoned since 1898. Three seams were present, as shown in the following section (Swan Tp., Sec. 18, Sw. qr.), the upper being about twenty-five feet above the level of the railroad track.

#### SAMPLE DRILLING AT SWAN.

	FEET.	INCHES.
10. Clay .....	23	
9. Coal .....	2	10
8. Fire clay .....	4	
7. "Slate" .....	11	8
6. Coal .....	3	3
5. Fire clay .....	3	
4. Sandstone .....	1	6
3. "Slate" .....	20	6
2. Coal .....	5	6
1. Fire clay .....	2	3

*Coal Creek.* Several small country mines are occasionally worked by slopes and shallow shafts along Coal creek (Pleasant Grove Tp., Secs. 17, 20, and 21). The seam is seldom more than three feet thick. The upper part of the section given below is exposed on the west bank of the creek (Sec. 20, Ne. qr., Nw.  $\frac{1}{4}$ ).

	FEET.	INCHES.
9. Surface wash .....	5	
8. Coal .....		6
7. Fire clay .....	2	
6. Shale, light-colored, argillaceous.....	2	6
5. Shale, drab, arenaceous .....	5	6
4. Sandstone, gray, laminated or massive.....	3	
3. Shale, gray, arenaceous .....	3	
2. Shale, black, upper 13 feet exposed to water level....	30	
1. Coal .....	2	6

*Red Rock.* One mile south of Red Rock, Keyes reports a four-foot coal lying immediately underneath the Red Rock sandstone, twenty feet above river level. This seam is said to have been opened on Teter creek and to be exposed at the ferry at Rousseau.

*Whitebreast Creek.* Along the upper portion of the valley of Whitebreast creek in Marion county, there is known to be much coal. Owing to lack of transportation facilities, only country mines have been opened. These are located chiefly in sections 24, 26 and 35 of Franklin township, and 19 and 30 of southwestern Knoxville township. The following sequence (Franklin Tp., Sec. 26, Ne. qr., Se.  $\frac{1}{4}$ ) is typical.

	FEET.	INCHES.
10. Drift and loess .....	5 to 15	
9. Sandstone, very hard .....	4	
8. Slate, gray .....	8	
7. Sandstone, yellow, soft .....	11	
6. Coal .....	2	2
5. Fire clay .....	6	
4. "Slate," gray .....	10	
3. Coal, at creek level .....	3	9
2. Fire clay and black "slate".....	.60	
1. Coal .....	4 to 6	

Number 3 of the above section is the coal usually mined, although some has been taken from the outcrop of number 6. In general, the coal is quite soft.

*Gosport.* Coal outcrops at several points along English creek in the vicinity of Gosport and has been drifted for local consumption. Where worked, the coal shows thicknesses of three feet and less, and near the outcrop naturally possesses a roof of poor stability. The coal seen along this creek probably belongs to a succession of basins lying in a limited number of horizons. The advent of a railroad would probably cause considerable development work to be inaugurated.

*Knoxville.* In the northeastern corner of the city of Knoxville, a number of mines were formerly opened to supply the city trade. The coal was about three feet thick on an average, increasing to six feet in a few places. It is said to have lain in a narrow trough running northwest and southeast and overlain by black "slate" and small patches of sandstone.

In the valley of English creek, south and southeast of Knoxville, several local mines have been opened to supply the surrounding country districts and Knoxville. Three miles south of Knoxville is a five-foot coal with a good roof of black "slate." Where reached by slopes, it dips southeastward. Farther east (T. 75 N., R. 19 W., Sec. 20), at least two coals, separated by twenty feet of shale, are known. The lower may be reached from the valley by drifts and is from forty inches to four feet in thickness. Evidences of coal may frequently be detected in descending the creek from this point. Three miles southeast of Knoxville, on English creek, are two coal banks which do an important wagon trade. Of these, the most southerly is the Hayes bank (T. 75, R. 19, Sec. 15, Sw. qr., Nw.  $\frac{1}{4}$ ). This is a slope driven east to a six-foot seam which lies about forty feet beneath the surface at the slope mouth. The soapstone roof requires careful watching. The Miller bank is on the opposite side of the creek, one mile north (Sec. 9, Se. qr., Nw.  $\frac{1}{4}$ ). A coal varying in thickness from forty inches to six feet is entered by a drift situated about forty feet above the level of the creek. This seam is the one also mined by the English Creek Coal Co., one mile north. It is said that a lower coal has also been found here; but details are not available.

*Flagler.* The Whitebreast and other coal companies mined out more than 100 acres at Flagler. Since only the best coal was removed, there still remains a fair supply at the village and a few small mines are utilizing it. There are two horizons, both of which have furnished workable coal. The old Whitebreast No. 11 worked in a lenticular basin which thinned rapidly in all directions from a central point where a thickness of fourteen feet is reported. The Knoxville Fuel Company has recently reopened a slope in the hillside, just below the station of the Chicago, Rock Island and Pacific Railroad (T. 75, R. 19, Sec. 3, Ne. qr., Se.  $\frac{1}{4}$ ). At present an elevated tramway runs 800 feet from the slope mouth to a tipple beside the Chicago, Burlington and Quincy tracks; but a new opening is planned for the near future. Rope haulage is to be installed shortly. At the slope mouth the seam is only slightly below the entrance; it dips strongly to the north for 300 feet, becomes level for 400, dips north once more

for the next 600, and then remains constant in position to the end of the entries. Since the slope opens to the south, water does not drain off naturally, but must be removed by siphoning and pumping. Prospecting in this neighborhood revealed a continuous basin covering at least 500 acres. The coal is quite regularly five feet thick and is overlain by from twenty to forty feet of hard "soapstone" shale. A boring at the Rock Island depot shows that the seam lies forty feet below the railroad; while a trial shaft one mile north of the Knoxville mine shows a continuance of five-foot coal to that point.

On the south side of the Chicago, Burlington and Quincy tracks, opposite the Knoxville mine, a few small slopes are taking coal left in old workings in the lower horizon. The amount to be won in this manner is not great.

One mile west of Flagler, the English Creek Coal Company operates what is commonly known as the "Hawkeye mine," loading on a switch from the Chicago, Rock Island and Pacific (Sec. 4, Se. qr., Sé.  $\frac{1}{4}$ ). The shaft is fifty feet deep to a seam which varies from three to six feet in thickness, and occasionally cuts out completely for short distances where rolls are present in the roof. The few "bowlders" in the coal do not give much trouble, nor do the slips, or geological faults, which sometimes change the level of the coal as much as three feet. The seam has a strong dip to the south. The mine has a good

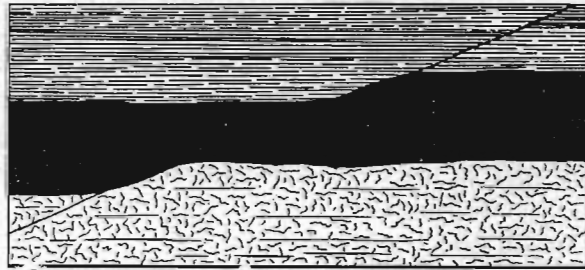


Figure 42. Fault in Hawkeye mine. Flagler.

"slate" roof, separated from the coal by two feet of "draw slate." Hoisting is done with a geared double engine, cylinders 12x18 inches. Three thousand feet of tail rope used for underground haulage are propelled by an engine situated above ground. Much coal has been mined out here, but the company owns a

large field where work is now being carried on, one-half mile to the south.

*Coalport.* At one time Coalport was an important town, supplying coal to the numerous steamboats then plying between the cities located on the navigable portion of the Des Moines river. With the cessation of navigation, mining on a large scale was abandoned and today only one mine is open—a drift in the face of the bluffs beside an abandoned channel of the river (Polk Tp., Sec. 14, Sw. qr., Se. 1/4). The coal here is from six to eight feet in thickness, lies fairly level at an elevation twenty-five feet above that of the river, and has as a characteristic feature a four-inch “sulphur band” in its center. Rolls occur, though the coal is never reduced to less than four feet. The coal is soft, but will stand transportation; a little is hauled to Howell and

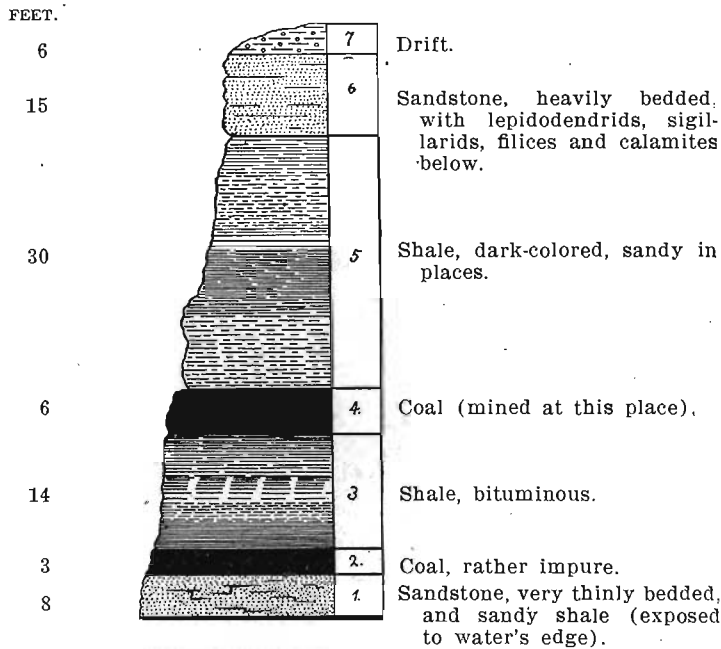


Figure 43. Section at Coalport (Keyes).

shipped from that point. A lower seam is also found here as shown in the accompanying illustration of the section found in the bluff.

*Harvey.* Workable coal is known near Harvey, both northwest along the Des Moines river and south as far as Walnut creek. Two local mines are now in operation a short distance south of the town. The V. R. Olive bank (Clay Tp., Sec. 9, Se. qr., Se.  $\frac{1}{4}$ ) is a hundred foot slope with a thirty per cent grade. The seam is four to six feet in thickness and contains a few pockets of ironstone "boulders." The roof is eighteen feet and more of a "slate" bearing occasional arenaceous patches. One-half mile southeast is the Lone Star slope (Sec. 15, Nw. qr., Nw.  $\frac{1}{4}$ ). The company is now pulling pillars preparatory to moving a short distance to a location nearer the center of the field. This particular basin is said to contain only thirty acres of good coal. With the exception of a few "boulders" the seam is clean and regular. Both the above mines haul some coal to Harvey for shipment.

The Hawkeye Portland Cement Co., located at Harvey, report that they have prospected 280 acres of land owned by them in section 20, Clay township, and 120 acres in neighboring parts of sections 21 and 28 and have found good coal under the greater part. The seam lies at slightly varying elevations, but is never more than 100 feet below the surface. The borings are said to show from fifteen to fifty feet of soil and yellow clay, forty to sixty of light-colored shale, six to seven and a half of coal, followed by fire clay, sandstone, and a succession of shales to the Saint Louis limestone. Between this area and Everest corporate interests control extensive coal rights on land which they are holding for future development.

*Everest.* Liberty township, in the southeastern corner of the county, is now the scene of vigorous activity in the mining industry. Everest (Sec. 17) is a new mining camp containing about 200 houses, the homes of employes of the Mammoth Vein Coal Co. The field is a large one and may be expected to turn out much coal. Mammoth Vein No. 5 is a short distance northeast of the camp (Sec. 17, Ne. qr., Nw.  $\frac{1}{4}$ ). In point of output it is the largest in the county and ranks well up with the best producers in the state. The average thickness of the seam at this mine is over eight feet; while as much as fourteen and a half feet has been carefully measured at one point and sixteen feet is

reported at another. From the foot of the shaft the bed dips gently toward the southeast and rises towards the northwest. The roof is a firm "slate" about eleven feet in thickness. Coal is hoisted forty-five feet from the bed to the surface by a geared double engine with cylinders 12x14 inches. Steam is furnished by four boilers, two of seventy-five horse power each and two of 150 each. The equipment for producing the electric power

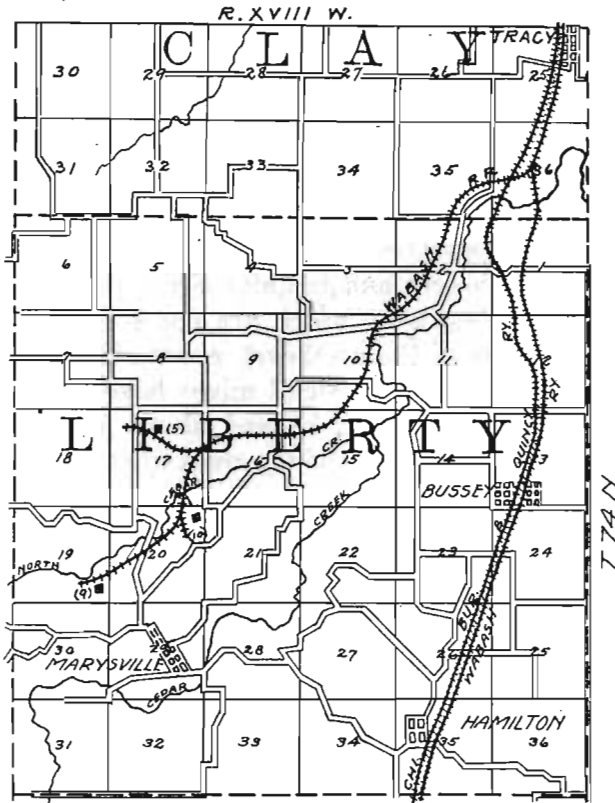


Figure 44. Map showing shipping mines in southeastern Marion county.

used at all the company's mines is located here. At No. 5, electric lighting is used in the main entries and haulage is effected over 2,500 feet of track running northeast and southwest by two class B Goodman motors.

Mine No. 9 of the same company is one mile northwest of Marysville (Sec. 19, Se. qr., Se. 1/4). This slope is not yet devel-

oped, although entries are completed for 1,000 feet and the mine is ready for work at any time. The coal is from six to ten feet in thickness. Near No. 9, on Mr. Feagan's land, is a small drift supplying a local trade from the same coal bed.

The Mammoth Vein numbers 10 and 11 are a pair of slopes facing one another from opposite sides of a deep ravine (Sec. 20, Ne. qr.). Formerly the two openings were connected across the gulch by an elevated tramway and dumped their product at the same point. A fire so seriously damaged No. 10, however, that it has been temporarily abandoned. Electric power is conveyed across country from No. 5 by cable. One class B motor hauls cars over 3,200 feet of rack-rail track in No. 11, and along the side of the ravine to the tippie. Electric lighting is employed in the main entries. The mine is entered by a slope 400 feet long, with a sixteen per cent grade. The coal averages about five feet in height and is quite clean, except for "bowlders" of impure limestone, which are not a serious source of trouble. The dip is to the northeast, about sixteen feet in 100.

*Marysville.* A number of small mines have operated in the valley of South Cedar creek, at and above Marysville. The Avery mine, on the south side of the creek near Marysville (Sec. 32, Ne. qr., Nw.  $\frac{1}{4}$ ), is now taking out some coal for local trade during threshing time and winter. At the end of a slope, 100 feet long and with a grade of one in eight, is found coal six feet in thickness, lying not far from the level of the water in the creek. The dip is southwest and the overlying stratum a sandstone. "Bowlders" of impure limestone occur in sizes ranging from pebbles to rocks three feet in diameter. The basin in which this seam lies apparently covers considerable territory in this region. A tract of land near Marysville has been purchased by one of the large coal companies of a neighboring county.

*Hamilton and Bussey.* Many openings have been made in the area embraced between Cedar creek and the railroads connecting Bussey and Hamilton. Just southwest of the latter town, there may still be seen the top works erected by the Southeastern Coal Company, which sank 200 feet to a seam from four to eight feet thick, but did not develop the mine farther. There is good coal here, although "bowlders" and thin lenticles of



rock in the coal give some trouble. The York Coal Company worked a shaft 164 feet deep half a mile north of town, on the Wabash railroad. The coal here was from three to six feet in thickness and was cut out by rolls in many places. The mine was abandoned one year ago (1906). West and northwest of Hamilton thick coal is found in several horizons; but reliable accounts of the relationships of the various seams cannot be obtained, as little mining has been done for a number of years. The forthcoming publication of a topographic map will enable more exact correlations to be made. The section at the Novelty mine, an abandoned shaft not far north of Hamilton, may be useful for purposes of comparison.

	FEET.	INCHES.
10. Clay, yellow .....	20	
9. Limestone .....	4	
8. Sandstone .....	2	
7. Shale, gray .....	60	
6. Shale, dark gray, fissile.....	14	
5. Coal .....	2	6
4. Shale, black, fissile .....	20	
3. Coal .....		8
2. Ironstone "boulder" .....	3	
1. Coal .....		1

Several shipping mines once operated west of Bussey in coal four feet and more in thickness. The O. K. company mined out nearly 100 acres from slopes and shallow shafts. When the region was visited by the author, only two mines, both small, were in operation. Near one of the former O. K. mines (Sec. 23, Nw. qr., Ne.  $\frac{1}{4}$ ), is the new slope of the Campbell and Guthrie Coal Company. The seam shows a constant thickness of about four feet; while two thinner coals appear at a slightly higher level. This slope works to the south and opens to the north. A short distance north, in section 14, is the small B. B. mine, worked during the colder portion of the year. Coal is elevated through the thirty-foot shaft by horse and gin. The bed worked is four feet thick and, as usual in this district, contains a few "bowlders" of clay ironstone.

## MAHASKA COUNTY

As in Marion county, the coal basins of Mahaska are seldom of large size, though often bearing thick seams of coal. Two causes have operated to limit the fields: (1) pre-glacial and post-glacial erosion have sometimes destroyed the continuity of basins previously quite extensive, and (2) the irregular basement upon which the Coal Measures rest in many cases restricted the original area covered by individual coal swamps by its influence on Pennsylvanian topography. The last statement perhaps requires some elaboration. As discussed elsewhere in this volume, the Des Moines strata everywhere lie unconformably on a strongly eroded surface which, previous to the deposition of the Coal Measures upon it, had been carved into hills and valleys much resembling the present surface of the county. When the region was depressed somewhat below sea level, or tilted so that drainage was checked, deposits of sand and clays were made first in the depressions on the surface and extensive swamps were also formed. The consolidation and compression of these deposits resulted in the formation of the sandstones, shales, clays and coals which today constitute the Coal Measures of Mahaska county. Thus we often find that the coal basins are limited laterally by the resistant calcareous strata that originally formed the sides of the valleys and wide depressions in which the coal plants grew. Continued deposition of sediments eventually buried even the highest points of the basal formation; but subsequent erosion removed much of the higher strata thus formed and again exposed the underlying limestones. In a large part of the northern and eastern sections of the county, where little coal has been discovered, Coal Measure strata remained in only isolated patches, so that the drift was laid down directly on the Saint Louis in many cases. The more important streams later removed both the drift and the Coal Measures from the lower portions of by far the greater part of their valleys.

Although great quantities of coal have been mined in Mahaska county, the productive areas have been confined to a comparatively small portion of the whole region. Mining on a large scale was first undertaken on Spring creek, near Oskaloosa, and

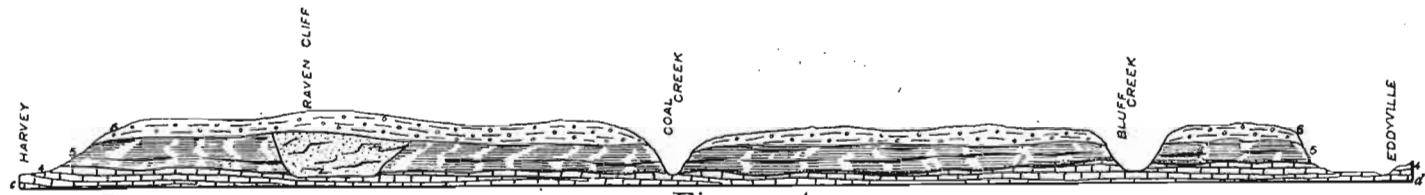


Figure 1.



Figure 2.

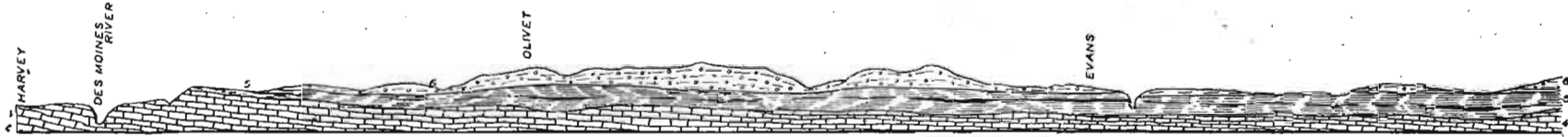


Figure 2.

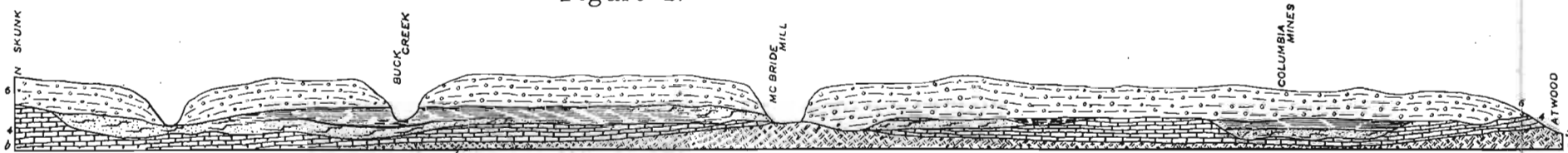


Figure 3.

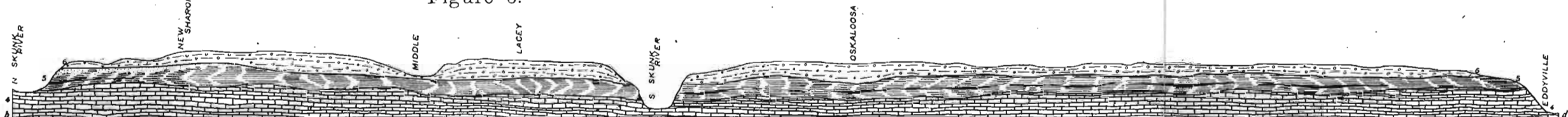


Figure 4.

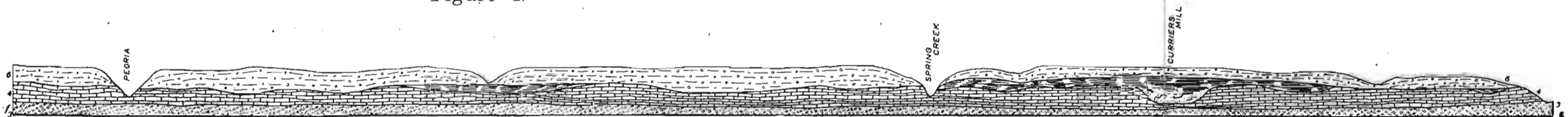
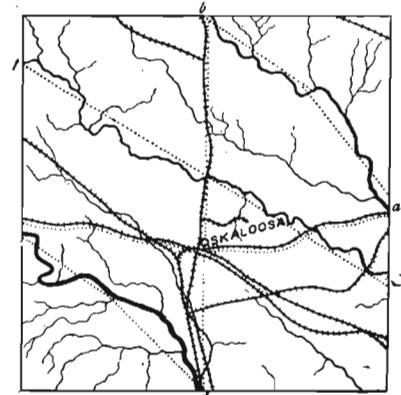


Figure 5.



Ver. 200 FEET  
 Scale  
 Hor. 1 MILE

Geological cross-sections in Mahaska County.

1—Osage stage; 2—Springvale beds; 3—Verdi beds; 4—Pella beds; 5—Des Moines stage; 6—Drift.

in the valley of Muchakinock creek. The coal worked lay in basins of limited extent, separated by areas in which coal was thin or lacking. The succession of strata above and below the coal roughly corresponds in the various fields and the altitude of the coal itself may be placed in several cases between 700 and 730 feet above sea level. It seems probable that the gradual subsidence of the region during Pennsylvanian times was checked at certain periods, sufficiently long to allow quantities of peat to accumulate in depressions on the lowlands.

Production in the Muchakinock valley has been largely replaced by the development of coal beds in the southwestern corner of the county, a fact made possible by the extension of the Chicago and North Western Railway into the latter territory. The coal seams of this area present the peculiarities of those of adjoining fields in Marion and Monroe counties. The basins of coal are lenticular in shape and are not large; the coal is higher than in many parts of the Iowa field, but where thickest often contains aggregations of clay ironstone 'boulders' distributed "like raisins in a cake." In this region the Coal Measures are found to extend to greater depths than in many other sections of the county, although shafts usually reach the coal at depths of less than one hundred feet.

As a producer, Mahaska has always stood at or near the head of the list of Iowa counties. During the eighties and early nineties she stood pre-eminent, but was passed by Monroe and Polk in 1901, and by Appanoose in 1902. The annual output given by the federal census for 1860 was 3,412 tons; for 1870, 32,550; for

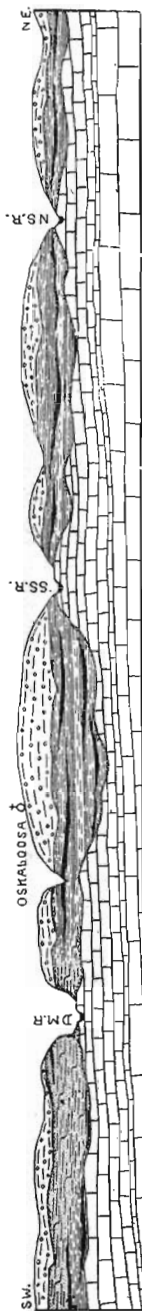


Figure 45. Ideal cross-section in Mahaska county.

1880, 283,961; and for 1890, 1,056,447. The production published by the Iowa and the United States Geological Surveys for the last ten years is:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	1,292,787	1903.....	707,459
1899.....	1,277,248	1904.....	663,943
1900.....	1,098,617	1905.....	714,945
1901.....	899,618	1906.....	602,487
1902.....	549,245	1907.....	757,778

The State Mine Inspectors report that 772,468 tons were produced and 1,586 men employed by the thirty-five largest mines in the county during the year ending June 30, 1908.

Below may be found a brief description of the various fields and of the mining in progress in August, 1907. The author is under obligations to previous reports of this survey for data respecting the older mining districts.\*



Figure 46. Map showing location of mines in southwestern Mahaska county.

#### DISTRICT NORTH OF SOUTH SKUNK RIVER.

This district appears to contain but few workable basins, although there are doubtless some which remain to be discovered. Considerable prospecting has, however, been undertaken without bringing any positive results. From Peoria east to New Sharon and beyond, and near Barnes City, Indianapolis, and Tioga, persistent search has been fruitless, in many cases not

\*Keyes. *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 340-356; Des Moines, 1894.

Bain: *Geology of Mahaska County*, *Idem*, Vol. IV, pp. 315-330. 1895.

even revealing thin seams. Still, it would be going too far to postulate from evidence so far gained, that northern Mahaska will not in time be the scene of active operations. The only localities in the district which have yielded good coal up to the present time are near New Sharon and Rose Hill.

*New Sharon.* An area covering a little more than two square miles on the ridge between North Skunk river and Buck creek, about three miles northeast of New Sharon, has furnished coal to a local trade for a number of years. Some large companies have prospected the region, but have apparently considered that their discoveries did not justify the considerable expense incident to the establishment of shipping mines. The Coal Measures are not very thick in this area, as shown by the fact that the St. Louis limestone has been found in the valley of the Skunk only a short distance both above and below the coal field.

Three local mines are now producing, all operating in the same coal. The Williams mine (Union Tp., Sec. 9, Sw. qr., Ne.  $\frac{1}{4}$ ) is entered by a slope 200 feet long, having a grade of one in three and a half. Entries extend one-fourth mile north, east and west, through coal which varies from two to five feet in thickness. The seam is sharply undulatory and has undergone faulting on a small scale. Nearly a score of old shafts and slopes have been worked on this farm. A short distance west is the Williams Brothers mine (Sec. 8, Se. qr., Ne.  $\frac{1}{4}$ ) with a slope 400 feet long. The average thickness of the seam here is four feet, while in other respects it has the same characteristics as at the Williams bank. As many as thirty men have been employed here during a few winters; but the output has declined of recent years. Cars are hauled up the slope by steam power. Not far northeast is the Duffus mine (Sec. 9, Nw. qr., Sw.  $\frac{1}{4}$ ), also a slope using steam haulage. The slope is 220 feet long and has a twenty-five per cent grade. This is comparatively a new mine at which only a few acres have been mined out. The coal averages about forty-four inches in height and shows no faults. A few "boulders" are present. The following section may be considered typical for the Buck creek district.

	FEET.
7. Soil and drift .....	40
6. "Slate" .....	2
5. Limestone .....	1

4. "Slate" .....	12
3. Coal .....	2-5
2. Fire clay .....	0-6
1. Sandstone .....	

Southwest of these mines, near the Skunk (Sec. 17, Sw. qr., and Sec. 18, Se. qr.), a seam forty inches thick, but split into two benches by twenty inches of clay, has been drifted a little. It does not appear to be continuous with the Buck creek coal.

*Rose Hill.* Three miles west and one north of Rose Hill, at Blyth, is the new mine of the Atwood Coal Company (White Oak Tp., Sec. 6, Nw. qr., Nw.  $\frac{1}{4}$ ). A spur track was run in from the Chicago, Rock Island and Pacific railway in January, 1907, and considerable coal is now being shipped. The shaft is fifty feet deep and a modern steam hoisting equipment has been installed. Walker's lift-rail device is used on the cages for dumping the cars. The operators plan to use a number of Ingersoll-Rand machines underground, both of the shearing and of the undercutting types. The seam is from five to six and a half feet in thickness, with the brightest and heaviest coal in the upper half of the bed. The roof is a dark "slate" which is always strong, while its thickness varies from fifteen to fifty-five feet. About one mile west (Spring Creek Tp., Sec. 1, Nw. qr.) coal believed to be part of the same seam was formerly mined.

Six miles east of Blyth, on the east side of North Skunk river, shipping mines were once in operation (Monroe Tp., Sec. 36, Ne. qr.). The basin found here was not of great extent, and in its higher portions possessed only a drift clay roof where the shale had been cut away. The sequence in this area is:

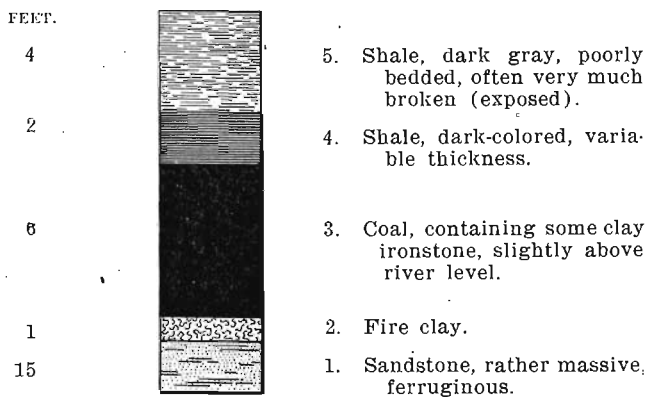


Figure 47. Seam of coal northeast of Rose Hill.

DISTRICT BETWEEN THE SOUTH SKUNK AND DES MOINES RIVERS.

This district for many years produced more coal than any other of equal size in the state, but the chief fields are now exhausted. The Muchakinoock valley and the country immediately surrounding Oskaloosa have yielded the most coal, while Black Oak and Cedar townships, forming respectively the northwestern and southeastern extremities of the district, have failed to show good basins. The region is magnificently supplied with railroad facilities and this feature has had much to do with the magnitude of the coal industry within it.

*Leighton.* A little coal is still taken out for the country trade from the district a mile or two southeast of Leighton, where a seam from three to five and a half feet in thickness has been reached by drifts and shallow shafts. Where the drift approaches dangerously near the coal, mining is precarious, but in many places a firm "slate" above the coal obviates this difficulty. A section of one of the old shafts (Scott Tp., Sec. 12, Ne. qr.) is:

	FEET.
5. Soil and drift .....	34
4. "Slate" .....	16
3. Coal .....	5
2. Fire clay .....	6
1. "Slate" .....	

*Olivet.* In 1904, the Rogers Coal and Mining Company took over a small mine near the Olivet station (Scott Tp., Sec. 9, Sw. qr., Ne. ¼) and has been gradually increasing the output. The seam varies from three to six feet in height and is unusually level. It lies 118 feet beneath the surface, at an elevation of about 700 feet above tide. Immediately over the coal is sixteen feet of "hydraulic rock," capped by a compact sandstone. Two coal horizons are known above the one worked. The fire clay forming the floor in the mine has been tested and shown to be of good grade for fire brick and glazed tile purposes. Only four acres of coal have been mined out; the operators report that 314 acres are known to be underlain with good coal and that probably twice as much may be assigned to this basin.



Half way between Olivet and Evans (Sec. 11, Se. qr.) is the small local mine of the Lester Butler Coal Company, open winters and threshing times only. Hoisting is done by horse-gin. The seam is about three feet thick and lies sixty feet under the surface of the country, indicating the possibility of its being in the same horizon as the second seam at Olivet.

*Evans.* Two miles west of Evans, on a switch running a half mile south from the Chicago, Rock Island and Pacific railway, is shaft No. 4 of the Garfield Coal Company (Scott Tp., Sec. 13, Nw. qr., Se.  $\frac{1}{4}$ ). This mine was opened in 1905 and has since worked three-fourths mile south and one-half mile west. The company owns 550 acres and leases 200 more, the whole known to be underlain with coal which, however, is thin in places. At the shaft the seam is five feet thick and lies 110 feet beneath the surface. Tail-rope haulage is employed in the south and west main entries. Some of the coal is mined with machines; four cutting and two drilling machines are driven by an Ingersoll air-compressor. Hoisting is by an Ottumwa direct-connected engine, supplied with steam by two boilers of 150 horse power each.

A half mile west of Evans, near Muchakinock creek (Garfield Tp., Sec. 18, Ne. qr., Se.  $\frac{1}{4}$ ), is the slope of the Clean Coal Company. The slope is 200 feet long; the air shaft forty feet deep. A small haulage engine brings cars to the surface by means of a pull-rope, whence they are propelled over a tramway 200 yards north to a coal switch. This seam averages three to four feet in thickness.

The greater part of the coal contained in the basin between Evans and Garfield No. 4 has been mined out. The basin is a large one; but the actual relationships of its various parts are so obscure that no attempt is made here to define its limits. Coal has been found in at least three horizons, separated from one another by from forty to eighty feet of shale and fire clay. The principal seam is said to have attained a thickness of eleven feet in a few instances. It is roofed by from twenty-five to fifty feet of carbonaceous "slate," and underlain by from three to twenty feet of fire clay. The dip is, in general, to the southwest. Following is the record of a drill hole in section 18 (Sw. qr.).

	FEET.	INCHES.
6. Drift .....	18	
5. Shale, gray .....	8	
4. Coal .....	1	
3. Shale, gray .....	25	
2. Shale, bituminous .....	47	
1. Coal .....	6	2

*Bolton.* Bolton is a mining camp three miles west of Beacon, at the end of a coal spur running north from the Chicago, Burlington and Quincy railway. Here, since 1902, has been located the slope of the Bolton-Hoover Coal Company (Garfield Tp., Sec. 19, Sw. qr., Ne. 1/4). The slope extends 150 feet to the coal, which lies seventy feet below the surface and is from four and a half to six feet thick, with an average of five feet three inches. Thirty feet of firm "slate" lies between the coal and the surface drift. Sumps ten feet deep fail to penetrate the fire clay beneath the seam. Sufficient coal is said to exist in this basin to supply the company's mines for ten years to come, although 220 acres have already been mined out. One-half mile southeast of the slope is a pre-glacial channel filled with drift and cutting out the coal over an area 400 yards long and 100 wide. In the mine the haulage rope extends over a mile to the present workings, while the tail-rope runs above ground for nearly a mile and descends into the mine through an old drill hole. Within another year, the company intends to run in another slope 1,200 feet northeast of the one now in operation.

*Beacon.* Much coal has been taken out on all sides of Beacon and operations have not yet ceased. Quite recently several shipping mines were located on a coal switch running west from the town through sections 27 and 28; but of these only one remains. Slope No. 3 of the Garfield Coal Company is a mile west of Beacon (Garfield Tp., Sec. 28, Ne. qr., Ne. 1/4). The seam here has shown as much as six feet of coal, although the average is nearer five feet. This slope, which opens to the south and works towards the north, has been in active operation for three years and its workings are just beginning to break into those of old Garfield No. 1, which was situated between number 3 and Beacon. When the mine was first opened rolls in the black shale roof gave considerable trouble, often cutting down the coal to a

thickness of three feet or less; but at present these are only infrequently encountered. Loaded cars are hauled 800 feet from the foot of the slope to the surface by a pull-rope operated by steam power.

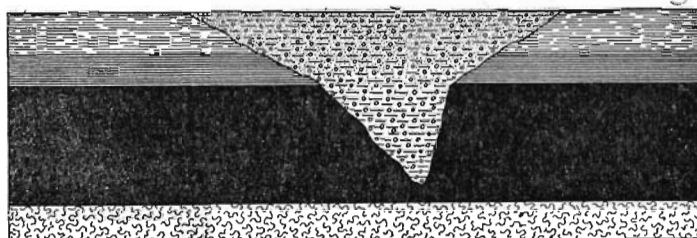


Figure 48. Coal bed, having small erosive channel filled with drift material.

West of the Garfield (Sec. 21, Sw. qr., Se.  $\frac{1}{4}$ ) is the small country mine of Toy and Deaver. Very little coal has been taken out yet from a fairly regular four-foot seam. Cars are pulled up the steep slope from the mine by horse and gin.

The succession of strata in the Beacon district is indicated by the following drill record (Sec. 28, Ne. qr., Sw.  $\frac{1}{4}$ ).

	FEET.	INCHES.
10. Surface .....	15	
9. Sandstone .....	1	
8. "Slate," gray .....	18	
7. Coal .....		4
6. Fire clay .....		6
5. "Slate," black .....	17	
4. Coal .....	1	
3. "Slate," black .....	26	10
2. Coal .....	4	8
1. Fire clay .....	2	
Total .....	86	4

A lower seam was discovered some time after bed number 2 of the above record had been opened up. It extends from Garfield No. 3 at least one mile west and is reported to be from forty to fifty inches in thickness. It is supposed to be a split from the upper coal, though little has been positively ascertained on this point. The coal worked at Beacon, Bolton, and Evans is very similar in character and is found with a similar association of strata; it may perhaps lie in a series of pockets belonging to the

same horizon. This point, however, is of little economic importance, since the general inconstancy of coal beds found in Mahaska and neighboring counties renders the drill the court of first and last appeal when definite information in regard to the occurrence of coal is desired.

A mile north of Beacon (Sec. 22, Ne. qr., Ne.  $\frac{1}{4}$ ) is the Ream bank, a small drift taking coal chiefly from old workings. The bed worked varies in thickness from two to six feet. Near the wagon road between Beacon and Oskaloosa are several local mines which do business in a small way. The one nearest Beacon is the Colter mine, formerly the Sowden (Sec. 23, Sw. qr., Nw.  $\frac{1}{4}$ ). This is an old mine operating a sixty-foot shaft to a seam five feet in average thickness. The roof is a "slate" which is not always firm. Near the Colter, but on the north side of the Chicago, Rock Island and Pacific cut-off (Sec. 23, Nw. qr., Se.  $\frac{1}{4}$ ) is the Raven mine, formerly a shipping concern, but now supplying local trade only. The coal available from the present fifty-foot shaft has been almost exhausted. The seam is three feet thick. A short distance north of the Raven, on the same land, a new slope is being driven into the hillside from the valley of a small stream. The coal is of the same thickness here as at the Raven, and outcrops in an adjacent ravine. Only a small area of coal remains to be won from this opening. Southeast of the Raven, on the south side of the Iowa Central tracks (Sec. 23, Se. qr.), is the Wassenchove mine, reached by a shaft seventy feet in depth. The bed averages four feet and thickens in the "swamps."

*Oskaloosa.* While there are places under Oskaloosa where coal has been cut away, or is only thin and of poor quality, the greater part of the city is built over a good bed of coal. A number of small mines have been operated in various parts of the city and east and northeast of the corporation limits, on Spring creek. As a typical section for the district, there may be taken the following record of the shaft of a former mine in the southern part of the city (Sec. 24, Ne. qr., Se.  $\frac{1}{4}$ ).

	FEET.
7. Drift .....	60
6. Sandstone .....	3
5. Shale, bituminous .....	21
4. "Hydraulic rock" .....	1
3. Shale, bituminous .....	18
2. Coal .....	6½
1. Fire clay .....	4

A few small mines are now operating for the city trade. In the northeastern section of Oskaloosa, north of the new cemetery, is the Cunningham mine. The shaft is sixty feet deep to a seam four and a half feet thick. The roof is a thick blue "slate." Just north of the city limits, near the old cemetery, is the forty-foot shaft of the Schultz mine. The work at present is in four feet of coal, although the average for the mine is slightly less. Both the above mines hoist by means of horse and gin. Several local mines are still taking coal from the once productive Carbonado district, but they are small affairs and usually work only during the winter months. Among the more important ones may be mentioned the Barrowman and Oakley mine, three miles northeast of Oskaloosa, and the Davis, one mile east of the same city. The coal at the last named mine varies from five to six feet in thickness and is, perhaps, a continuation of that of the Oskaloosa district and separated from it by pre-glacial erosion. Several hundred acres of coal was left untouched because of the failure of suitable cover between it and the drift.

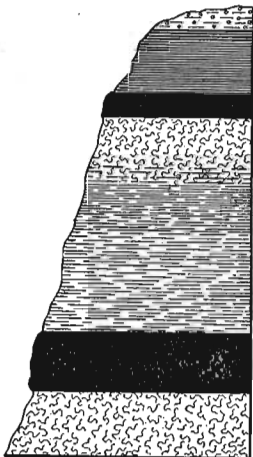
*Muchakinock.* For many years the region around Muchakinock, a former mining camp one mile east of Given, produced more coal than any field of similar size in Iowa. Later the mining companies turned their attention a short distance to the north, and finally, having completely exhausted the basin, left for new fields. Coal was shipped over a long coal spur of the Chicago and North Western Railway, chiefly by the Consolidation Coal Company, the largest operator in the district. The coal lies in an irregular area about two and one-half miles east and west by three and a quarter north and south. The area extends but a short distance south and about an equal distance east and west of Muchakinock itself. "The coal does not connect

directly with that of the other basins, low coal shales and 'hydraulic rock' occupying its place along the dividing lines. The bed lies at a general elevation of thirty feet above the underlying limestone with fire clay, graduating below into shales, between. An upper coal is usually found wherever the cover is sufficient to have protected it. It varies in thickness from one to four feet, but it is of poor quality and of no value.'\*\*

Below is the record of a drill hole bored from the prairie level near old Consolidation No. 7 (T. 75, R. 16, Sec. 36, Nw. qr.):

	FEET.
6. Drift .....	28
5. Shale, gray, argillaceous .....	26
4. Coal, with pyrites .....	½
3. Sandstone .....	3
2. Shale, bituminous, fairly firm.....	54
1. Coal .....	5
Total .....	116½

The only mines now to be found in the district are three small, local banks that are utilizing coal which the exigencies of mining caused the larger companies to pass over. These banks are: (1) the Boggs, one-half mile north of old Muchakinock (Harrison Tp., Sec. 7, Nw. qr., Sw. ¼); (2) the Plum, one-half mile east of Muchakinock (Sec. 7, Sw. qr., Se. ¼); and (3) the Kennebec,



	FEET.
6. Soil .....	1
5. Shale, dark gray, somewhat fissile.....	3
4. Coal .....	1
3. Fire clay, and clay shale.....	10
2. Coal .....	3
1. Fire clay (exposed).....	3

Figure 49. Bluff near Given.

\*Bain: Iowa Geol. Surv., Vol. IV, p. 362; Des Moines, 1895.

one-half mile south of the Plum (Sec. 18, Nw. qr., Se.  $\frac{1}{4}$ ). Before the Pekay switch was removed, the Kennebec hauled some coal to it for shipment.

*Given.* West of Given is a small coal area distinct from that of Muchakinock, yet closely related to it. Of former mining in this basin, nothing remains. The exposure shown in the figure may be seen in the bluff near Given.

Half way between Given and Beacon is an area of coal closely related to that in the Muchakinock basin, as may be seen by comparing the Muchakinock section already given with the following record at old Consolidation No. 8 (Garfield Tp., Sec. 34, Sw. qr., Se.  $\frac{1}{4}$ ):

	FEET.
8. Drift .....	18
7. Shale, gray, argillaceous .....	32
6. Coal .....	1½
5. Sandstone .....	4
4. Shale, bituminous .....	49
3. Coal .....	7
2. Fire clay, graduating below into gray shale.....	35
1. Limestone (Saint Louis).....	

With its field of action limited by old workings north and south, the mine of the National Union Coal Company, two and one-half miles south of Beacon (E. Des Moines Tp., Sec. 3, Ne. qr., Sw.  $\frac{1}{4}$ ), still continues to do a considerable shipping business. Coal is brought to the surface by both a slope and a shaft, the former 100 feet long, the latter thirty-three feet deep. Rope haulage is already in use from the foot of the slope to the surface and is to be extended underground. Undulations in the coal bed are sufficiently pronounced to create heavy grades in the roads. The following average section for this territory shows that pre-glacial erosion has cut out much of the indurated beds found above the coal at old Consolidation No. 8.

	FEET.
5. Drift .....	variable
4. "Soapstone" .....	12
3. Shale, black, bituminous .....	20
2. Coal .....	5 to 7
1. Fire clay .....	

*Pekay.* The Pekay and Lost Creek district, from which large quantities of coal have been taken out in the past, may be regarded as the southern representative of the Muchakinock basin and as separated from it by areas of thin coal. The Pekay basin extends from a point a mile southeast of old Muchakinock for a little over three miles in a southeasterly direction. Where normal, the coal is five to six feet in thickness, but in places the bed becomes attenuated. An upper seam, two feet thick and forty or fifty feet above the one worked, has been removed by erosion in all but a few localities. This basin is now nearly exhausted.

One mile south of Pekay, and one-fourth mile east of the Buxton branch of the Chicago and North Western Railway, is the slope of the Western Fuel Company (Harrison Tp., Sec. 29, Nw. qr., Ne.  $\frac{1}{4}$ ). This mine is taking out the coal left on the southern border of the old Whitebreast workings. The seam is here from four to six feet in thickness, clean, and level. Between the coal and the drift is a variable amount of "slate"; at the foot of the slope, where doubtless it has suffered considerable pre-glacial erosion, it is only four feet thick, but farther east it increases to twenty feet. Under the coal is a thick stratum of fire clay. Cars are pulled 150 feet up the gentle slope and one-fourth mile west to the tippie by a large tail-rope engine equipped with a powerful friction clutch. Rope haulage is also employed for a distance of 200 yards in the mine itself. The mine is not yet old, and will increase its output shortly.

One-half mile east (Sec. 29, Ne. qr.) is a fifty-foot shaft operated for the local trade by Gott Brothers. Twenty-five feet of "slate" intervenes between the coal and the drift at this point. Southeast of the Gott mine is the Gray bank and south of that, near the county line, is the Davis. These are small local mines. Small pockets of coal are common near Eddyville and are utilized by a country trade; but none, apparently, are of sufficient size to warrant development on a large scale.

*Wright.* Three miles northeast of Wright, a coal occupying a position but little above the Saint Louis limestone, has been mined in a small way. A section of the shaft (White Oak Tp., Sec. 16, Sw. qr.) shows:



	FEET.
4. Drift .....	30
3. Shale, bituminous .....	25
2. Coal .....	3½
1. Fire clay .....	

A seam in what is perhaps the same horizon has been drifted from the river valley, a mile and a half northeast of the above mine. Both basins are probably of limited extent.

#### DISTRICT SOUTH OF DES MOINES RIVER.

Southwestern Mahaska was known to contain basins of thick coal some time before any attempt was made to develop large mines in the region. It was not until the lower Muchakinock valley had been worked out that the Chicago and North Western Railway was extended into this territory to open up what has proved to be a very productive area. The adjacent portions of Marion and Monroe counties are also turning out quantities of coal. In Mahaska, individual basins are not extremely large; but the coal is often quite thick. "Bowlders" of an impure limestone, termed clay-ironstone, are sometimes so numerous as to cause considerable difficulty in mining.

*Cedar and Coal Creeks.* A little mining for local purposes has been prosecuted along Cedar and Coal creeks; but the absence of railroad facilities in much of this territory has retarded development. Four seams of coal of workable thickness have been reported as found in a well about one mile east of the iron bridge over Cedar creek. On South Coal creek, near old Eveland postoffice, is an exposure showing ten feet of impure coal, overlain by twelve feet of shaly sandstone, and underlain by three feet of fire clay (Fig. 50). Drifts have been operated in this coal, but the greater part of the seam is of very poor quality.

*Durfee.* Durfee is a mining camp of 100 houses situated on the upper part of South Coal creek, at the extremity of a four-mile coal spur from the Buxton branch of the Chicago and North Western Railway. At this point the Rex Coal Company operates a shipping mine (Jefferson Tp., Sec. 19, Se. qr., Sw. ¼). The seam lies 118 feet below the surface at the shaft and varies in thickness from five and a half to thirteen feet, with an average

of seven feet. It is so undulatory that some difficulty is experienced in draining the mine; ditches are dug in the higher parts of the entries wherever practicable, yet it is necessary to use three gasoline engines to pump water over the more pronounced "hills" or to the surface. The company controls 700 acres of coal, of which the south and east portions are quite clean. On the north side of the basin a dark impure limestone occasionally comes in to divide the seam into two benches. Rock is so plentiful in this portion of the coal that hand mining is rendered diffi-



Figure 50. Coal near Eveland.

cult and Ingersoll-Rand machines are to be installed as an experiment. Tail-rope haulage is employed for half a mile on the main north and south entry. The top works are modern and well equipped. Power is furnished by four boilers capable of producing a total of 260 horsepower. The handling of the coal is accelerated by the use of Olson automatic cages and a Christy box-car loader. There are three pairs of double engines at this mine, one each for the tail-rope, for the box-car loader, and for hoisting.

*Buxton.* Number 14 of the Consolidation Coal Company is a new mine still in course of development. The shaft is  $133\frac{2}{3}$

feet in depth and is located about a mile and a half north of Buxton (Jefferson Tp., Sec. 28, Sw. qr., Ne.  $\frac{1}{4}$ ). The nature of the seam and its accompanying strata and the type of equipment are much the same as at the other Consolidation mines described in the chapter on Monroe county. At this mine, however, the retreating method of work is to be essayed; entries are to be driven to the boundaries of the property before rooms are turned and work will then be carried back toward the shaft. Progress is retarded by the presence of numerous pyritic concretions and clay ironstone "bowlders" in the coal bed. A Norwalk air-compressor furnishes power for the drills used in driving entries. The all-steel tippie is the latest and best of those erected at the various Consolidation mines and the top equipment is, in general, of the best pattern. The company owns 600 of the 700 acres or more included in this particular basin.

The Crawford Coal Company operates a shipping mine on a short switch from the Buxton branch, about half way between No. 14 and Buxton (Sec. 23, Nw. qr., Se.  $\frac{1}{4}$ ). The shaft is forty feet in depth and from its foot entries have been driven 2,500 feet south, 400 north, and 400 west. The company expects to work over about 160 acres. Rope haulage is to be installed in the main south entry. A typical section at this point, given from memory by the superintendent, is:

	FEET.
4. Drift .....	3
3. Sandstone .....	10
2. "Slate" .....	27
1. Coal .....	4 to 6

*Eveland.* The Eveland mine is at the camp of that name, one mile northeast of Buxton (Jefferson Tp., Sec. 34, Nw. qr., Ne.  $\frac{1}{4}$ ). The seam worked is from four to seven and a half feet in thickness, ordinarily showing five feet. Rock in the coal gives little trouble. The roof is of a peculiar type, presenting the appearance of a mass of "bowlders" firmly welded together so as to form a secure cover over the workings. Irregularities in the under surface of this stratum sometimes cut out the top coal. This mine has been in operation five years and has worked one-half mile east and one-fourth mile north and south. The

product is loaded on a short spur running west to the Buxton branch of the Chicago and North Western Railway. The basin is a small one. Northeast of the shaft the seam splits, shale coming in between the two benches. At the shaft the coal lies only fifty feet below the surface, but under higher land near by

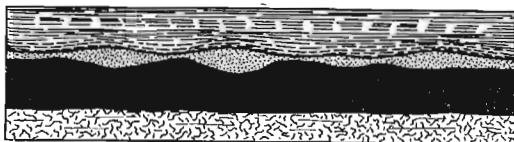


Figure 51. Ironstone band in roof of coal seam, Eveland mine.

a considerable thickness of strata is found between the coal and the drift, as shown in the following record.

	FEET.	INCHES.
4. Sandstone .....	35	
3. "Slate," gray and blue.....	45	
2. "Hydraulic rock," very hard.....	3	6
1. Coal .....	5	4

*Crickett.* On the west side of Bluff creek, a little more than a mile north of the Eveland mine, is the shipping mine of the Crickett Coal Company (Sec. 27, Nw. qr., N. ½). The shaft is fifty-four feet deep and was sunk in 1905. Not very much territory has as yet been mined out. The seam worked averages five and a half feet in thickness, although a few rolls in the roof cut out some of the coal under small areas. As in many other parts of this section of the county, "bowlders" are plentiful in places. In working out the coal two shearing machines and a compressed-air drill prove of service.

*Lakonta.* Two miles southwest of Lakonta and about the same distance east of the Crickett, is the mine of the Greenridge Coal Company (Jefferson Tp., Sec. 25, Ne. qr.). The product is shipped over a switch from the No. 13 spur of the Chicago and North Western Railway. The company leases 280 acres of land, at least 160 of which is said to have been prospected and proven to be underlain by from four to seven and a half feet of coal. "Bowlders" are extremely plentiful in parts of the seam. Where the coal attains its greatest height conditions detrimental

to profitable mining prevail, such as an abundance of rock in the seam or, perhaps, a poor roof. As the mine has been in operation only a short time, mule haulage is still found adequate. The electric shot firing system employed gives good results: wires from the top station traverse each main entry, and may be tapped and a current run into the rooms as required. Separate buttons control the firing in each room. The shaft is 100 feet deep; coal is hoisted through it by a geared engine, capable of elevating 700 tons daily. The mine is not now running full capacity and an effort will be made to increase the output during the coming winter.

*White City.* White City is an attractive mining camp two miles west of Lakonta, on the Buxton branch of the Chicago and North Western Railway. One-half mile north, on a short railroad spur, the Crescent Coal Company has sunk a shaft (Jefferson Tp., Sec. 13, Sw. qr., Nw.  $\frac{1}{4}$ ). A large quantity of coal is shipped. The following is a record of a drilling near the shaft.

	FEET.	INCHES.
3. Drift .....	37	
2. "Slate" .....	27	2
1. Coal .....	7	9

A few places in the mine show eleven feet of coal, yet the average height is nearer seven feet. "Bowlders" of sandstone and clay-ironstone are freely distributed through the coal in some localities, leaving others quite free from them. Although the seam may contain considerable rock, the latter is often so easily removed that the working remains good from a miner's viewpoint. The coal bed is sharply undulatory. About 125 acres have already been mined out. There are about 350 acres of coal, usually thick, in basins tributary to this shaft; but the drillings cannot, of course, be depended upon to show how much of this is sufficiently clear of rock to be profitably mined. The equipment of the Crescent mine is modern, and adequate in every respect.

## UNION COUNTY

The rocks immediately underlying the heavy drift cover of Union county belong without exception to the Missouri, a stage that may contain seams of coal. These coals are usually so thin, however, that they can be worked with profit only when they occur near the surface and present few obstacles to facile development. Below the Missouri lies the Des Moines, the productive stage of the main Iowa coal field. Its summit probably lies at least 400 feet below the surface in Union county, excepting, perhaps, the northeastern corner, where the depth is less; but as the upper part of the Des Moines is nowhere very productive, horizons of good coal might not exist above a depth of 600 or 700 feet. Moreover, it has not yet been proved that the Des Moines bears coal at any level as far southwest as the region under discussion. It is not probable that prospecting would yield a proper financial return, even though a workable coal basin were finally located.

## CLARKE COUNTY

Clarke county is covered by a heavy mantle of drift under which lie beds of Pennsylvanian age. The greater part of the region bears Mississourian strata, thin in the eastern section and 100 feet or more thick in the western; yet where pre-glacial erosion has cut to exceptional depth and in the valleys of the main streams in the eastern and northern parts of the region, the Des Moines is the highest of the indurated formations. The outlook for basins of thick coal near the base of the Des Moines is good, but the depth to which prospects would necessarily be carried in order to reach the best horizons, would make the expense of locating a field quite high. Coal has been mined at Cleveland, in Lucas county, only two miles from Clarke, at a depth of 326 feet. Recent borings at Leon, in Decatur county, revealed good coal horizons at about 500 feet. At both these localities the best coal lies at from 550 to 600 feet above sea level, although other horizons are present nearer the summit of the Des Moines. If coal is to be sought at Osceola or at other points in the central portion of Clarke, borings should be sunk 600 feet in order to reach the coal horizons known to exist on the

east and south. Farther west these horizons lie still farther below the surface, both because the elevation of the latter is greater and because of the westerly dip of the formations; but in the deep valleys of eastern and northern Clarke, a depth of 400 feet would probably reach the base of the Coal Measures.

#### LUCAS COUNTY

The gentle dip to the southwest that is common to the Carboniferous beds in most of the Iowa coal fields lessens greatly in Lucas county, so that the limestones of the Missouri stage appear only in a few places on its extreme western border and the Saint Louis limestone lies closer to the surface than would otherwise be the case. The highest indurated rocks of practically the entire county belong to the lower and more productive division of the Coal Measures and bear coal in considerable quantity. A zone of upper horizons bearing coals of moderate thickness outcrops along Big and Little Whitebreast, English and the various branches of Cedar creek; while lower horizons containing thicker coals have been found in drillings and shafts in the Lucas district, northeast of Chariton, and on Cedar drainage. As in the lower Coal Measures of the region north and east, the coal lies in discontinuous basins along more or less definite horizons. The largest basin so far located contains less than 4,000 acres; while the driller considers himself fortunate if he discovers a thousand acre field in prospecting ten or fifteen miles along the valleys. The shales and sandstones making up the bulk of the Des Moines stage are equally erratic in occurrence, grading into one another laterally with startling rapidity. Even the limestones, which are few and poorly developed, have little persistence and do not serve as horizon markers for the driller or geologist.

In the northeastern part of the county, where prospecting has been actively pursued in recent years, the best coal has been found between 700 and 750 feet above tide, with some between 625 and 700 A. T. It should be remembered in this connection that the level of a continuous bed may vary by forty or fifty feet at neighboring points because of undulations. Since the elevation of the uplands is about 1,040 feet A. T. and the streams have

often cut over a hundred feet below the divides, it is evident that the depth to which borings need be carried is by no means prohibitive. The base of the Coal Measures lies at about 611 feet A. T. on an average, though the surface of the underlying Saint Louis calcareous formations is extremely uneven, changing in elevation as much as 100 feet in one mile. On the uplands it is sometimes necessary to drill 200 feet before the drift is penetrated, but commonly 150 feet or less is sufficient.

In the western portion of the county the Saint Louis lies at somewhat greater depth and the best coal is found about 300 feet below the lowlands along Whitebreast creek. Little is known of conditions in the four southern townships, nor has the Mystic coal of the Appanoose-Wayne field been recognized within the county, although it is probably present in the southeastern corner. A deep drill record from section 12 of Benton township fails to show any trace of the Appanoose formation or to bring to light lower coals of workable thickness.

The early production of coal in Lucas county was not large, having been 945 tons in 1860 and 37,284 bushels in 1868. In 1880, however, as a result of the opening of the Whitebreast mines east of Lucas, the county had forged to the front with an output of 126,498 tons and in 1890 the total was still larger, 339,229 tons. Hardly more than a year later, the closing of the larger mines caused a decline that was only checked by the installation of the Whitebreast No. 4 at Cleveland. Recent statistics are:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	6,600	1903.....	295,554
1899.....	3,700	1904.....	189,895
1900.....	221,922	1905.....	147,093
1901.....	216,058	1906.....	97,147
1902.....	238,862	1907.....	105,536

The closing of the Big Hill mine in 1907 and the abandonment of the Cleveland mine early in 1908 left the county without a shipping mine and reduced the output for the year ending June, 1908, to 74,288 tons. As soon as railroad facilities are provided for the northeastern quarter of Lucas, it will again become one of the most important of Iowa coal counties. The following pages contain a brief review of the coal data available in July, 1907.



*Cleveland.* The Whitebreast Fuel Company of Illinois drilled fifty holes near Lucas, as a result of which the mine now known as Cleveland No. 4, was opened about two and one-half miles southwest of Lucas at Cleveland. The shaft was sunk 326 feet early in 1899, penetrating the following coal horizons.

COAL.	THICKNESS IN	DEPTH IN
	FEET.	FEET.
No. 1.....	1.5	81
No. 2.....	1.5	100
No. 3.....	0.6	122.4
No. 4.....	0.2	216.6
No. 5.....	0.9	294.9
No. 6.....	4.9	318

The basin now mined shallows rapidly to the west, southwest and northwest, extends one and one-half miles southeast of the shaft, and connects through an area of low coal with the Lucas seam on the northeast. The coal varies in thickness from one foot to six feet, but the roof is apt to be of poor quality over the thickest coal. Elsewhere the roof is a fairly firm and thick black fissile shale. Undulations are well marked. Little sulphur and no black jack interfere with the purity of the coal. In the south workings a large erosion channel in which the coal is replaced by shaly clay was encountered and was tunnelled through for several hundred feet before the coal was again found. Electric haulage is employed in the main entries, three eighty horse power motors being in service and one held in reserve. The power is derived from a Brownell engine, with a Milwaukee generator. The pit cars are built of steel alone. Hoisting is done by a double engine with 18x32 inch cylinders. The tower and tibble are of steel construction, erected by the Pittsburg Steel Co. The link-belt shake and screen are used. The automatic dirt dump was made at the mine. This mine has now almost exhausted its territory and will be abandoned early in 1908.

*Lucas.* In June, 1874, Mr. William Haven and others leased 540 acres of land on Whitebreast creek, two miles east of Lucas, and the next year began drilling operations. Two upper seams were penetrated within 138 feet and after considerable delay due to financial difficulties a lower coal over five feet in thick-

ness was finally found. The Whitebreast Coal Company was organized to work this field and did so by means of three mines between Phillips and Lucas. Until the field was exhausted in 1891 it was one of the most productive in the state. In an endeavor to find more coal the company bored 123 diamond drill holes along a strip of varying width and considerable length trending northeast and southwest from their mines, but no basin of sufficient extent for development on a large scale was located. These prospects covered an area of about twenty square miles, chiefly in Whitebreast valley, and were continued to about 300 feet below the surface level. Of 120 holes, seventy showed less than three feet of coal, twenty-two between three and four feet, twelve between four and five feet, and sixteen over five feet. In one prospect a thickness of seven feet of coal was penetrated, and in another eight feet.

In the Lucas district there are reported to be four coals in addition to one that outcrops in the hillsides. These are said to be as follows:

COAL	THICKNESS FEET.	DEPTH, AVERAGE, FEET.
No. 1. ....	1 2-3	60
No. 2. ....	2¼	90
No. 3. ....	3½ to 5	290
No. 4. ....	4	330

These coals are not continuous over large areas but appear to lie in basins along fairly definite horizons. It will be seen that they correspond quite well with the coals found in the shaft at Cleveland. Strong undulations rendered the level of every seam somewhat variable. Coal in the second horizon can be profitably worked longwall and is so mined by Skidmore Bros., who are operating a local mine about one mile northeast of Lucas. The third horizon has supplied most of Lucas county coal and is now utilized at the Big Hill mine. The fourth horizon is not definitely known to contain thick coal at Lucas, but is that worked at Cleveland. It is possible, however, that the coal mined at Cleveland and at Lucas lies in the same horizon, since the Saint Louis limestone is encountered not far below the third seam at Lucas.

The Big Hill mine ships over the Burlington from a location not far from the station at Lucas and although of limited extent, this mine has at times produced considerable coal. It is now idle because of trouble with water and for other reasons. The shaft is 290 feet deep to a coal a little over four feet in average thickness. Above the seam is a considerable thickness of sandstone which makes a firm roof but lets in much water. Laterally this rock grades into shale. A thick sandstone is found also at Cleveland between coals Nos. 4 and 5 of the shaft record.

*Big Whitebreast Drifts.* Coal outcrops at several points in the valley of Whitebreast creek from old Cleveland northeast to the county line and, though usually thin, has furnished limited supplies for purely local consumption. In sections 5 and 8 of Whitebreast township some coal is occasionally taken from a fourteen-inch seam that outcrops near high water level in the creek. The section made by St. John farther down the creek at the old Wheeler Mill is shown in figure 52. At and near the confluence of Big and Little Whitebreast creeks, a rather constant bed of thirty inches outcrops and has been drifted to some extent on Whitebreast and Barker creeks.

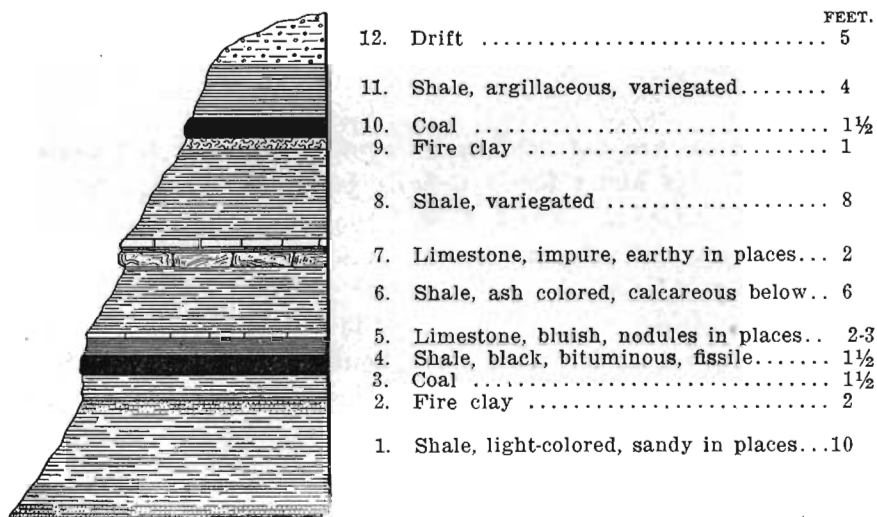


Figure 52. Section on Whitebreast creek. Six miles below Lucas.

*Chariton.* An unsuccessful attempt to find thick coal was made near the Chariton river, in the northern part of Chariton. One boring which was continued for 322 feet (Sec. 30, Sw. cor-

ner) encountered only two thin coals at 112 and 318 feet respectively. Another drilling struck a small pocket of five foot coal at the depth usual for the "lower vein." A good basin of deep coal was, however, located northeast of Chariton where the mine of the Inland Coal Company is situated. The Inland shaft record is (Lincoln Tp., Sec. 9, Nw. qr., Ne.  $\frac{1}{4}$ ):

	FEET.	INCHES.
33. Soil and drift .....	34	6
32. Shale, sandy, light-colored.....	7	
31. Shale, sandy, black .....	11	
30. Coal, good .....	2	
29. Fire clay .....	5	
28. Sandstone, dry, light-colored.....	2	
27. Limestone .....		10
26. Sandstone, dry, light-colored.....	2	
25. Shale, variegated .....	26	
24. Shale, hard, black .....	8	
23. Coal .....	1	
22. Fire clay, impure .....	3	
21. Shale and limestone.....	8	
20. Shale, hard, dark .....	7	
19. Coal, not good .....	1	6
18. Fire clay .....	7	
17. Sandstone .....	3	
16. Shale, variegated .....	10	
15. Shale, hard, dark .....	7	
14. Coal, part bony .....	1	
13. Sandstone .....	2	
12. Shale, black .....	1	
11. Coal .....		6
10. Fire clay, with shale.....	5	6
9. Sandstone .....	31	
8. Shale, dark .....	10	
7. Sandstone .....	2	
6. Shale, light-colored .....	6	
5. Shale, dark .....	22	
4. Shale, lighter colored .....	15	
3. Coal .....	7	
2. Fire clay .....	3	
1. Sandstone .....	8	

The thickness of the lower coal (No. 3) varies considerably. The upper horizons seem fairly persistent, but bear only thin coals. Although the Inland mine has no railroad connections and so supplies only a local trade, it is extremely well managed and is one of the best coal properties in the state. As soon as railroad

facilities are provided it will become one of the important mines of the Iowa field.

*Little Whitebreast Surface Mines.* At numerous places on both sides of Little Whitebreast creek, from section 22 of Lincoln township to section 19 of English, coal has been taken for local consumption from seams outcropping in the valleys. In Lincoln township the establishment of the Inland mine caused the abandoning of most of the work in this upper coal, for it is seldom more than thirty inches in thickness. In English township, also, little mining is now done. Two coals, the upper about eighteen inches and the lower slightly thicker, outcrop here. Sometimes these two seams approach sufficiently close to be mined as one, and again, they may be separated by a distance of fifteen feet or more.

*Wild Cat Drifts.* Along Wild Cat or English creek and its branches, in sections 11, 12, 14 and 15 of English township, small drifts have been opened during the winter months. The coal mined is in most cases only from fourteen to eighteen inches in thickness and lies only a short distance above the creek bottoms. A mine on W. S. Dungan's land (Sec. 12, Nw. qr.) is said to have worked a thirty-inch bed.

*Drifts on Cedar Drainage.* Some fairly thick surface coals have been mined for local use in the valleys of Pleasant township, and, since this region is far from any railroad, are of considerable importance to the farming communities. At least three horizons containing discontinuous basins of coal may be recognized, but in the absence of a topographic map no correlation of separated outcrops can be made with any certainty. Reported occurrences of the upper coals along Cedar drainage are noted in the following list. No mines were open when the region was visited in the summer of 1907.

LOCATION.	THICKNESS.	REMARKS.
Lincoln Township— Sec. 12, near center.....	18 inches....	
Cedar Township— Sec. 6, near center.....	14 inches....	Outcrop now concealed.
Pleasant Township— Sec. 24, north central.....	3 feet.....	The Briggs drift. It supplies a large country trade.
Sec. 23, Se. qr., Ne. $\frac{1}{4}$ .....	.....	A small shaft.
Sec. 21, Nw. qr., Nw. $\frac{1}{4}$ .....	.....	A small drift on Little Cedar creek.
Sec. 13, Se. qr., Sw. $\frac{1}{4}$ .....	.....	The Umbenheuer drift on Big Cedar.
Sec. 12, Nw. qr., Sw. $\frac{1}{4}$ .....	3 feet.....	A new drift on Little Cedar.
Sec. 11, Sw. qr., Ne. $\frac{1}{4}$ .....	3 feet.....	An old drift on Little Cedar.
Sec. 1, Sw. qr., Ne. $\frac{1}{4}$ .....	3 feet.....	A new opening.
Sec. 1, Ne. qr., Se. $\frac{1}{4}$ .....	.....	The Van Loon mine.
Sec. 2, N. $\frac{1}{2}$ .....	.....	Abandoned drifts.
Sec. 3, Se. qr., Nw. $\frac{1}{4}$ .....	3 feet.....	An abandoned drift.
Sec. 3, N. $\frac{1}{2}$ .....	{ 3 $\frac{1}{2}$ feet.....	Top seam, mined by stripping.
	{ 3 feet.....	Second seam, drifted.
	{ .....	Third seam, drifted from creek bottom.

*Zero.* At Zero, on the Chicago, Burlington and Quincy Railroad, a mile and a half west of the Monroe county boundary, a mine was formerly operated by the Creston Mining Company. The shaft was 260 feet deep, with coal five feet in thickness. Where worked the seam was quite irregular, on which account the mine was finally abandoned after several companies had worked out considerable coal.

*Deep Coals on Cedar Drainage.* The Consolidation Coal Company, Inland Coal Company, and others have for several years been conducting prospecting operations in northeastern Lucas county in an endeavor to find workable basins in the more productive horizons near the base of the Coal Measures. There is little doubt that success has attended these efforts and that only the advent of a railroad in this region is necessary to place Lucas in the front rank of coal producing counties. Mr. Haven of the Inland Coal Company reports the location of five good basins, comprising a total of several thousand acres. The Consolidation Coal Company has purchased the mineral rights of a large tract in sections 9, 10, 15, 16, 17, 20 and 21 of Pleasant township. Coal of an average thickness of four feet eight inches

is said to have been found in all holes drilled here on over 2,500 acres of land. The strata are extremely variable, yet the following drill records give some idea of their succession.

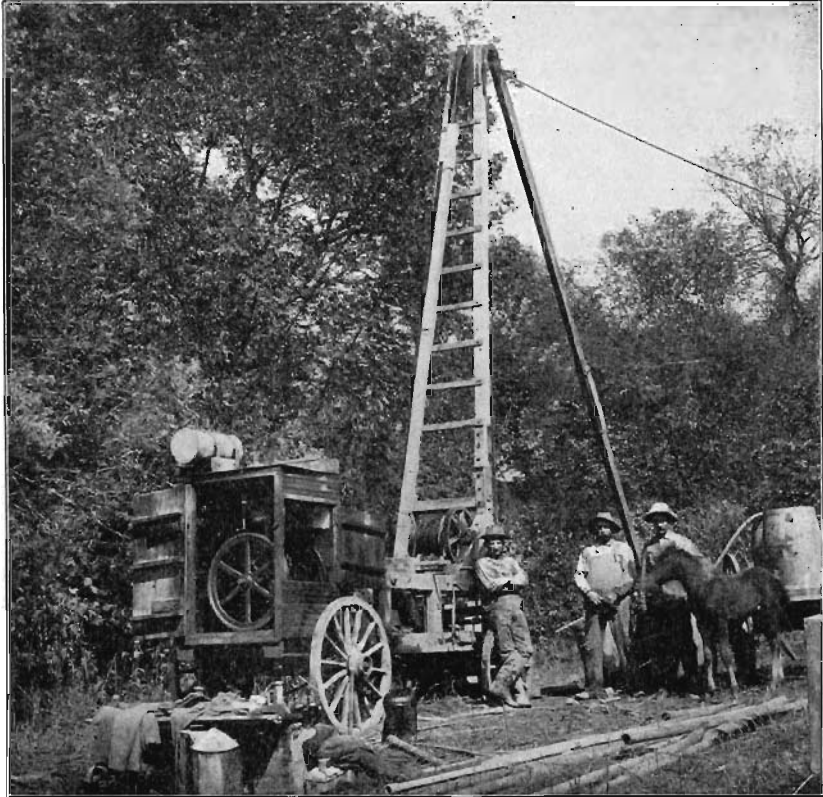


Figure 53. Churn drill of the Consolidation Coal Company, operated by a gasoline engine.

PLEASANT TOWNSHIP, SEC. 15, NE. QR., NW.  $\frac{1}{4}$ .

	FEET.
4. Clay .....	.15
3. Shale, light-colored .....	5
2. Shale, gray .....	.42
1. Coal .....	4
	—
Total .....	.66

LUCAS COUNTY

PLEASANT TOWNSHIP, SEC. 16, SW. QR., NW. ¼.

	FEET.	INCHES.
5. Soil and drift .....	67	11
4. Shale .....	69	11
3. Shale, gray .....	80	9
2. Coal, good .....	3	10
1. Coal, dirty .....	2	1
Total .....	224	6

PLEASANT TOWNSHIP, SEC. 17, SE. QR., SE. ¼.

	FEET.	INCHES.
14. Soil and drift .....	52	
13. Shale, light-colored .....	22	
12. Shale, dark .....	5	8
11. Coal .....	1	1
10. Shale, light-colored .....	19	
9. Rock (concretion ?) .....	2	
8. Shale, dark .....	4	
7. Coal .....	1	4
6. Shale, light-colored .....	10	
5. Rock (concretion ?) .....	4	
4. Shale, light-colored .....	18	3
3. Coal .....	1	
2. Shale .....	88	
1. Coal .....	5	9
Total .....	234	1

The unreliable character of much of the coal in the lower horizon is illustrated by six drillings made on J. F. Carson's land in and near section 32 of Pleasant township, which showed that the seam present ranged from six inches to five feet in thickness on a comparatively small bit of land. One of these drill records is:

PLEASANT TOWNSHIP, SEC. 32, NE. QR., SE. ¼.

	FEET.	INCHES.
12. Soil and drift .....	125	9
11. Shale, dark .....	10	3
10. Shale, light-colored .....	3	6
9. Shale, gray .....	33	6
8. Sandstone .....	2	4
7. Shale, gray .....	9	1
6. Sandstone .....	2	7
5. Shale, gray .....	32	
4. Rock ("bowlder" in coal?) .....		10
3. Coal .....	1	2
2. Coal, dirty .....	1	3
1. Shale, calcareous .....	4	9
Total .....	227	



**MONROE COUNTY**

Magnificently served by railroads and lying in a highly productive coal belt, Monroe county has for several years been the most important coal producer in Iowa. The number of mines is not exceptionally large, yet they are with few exceptions the property of companies that are willing and able to risk a large amount of capital in order to obtain a proportionately large return. Prospecting has been systematic and thorough, so that the larger corporations are able to look far into the future when planning the location of their mining camps and mines. As a result, the larger basins of workable coal are being exploited one by one in definite geographic order.

With the exception of a small area of about three square miles in the valley of the Des Moines river near Eddyville and for short distances up Gray and Miller creek, where the Saint Louis limestone outcrops, the entire county is underlain with Coal Measure strata of the Des Moines stage. From a thickness of zero at Eddyville these increase progressively toward the southwest until probably a thickness of about 400 feet is attained in the southwestern corner of the county. Very few test holes are continued to the Saint Louis, a practice which is to be condemned, as thick coals lying near the base of the measures may thereby be overlooked. In section 28 of Bluff Creek township the limestone was reached at a depth of 199 feet; yet two miles north the coal mined descends abruptly into a small basin 283 feet below the surface, a feature probably due to a local depression in the basement limestones. A boring in section 29 of Mantua township found the Saint Louis at 216 feet, while drillings of about the same depth at Hilton and Foster stopped in the Coal Measures. A drill hole put down by the Hocking Coal Company to a depth of 317 feet in section 34 of Troy township encountered at least 272 feet of coal-bearing strata. Coal is reported at 313 feet in section 4, Wayne township.

Notwithstanding the amount of development work that has been done in this county, mining has been confined chiefly to the northern and central portions; while large portions of the southwestern quarter remain practically unexplored. It is in the extreme southwestern corner that the Mystic seam of the

Appanoose-Wayne field is most likely to be found if it be present at all in Monroe county.

Although coal was mined along Bluff, Miller, and Avery creeks, and west of Albia at an early date, the county did not rank among the few best producers until the seventies. As

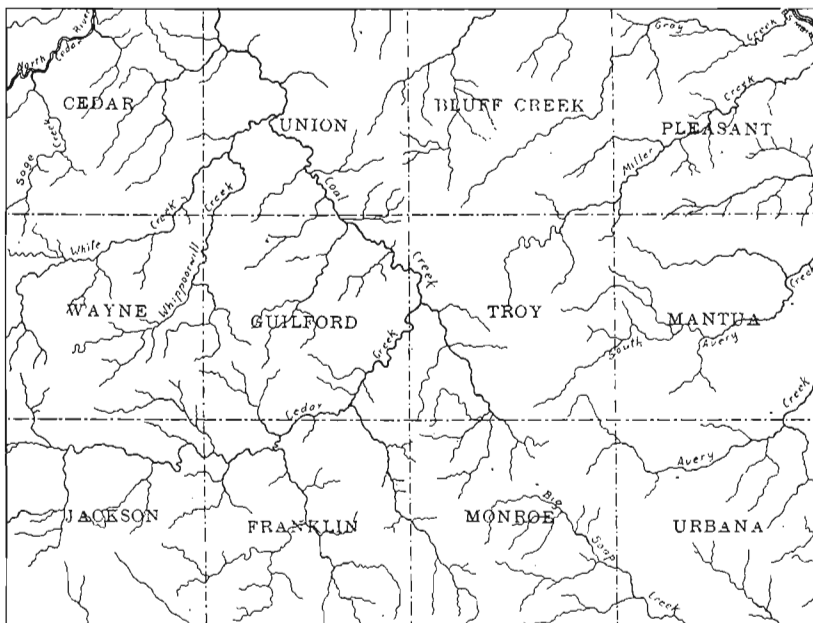


Figure 54. Sketch map of Monroe county.

given in the U. S. census reports, the output for 1860 was 2,756 tons; for 1870, 15,410; for 1880, 181,288, and for 1890, 258,401. With the exception of the period of business depression ending in 1896, the coal industry of succeeding years has advanced steadily and notably. In 1901 the county passed all others and since then has held first place. According to reports of the Iowa Geological Survey, statistics for recent years are:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	584,578	1903.....	1,768,054
1899.....	684,004	1904.....	2,061,877
1900.....	772,457	1905.....	2,227,177
1901.....	1,237,332	1906.....	2,458,473
1902.....	1,349,722	1907.....	2,476,021

During the year ending June 30, 1908, twenty-three mines produced 2,167,061 tons of coal and employed 3,634 men. Whereas in 1883 Monroe was responsible for less than two and one-half per cent of the production of the state, in 1907 she mined over thirty-one per cent of the total.

The status of the industry, so far as known in July, 1907, is sketched in the following pages.\*

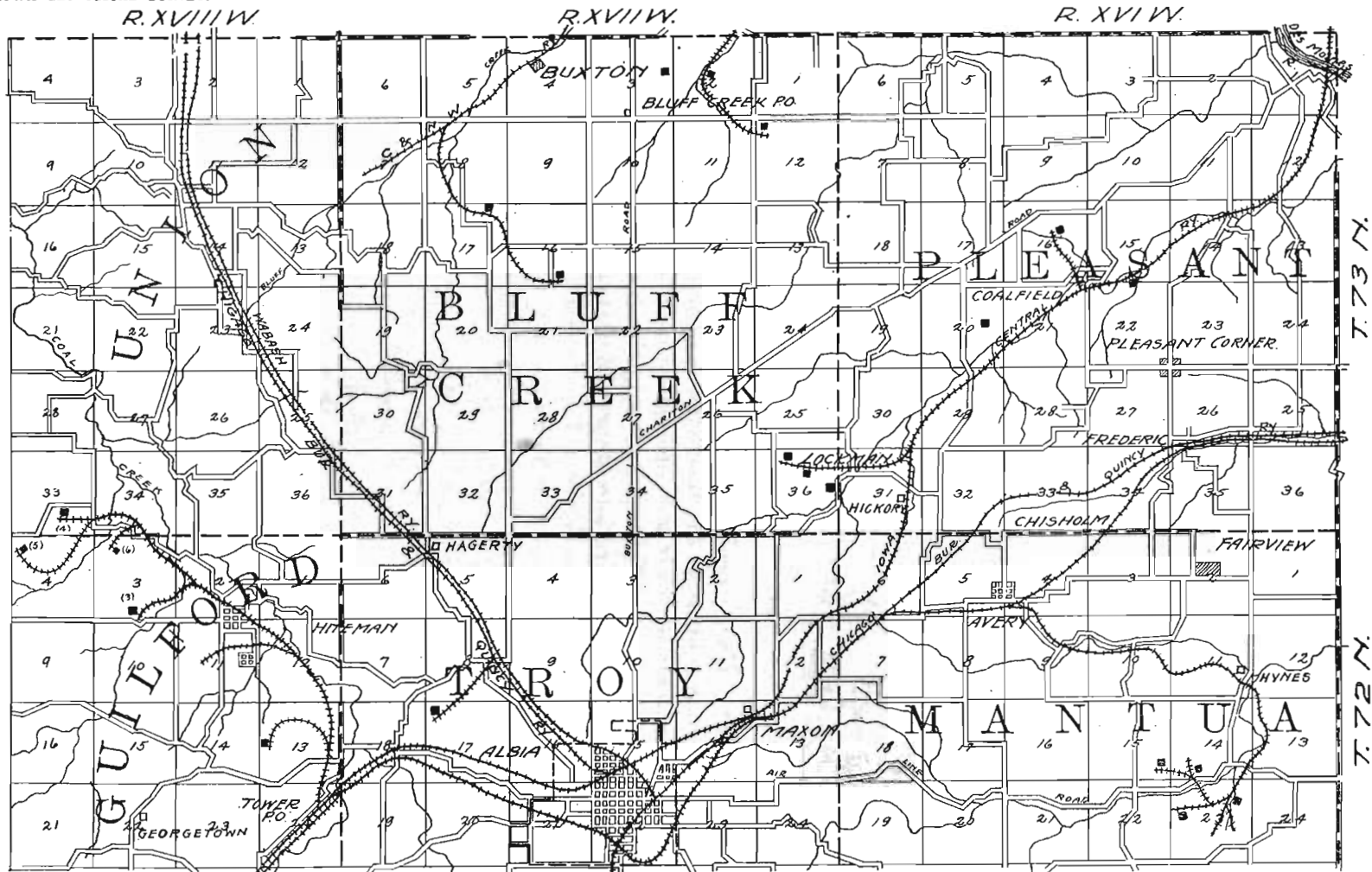
#### MONROE MINES AND COAL BEDS.

*Northwestern Townships.* The Consolidation Coal Company has done considerable prospecting in Union, Cedar, and Wayne townships and has located and purchased several basins of coal which will be exploited at some future date. The Consolidation driller reports that coal averaging four feet eight inches was found in over 1,000 holes drilled in a strip one-half to two miles wide along White creek in Wayne township. This area forms part of a continuous basin said to contain 7,000 acres of coal. One of the drill records of a boring in this territory follows (Wayne Tp., Sec. 7, Nw. qr., Se.  $\frac{1}{4}$ ).

	FEET.	INCHES.
Drift .....	97	
Shale .....	26	
Coal .....		8
Shale, dark .....	18	6
Rock (sandstone ?) .....	1	6
Shale, gray .....	30	2
Coal .....	4	
	177	10
Total .....	177	10

Another basin containing the same average thickness of coal occupies sections 7, 8, 17, and 18 of Union township and adjoining portions of Cedar. It is said to comprise 3,000 acres of coal. A smaller basin of 210 acres is reported from sections 14, 23, and 24 of Union township, south of Lovilia. Coal is also known north of Lovilia, where country mines are occasionally operated. The following record is from section 3 of Union township.

\*Acknowledgments for material are due to Beyer and Young: *Geology of Monroe County, Iowa Geol. Surv., Vol. XIII, pp. 353-433; Des Moines, 1903.*



Map showing mines in northern Monroe county.

	FEET.	INCHES.
Drift .....	30	
Sandstone, buff .....	3	
Shale, sandy, gray .....	7	
Shale, blue, light-colored.....	30	6
Shale, blue, dark .....	6	
Coal .....	5	6
Fire clay .....	—	6
	—	—
Total .....	82	6



Figure 55. View of Buxton from the west.

*Buxton.* The Consolidation Coal Company was organized in 1875 with headquarters at Muchakinock, in Mahaska county, and was reorganized under the present ownership in 1881. The Chicago and North Western Railway extended its already long coal spur southwestward into Monroe county and the Consolidation headquarters were moved to the new mining camp, Buxton. Buxton is a thriving town containing a population of about 5,000 people, chiefly colored. It possesses a \$20,000 Y. M. C. A. building, a large company store, well built houses for the miners, and is, in general, progressive. Special trains carry the men to and from the mines, of which there are five operated by the company. Mine No. 14, situated in Mahaska county, is discussed in another place in this volume. No. 10 lies two miles south of Buxton (Bluff Creek Tp., Sec. 17, Ne. qr., Nw.  $\frac{1}{4}$ ), No. 11 about one mile southwest of No. 10 (Sec. 16, Se. qr., Sw.  $\frac{1}{4}$ ), No. 12 three miles east and south of Buxton (Sec. 12, Nw. qr., Nw.  $\frac{1}{4}$ ), and No. 13 two miles east of the same place (Sec. 2, Nw. qr., Se.  $\frac{1}{4}$ ). Within a year Numbers 11 and 13 will be abandoned and Number 15 will be sunk one mile southeast of Number 11.

The coal worked at these mines varies from four to seven feet in thickness, with an average of four feet six inches. Several

unworked coal horizons are also known. A section representative of prospects in the territories of Numbers 10 and 13, which are located on the bottom lands, is as follows:

	FEET.	INCHES.
9. Surface wash and drift.....	12	
8. Sandstone .....	1	6
7. Clay shale .....	3	
6. Shale, dark .....	6	
5. Clay shale .....	10	6
4. Shale, dark .....	9	7
3. Coal .....	1	8
2. Shale, dark .....	62	7
1. Coal .....	6	2
	<hr/>	<hr/>
Total .....	113	

Of the upland prospects, as found at Numbers 11 and 12, the following is about an average.

	FEET.	INCHES.
20. Drift and loess.....	25	
19. Sandstone, gray .....	29	6
18. Clay shale .....	3	6
17. Shale, dark .....	3	1
16. Coal .....	1	9
15. Shale, light .....	10	2
14. Coal .....	2	
13. Shale, dark .....	3	6
12. Coal .....	1	3
11. Shale, light .....	32	
10. Coal .....		10
9. Shale, light .....	21	
8. Shale, dark .....	2	4
7. Coal .....		6
6. Shale .....	15	10
5. Sandstone .....	3	
4. Shale, gray .....	13	11
3. Coal .....	2	
2. Shale, dark .....	49	
1. Coal .....	5	
	<hr/>	<hr/>
Total .....	225	3

The roof-shale is fairly firm and the coal is usually uniform in character, though where there are strong undulations it is apt to "pinch out." The company's mining engineer reports a very remarkable occurrence from mine Number 10. At the time

the region was visited by the writer this mine was temporarily closed, so that the phenomenon was not personally investigated by him, but the source of information is apparently reliable. It is said that the seam drops nearly 145 feet in a horizontal distance of 800 feet, with good five foot coal continuous throughout the entire distance. A deep depression elongated northeast-southwest and embracing thirty acres, is formed in this manner. The following drill records taken 700 feet apart show the relationships (Sec. 16, Sw. qr., Nw.  $\frac{1}{4}$ ).

## HOLE A.

	FEET.	INCHES.
15. Clay .....	13	
14. Shale, light-colored .....	42	10
13. Sandstone .....	1	6
12. Shale, light-colored .....	74	8
11. Shale, dark, sandy .....	10	2
10. Coal .....		8
9. Shale, light-colored .....	42	8
8. Shale, dark .....	11	3
7. Coal .....	1	8
6. Shale, light-colored .....	7	2
5. Shale, sandy .....	4	6
4. Shale, mixed .....	22	3
3. Coal .....	1	
2. Shale .....	44	7
1. Coal .....	5	11
Total .....	288	10

## HOLE B.

	FEET	INCHES.
14. Drift .....	24	
13. Shale, dark .....	6	7
12. Coal .....	1	3
11. Shale, light-colored .....	19	10
10. Shale, dark .....	3	
9. Coal .....		6
8. Shale, light-colored .....	7	10
7. Sandstone .....	3	4
6. Shale, dark .....	5	9
5. Coal .....		3
4. Shale, light-colored .....	4	6
3. Coal .....		7
2. Shale, gray .....	51	10
1. Coal .....	4	11
Total .....	134	2

There is also in Number 10 workings a contemporaneous erosion channel in which shale replaces the coal. The ancient stream ran north or south, and evidently divided into two parts and flowed around a small coal-producing area; for an "island" of fifteen acres of coal is now found in the mine, with a barren strip 360 feet wide on one side and another 150 feet wide on the other. True faults with a maximum throw of five feet each occur in the same workings; while a similar feature is encountered in the main south at Number 11. Pyritic concretions and clay-ironstone bowlders are not especially common, excepting at Number 13. Below are tabulated summaries of the results of mining operations.

MINE NUMBER.	DEPTH OF SHAFT (FEET.)	ACRES MINED OUT.	ACRES IN BASIN, PROBABLE.
10	100	320	640
11	208	260	560
12	182½	220	1300
13	100	200	

At the present rate of working, these basins will soon be exhausted, but the company owns large tracts of coal land farther west, in Monroe and Lucas counties.

The room and pillar system of mining is used, the rooms being turned forty feet and driven 210 feet. Widening out begins after ten feet and coal is obtained by shooting from the solid. At numbers 11 and 12 all the water pumped is used in wetting down the entries. Electric third-rail haulage, for which the current is carried in the rack-rail and returned in the running-rail, is used on all the main entries. Ten gathering motors have also been ordered and will be operated by rack-rail in the entries and by trolley in the rooms. The capacity of the pit cars is from 2,000 to 3,000 pounds, although smaller ones are used on the edges of the basins where the coal is low. Nothing is worked out within 200 feet of the shaft. Forty-five Whitcome cutting machines, the same number of post-drills, and four Norwalk compound air-compressors are in use.

The tipples are all of the same pattern and, aside from that at number 11, of steel construction. Reynolds-Corliss and Litchfield engines are used in hoisting. Loading is facilitated by the use of Olson self-dumping cages and by box-car loaders at



numbers 10 and 12. The equipment on top is complete in every respect.

West of Number 13, in an area surrounded by Consolidation holdings, is the Regal mine (Bluff Creek Tp., Sec. 3, Ne. qr., Se.  $\frac{1}{4}$ ) and the associated mining camp, Frakerville. A five-foot coal is reached at a depth of 164 feet. Entries extend about one-fourth mile east, west, and south to the limits of the 160 acres controlled by the company. Aside from an occasional streak of pyrite the coal is clean, though it is not so good in the north-western workings. Hoisting is by a direct-connected engine and dumping by automatic cages.

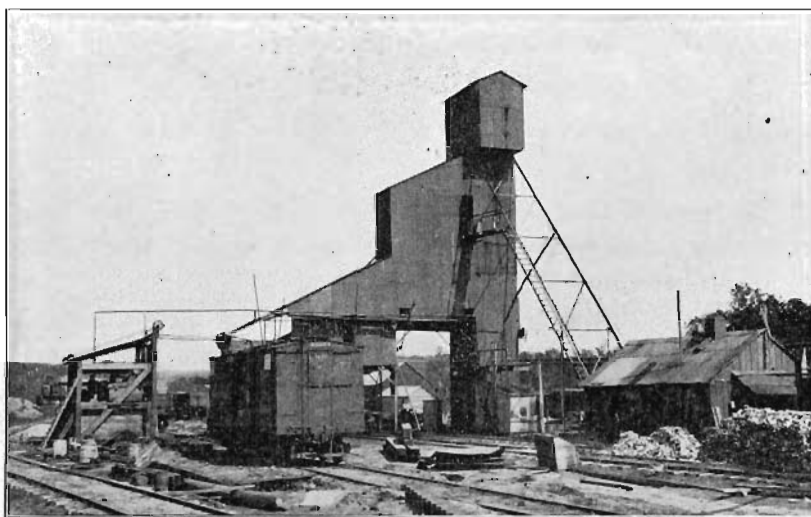


Figure 56. Steel tippie, showing box car loader, Shaft No. 10, Consolidation Coal Company. Buxton.

*Coalfield.* In the valley of Miller creek are a number of mines, chiefly local, operating in coals that lie not far beneath the surface and are reached by slopes. Near Eddyville the coal basins are found quite near the Saint Louis limestone. Two mines near Coalfield do a shipping business. The Coalfield Fuel Company works a slope on a short spur from the Iowa Central, northwest of Coalfield. Coal from three to four and a half feet thick has been mined across section 9 into section 8. The seam is slightly undulatory and dips, in general, to the southwest. Boden's slope is a short distance southeast of Coalfield and is

also a railroad mine. The bed worked bears an average of three feet six inches of coal, dipping strongly to the southeast as far (one-fourth mile) as an entry has been driven into the hill. The coal thins on the south of this territory.

*Lockman.* The Central Coal Company now operates three shipping mines near Lockman, of which Number 3 is expected to become the best producer. This slope, which lies near the western extremity of the coal spur through the northern portion of section 36 of Bluff Creek township, pitches four and one-half inches to the yard. Wire-rope haulage is effected by means of a double Taylor engine. Slope Number 2 enters the hill not far from the mouth of Number 3. Shaft Number 4, lying one-half mile southeast, is forty-five feet deep and has just been made ready for work. In all three mines from four to five feet of coal is worked, except where local irregularities in the thickness are present. Contemporaneous erosion channels, filled with sandstone, cut out the coal in places. The four-foot coal has been located in many drill holes in sections 25 and 36 of Bluff Creek, section 31 of Pleasant, and section 1 of Troy township, while at least one thinner seam is commonly found in some higher horizon. Following is a representative record from section 25, Bluff Creek township.

	FEET.	INCHES.
12. Soil and drift-clay .....	45	
11. Shale .....	35	
10. Sandstone .....	2	
9. Shale .....	12	
8. Coal .....		6
7. Sandstone, gray .....	7	6
6. Shale .....	23	
5. "Slate" .....	14	
4. Coal .....		8
3. Shale, dark and fissile below.....	5	7
2. Coal .....	3	11
1. Fire clay .....	1	6
	150	8
Total .....	150	8

*South Avery Creek.* For many years coal has been extensively mined in the valley of Avery creek, in Mantua township. As the areas near Hynes became exhausted, a coal spur was extended southward along the valley of South Avery creek and

new mines were opened. The Smoky Hollow Coal Company has been the largest producer in the district and to-day operates two slopes, Number 6 (Sec. 23, Ne. qr., Nw.  $\frac{1}{4}$ ) and Number 7 (Sec. 23, Nw. qr., Sw.  $\frac{1}{4}$ ). The coal either outcrops in the hillside or is covered only lightly by the drift. It varies from forty to sixty-six inches in thickness and is fairly level except for minor undulations. Prospects over a considerable territory show that the coal is usually present, although somewhat irregular in occurrence. At least one thin coal is commonly found above the bed worked; while in the territories of Numbers 6 and 7, a seam that infrequently shows a workable thickness occasionally comes within six inches of the bed mined, only to be separated from it again by distances of twenty feet or less. A prospect three-fourths mile west of Number 7 disclosed as many as four coals in a vertical interval of forty-five feet. The company has worked chiefly in sections 9, 10, 11, 13, 23 and 24 of Mantua township. The following section may be taken as an average for the district.

	FEET.	INCHES.
16. Drift and alluvium .....	20	
15. Sand and gravel .....	60	
14. Clay mixture .....	20	
13. Shale, black .....	14	
12. Coal .....		8
11. Shale, light .....	13	
10. Shale, dark .....	5	
9. Shale, light .....	6	
8. Shale, dark .....	6	
7. Coal .....	1	
6. Fire clay .....	3	
5. Shale, dark .....	8	
4. Coal .....	5	6
3. Shale, sandy .....	4	
2. Sandstone .....	21	
1. Shale, gray .....	2	
	—	—
Total .....	189	2

Mine Number 6 is the best producer, Number 7 not being fully developed. Number 6 workings are nearly a mile and a half from the slope mouth; while Number 7 has worked in about 1,700 feet. Tail-rope haulage is employed in both mines. Two new shafts are now being prepared for future production: Num-

ber 8, forty-five feet in depth (Sec. 14, Sw. qr., Se.  $\frac{1}{4}$ ), and Number 9, fifty-five feet deep (Sec. 15, Se. qr., Se.  $\frac{1}{4}$ ). A spur will be run off to them from the company's main spur between the two slopes.

The White Ash Coal Company has worked a slope for eight years one mile south of Avery. The coal bed varies between three and one-half and six feet in thickness. A local trade is supplied, chiefly in the winter months. A tramway may soon be built to Avery and a shipping trade inaugurated.

*Albia.* Although numerous shafts have at one time and another been opened just north and west of Albia, especially in sections 8, 9, 10, 17 and 18 of Troy township, only one mine is now in operation in this district. The Star mine, two and one-half miles northwest of Albia (Sec. 17, Nw. qr., Nw.  $\frac{1}{4}$ ), has been open seven months in the year for about ten years. The shaft was sunk to a coal forty-four inches to six feet thick. A three-foot seam is said to lie forty feet below the surface at the shaft. The product of this mine is hauled to Albia, and to a switch on the Chicago, Burlington and Quincy railway whence it is shipped.

The Albia Fuel Company has completed the sinking of a shaft one mile south of Albia (Troy Tp., Sec. 28, center of east line). The mine lies on the west side of the Iowa Central tracks, over which the product will be shipped.

*Hocking.* For a number of years the Hocking Coal Company has mined extensively in and near the valley of Coal creek. Their mine Number 1, at Hocking, was abandoned in 1906. Number 2, southeast of Hocking (Monroe Tp., Sec. 4, Ne. qr., Ne.  $\frac{1}{4}$ ), is still in operation, but its output is steadily decreasing and it will also be abandoned in the course of a year or two. Number 3 was sunk in 1905 two and a half miles south of Albia, beside the main line of the Iowa Central (Troy Tp., Sec. 34, Se. qr., Sw.  $\frac{1}{4}$ ). It is probable that another mine will be started southwest of Hocking. The coal in all these mines is of the same general character and lies at a depth of 315 feet at Number 3 and 208 feet at Number 2, which is situated on lower ground. It varies in thickness from three and one-half to six feet. Round concretions of sandstone and ironstone are fairly common in the coal and roof-

slate and undulations render the floor quite irregular in places, causing maximum variations of twenty-five feet in the level of the bed. The general dip of the strata is toward the south. Where the coal is thickest the underlying fire clay often shows a strong tendency to heave. During the summer months the warm air-currents deposit much of their moisture on the cool sides of the entries and rooms, altering the pyrite and marcasite of the roof-shale so that the latter breaks down somewhat. At Number 3 the coal lies in a trough-like basin trending east and west. On the north it rises and disappears; on the south it rises and thins. The basin is from 1,320 feet to three-fourths mile in width. On the north the roof and bottom become more firm. The following section (Monroe Tp., Sec. 4, Se. qr., Nw.  $\frac{1}{4}$ ) is representative for the district.

	FEET.	INCHES.
19. Drift .....	25	
18. Shale, light-colored .....	10	
17. Sandstone .....	25	
16. Shale, light-colored .....	25	
15. Sandstone .....	10	
14. Shale, light-colored .....	15	
13. Rock, hard .....	2	
12. Shale, dark .....	43	
11. Rock, hard .....	5	
10. Shale, light-colored .....	11	
9. Sandstone .....	10	
8. Shale, light-colored .....	8	
7. Coal .....	1	
6. Rock, hard .....	1	
5. Shale, light-colored .....	11	
4. Rock, hard .....	2	
3. Shale, dark .....	92	8
2. Coal .....	4	4
1. Fire clay .....	1	
	—	—
Total .....	302	

Both mines are well equipped and well managed,—especially Number 3. About 400 acres have been mined out from Number 2 shaft. At Number 3 automatic cages, stokers, and pit-car oilers, and a cleaver breaking device on the pit-cars facilitate the handling of the coal. The fan used is of an improved pattern devised by Mr. John Verner, one of the State Mine Inspectors.

The steel tower is sixty-six feet high to the sheave wheels. Coal is loaded through a curved shoot, a somewhat doubtful method of preventing breakage.

*Hilton.* The Whitebreast Fuel Company established one of the largest producers in the state at Hilton, two miles south of Hocking Number 3, but closed it in July, 1907. The roof was



Figure 57. Tippel of shaft No. 2, Hocking Coal Company, Hocking.

poor, making it necessary to use many props and to handle considerable dirt. The coal, however, was of fair quality and is not yet exhausted. The record given below is typical of the sequence of strata in this district.

MONROE TP., SEC. 10, NE. QR., NW. ¼.

	FEET.	INCHES.
35. Drift .....	71	
34. Shale, yellow .....	10	
33. Shale, gray and clayey.....	9	5
32. Coal .....	1	9
31. Shale, blue .....	1	4
30. Coal .....	1	1
29. Shale, blue .....	25	5
28. Shale, black .....	4	
27. Sandstone, gray .....	2	
26. Shale, black .....	7	

## COAL DEPOSITS OF SOUTH CENTRAL IOWA

25. Coal .....	1	6
24. Clay shale, light.....	9	6
23. Sandstone, hard .....	6	
22. Shale, dark .....	3	
21. Shale, sandy, light .....	10	
20. Shale, dark .....	6	8
19. Coal .....		9
18. Shale, dark .....	4	7
17. Clay shale, light .....	3	
16. Shale, dark, banded.....	7	
15. Shale, gray .....	5	
14. Coal .....		4
13. Shale, dark, and light below.....	17	8
12. Sandstone .....	3	
11. Shale, mixed .....	7	
10. Sandstone .....	2	
9. Shale, dark .....	4	10
8. Coal .....	1	4
7. Sandstone, hard .....	2	10
6. Shale, dark .....	36	6
5. Coal .....	4	2
4. Coal, shaly .....		7
3. Shale, dark above and light below.....	5	9
2. Sandstone .....	3	
1. Shale, dark .....	4	
Total .....	283	

*Hiteman.* For a number of years the Wapello Coal Company has mined extensively in Guilford and Union townships, using as headquarters the attractive mining camp named Hiteman, near the northeast corner of Guilford. The company has constructed a spur from the Chicago, Burlington and Quincy railroad northward to the camp and beyond to their mines. Mine Number 1, immediately south of Hiteman, was abandoned in 1903 because of the long haul of over a mile from the workings to the shaft. Number 2, just north of the town, was never considered a profitable mine and was abandoned in 1901. Number 3, one mile west of Hiteman, and Number 4, three miles northwest of the same place, are still in operation. Shaft Number 3 is located in a basin running east and west and for several reasons was sunk so as to penetrate the lowest point in the basin, although the coal at that point is rather poor and contains much rock. The coal runs no thicker in the basins than on the rises. Haulage on the south side of the mine has recently been materi-

ally improved by the installation of a first-motion tail-rope engine and the making of a cut-off that obviates the necessity for two turns in the road, besides shortening the haul. The north workings are approaching depletion. Mine Number 4 is one of the best producers in the state. It was opened in 1902 by a shaft 150 feet in depth through which coal is hoisted by a geared engine with a six foot drum. The main haulage is effected by a first-motion tail-rope engine over roads laid with forty pounds of iron to the yard.

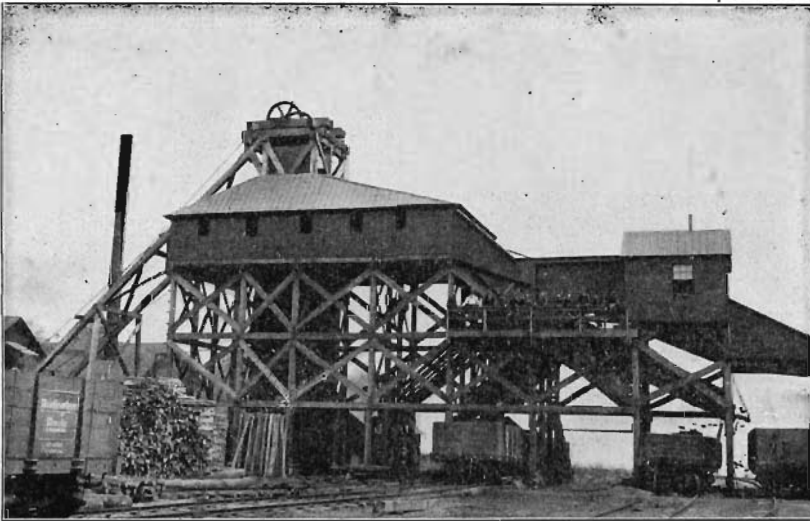


Figure 58. Tippel at shaft No. 3, Wapello Coal Company, Hiteinan.

The Wapello Coal Company has operated diamond drills in this district for many years and has gained a complete knowledge of the various coals. Coal from four to six and one-half feet in thickness has been located in sections 1, 2, 3, 5, 9, 11 and 12 of Guilford township and 27, 28, 31, 34 and 35 of Union township. This statement is not meant to convey the idea that one continuous seam covers an extensive area; the strata are variable in thickness and occurrence, as in other parts of the main Iowa field. The undulatory nature of the coal beds renders their level quite changeable between neighboring points. In most of the drillings a heavy stratum of dark, fissile shale, from twenty-five to sixty-five feet in thickness, lies immediately above



the thicker coal. Where the drift does not extend to this layer, a sandstone is often found next above it, with a thinner coal bed still higher in the series. The following sections illustrate the position of the strata.



Figure 59. Diamond drill of the Wapello Coal Company.

UNION TP., SEC. 34, SW. QR., NE.  $\frac{1}{4}$ .

	FEET.	INCHES.
3. Soil .....	15	
2. Shale, fissile .....	60	6
1. Coal .....	6	
Total .....	81	6

GUILFORD TP., SEC. 2, NE. QR., SE.  $\frac{1}{4}$ .

	FEET.	INCHES.
8. Soil and drift.....	31	
7. Soapstone shale .....	8	
6. Shale, fissile .....	6	6

5. Coal .....	1	
4. Shale, fissile .....	1	6
3. Sandstone .....	4	
2. Shale, fissile .....	72	6
1. Coal .....	5	
	129	6
Total .....	129	6

*Foster.* The only mine of importance in the southeastern corner of the county is Number 6 of the Phillips Fuel Company, located one-half mile west of Foster and shipping over the Chicago, Milwaukee and Saint Paul Railway. The bed mined lies 184 feet below the surface and is from four to five and one-half feet thick. Two coal "blossoms" were penetrated in sinking the shaft. A few well-marked geological faults of moderate throw are found in the workings, one of which made necessary the construction of an inclined tunnel sixty feet in length. Some trouble is also experienced from a "squeeze" that is slowly spreading over a part of the mine.

The records of prospect holes in this vicinity are so variable that they form but a slight basis upon which to rest general conclusions. Usually a two-foot "cap rock" is found about four feet above the coal mined, and at least two thin coals occur between it and the surface. Some attempt has been made to correlate a coal which outcrops along Soap creek near Foster and on Avery creek in Urbana township with the Mystic seam of Appanoose county. This bed shows three feet of coal, split into two benches by a thin clay parting as at Mystic, but the beds are of poor quality for fuel purposes and have not been drifted into for many years. There is some evidence of the limestone "cap rock" of the Mystic seam, yet no "bottom rock" has been discovered and neither the limestones nor the coal appear in several borings made south of Foster. Various theoretical considerations lead us to doubt the verity of the suggested correlation.

#### RINGGOLD COUNTY

Ringgold county is underlain by strata of the Missouri stage, sometimes known as the upper or barren Coal Measures. They are not completely lacking in coal, however, as is shown by the mining now being done in them in the counties on the west.

Nevertheless, such coal beds as have been found in this group of strata are thin and workable only under very favorable conditions. Several hundred feet below the surface of this region the rocks of the Des Moines stage, the true coal bearer of Iowa, may be reached; but the best coal horizons lie near the base of the Des Moines, several hundred feet farther down. Very little deep drilling has been undertaken in this part of the state, so that the exact location of various formations is but imperfectly known. The recent discovery of coal at Leon, at depths of approximately 500 feet below the surface, leads us to conclude, however, that coal may at some future date be found in Ringgold at depths that will be somewhat greater because of the westerly dip of the formations. Considering the depth to which prospect holes must be carried in order to reach the best horizons of the Des Moines, the number of prospects necessary to definitely determine the extent of any basin encountered, and the lack of certain knowledge that thick coal does exist so far southwest, drilling for coal alone cannot at present be encouraged in this county.

#### DECATUR COUNTY

The indurated rocks found immediately beneath the drift in the greater part of Decatur are of Missourian age, except where the drift deposits extend to exceptional depths. Des Moines strata outcrop only in the valley of Grand river as far north as Terre Haute and in the extreme southeastern corner of the county. The Missouri may carry thin coals of some importance, but is probably practically barren in this region, so that coal must be searched for among the Des Moines beds beneath it, and preferably in the lower portion of the latter, where coal horizons corresponding in stratigraphic level to those mined in Lucas, Monroe, Wapello and other counties may exist. It is not probable that the persistent seam, the Mystic, which occupies a higher level in Wayne and Appanoose counties, preserves its identity as far west as Decatur county. As is well known, the coal of the deeper horizons lies only in basins of limited lateral extent, so that barren prospects are often drilled in the midst of valuable fields. An unsuccessful drilling is not, therefore, an

absolute indication that no coal exists in the neighborhood, nor does the finding of thick coal in one hole necessarily mean that a workable field has been encountered, for it may be that the drill has penetrated only a small pocket. The discovery of thick coal does indicate, however, that workable basins probably are present at approximately the same level somewhere in the district.

Bain\* cites a few attempts to find coal in this region. At Davis City a boring was carried 212 feet below the Bethany limestone, which outcrops near that point, and penetrated two seams of coal four inches and six inches thick respectively. A boring near De Kalb was unsuccessful. Neither of these two holes were carried sufficiently far to reach the most productive horizons. Mr. C. Woodruff of High Point reported finding three beds of coal respectively one foot, three feet, and four inches in thickness. The hole was located on the highland, approximately 1,125 feet above sea level and was 412 feet in depth.

Recently three interesting borings have been made near Leon. The core of one that was drilled with a diamond drill was examined by James H. Lees, Assistant State Geologist, and his report of the section is given in full below. The thicknesses given for the coals are doubtless smaller than the actual facts, as some material was lost in removing the core.

RECORD OF PROSPECT DRILLING IN PASTURE OF ED. SHARP, IN NW. QR.,  
NE. ¼, SEC. 32, TP. 69, R. 25, LEON.

Altitude at Top About 1050 Feet Above Tide.

NO.		FEET.	INCHES.	TOTAL.
54.	Boulder drift .....	23		
52.	Glacial drift .....	274		300
52.	Glacial, drift .....	274		300
51.	Sand, with water.....	5		305
	(Core begins here.)			
50.	Shale, light gray, fine-grained, hard, fractured surface rather rough.....	3		308
49.	Shale, blue, growing darker below, very fine-grained, fissile, softer than No. 50, fractured surface smooth, soapy.....	12		320

\**Geology of Decatur County*, Iowa Geol. Surv., Vol. VIII, pp. 296-297; Des Moines, 1898. The reader is referred to this report for a more detailed discussion of the stratigraphy than it is possible to give here.

## COAL DEPOSITS OF SOUTH CENTRAL IOWA

NO.		FEET.	INCHES.	TOTAL.
48.	Shale, black, rather rough feel, but not sandy, becoming calcareous below; last 3 inches impure coal or carbonaceous shale. Shale for 9 inches above coal very calcareous and fossiliferous, carrying brachiopods .....	3		323
47.	Clay shale, gray, breaking very irregularly (air-slaked), crumbly, fine-textured, rather soapy, quite calcareous. Occasional small limestone nodules. (Core shows 12 ft. 6 inches.) .....	16		339
46.	Limestone, or very calcareous shale, gray, responding readily to acid, rough fracture .....	1	10	340-10
45.	Shale, black, fine-textured, quite smooth feel, noncalcareous, similar to No. 48. Has numerous thin bands blue-gray material, not respondent to acid, evidently shale, also some pyritic nodules, as well as a 3-inch band of gray, rather calcareous shale, similar to No. 46, 6 inches from top. ....	3	6	344-4
44.	Shale, harder than overlying member, rather rough, calcareous, gray, pyritic, not in definite layers except near bottom, where they are inclined from the horizontal .....	2		346-4
43.	Shale, typical clay shale, blue, soapy, slightly calcareous .....	3	6	349-10
42.	Shale, blue, finely sandy, with fine specks of mica, noncalcareous. ....	8		357-10
41.	Shale, blue, fine-grained, fissile, rather soft, noncalcareous, becoming slightly darker below .....	10		367-10
40.	Shale, brown, very fine and fissile, rather soft, noncalcareous. ....	3		370-10
39.	Shale, similar to above except for blue-gray color, becoming darker below. .	5		375-10
38.	Shale, gray, finely arenaceous, noncalcareous .....	6		381-10
37.	Sandstone, gray, very fine-grained, gradation from No. 38. ....	7		388-10
36.	Shale, blue-gray, fine-textured, fissile, noncalcareous; occasional reddish concretions, possibly oxidized pyrite	19		407-10

DECATUR COUNTY

249

NO.	FEET.	INCHES.	TOTAL.
35. Limestone, dark gray, crystalline, with thin streaks of hard, dark gray shale. Transition from shale above seems to be quite abrupt so far as shown by core. Apparently some fossils are present .....		6	408-4
34. Coal No. 1, in part hard and firm, in part slaked down to dust (blossom). Impure at top. Transition quite abrupt from limestone above to impure coal. According to driller's record .....	1	7	409-11
33. Shale, blue-gray, fissile, some layers slightly sandy, with ironstone concretions; noncalcareous; becoming darker below. Thin films of carbonaceous matter interspersed in upper portion, small mica flakes present	16		425-11
32. Clay shale, gray, fine-textured, non-calcareous, except for certain thin lenses of gray calcareous material. Becomes darker below, but core shows no gradation into coal.....	4	6	430-5
31. Coal No. 2, rather better than coal No. 1. Stands air better. First and last 2 inches, impure. Record shows..	1	2	431-7
30. Clay shale, not so fine as No. 32. Breaks irregularly. Contains small concretions, probably ironstone. (Core shows 2 ft. 6 in.).....	6		437-7
29. Shale, blue-gray, strongly calcareous. Contains some fossils.....	2		439-7
28. Shale, blue, fine-textured, fissile, darker near the base.....	4		443-7
27. Shale, black, carbonaceous, finely gritty, contains some pyrite .....	2		445-7
26. Limestone, dark gray, very fine-grained, hard, apparently nonfossiliferous, responds to acid. Grades both above and below into dark gray calcareous shale .....		9	446-4
25. Shale, black, carbonaceous, quite fine-grained, fissile, has numerous thin, small lenses of hard, gray, slightly calcareous shale 1/8-1/4 inch thick. In places becomes very carbonaceous.	2		448-4
24. Coal No. 3, quite solid and hard. According to record.....	2		450-4

## COAL DEPOSITS OF SOUTH CENTRAL IOWA

NO.	FEET.	INCHES.	TOTAL.
23. Shale, gray, argillaceous, slightly arenaceous, contains fine black concretions of ironstone. Grades down into No. 22.....	2	6	452-10
22. Shale, gray, finely sandy and pyritiferous above, then arenaceo-calcareous, becoming less calcareous and more arenaceous below. Here it becomes bluish and grades into true clay shale, finally grading into No. 21....	16		468-10
21. Shale, dark gray to black, similar to other black shales in general character. Some pyrite and some streaks of hard, gray, noncalcareous shale. Near the base the bed becomes carbonaceous, rather fine, fissile.....	4	2	473
20. Coal No. 4, solid and hard. According to record .....	1	6	474-6
19. Clay shale, gray, rather rough, noncalcareous; irregular fracture, grades into calcareous shale below.....	2	6	477
18. Limestone, hard, dark gray, fine-grained, subconchoidal fracture; considerably broken up and has shale and softer material in interstices....		8	477-8
17. Clay shale, bluish, quite smooth textured, surface of core roughened in places by minute pyrite nodules. Below, the shale contains small black, calcareous concretions. The last 1½ feet becomes darker and grades into calcareous shale, then into brownish, impure coal, then into No. 16.....	4	6	482-2
16. Coal No. 5, some parts firm and solid, others slaked and disintegrated into blossom. According to record.....	2	9	484-11
15. Shale, black, carbonaceous, with 2 inches of coal blossom at top. Coal has slaked badly, with small, white, feathery crystals.....		8	485-7
14. Shale, blue-gray, quite fine-textured for first 2 feet, then becoming slightly more arenaceous for about 2 feet, then argillaceous again and bluish. Pyritiferous locally. Is more fissile near base .....	8	3	493-10

DECATUR COUNTY

NO.	FEET.	INCHES.	TOTAL.
13.			
		9	494-7
12.	6		500-7
11.	1	7	502-2
10.			
	7	6	509-8
9.			
	4	3	513-11
8.	4		517-11
7.		6	519-5
6.	2		521-5
5.	1	4	522-9
4.			
	3	6	526-3
3.			
	2		528-3
2.			
	2		530-3
1.			
			554

The Albaugh prospect, a short distance southeast of Leon (Center Tp., Sec. 33, Se. qr.), penetrated 283 feet of drift, and coals as follows:



## COAL DEPOSITS OF SOUTH CENTRAL IOWA

COAL.	THICKNESS		DEPTH ELEVATION	
	FEET.	INCHES	FEET.	ABOVE TIDE.
No. 1.....	1	11	352	668
No. 2.....	1	6	397	623
No. 3.....		10	401	619
No. 4.....		4	403	617
No. 5.....	4	6	425	595

The Biggs prospect at Leon was begun on higher ground and continued to greater depth than either of the two drillings just quoted. A churn drill was used, but the record was kept with some care and is given below for purposes of comparison.

## LOG OF BIGGS PROSPECT DRILL, SW. COR. SEC. 28, TP. 69, R. 25, LEON.

Altitude of curb about 1120 feet above tide. Now used as city well.

				ABOVE
	FEET.	INCHES.	TOTAL.	TIDE.
20. Glacial drift .....	333		333	
19. Limestone .....	2		335	
18. Coal (No. 1).....	1	8	337	783
17. Soapstone .....	7		344	
16. Blue stone .....	10		354	
15. Blue soapstone .....	23		377	
14. Coal (No. 2).....		10	378	742
13. White soapstone .....	62		440	
12. Limestone .....	4		444	
11. Black slate .....	6		450	
10. Hard soapstone .....	20		470	
9. Slate, black .....	1		471	
8. Coal (No. 3).....	4		475	645
7. Blue soapstone .....	33		508	
6. Limestone, white .....	7		515	
5. Soapstone, white .....	6		521	
4. Hard white soapstone.....	44		565	
3. Coal (No. 4) .....	4	6	569-6	550
2. Soapstone .....	66		635-6	484-6
1. Sandstone, white .....	158		793-6	326-6

An examination of these three records shows that a number of coal horizons, some bearing in places coal of workable thickness, lie between elevations of 783 and 527 feet above sea level, with the thickest seams between 550 and 600 feet. While a sufficient number of holes have not been sunk to determine whether a basin of coal that would justify exploration be present at Leon, the results obtained are encouraging as showing that good

coal does underlie Decatur county along several horizons. We may look forward hopefully to the time when better market conditions will justify the expenditure of large sums in locating and developing the mineral resources of the region. Chemical analyses of the coals found in the Leon drillings are given in another place in this volume.

The three prospects were drilled in greater part through the drift and the Des Moines. The Missouri has been removed at Leon by pre-glacial erosion, its place being taken by about 300 feet of drift. Since outcrops of Des Moines strata have been identified by Bain at Davis City at an elevation of about 915 feet A. T., the base of the Missouri may be expected to occur above that level in the central part of the county. The highest indurated beds shown in the three records lie at an altitude of 837 A. T., and are evidently, therefore, of Des Moines age, as is indicated also by the character of the beds shown in the sections. Numbers 1 and 2 of the Biggs' log are apparently incorrectly interpreted. Number 2 perhaps, presents a succession of shales with some sandstone, at the base of the Des Moines, and No. 1 a series of limestones, calcareous shales, and sandstones belonging to the Mississippian. This interpretation, which is merely tentative, would make the thickness of the lower, or productive, Coal Measures of the district, 400 or 450 feet in thickness. No coal will be found below the Des Moines.

Recent drilling near Cainsville, a few miles south of the Iowa state line, in Missouri, is said to have revealed some deep coals at that point. The accuracy of the report could not be verified, but the following statement is the one commonly given out.

COAL.	THICKNESS		DEPTH.
	FEET.	INCHES.	FEET.
No. 1.....	4	4	500
No. 2.....	2	2	520
No. 3.....	3	6	525
No. 4.....	1	6	546

## WAYNE COUNTY

In the eastern third of Wayne county is found the western continuation of the Mystic coal and the accompanying strata of the Appanoose formation. These beds and their stratigraphic relationships will be briefly described later in the chapter on Appanoose county. They are found to extend almost unchanged into Wayne county, and the coal is mined at several places in the eastern townships where, however, it is a few inches thinner than at Mystic and Centerville. At Seymour, where the coal is rather extensively mined, the bed is usually little more than twenty-five inches in thickness. A number of local mines are in operation in the vicinity of Confidence in coal about twenty-eight inches high. In tracing the coal west from Seymour it is found to become gradually thinner and poorer in quality; it thins out and even disappears in places, while the roof is sometimes uncertain. In short, there occurs a disappearance of the constant characters the formation possesses in Appanoose county. The results of the only systematic prospecting that has been undertaken within the county are not now available, so that data are somewhat meager; but so far as can be learned the western boundary of the Mystic coal lies a few miles west of a line drawn through Sewal, Harvard, Bridgeport, and Bethlehem. Mr. R. C. Poston of Corydon drilled several holes three miles north of Harvard, on the Vollmar farm (Corydon Tp., Sec. 34). The record of one of these is:

	FEET.	INCHES.
57. Sand and gravel.....	35	
56. Gray drift and sand.....	96	
55. Shale, unctuous .....	5	6
54. Shale, dark .....	3	6
53. Coal (at 140 feet).....		3
52. Shale, argillaceous .....	10	9
51. Shale, sandy .....	6	
50. Limestone, fossiliferous .....	3	5
49. Shale, sandy .....	10	
48. Shale, gray .....	7	9
47. "Slate" .....	2	
46. Shale, gray .....	1	10
45. Coal (at 182 feet).....		2
44. Fire clay .....	4	2
43. Rock, hard .....	3	

WAYNE COUNTY

255

42. Shale, sandy .....	13	3
41. Sandstone, light-colored .....	2	
40. Shale, dark .....	4	6
39. Shale, light-colored .....	4	
38. Shale, sandy .....	22	
37. Shale, gray .....	21	
36. Coal (at 256 feet).....	1	3
35. Clay parting .....		1½
34. Coal, impure .....		3
33. Coal .....		3
32. Shale, light-colored .....	1	
31. Sandstone, gray .....	6	
30. Shale, gray .....	13	
29. Shale, dark .....	2	1
28. Coal (at 280 feet).....	1	6
27. Coal, impure .....		2
26. Shale, light-colored .....	3	
25. Rock, hard .....	4	6
24. Shale, dark .....	7	
23. "Slate" .....	2	4
22. Coal (at 298 feet 7 inches).....	1	3
21. Shale, light-colored .....	1	
20. Rock, hard .....	2	6
19. Shale, sandy .....	10	
18. Shale, light-colored .....	7	4
17. Shale, dark .....	1	
16. "Cap rock" .....		8
15. Shale, dark .....	2	
14. "White top" .....		8
13. Shale, dark, sandy.....		8
12. Coal (at 325 feet 8 inches).....	1	
11. Coal, impure .....	1	11
10. Shale, light-colored .....	2	
9. Shale, sandy .....	2	9
8. Sandstone, gray .....	2	8
7. Shale, light-colored .....	1	6
6. Shale, dark .....	2	
5. "Slate" .....	1	2
4. Coal, impure (at 340 feet 8 inches).....	2	7
3. Shale, light-colored .....	1	
2. Limestone .....		10
1. Shale, calcareous .....	4	1
Total .....	349	2

Two other drillings made in the same locality show a general correspondence with the above record, although the inconstancy of strata peculiar to the typical phase of the Des Moines stage is evident. It will be observed that not less than seven thin coals

appear in the record given above, not one of which can be correlated with certainty with the Mystic seam. In the other two holes the thin coals, numbers 45 and 54 of the above section, were not encountered. It is barely possible that some of the identifications made by the driller are open to question and that the Mystic coal is present here in workable thickness.

Reports of borings made at Corydon are rather conflicting. Six drillings were made within a mile of the city and it is claimed by reliable men that three feet of coal were found beneath a considerable thickness of drift. No exploitation was attempted. It appears probable that the Mystic seam, if present at all in central Wayne county, lies over 300 feet beneath the general level of the surface.

The average dip of ten feet per mile to the southwest that the formations exhibit in northwestern Appanoose county is doubled from Jerome to Seymour, but appears to flatten out or even to become reversed southwest and west of the latter town. From Brazil westward to Plano an exceptionally strong dip or else a geological fault is also noted, coal being reached at a depth of two hundred feet at Plano. This dip practically ceases between Plano and Promise City. In Wright township the coal lies near the level of the creek bottoms and dips towards the south, with a smaller component in a westerly direction. The northern boundary of the Appanoose formation is to be found in Lucas county, not far north of the Wayne county line.

Some effort has been made to locate workable coal near Promise City. The following drilling was made by the Scandinavian Coal Company on the Hart land, a short distance west of that town.

DRILLING WEST OF PROMISE CITY.

	FEET.	INCHES.
12. Drift .....	199	
11. Coal .....	1	2
10. Fire clay .....	1	
9. Limestone .....	1	2
8. Shale, blue, arenaceous.....	15	
7. Shale, blue, argillaceous.....	4	
6. Limestone .....	1	10
5. Shale, black, argillaceous.....	3	2
4. Coal .....		1

3. Shale, gray .....	24	
2. Shale, black .....		8
1. Shale, gray and red.....	6	
	257	1
Total .....	257	1

Number 11 of the above section corresponds very well in position with the lower bench of the Mystic seam found farther east, the upper bench having been removed by pre-glacial erosion. Number 9 then falls into place as the "bottom rock" of the Mystic district. The full thickness of the coal, twenty-six inches, is reported as found on Mr. Sharp's land, two and one-half miles farther west, and on the Lord place, east of Promise City, but sufficient roof is present only in places.

Some attempt was made to find coal in the northwestern section of the county, where practically the entire thickness of the typical facies of the Des Moines is present. Coal seams, often thick, are abundant in these strata, but are seldom even moderately persistent when traced laterally. A drilling begun one-half mile northeast of Humeston was abandoned after the remarkable thickness of 402 feet of drift had been penetrated.

All of the coal mined in Wayne county has been taken from the Mystic seam. The earliest authentic record we have of annual output is that of the State Census of 1865, which gives a total of 9,230 bushels. The federal census cites a production of 155 tons for 1870, 6,000 for 1880 and 17,480 for 1890. Variations in tonnage during recent years are as follows:

YEAR.	TONS.	YEAR.	TONS.
1898.....	51,550	1903.....	75,488
1899.....	60,418	1904.....	98,879
1900.....	54,503	1905.....	112,549
1901.....	19,478	1906.....	136,694
1902.....	64,164	1907.....	146,901

During the year ending June 30, 1908, the State Mine Inspectors report that 124,465 tons were produced, chiefly by the two shipping mines at Seymour, and that 471 men were employed.

WAYNE COUNTY MINES.\*

*Confidence.* For nearly forty years local mines have been operated in the northeastern corner of the county; yet the total amount of coal taken out is not large, as only local trade has been supplied. At one time and another shafts have been sunk on nearly every section in the eastern third of Wright township. The mines at present open are located chiefly south of Confidence.

The present L. Frye mine (Wright Tp., Sec. 23, Sw. qr., Se. ¼) has been worked for three years. The shaft, located on high ground, is 110 feet deep. A small steam engine is used for hoisting. About fifteen acres were mined out from an old shaft one-fourth mile north. Below the thirty-inch limestone "cap rock," the section at the new mine is:

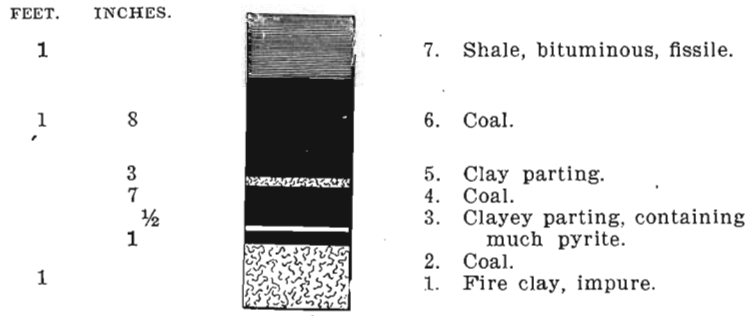


Figure 60. Coal seam in Frye mine. Confidence.

On the same piece of land, just west of the Frye, is the J. Hayhurst bank. A strong dip to the southwest at this point lowers the Mystic coal fifteen feet between the two mines. At the Hayhurst bank the "cap rock" has increased in thickness to five and one-half feet and the coal to twenty-nine inches. On the south is the Jared bank (Sec. 26, Sw. qr.). The shaft is twenty-eight feet deep and is on low ground. The section here is:

	FEET.	INCHES.
6. "Cap rock" .....	8	
5. "Clod" .....		10
4. "Slate" .....	1	8
3. Coal, with "mud band".....	2	5
2. Fire clay .....	4	
1. "Bottom rock" .....	5	6

\*As found in operation in August, 1907.

The A. H. Hayhurst bank is farther down the creek (Sec. 35, Ne. qr., Sw.  $\frac{1}{4}$ ). The shaft is thirty feet in depth and the section at its base is essentially the same as that at the Jared bank, although the "cap rock" is reduced to five feet. Below this mine is the E. A. Sipes bank, now operated by Mr. Edwards (Sec. 35, Se. qr., Se.  $\frac{1}{4}$ ). The seventy-foot shaft is located part way up the valley slope. The thickness of the Mystic seam is from twenty-six to twenty-eight inches. A short distance southeast is the Sims bank (South Fork Tp., Sec. 1, Ne. qr., Ne.  $\frac{1}{4}$ ). The Mystic coal lies sixty feet below the surface at the shaft and is accompanied by the following strata.

	FEET.	INCHES.
6. "Cap rock" .....	6	
5. "Clod" .....		4
4. "Slate" .....		4
3. Coal, with "mud band".....	2	5
2. Fire clay .....	1	
1. "Bottom rock," about.....	6	

Four miles west, on South Chariton river, is the Davis bank (South Fork Tp., Sec. 5, Se. qr., Ne.  $\frac{1}{4}$ ). A shaft low down in the valley reaches the coal at seventy-two feet, but has not been used for some time. There is a local dip to the northwest here. A section at this point shows:

	FEET.	INCHES.
Soil .....	14	4
Limestone (the "fifty-foot limestone").....	5	11
Shale, argillaceous .....	25	2
Limestone .....	1	2
Shale, calcareous } (the "seventeen-foot limestone")		10
Limestone, impure } .....	1	10
Shale, mixed .....	9	11
Limestone .....	2	5
Shale, unctuous .....	2	7
Limestone, fossiliferous (the "cap rock").....	1	6
"Slate" .....		11
Coal, upper bench .....	1	3
Clay parting (the "mud" band).....		2
Coal, lower bench.....		7
Fire clay .....	1	9
Total .....	70	2

This section corresponds very well with the generalized section of the Appanoose beds given in the chapter on Appanoose county



as typical for the Appanoose field. Some drilling done one-half mile west of Bethlehem failed, however, to reveal workable coal.

*Seymour.* By far the greater part of the coal mined in Wayne county is taken out by the two mines of the Numa Block Coal Company at Seymour. Mine No. 2 is situated on the north side of the Chicago, Milwaukee and Saint Paul railway, one mile east of the Milwaukee depot at Seymour (Sec. 13, Ne. qr., Sw.  $\frac{1}{4}$ ). This mine, known as the "Big Jim," has produced more coal during recent years than any other in the Appanoose-Wayne coal field. Working full time it can easily produce 100,000 tons per year. It is equipped with an Ottumwa first-motion hoisting engine, steam dirt dump, Ottumwa box-car loader, and self-dumping cages. The remainder of the equipment is good. The shaft is 202 feet in depth. Mine No. 3, called the "Sunshine" mine, is in the southeastern part of Seymour about one-half mile from the Rock Island station. It loads a considerable output on the Chicago, Rock Island and Pacific railway. The shaft is 240 feet deep, showing that the strong southwesterly dip seen in the mines is continued between Nos. 2 and 3. The lower part of the section in this district, as given by Keyes, is:

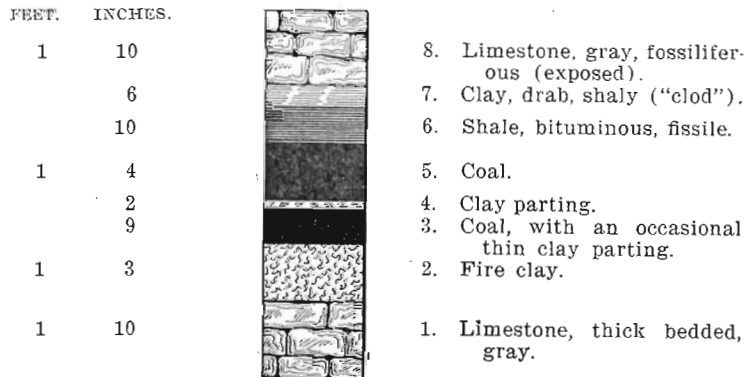


Figure 61. Coal at Seymour.

Four miles southwest of Seymour, is the Carey Brothers mine (Monroe Tp., Sec. 3, Nw. qr., Nw.  $\frac{1}{4}$ ). A small double engine hoists 140 feet from the pit bottom to the surface. The mine supplies only a local trade and so has worked out only a small area during the four years of its existence. The strata accompanying the Mystic coal are:

	FEET.	INCHES.
6. Limestone .....	1	
5. Shale .....	1	
4. "Slate" .....		7
3. Coal (upper two inches impure).....	1	4
2. Clay parting .....		3
1. Coal .....		10

About two miles northwest of the Carey is the Winger mine (Walnut Tp., Sec. 29, Sw. qr., Ne. ¼). The shaft is 145 feet in depth. Hoisting is done by a small single engine. The limestone "cap rock" occasionally rests directly on the coal; elsewhere "slate" intervenes as shown in figure 62.

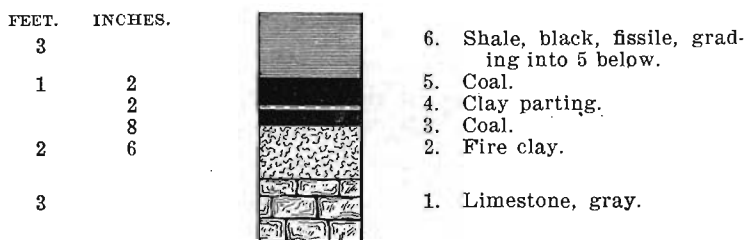


Figure 62. Bed of Winger mine. Harvard.

Between Sewal and Harvard is the Slack mine, now operated by Mr. Blue (Jackson Tp., Sec. 22, Se. qr., Se. ¼). The shaft is 165 feet deep and hoisting is done by horsepower gin. In places in this mine the coal is absent, in others as much as twenty-six inches occurs. From four to eight inches of "slate" separates the "cap rock" from the coal.

A shaft has recently been sunk one and one-half miles east of Harvard (Sec. 14, Ne. qr., Nw. ¼), where it is claimed as much as twenty-six inches of coal is known to occur. The mine is idle at present, owing apparently to a weak roof and an unreliable coal seam. Sufficient work has not yet been done here to determine the exact nature of the coal bed.

APPANOOSE COUNTY

Appanoose and Wayne are unique among Iowa coal counties, inasmuch as they contain a coal bed which is continuous over a considerable area and yet forms part of the Des Moines stage. With the exception of the few places where erosion channels have

removed it, this coal, known as the Mystic seam because of its typical development at Mystic, appears to be present under the entire western half and more of Appanoose and adjoining portions of Wayne county on the west and the state of Missouri on the south. Moreover, it is not alone the Mystic coal which possesses the feature so anomalous for the Des Moines, of continuous and uniform deposition over an extensive area. The strata associated with the coal are remarkably similar at widely separated points, so that Bain\* in his study of the county was led to distinguish the entire assemblage as the Appanoose formation, a sub-stage of the Des Moines terrane. The appearance of persistent strata, including bands of limestone, is far different in character from the typical Des Moines facies as found in other parts of the Iowa field, and represents deeper sea conditions of deposition more nearly like those which governed the growth of the Missouri stage. The Appanoose formation lies in the upper portion of the Des Moines in a region where the latter possesses a greater thickness than is found in Lucas county, for example, where nearly the entire series from the base of the Missouri to the top of the Saint Louis is present. The Appanoose beds represent the transition stage from the shallow water conditions governing the deposition of the lower Des Moines to those of the upper Des Moines and of the Missouri. A somewhat similar assemblage of strata, with rather persistent limestones and coal horizons, has been traced through parts of Madison, Dallas and Guthrie counties and has been assigned to late Des Moines time. A conglomeratic member at the summit of the Appanoose formation serves to separate it to a limited extent from the beds that formerly overlay it. The strata mentioned as occurring in the more northerly counties are evidently also the result of a transition from the extremely unstable conditions of sedimentation prevalent throughout earlier Des Moines time to relatively more stable relationships of land and sea.

Several layers of limestone, shown in the sections given below, act as markers for the Mystic coal wherever it occurs. The names applied to them locally—the "floating rock," "fifty-foot

\**Geology of Appanoose County*, Iowa Geol. Surv., Vol. V, pp. 363-438; Des Moines, 1896. The writer is indebted to this report for much information in regard to the geology of the region. Acknowledgments are due also to Mr. John Verner, Mine Inspector for the first district, for data concerning several mines and for courtesies extended.

limestone," "seventeen-foot limestone" or "little rock," the "cap rock," and the "bottom rock"—indicate succinctly their stratigraphic position with respect to the coal. While these rock bands are not of exactly the same thickness or at exactly the same distance above or below the coal in all sections of the field, the differences noted at widely separated points are minor ones. The Mystic seam itself is also remarkable in preserving unchanged certain characteristic features wherever it is found. It is split into two benches by a thin layer of clay known as the "mud band," and usually also bears a second and thinner clay seam, termed the "dutchman," below the first. While the coal bed varies somewhat in thickness from point to point, the variations are merely a matter of inches. Bain gives the following generalized section for this field.

	FEET.	INCHES.
17. Limestone, gray, subcrystalline, the "floating rock"	2-4	
16. Shale, argillaceous, color variable.....	12-30	
15. Limestone, heavy ledges, the "fifty-foot limestone" ..	4-10	
14. Shale, argillaceous, blue and red.....	14	
13. Shale, arenaceous, frequently sandstone.....	8	
12. Shale, argillaceous, blue to gray.....	10	
11. Limestone, somewhat variable in thickness, the "seventeen-foot limestone" or "little rock".....	1-3	
10. Shale, sometimes gray, frequently bituminous and pyritiferous .....	7	
9. Limestone, sometimes gray and coarsely subcrystalline; sometimes fine-grained, bituminous, and grading into shales above and below; the "cap rock" .....	2-4	
8. Shale, usually bituminous and known as "slate," occasionally in part soft and clay-like, then known as "clod;" at times, heavy and homogeneous, nonfissile, in which form it is known as "black bat" .....	1-3	
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 .....	1-6	
1. Limestone, the "bottom rock".....	3	6

The deepest shaft in the county is that of the new Scandinavian mine at Plano. Owing to the considerable thickness of the drift here, the "fifty-foot limestone" is not present.

## COAL DEPOSITS OF SOUTH CENTRAL IOWA

## SHAFT RECORD OF SCANDINAVIAN NO. 2.

	FEET.	INCHES.
8. Drift .....	159	
7. Shale, arenaceous.....	7	
6. Shale, argillaceous, blue and brown.....	8	
5. Limestone, fossiliferous .....	3	
4. Shale, blue .....	11	
3. Shale and "cap rock".....	8	
2. "Slate" .....	1	9
1. Mystic coal .....	2	5
Total .....	200	2

In the Cincinnati district, which is rather distant from the type area, the "seventeen-foot limestone" is often called the "nineteen-foot limestone" and sometimes lies immediately beneath a thin "blossom" of coal. The "cap rock" may be as much as eight feet in thickness, but is very variable and may be altogether lacking. The "clod" is from six inches to a foot thick and is accompanied by six to eight inches of "slate." Especially toward the south the "cap rock" may rest directly on the coal. The coal is twenty-eight to thirty-four inches thick, occasionally slightly more. The underlying fire clay is from eighteen to twenty-four inches in thickness. The "bottom rock" is infrequently absent. "Slips" and erosion channels disturb the continuity of the coal bed at several points. East of Cincinnati, at Exline, and southeast, at Coal City, the Mystic coal shows local augmentation in thickness. Following is the record of a drilling made on the east line of the lease of the Thistle Number 2, a short distance east of Cincinnati. The Mystic coal is slightly below its normal thickness in this record.

## SECTION EAST OF CINCINNATI.

	FEET.	INCHES.
Soil and drift .....	64	
Shale, green .....	2	6
Limestone .....	3	2
Shale, light-colored .....	1	
Shale, argillaceous, gray.....	11	4
"Cap rock" .....		7
Shale, blue .....	1	6
"Slate," black .....		10
Coal .....	1	4
Clay parting .....		5
Coal .....		10
Fire clay .....		10
Total .....	88	4

The Appanoose beds dip, in general, to the southwest at the rate of about ten feet per mile. This dip is far from universal, however, if limited areas be considered; for local anticlines and synclines disturb the symmetry of the inclination. Thus, although from Mystic to Jerome the dip is nearly normal, from Jerome to Seymour it is almost doubled. Also the coal at Plano lies nearly at the same elevation as that at Exline, Cincinnati and Seymour, and is surprisingly lower than that at Jerome or Brazil. In the southern half of the county the dip, however, veers to about ten feet per mile toward the south; while the western component is often absent or even reversed. Brazil, Numa, Cincinnati, and Exline lie on a broad low anticline which interrupts the general southwesterly dip. In the absence of a topographic map of the region and because of the lack of agreement between the datum planes of the profiles of the various railroads, absolute determination of the altitudes above sea level of the coal in various mining districts is rendered impossible. Owing to the general dips to the south and southwest, the lowermost beds of the Appanoose formation outcrop at the surface along a line that corresponds, roughly speaking, with the course of the Chariton river. North and east of this line the Mystic coal does not exist except, perhaps, in isolated outliers.

There is little doubt that workable basins of coal exist at levels stratigraphically lower than that of the Mystic seam, but it is not likely that there are other beds as continuous and persistent over large areas. Because of the presence of so reliable and easily mined a coal as the Mystic, the location and development of lower horizons is necessarily a matter for the somewhat distant future. In spite of the millions of tons of coal that have been taken from the Appanoose formation, only a narrow strip on each side of portions of the lines of railroad has been mined out. Great quantities of coal still remain untouched in the Mystic seam. Rumors of the presence of lower coals at Rathbun, Mystic, and Moravia have been circulated recently and are apparently authoritative, especially as regards the Rathbun district. Some attempts to locate new fields have been made in the eastern part of the county, in the typical phases of the Des Moines terrane. A boring at Unionville was aban-

done after 200 feet of drift had been penetrated. Four borings made upon the plain near Udell found coal at a depth of about 175 feet. There is a possibility that this is the Mystic seam, though direct proof of this is lacking. The Mystic outcrops and is mined at the mouth of Snort creek, not far westward. Fresh drillings are to be undertaken at Udell in the near future. Several drillings were made between Sedan and Dean. Mr. Hanson of Dean reports that the following sequence was penetrated in a core boring headed near the Sedan station, about four feet above the level of the railroad tracks.

## BORING AT SEDAN.

	THICKNESS		DEPTH	
	FEET.	INCHES.	FEET.	INCHES.
43. Soil and drift.....	74		74	
42. Coal .....	2	5	76	5
41. Fire clay .....	2		78	5
40. Soapstone shale .....	21		99	5
39. Coal .....		5	99	10
38. Fire clay .....	3		102	10
37. Shale, dark, with limestones.....	16		118	10
36. "Slate," black .....	10		128	10
35. Shale, clayey, white .....	29		157	10
34. Coal .....	1	10	159	8
33. Shale, black .....	3		162	8
32. Soapstone shale .....	30		192	8
31. Coal .....	1	10	194	6
30. Sandstone .....	7		201	6
29. Shale, blue .....	5		206	6
28. Coal .....		9	207	3
27. Shale, gray .....	9		216	3
26. Shale, sandy .....	16		232	3
25. Shale, black .....	4		236	3
24. Coal .....		7	236	10
23. Shale, clayey, blue.....	2		238	10
22. Coal .....	2	3	241	1
21. Shale, blue .....	5		246	1
20. "Conglomerate" .....	1		247	1
19. Coal .....	2	10	249	11
18. Soapstone shale .....	7		256	11
17. Shale, gray .....	4		260	11
16. Shale, blue .....	2		262	11
15. Coal .....	1	3	264	2
14. Shale, gray .....	5		269	2
13. Shale, blue .....	20		289	2
12. Sandstone .....	14		303	2
11. Shale, blue .....	18		321	2

10. Coal .....	2	10	324	
9. Fire clay .....		8	324	8
8. Coal .....	2	1	326	9
7. Shale, blue .....	9		335	9
6. Coal .....	2	4	338	1
5. Fire clay .....	7		345	1
4. Shale, gray .....	13		358	1
3. Shale, blue .....	2		360	1
2. Soapstone shale, white .....	17		377	1
1. Limestone (probably Saint Louis)	5		382	1

Three other holes bored along the line of the Keokuk and Western railway between Sedan and Dean, showed essentially the same strata as far as they went, but were discontinued at 300 feet or less. A deeper hole one mile south of Sedan, near the Iowa Central railway, failed to find thick coal in the lower horizons. It will be noticed that in the above record no less than twelve coal horizons are shown. This may be taken as an index of the possibilities of the typical Des Moines strata in Appanoose county, though it must not be forgotten that coal in these horizons is apt to be pockety.

In the Sedan record, the Saint Louis limestone was reached at an altitude of approximately 443 feet above tide, Cairo datum. This indicates that an average dip of eight feet per mile is maintained from Ottumwa, where the highest Saint Louis outcrops lie at 680 feet A. T., southwest to Sedan. It is thought that the limestone was reached in a well at Centerville at 600 feet, an altitude corresponding very well with that of the same formation in the Sedan boring. Any of the strata lying between the Saint Louis and the drift may be safely considered to be possible coal bearers.

All the mines in the county work the Mystic seam. Owing to the slight depth at which the seam may be found in many places and to the lack of any necessity to prospect thoroughly lands about to be developed, a great number of shafts have been sunk and local mines are too numerous to mention. The presence of a firm limestone "cap rock," of the thin "mud band" in the center of the seam, of but little water, of an abundance of good clean coal at moderate depths, and of easy railroad communication render mining peculiarly easy and profitable. Although the coal averages but thirty inches in height, a large proportion of



the total present can be won by the longwall methods to which a majority of the mines have changed. The amount of coal won per acre is, therefore, high in proportion to the thickness of the coal. The properties of the Mystic coal will be found described in another place in this volume. In point of production, the county has advanced steadily until it now ranks third in the Iowa field. It will continue to hold its high position for many years to come. In 1860 Appanoose produced 1,438 tons; in 1870, 6,709; in 1880, 59,160; in 1890, 285,194. Statistics for more recent years are given by reports of the Iowa Geological Survey as follows:

YEAR.	TONNAGE.	YEAR.	TONNAGE.
1898.....	608,165	1903.....	893,021
1899.....	633,899	1904.....	872,920
1900.....	734,698	1905.....	875,248
1901.....	868,967	1906.....	1,101,595
1902.....	771,363	1907.....	1,123,407

During the year ending June 30, 1908, 1,107,806 tons were produced and 4,026 men were employed by ninety-one mines. Of these, sixty-two were railroad mines, fifteen shipping over the Keokuk and Western railway, twelve over the Chicago, Burlington and Kansas City, nine over the Chicago, Rock Island and Pacific, twenty-four over the Chicago, Milwaukee and Saint Paul, two over the Iowa Central, and one over the Iowa and Saint Louis. Of the larger mines, thirty-three used the room and pillar method and forty-eight the longwall. There is no practical limit to the coal in sight; only the inadequacy of the market and a scarcity of men limits operations.

In the following pages may be found mention of all shipping mines in operation in July, 1907, and of the principal local mines. Numbers in parentheses refer to the positions of certain mines on the accompanying map.

#### APPANOOSE COUNTY MINES.

*Independence Township.* Owing to a lack of railroad facilities rather than to the absence of workable coal, only small local banks exist in the extreme northwestern corner of the county. Aside from a slight decrease in the thickness of the lower bench,

the coal mined is in all respects similar to the Mystic seam as typically developed, and lies only a few feet above the level of the major streams. Among the principal coal banks in operation may be mentioned the Fenton (Sec. 20, Sw. qr.), the Mosly (Sec. 30, Sw. qr.), the Phillips (Sec. 30, Se. qr.), and the new Young mine near Griffinville.

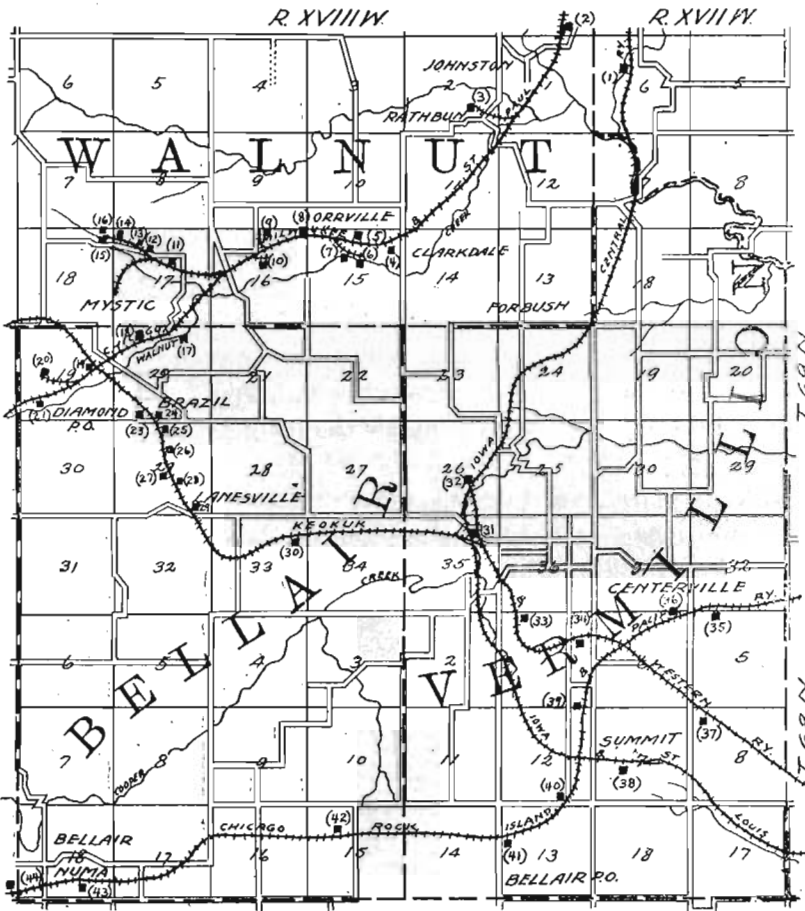


Figure 63. Map showing shipping mines in central Appanoose county.

*Moravia.* Three miles east of Moravia a shallow shaft is now being sunk. Small banks have been essayed in this area at successive intervals, but have led short lives because of the softness of the coal and the frequency of "slips" and "washouts." The seam present shows the usual thin clay parting, but is not so

thick as farther southwest and apparently lacks the overlying limestones characteristic of the Mystic coal. Nevertheless, it is possible that an outlier of the Appanoose beds exists here. A lower coal, about which no definite information could be obtained, is said to be present also.

*Rosebrook.* At Rosebrook, a new station on the Iowa Central, is the new mine (1) of the Sunnyside Coal Company, with a shaft eighty-two feet in depth (Douglas Tp., Sec. 6, Nw. qr.). It has been worked only 150 feet east and west of the shaft, and apparently lies on the eastern border of the Appanoose formation. A local mine is worked by Wm. Henry from an eighteen-foot shaft on the same farm on which the Sunnyside is located. One-half mile south is another small bank.

*Darbyville.* The Unity Block Coal Company (2) operates a slope at Darbyville (Walnut Tp., Sec. 36, Se. qr.), but is not putting out much coal at present. Natural drawbacks on the east and an old mine on the west have retarded development. This mine loads on the Chicago, Milwaukee and Saint Paul railway. The Mystic coal lies a few feet below the level of the river at this point.

*Rathbun.* The Star Coal Company mine at Rathbun (3) is located on a short spur from the Chicago, Milwaukee and Saint Paul railway (Walnut Tp., Sec. 2, Se. qr., Sw.  $\frac{1}{4}$ ). This is one of the best equipped longwall mines in the county. In the northern portion of the Walnut creek coal field the Mystic coal comprises:

	INCHES.
Coal .....	16-18
Clay .....	2-4
Coal .....	14

At Rathbun and other points on Walnut creek a lower horizon with coal from four to five feet in thickness is reported on good authority. Its depth could not be definitely ascertained, but appears to be about 100 feet greater than that of the coal now mined.

*Clarkdale.* The Mystic Block Number 5 (4) is located at Clarkdale (Walnut Tp., Sec. 15, Ne. qr., Se.  $\frac{1}{4}$ ), two miles east of Mystic. The shaft is seventy feet in depth. A substantial

Cleveland Iron Works hoisting engine, mounted on fifteen-foot foundations, is in use.

The Interocean Coal Company operates its mine No. 6 (5) one and three-fourths miles east of the Mystic station (Sec. 15, Ne. qr., Nw.  $\frac{1}{4}$ ). The shaft is seventy-five feet deep. A local dip of the coal bed to the southeast causes the north end of the workings to be left quite dry. Both the Interocean and the Mystic Block Number 5 load on the main line of the Chicago, Milwaukee and Saint Paul railway.

A short distance south of the last mentioned mine is the Elgin and Barret (6), a slope mine reached through the old workings of the Iowa Block Coal Company. The slope mouth is located on the south side of Walnut creek, so that cars must be carried over to the tipple on the north bank on a long trestle. Formerly coal was very extensively worked at this point.

The Beggs Coal Company has a fifty-foot shaft (7) a few rods west of the last mine mentioned and on the same short spur from the Chicago, Milwaukee and Saint Paul railway. Hoisting is done by horse gin and only three or four acres have been mined over. In this district there is a local dip to the southeast, which amounts to about one foot in one hundred in the Beggs workings.

*Mystic.* One mile east of the Mystic station is the slope of the Winnifred Coal Company (8), situated on the north side of the Chicago, Milwaukee and Saint Paul tracks. This mine is known as the "Lady Mary" and has been intermittently worked for about fourteen years. The company intends to install tail-ropes haulage from the bottom of the slope to the tipple.

The Mystic Block Coal Company Number 12 (9) is on the "reservoir switch" in the eastern section of Mystic. The slope and main roadway extends about one-half mile under the hill to the north. The coal lies a few feet below the level of the tracks. A shaft is to be sunk some time in the future and the slope abandoned. The output of Number 12 ranks among the best in the district. Between this mine and the "Lady Mary" is a wide pre-glacial channel, running off to the northwest and cutting out considerable coal.

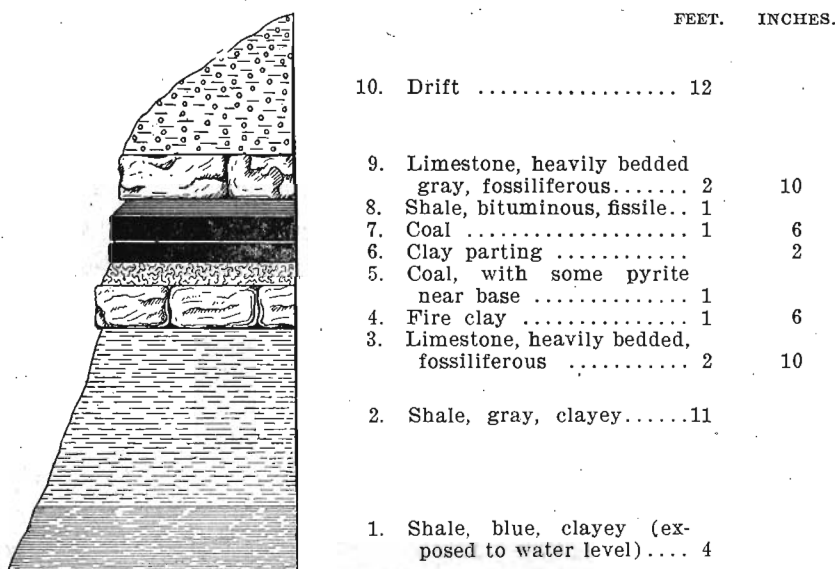


Figure 64. Bluff on Walnut creek. Mystic.

Peerless Number 6 (10) is a mine of considerable extent, entered by a drift located on a short spur running southeast from the main line near the Mystic station. Tail-rope haulage is employed and an Ottumwa box-car loader facilitates the handling of the product at the tippie. The strata here show a slight dip to the north of about four inches in a hundred feet. Peerless Number 3, a slope just east of Number 6, is now shut down and its output will in future be pulled out through another opening not yet decided upon.

A railroad spur a mile and a half in length runs west from the main line at Mystic up the valley of a small creek, and on and near it are located a number of mines. The easternmost of these, on the Klondike switch, is the Mystic Block Number 29 (11), termed also the "Klondike mine." It has a shaft opening fifty feet deep, located in the northwestern part of Mystic, about one-fourth mile from the station. No work was done here from March to July, 1907. Two Lee electric mining machines, which have been employed with success in some longwall mines, were formerly used here, but are not now in service because of there being too little face for two machines and too much for

one, and because the purchase and transmission of electric power from another mine proved to be expensive.

One-fourth mile northwest of the mine last mentioned is the slope of Acken Number 1 (12), situated on the north side of the spur previously mentioned. The slope has lately been re-timbered. Number 2 of the same company (13) opens by a twenty-five foot shaft a short distance west of Number 1. The output has been small, but is now increasing. Number 1 and Number 2 really constitute a single mine, as the face is continuous between the workings of each and both can be acceptably ventilated by a fan placed at Number 2 air shaft.

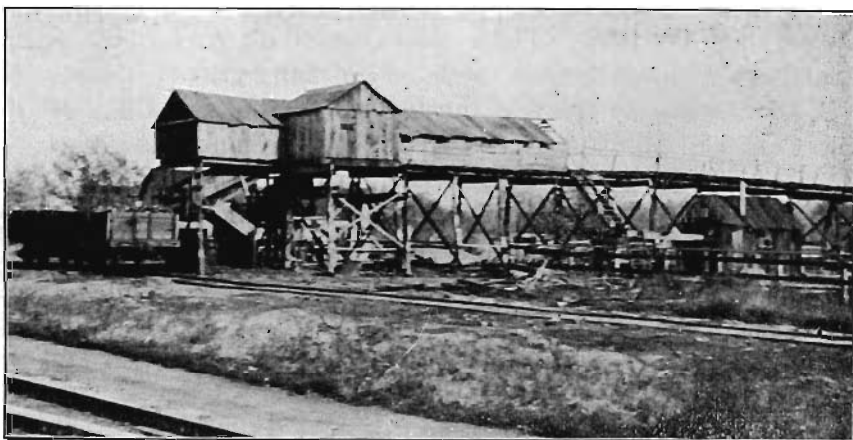


Figure 65. A type of tippie at the smaller mines.

Less than half a mile farther up the switch is mine Number 2 of the Peerless Coal Company (14). The product of the near-by Number 1 now goes out through Number 2 shaft and the two mines are ventilated as one. Number 1 workings are to move down to a new face while Number 2 mines at both its own face and the one formerly used by Number 1. Two Lee electric mining machines have been employed and another is to be installed.

At the end of the spur mentioned above as running west from Mystic are the three openings of the Mystic Coal Company. Number 3 (15) is a slope lying a short distance west of Number 2, which has a shaft opening. The workings of the two mines were recently connected, so that coal can now be taken out

through either opening. Mystic Number 1 (16) is a small slope on the north side of the railroad spur, between the other two openings of the same company. Its territory is limited by an erosion channel that cuts out considerable coal in a strip oriented northeast and southwest.

On the main line, about half way between Mystic and the Keokuk and Western crossing, is the drift of the Egypt Coal Company (17). The opening is located on the south side of the creek, so that a long trestle has been constructed on which to carry the coal across the stream to the tippie. As in other mines, some trouble is experienced in obtaining men, and as a result work is rather intermittent. Tail-rope haulage is employed on the trestle. The company controls coal rights sufficient to supply territory to the mine for many years to come.

A short distance west of the Egypt, on the opposite side of the Chicago, Milwaukee and Saint Paul tracks, is Peerless Number 5 (18) also known as "The Twins." Dirt is pulled out by an electric tail-rope system through a slope on the side of the railway track opposite the thirty-five foot hoisting shaft. A neat brick engine house contains a Corliss engine, tubular boilers, producing 125 horsepower, and a Siemens and Halske dynamo that supplies power for the tail-rope and the three Lee electric mining machines used in the workings.

The "Keokuk and Western" or "Baker slope" (19) is a small mine situated in the southwestern angle made by the crossing of the Keokuk and Western and the Chicago, Milwaukee and Saint Paul railroads. It operates only during the fall and winter.

*Diamond.* The Mystic Block Number 22 (20) is a new mine one-fourth mile west of the main line of the Chicago, Milwaukee and Saint Paul Railway, on the "22 switch." The shaft, which is seventy-five feet deep, has been in operation three years. The Mystic coal lies essentially level here. A double hoisting engine with a four-foot drum is utilized for hoisting. The tippie and other top works are well equipped.

The Mystic Block Number 21 (21), on the south side of the Chicago, Milwaukee and Saint Paul tracks at Diamond, is a slope mine. It has not been in operation for over a year because

of the difficulty experienced in housing miners for both it and Number 22.

About one mile southwest, on the south side of the main line, is the shaft, eighty feet in depth, of the "Juckett" mine (22), leased by the Big Jo Coal Company. It employes few men but turns out a not inconsiderable output. Hoisting is effected by means of a Rochester engine. This mine, formerly operated by F. H. Juckett, changed hands in June, 1906.

*Harkis.* The Big Jo Number 1 lies on the south side of the tracks at Harkis, somewhat more than a mile southwest of the Juckett (Johns Tp., Sec. 35, Ne. qr.). The shaft is eighty feet deep and the tower forty feet high. There are separate buildings for the engine house, blacksmith shop, office, store room, fan house, and barn. A Rochester double hoisting engine is used. About 150 acres have been worked out. The coal seam exhibits a gentle dip to the southwest, and contains some "black bat." In this district the upper limestones have been removed in places by pre-glacial erosion.

*Jerome.* One-fourth mile east of the Jerome station, on the north side of the main line tracks, is the shaft of the Consumers Coal Company. This mine works on half time during half of the year and produces considerable coal during the winter months. An Ottumwa geared hoisting engine is used. The tower is but eighteen feet high, but is soon to be raised and improved. The Mystic coal lies 125 feet below the surface at this point. About eighty acres have been mined out.

*Plano.* Mine Number 2 of the Scandinavian Coal Company is located on the south side of the Keokuk and Western tracks, a short distance west of the station at Plano. The shaft, a section of which is given on a previous page, is the deepest in the county, being 200 feet from the surface to the base of the coal. Owing to the great thickness of the drift, chiefly clay, considerable difficulty was experienced in timbering substantially the upper portion of the shaft. The Mystic coal is of essentially the same character here as at Mystic and Centerville, though very slightly thinner (twenty-eight inches). A modern equipment has been installed and 320 acres are under lease, north and south of the railroad; but as yet the property has not proved



very profitable owing to an inadequate demand for the coal and to the difficulty of securing men. South and east the bed is nearly level; it rises towards the north and somewhat toward the west also. No "slips" or "faults," or other checks on mining have been encountered. Hoisting is done with an Ottumwa first-motion engine.

*Brazil.* A number of mines are located between Brazil and Centerville, on the Keokuk and Western railway, now part of the Burlington system. A few yards north of the Brazil station is the Walnut Block mine (23), entered by a drift. The coal lies about six feet above the level of the railroad tracks and is twenty-eight inches in thickness. Mining has been carried about three-fourths mile under the hill to the south and west. The main roadway is now in course of improvement.

On the east side of the Keokuk and Western, three-eighths mile south of the Brazil station, is the Phoenix drift (24). The coal dips to the southeast as far (one-half mile) as work has been carried in that direction. On the north the so-called "nineteen-foot rock" outcrops, while the coal may be seen in the small valleys of the neighborhood. The main road in the mine runs north, with side roads to the west. A sixty-horsepower Ottumwa engine furnishes power for the tail-rope employed.

The Centerville Block Number 5 (25) is an old slope mine, a short distance south of the Phoenix. This mine produces more coal than any other loading on the Burlington system in this county. The main road is one-half mile long and tail-rope haulage is in use. The coal is nearly level. A tramway crosses the railroad tracks to a covered way in which pit cars may be stored. Part of the product is dumped into engine chutes for locomotive consumption.

About one-fourth mile south of the slope last mentioned is the Tipton Co-operative drift (26). About forty acres have been mined out and little coal is left within the territory. Not much work is being done at present. The Mystic seam is here thirty inches thick, with a dip to the east. Under the low lying land the roof is too poor to allow of profitable exploitation.

The Peacock slope (27) is on the west side of the Keokuk and Western, about one-half mile south of the Brazil station. The

slope is 100 feet long, with a drop of four inches to the yard. Eighteen acres of the 160-acre lease have been mined out. The equipment is light. At this point the Mystic coal dips, in general, to the east and is slightly undulatory.

Not far from the Peacock is the Oriental Number 1 slope (28). The slope mouth is on the east side of the Keokuk and Western tracks while the top works are on the west side, the two being connected by a way running under the railroad. Tail-rope haulage is employed. The workings have been carried in nearly 2,000 feet. The company has 320 acres under control. The Mystic coal lies about forty feet beneath the level of the railroad tracks, and shows slight and variable dips.

*Lanesville.* The Perfection Block mine (29) is on the east side of the Keokuk and Western, at Lanesville (Bellair Tp., Sec. 29, Se. qr., Se. ¼). The shaft is seventy-two feet in depth. A large area of old holdings have been mined out here, but the company controls 160 acres of untouched land on the west.

About one mile southeast of the Perfection Block, on the south side of the Keokuk and Western tracks, is the shaft of the Sunshine Coal Company (30). Coal is hoisted 130 feet from the seam to the surface by a two-horse gin, but a more modern equipment will soon be installed. The dip is to the south.

*Centerville.* The Centerville Block Number 3 (31) is situated at the junction of the Keokuk and Western and the Iowa Central, loading on both lines. This is the old "Relay mine" and has a shaft opening 107 feet in depth. The present workings are at a considerable distance from the shaft. Six Legg and Harrison machines and a Norwalk air-compressor assist in keeping up the output. In the "Relay mine" has been encountered one of the heaviest dips found in the county; in a distance of 1,944 feet the coal rose thirty-six feet. Following is a section of the Mystic coal as it appears in this territory.

	INCHES.
Top coal .....	21
Clay parting .....	2
Bottom coal .....	11

The Centerville Block Number 9 (32) is about one-half mile north of Number 3, on the west side of the Iowa Central. The

shaft is seventy-two feet deep, the upper twenty-two feet being drift. Six Harrison and Legg machines and a Norwalk air-compressor are in use in driving entries and turning rooms. A measured section at the bottom of the shaft showed:

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

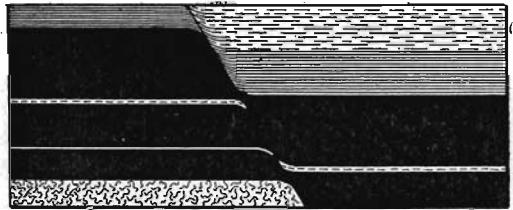


Figure 66. Fault in Centerville Block No. 9. Centerville.

On the Keokuk and Western, in the southern part of Centerville, is the seventy-foot shaft of the Anchor Mine Number 1 (33). A steam hoist and fan are employed. It has proved difficult to properly ventilate the north workings. About forty acres have been mined out.

The Scandinavian Number 1 (34) is in the southeastern portion of Centerville, on the south side of the Keokuk and Western railway. The coal lies about 100 feet below the level of the railroad. Under various names this mine has been worked twenty-five years and has exhausted 300 of the 340 acres controlled. Three rather large geological faults have been encountered. The first was found many years ago in driving south and east from the shaft, and it appears to have caused considerable displacement of the strata. The second is a trough fault which has lowered a section of the coal bed twenty-eight feet. The fault plane lies north and south and probably joins that of the

first fault near the water works. A third fault, running southwest and northeast, has a rather uncertain relationship. As the zone of disturbance is approached the coal is found to be badly broken and to rise sharply.

A large number of local shafts operate within and near the Centerville city limits to supply the local trade. They are small affairs, usually hoisting with horse and gin, and do but little work during the warmer months of the year. The chief producers are the Centerville Block Number 8, Citizens, White Oak, Woodlawn, North Hill, Koontz, Trio, Rock Valley, Star, Smith, Sears and Wright. The coal mined at these banks differs in no essential respect from the Mystic seam as typically developed elsewhere.

About one mile east of Centerville, on the Chicago, Rock Island and Pacific railway, is the Centerville Block Number 10 (35), known also as the "Raven mine." Coal is reached at a depth of 130 feet. The drift is quite thick here, being ninety feet at the shaft, while the "cap rock" is only one foot in thickness and the "bottom rock" is also thinner than usual and is underlain by sandstone. A short distance west of Number 10 and connected with it is the Centerville Block Number 1, the old "Diamond mine" (36). The haul necessary here is more than a mile. Six Harrison and Legg machines and a Norwalk air-compressor are used in the workings. The tippie at Number 1 has recently been improved and revolving screens are used at both mines.

On the Keokuk and Western, a little over a mile southeast of Centerville, is the Dewey mine (37). This is one of the good producers of the district and hoists by means of a geared engine.

The Manufacturer's Coal and Coke Number 30 (38) lies on a short spur from the Chicago, Rock Island and Pacific railway, about one mile southwest of the Dewey. A neat mining camp of twenty-five houses is situated here. The Mystic coal is thirty-one inches thick at this point and lies in a shallow basin that dips from all directions toward the shaft. A short distance from the latter the north entry encountered a pre-glacial channel which had cut out the roof, but not the coal, for a distance of over 400 feet north and south. A drift-clay filling containing

leaf impressions and bearing water lies directly on the coal. The same channel was found also north of the west entries; while on the east it lay farther east the farther south the workings were carried. The channel appears, therefore, to have a curvilinear course and to bear off towards the southeast. An attempt will be made to penetrate it with an east entry.

The Center mine (39) loads on the Chicago, Rock Island and Pacific railway, about one-half mile south of Centerville. The shaft is 136 feet in depth to the Mystic coal, which varies in thickness from thirty to thirty-five inches. 200 acres are under lease.

The Anchor Coal Company has worked out fifty acres from its mine Number 2 (40), one mile south of the Center and on the north side of the Chicago, Rock Island and Pacific railroad. Coal of the usual character is found here at 155 feet.

*Bellair.* Anchor Number 3 (41) lies on the opposite side of the same railroad, at Bellair. Drift extends down to the "fifty-foot rock," which was struck at a depth of ninety feet. The "cap rock" is only six inches thick at the hoisting shaft, but shows three and one-half feet at the air-shaft. As a general rule in this mine the "cap rock" is thin, but the "slate" immediately above the coal is sufficiently tough to insure safety in mining. Above the firm "slate" is softer shale. About eighty acres have been mined out, most of the product going to Kansas and Nebraska.

Two miles west of Bellair is the Prairie Block mine (42). The shaft was sunk 160 feet to the Mystic seam in 1904 and later a small group of houses was constructed. A lease of 560 acres is owned by the company. The coal presents essentially the same features as at Centerville.

*Numa.* The Numa Block mine (43), one-fourth mile east of Numa, is the largest producer in the county, although work was checked this year by a fire that destroyed the top works in March, 1907. Thirty to thirty-two inches of coal lie 150 feet below the surface. "Slips" and "black bat" give a little trouble. Two hundred acres are under lease and more will be added.

Just west of Numa station is the Centerville Block Number 2 (44). This is an old mine from which about 300 acres have

been worked out. Tail-rope haulage is employed. The shaft is 150 feet deep and the tower forty-five feet to the sheave wheels. The Mystic coal is here thirty-two inches in thickness.

The Walnut Grove mine (45) is immediately north of the cemetery north of Numa, where a gin-shaft sixty-four feet in depth is operated. Although the mine is a mile from the railroad, a portion of the product is hauled to Numa and shipped. The coal is thirty inches in thickness, and without perceptible dip. The "cap rock" is exceptionally thick in places. Small "slips" and some "black bat" have been encountered.

*Exline.* The Iowa Block mine is one-fourth mile east of the station at Exline (Caldwell Tp., Sec. 32, Ne. qr., Nw.  $\frac{1}{4}$ ), on the north side of the Chicago, Burlington and Kansas City railway. The Mystic coal is here 150 feet below the surface, is thirty-six inches thick, and exhibits a southerly dip with a small eastern component. Near the shaft small pre-glacial channels filled with clay, and "slips" are numerous, but in the northwestern part of the workings are less plentiful. Both the channels and the fault planes are commonly oriented northeast and southwest. The throw of the faults is seldom greater than is necessary to bring the roof "slate" down to the level of the "Dutchman."

The old Royal slope, about two miles east of Exline (Sec. 34, Ne. qr., Sw.  $\frac{1}{4}$ ), is resuming work after a long idleness. Water gives so much trouble it is doubtful if much of an output will be attained.

The two mines of the Exline Coal Company are situated about three-fourths mile southwest of Exline (Sec. 31, S.  $\frac{1}{2}$ ), on the east side of the Chicago, Burlington and Kansas City railway. At Number 2, the mine nearest the Exline depot, the coal lies about 130 feet below the railroad tracks. A considerable territory is controlled by the company. A large so-called "fault" which is at least eighty feet in width at a point about 600 feet northwest of the shaft is found at Number 2 mine. Numerous small "faults" and one of undetermined extent run northeast and southwest at a high angle to the first mentioned and still further limit the territory as it is at present known. Some, at least, of these features are due to true geological faults.

A local mine, the White Oak, operates about one mile northwest of Exline. A little of the product is carted to the railroad and shipped.

*Cincinnati.* Less than a mile east of Cincinnati (Pleasant Tp., Sec. 3, Se. qr.) are the three mines of the Thistle Coal Company. Mines Numbers 1 and 2 open on the north side of the Chicago, Burlington and Kansas City by shafts 115 and 100 feet, respectively, in depth and about one-fourth mile apart. Number 3 shaft is 147 feet deep and lies on the south side of the railroad. All these mines have steam hoisting apparatus and are, in general, well equipped. The coal is about thirty-four inches thick in all and bears the relationships to other strata shown in the section given on a previous page. An old erosion channel, 100 feet wide and running southeast and northwest, has cut out the coal on the east side of Number 2 workings. The company intends to tunnel through it to the east where the seam again makes its appearance at its former level. The channel apparently winds in a broad, sweeping curve; for it, or a very similar one, has removed the coal on the southeastern side of

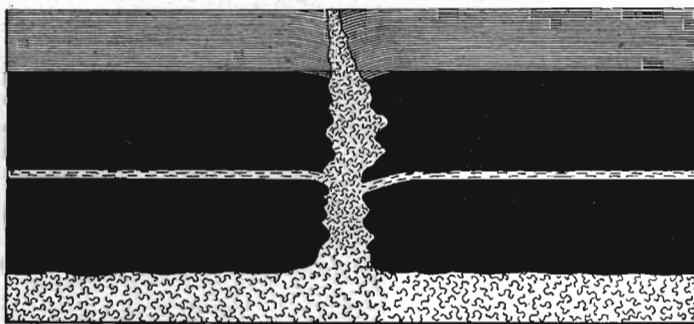


Figure 67. Fissure in seam at Thistle No. 1. Cincinnati.

Number 3 workings and was reached by the Appanoose while working south and by the old Streator (Sec. 9, Ne. qr., Se.  $\frac{1}{4}$ ) while driving east. Mines which were working up from Mendota struck the south side of the channel where it again swings back to an irregularly east and west course. In the hollow of the curve, between the barren areas found by the Thistle and the southern mines, the coal bed reappears.

In the southeastern corner of Cincinnati is the old Appanoose mine, now owned by the Mendota Coal and Mining Company. The Albert mine, about one mile southwest, on the west side of the railroad (Sec. 9, Ne. qr., Nw.  $\frac{1}{4}$ ), is now operated as mine Number 2 of the same company. Number 1 shaft is 180 feet in depth; Number 2, 102 feet. The seam exhibits no noticeable dip and is divided as follows:

	INCHES.
Top coal .....	18
Clay parting .....	2
Bottom coal .....	12

The "cap rock" is from two to eight feet in thickness, the "bottom rock" nothing to five feet, the fire clay between the latter and the coal two feet. Between the two mines is a "wash-out" running southeast that has never been penetrated by tunnels.

A short distance north of Cincinnati (Sec. 4, Ne. qr., Ne.  $\frac{1}{4}$ ) is the shaft, 112 feet deep, of the Domestic Coal Company. A two-horse gin effects the hoisting. About half of the product is hauled to the railroad and shipped; the rest is sold locally. A few small "slips" appear in the strata. The "cap rock" is sometimes lacking, yet the "slate" next the coal remains tough and forms a fairly safe roof.

An equal distance west of Cincinnati (Sec. 4, Sw. qr., Ne.  $\frac{1}{4}$ ), the Armstrong mine now ships coal over a short spur from the Chicago, Burlington and Kansas City railway. The coal dips to the south eighteen inches in 100 feet near the shaft and then continues at a uniform level. It lies 139 feet beneath the surface at the shaft. Here, also, the "cap rock" is lacking in places, but is present in others.

The Consolidated Block is a slope on the west side of the Chicago, Burlington and Kansas City railway, one and one-half miles southwest of Cincinnati (Sec. 9, Se. qr., W.  $\frac{1}{2}$ ). The coal bed is nearly level and averages thirty-two inches in thickness.

Half a mile southwest of the Consolidated Block, on South Shoal creek, is the mine of the Cincinnati Coal and Mining Company (Sec. 16, Nw. qr., Nw.  $\frac{1}{4}$ ). This is a slope 300 feet long to the coal. The product is pulled over a long tramway to the railroad.



*Coal City.* The top-works and slope mouth of the Manufacturers Coal and Coke Number 10 are in Missouri; but the air shaft and slope bottom are on the state line and all the coal mined is in Iowa, near Coal City. Loading is done on a switch from the Iowa and Saint Louis railway, a part of the Burlington system. A gravity slope brings pit cars to the top of the tipple and returns empties. The Mystic coal often shows a thickness of forty-two inches in this district, the upper bench taking the increase. It seems probable that the Appanoose formation extends only a short distance north of the state boundary, for drillings made one mile northeast and one mile east of the slope just mentioned failed to locate the Mystic coal or the limestones characteristically accompanying it.

## PART III

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### COAL DEPOSITS OF SOUTHEASTERN IOWA

#### KEOKUK COUNTY

Keokuk county lies on the eastern border of the main Iowa coal field and contains only about eighty-five square miles of coal measures, of which the greater part is connected on the west and south with the Mahaska and Jefferson county fields respectively. With the exception of the eastern tier of sections, Prairie and Washington townships are underlain by Des Moines strata. There is also a similar but smaller area extending from west to east across central Warren township, and another in the southwestern quarter of Benton. A projection from the Jefferson county field is found in the southernmost sections of Richland township. Several small Des Moines outliers, each less than a square mile in extent, are scattered over the remainder of the county.

The relationships of the Des Moines to the underlying and overlying formations have been described elsewhere in this volume. Suffice it to say here that the results of the periods of erosion which preceded and followed the deposition of the Coal Measures are particularly conspicuous in regions which are situated, as Keokuk is, on the attenuated margin of the Des Moines outcrop. Wherever Coal Measures are found within the limits of the county, they are of slight thickness and usually lie in depressions in the Saint Louis limestone. As a consequence, the coal basins are often limited laterally by limestone walls. Again, the unequal erosion which immediately preceded the deposition of the drift scoured deep valleys in even these Coal Measures that it did not completely remove; so that in many cases we find coal seams cut into and seriously damaged by channels filled with unconsolidated clay and sand.

In spite of the facts which conspire to reduce the value of Keokuk coal basins, the county achieved and maintained for many years, one of the leading places among Iowa coal fields. The Coal Measure strata present necessarily belong to the first group deposited upon the subsiding limestone surface, and it is this lower section of the Des Moines which has proved most productive in the southern part of Iowa. Conditions seem to have been particularly favorable to coal formation during the earliest stages of Pennsylvanian time, and thus it is that the thin layer of Upper Carboniferous rocks found in parts of Keokuk county contains some thick coals that have proven of great value. The What Cheer district has been the chief producer and it was not until the beginning of the present century that its standing as a large mining field began to be seriously impaired. At the present time only local mines, located chiefly near What Cheer, are in operation, and it seems probable that the county will never again regain its former prestige.

In 1860 Keokuk produced 472 tons of coal; in 1870, 3,400; in 1880, 49,350. The United States Census of 1890 registers an output of 455,162 tons, and places Keokuk second only to Mahaska among Iowa coal counties. The following statistics from reports of the Iowa Geological Survey show the gradual decline during recent years.

YEAR.	TONS.	YEAR.	TONS.
1898.....	251,145	1903.....	63,945
1899.....	336,065	1904.....	41,512
1900.....	227,727	1905.....	16,460
1901.....	366,915	1906.....	17,144
1902.....	160,401	1907.....	27,716

The average price per ton at the mines in 1907 was about \$2.29, a high figure.

The State Mine Inspectors report for the year ending June 30, 1908, a production of 11,900 tons from the five principal mines. Thirty-five men were employed. The mines cited below include those in operation in August, 1907. Data as to earlier operations have been taken from former reports of the Survey.\*

\**Keyes: Coal Deposits of Iowa, Iowa Geol. Surv., Vol. II, pp. 357-366; Des Moines, 1894.*  
*Bain: Geology of Keokuk County, Idem, Vol. IV; pp. 255-311; 1895.*

*What Cheer.* For many years the What Cheer district was one of the most important producers in the state. Occupying as it did an important strategical position for marketing its output, the field was energetically developed and almost completely exhausted. In their haste to achieve quick results, however, the large companies operated in a rather wasteful and extravagant

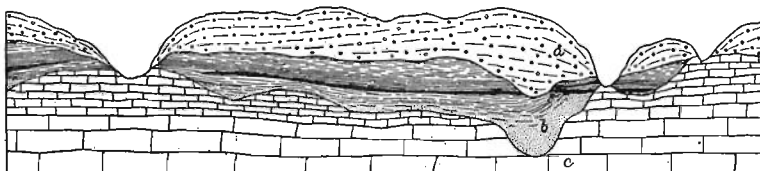


Figure 68. Ideal cross section through the What Cheer district from Rock creek to the North Skunk river.  
a—Drift. b—Coal Measures. c—Saint Louis.

manner, taking only the best coal and leaving untouched areas which offered minor obstacles to profitable development. Thus it is that numerous small mines have done a good business while taking out coal left in larger workings and selling it to supply the large local demands. Several local mines are also now engaged in opening up small areas heretofore unleased.

Only one coal horizon is known in the What Cheer field, although the elevation of its different basins varies within rather wide limits. The conditions under which the coal was deposited were much the same as those sketched for the region on the west in the chapter on Mahaska county. The size of individual basins is limited by that of the depression in which the coal swamps formed, and by subsequent erosion. In many places ridges of the underlying Saint Louis limestone project above the level of the beds mined and at other points the coals are abruptly cut off by Pennsylvanian erosion channels filled with consolidated sediments, or by pre-glacial channels filled with drift. In and around What Cheer are fifty or sixty square miles underlain by Coal Measures, but it is more than likely that all the coal which could be handled in a large way has already been removed. The region has been thoroughly prospected and a considerable portion of it proved barren. In several cases coal has not been worked because of the absence of a suitable cover

between the mineral and the surface drift. Where mining has been undertaken, a "slate" usually less than fifty feet in thickness, constitutes the sole representative of Coal Measures younger than the coal. There are undoubtedly many small basins of good coal left in this field and these will furnish supplies for small local mines for many years to come. The mines in operation in August, 1907, are briefly mentioned below. They hoist, in most cases, with horse and gin and do little work in summer.

In the southeastern corner of What Cheer (Sec. 10, Se. qr., Sw.  $\frac{1}{4}$ ) the Karston Brothers' shaft was sunk forty-two feet to the coal in 1906. The seam here varies rapidly in thickness, yet commonly shows from five to six and a half feet of coal. A "fault" has been encountered 100 yards north of the pit bottom and has not as yet been penetrated. This feature and old workings in adjacent territory greatly limit the fuel supply available at this point. Above the coal is a bare six feet of "slate" that is more compact than that in much of the district.

Near the plant of the Volunteer Brick and Tile Co. is a mine which supplies it with fuel (Sec. 10, Se. qr., Se.  $\frac{1}{4}$ ). A steam hoisting outfit elevates the cars forty feet from the seam to the surface. The coal mined shows an average of four and a half feet in thickness, with a maximum variation of one foot. North of the shaft the margins of two closely related seams overlap. Prospecting now being done north of the mine shows a northerly dip of fourteen feet in seventy yards.

One-half mile north of the Volunteer, the shaft of Armstrong Brothers' mine (Sec. 10, Ne. qr., Se.  $\frac{1}{4}$ ), sunk in 1903, penetrated the following strata.

	FEET.	INCHES.
3. Drift .....	63	6
2. "Slate" .....	30	
1. Coal .....	4	6
Total .....	98	

On the western edge of what Cheer (Sec. 9, Nw. qr., Se.  $\frac{1}{4}$ ) is the new mine of the Creamery Coal Co. The coal has been removed on the north and east by older mines; while in other

directions the seam rapidly becomes attenuated. The available area is thus limited to a few acres. The shaft record is reported as:

	FEET.
3. Drift .....	16
2. "Slate," soft .....	4
1. Coal .....	6

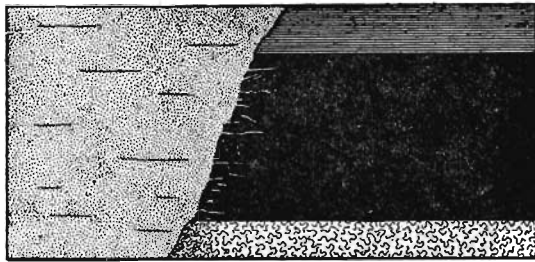


Figure 69. "Fault" in What Cheer coal.

Lee Brothers' mine is in the north-central part of section 3, one mile northeast of What Cheer. Five-foot coal is being worked here, in an area left in the midst of old workings. This company operates a steam hoist and hauls half of its product to the railroad for shipment. A section one-fourth mile west of the shaft gives:

	FEET.
3. Drift .....	90
2. "Slate" .....	45
1. Coal, bony .....	4 to 6

Northwest of the Lee mine and about one mile east of the village of Coal Creek, is the Maxwell, a shaft mine which reaches a five-foot coal at a depth of about sixty feet. One-half mile west is the Ladd mine in the same or a closely related seam.

*Delta.* Delta itself lies in a region of Mississippian outcrop; but shales and sandstones of Des Moines age are found within a half mile due south and also a short distance north. Two miles north a small country mine takes a little coal from a thin seam. One and a half miles southeast of Delta (Warren

Tp., Sec. 14) is a small area of Coal Measures in which from four to five and one-half feet of coal has been found. The seam lies at an elevation of about 712 feet above sea level and is mined during the winters by slopes and shallow shafts which migrate perennially. The quality of the coal is good, but the quantity is limited.

*Sigourney.* A group of three small Coal Measure outliers lying two miles northeast of Sigourney has furnished small quantities of coal. Up to 1897 some mining was carried on in the northwest quarter of section 25. Coal was taken from the central part of section 24 at a later period and perhaps some pillar and crop work may be done during the coming winter. (1907-8.) The shafts in this outlier have been from twenty-four to seventy-eight feet in depth and have seldom been operated for long periods. The coal bed is three to four and one-half feet thick, and has a weak and thin roof of "slate" or, over the best coal, sandstone. Some coal is still left in this vicinity, yet a high market price is essential to its profitable exploitation.

Several years ago an attempt was made to open a twenty-two inch seam included in a very small Coal Measure area four miles east of Sigourney.

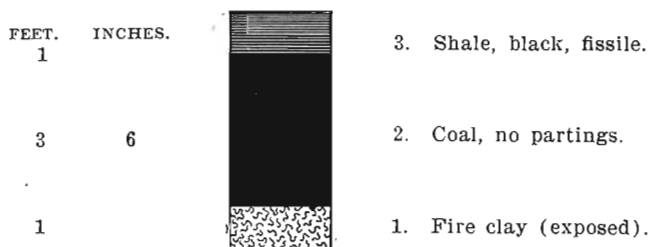


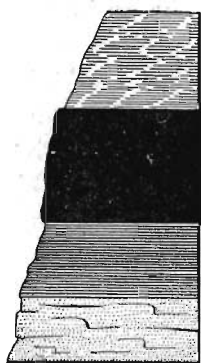
Figure 70. Coal bed at Rowley mine. North of Sigourney.

*Richland.* What is probably the northern extension of the Jefferson county Coal Measures occupies about nine square miles of territory south and west of Richland. Coal has been mined for the local trade at several places in the southeast corner of Richland township (Secs. 31 and 32) and the last opening, the Snider, was closed quite recently. The coal is found in a single horizon lying about eighty feet below the uplands and occurs, apparently, in small pockets. Water and

an inadequate roof usually limit the life of a mine to a single winter, so that numerous openings may be found on a single piece of land. Commonly, less than ten feet of weak, gray shale intervenes between the coal and the overlying drift, rendering close timbering necessary. The coal bed varies between three and five feet in thickness.

WASHINGTON COUNTY

Aside from an extension of the main Iowa coal field occupying less than two square miles in the extreme southwestern corner, only a few small outliers of the Coal Measures are known to occur within the limits of Washington county. Before preglacial erosion had denuded the surface of the region, Des Moines strata undoubtedly occupied a larger area than at present, yet it is open to question whether the entire county was ever covered by the Pennsylvanian sea or whether sediments of this period were deposited in isolated basins. Four Pennsylvanian outliers, covering a few hundred acres each, rest upon Mississippian formations. One of these is in section 27 of Clay township, another in sections 4 and 5 of Brighton; while two others may be found in Highland, one in section 21 and the other in adjoining corners of sections 26, 27, 34 and 35.



	FEET.
5. Shales, argillaceous .....	3
4. Coal .....	3½
3. Clay ... ..	2
2. Sandstone, ferruginous, partially exposed.... ?	
1. Limestone, Saint Louis (exposed).....	10

Figure 71. Coal near the old Liebig mine. Verdi.

Although practically nothing has been mined for many years, at least two Coal Measure areas have proved slightly productive. The deposits northwest of Verdi are composed chiefly of coarse-grained, ferruginous sandstone, with a few feet of in-



tercalated shales and the coal bed shown in the accompanying figure. Several diggings were at one time located near here (Brighton Tp., Sec. 5, Ne. qr., Ne.  $\frac{1}{4}$ ). On Whiskey Run (Highland Tp., Sec. 34, Ne. qr.) a thin coal seam occurs and has been mined a little. It varies in thickness between six and twenty-two inches, is covered only by drift and apparently rests on clay. A report that Coal Measure sandstone existed near Wassonville led to the sinking of an eighty-foot shaft at this point, but with the exception of some bituminous shales probably of Kinderhook age, no coal beds were found.

The only collection of mining statistics in which mention is made of Washington county is contained in the State Census for 1866, when a production of 4,000 bushels was reported and for 1868, when 160 bushels were produced. While additional Coal Measure outliers may be located in the future, the exploitation of any coals that they may contain is more likely to result in financial loss than in profit. Sums so far expended in prospecting and mining have been greater than those gained from the sale of the coal won.

#### LOUISA COUNTY

Coal Measures that were at one period deposited over a large part of Louisa county, either in independent basins or in more or less continuous sheets, have been almost completely removed by the intense denudation which the region subsequently underwent. A few small outliers, covering 400 acres or less each, still remain, the largest being in the west bluff of the Iowa river in adjoining corners of sections 16, 17 and 21 of Union township. It bears some dark shale, a grayish white sandstone, and a few inches of coal. Small areas showing similar strata were discovered in section 13 of Elm Grove township; while twenty feet of Coal Measure sandstone were penetrated in wells in sections 20, 21 and 28, a short distance southwest. This sandstone has been found in various parts of the county, chiefly as narrow dike-like aggregations in crevices of the underlying Mississippian limestone.

The only recorded output of coal for the county is that of forty bushels for 1862. At least two of the outliers have yielded

minute quantities of fuel, but little hope for profitable exploitations can be held out for any portion of the county. In some cases money has been wasted in the exploration of bituminous shales of Kinderhook age and therefore barren. A few concealed outliers, which should be looked for principally in the western townships where erosion has been least active, may perhaps be found beneath a covering of drift, yet even should they contain coal the roof would be weak and the product mined of poor quality.

#### WAPELLO COUNTY

As is the case with most of the counties that are traversed by the Des Moines river, Wapello has been a consistent producer of coal for a long period of time. Most of the coal mined lies at no great depth beneath the surface and the Coal Measures themselves are not thick, being, perhaps, only 250 feet at a maximum and in by far the greater part of the county considerably less. The Saint Louis limestone, which lies immediately beneath the coal-bearing rocks, outcrops in the valley of the Des Moines from the northwestern corner of the county to the mouth of Sugar creek, below Ottumwa, and reappears once more about one mile below Eldon. In these sections of the valley the Des Moines stage is lacking under a strip of territory about one mile in width. In the valleys of the principal tributaries in the northwestern quarter of the county the limestone appears for a distance of several miles back from their points of union with the master stream; in North Avery creek it may be found nearly as far west as the Monroe county line. Outcrops of the same formation have also been reported from Cedar creek, near the Mahaska boundary, and in the northern tier of sections of Compétine township.

Mining in Wapello county has been confined almost entirely to the immediate neighborhood of the Des Moines river and its principal tributaries, for it is only in those districts that good outcrops of the Coal Measures are found. In the northeastern and southwestern portions of the county, the covering of drift effectually conceals the indurated rocks; yet there is little doubt that basins of workable coal do exist under the highlands away

from the Des Moines valley and that these will be exploited at some future period when the areas now known have become exhausted. Wapello coal basins are, however, of limited extent, as are those in most of the Iowa field, seldom underlying more than a few hundred acres in continuous seams. Only thorough prospecting can, therefore, be successful, and for every drilling that penetrates thick coal several may be barren. The discovery of a seam of workable thickness in one prospect does not prove that a workable pocket has been found, for another



Figure 72. Unconformity between the Saint Louis limestone, 1, and the Coal Measure shales, 2. The shales rest on the uneven and weathered surface of the limestone. At the old quarry on the Des Moines river, three miles above Ottumwa.

hole a few hundred feet distant may give quite different results. Coal is not entirely unknown in those areas where but little development has been undertaken. For example: a few small country banks have been opened in Green township, and near Ormanville two seams outcrop, the upper three feet thick and the lower eighteen inches. Prospecting on Cedar creek revealed some good coal, although north of it, near the Chicago, Milwaukee and Saint Paul railway, nothing came to light. A well in section 12 of Pleasant township penetrated 222 feet of Coal

Measures, including three and one-half feet of coal at a depth of 135 feet. The record of this well is:

	FEET.
13. Drift clay .....	60
12. Sand .....	3
11. "Soapstone" .....	15
10. Shale, gray .....	30
9. "Soapstone" .....	20
8. Shale, black, carbonaceous.....	7
7. Coal .....	3½
6. Shale, blue .....	15
5. "Soapstone" .....	10 to 15
4. Shale .....	8
3. "Soapstone" .....	10 to 14
2. Shale, black .....	100
1. Limestone (Saint Louis) alternating with thin layers of blue "sandstone" .....	182

During the early history of coal mining in Iowa, Wapello ranked first among the counties in point of production for a number of years. As long ago as 1857 there were mines near Kirkville and Dahlonga, in the river bluffs four miles below Eddyville, and along Bear creek four miles west of Ottumwa. In 1860, Wapello's annual production was 17,062 tons, nearly three times that of Jefferson, the next in rank. Later on the chief mining districts were one mile south of Dudley, on Middle Avery creek, where a four-foot seam lay fifty feet above the Saint Louis limestone; at Happy Hollow (Center Tp., Sec. 8), in a five-foot coal; near Keb (Richland Tp., Sec. 33) where the coal was more than four feet thick, and especially at Alpine, two miles below Cliffland. In 1870 the output was 31,630 tons, but the county had fallen to fifth place as a producer. During the next decade Happy Hollow continued to produce, and for a number of years prior to 1890 extensive mines were operated just south of Kirkville. In 1880, 67,555 tons were mined; in 1890, 359,199. Production during recent years has failed to advance; statistics gathered by the Iowa and federal geological surveys are as follows:

YEAR.	TONS.	YEAR.	TONS.
1898.....	252,484	1903.....	382,398
1899.....	316,460	1904.....	379,560
1900.....	270,330	1905.....	303,360
1901.....	249,880	1906.....	243,256
1902.....	340,579	1907.....	258,651

During the year ending June 30, 1908, Wapello turned out 244,214 tons of coal and ranked seventh among the coal counties. Twenty mines were in operation, employing a total of 559 men. According to the best available data, the county has produced about 8,700,000 tons during the period since mining first began. Since about 3,200 tons per acre are usually to be won from a four-foot seam in this area, over 2,700 acres have been deprived of at least their best coal. The coal remaining untouched and largely undiscovered may safely be taken to be many times that mined out.

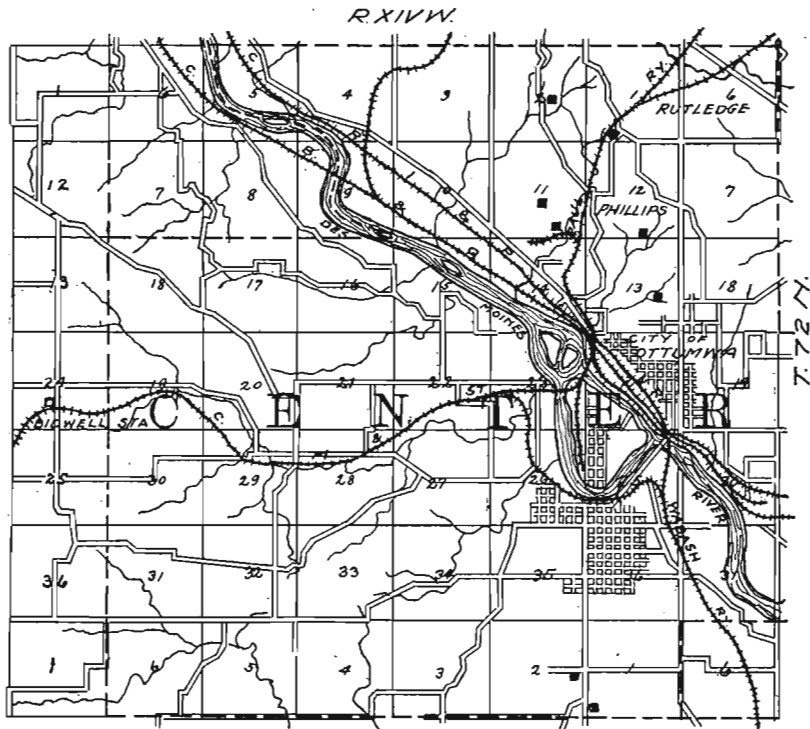


Figure 73. Map showing mines in central Wapello county.

The progress of recent development to August, 1907, is sketched in the following pages. Considerable material has been taken from previous reports of this Survey.\*

\*Keys: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 383-393; Des Moines, 1894. Leonard: *Geology of Wapello County*, *Idem*, Vol. XII, pp. 433-499; 1902.

*Eddyville.* Local mines have been operated since the earliest settlement of the region in the vicinity of Eddyville in Wapello, Monroe, and Mahaska counties; but the coal basins appear to be quite limited in extent. The workings of one shipping mine, No. 9 of the Consolidation Coal Company, were situated chiefly in Wapello county, two and one-half miles east of the town (Columbia Tp., Sec. 3), where a four-foot seam lies near the surface. Local mines are still worked intermittently in this district.

*Kirkville.* Until 1890 large shipping mines were operated just south of Kirkville by the Wapello Coal and Mining Company and subsequently local banks utilized the same seam. Only two small mines are now located in the vicinity. One mile south of Kirkville is the George Knight bank, where a new shaft was sunk early in 1907 near that of the old Davis Coal Company (Richland Tp., Sec. 18, Ne. qr.). The bed worked lies fifty-five feet below the surface, averages four feet in thickness, and is strongly undulatory with a general dip to the south. About ten feet of "slate" capped by a thick sandstone overlies the coal. A mile and a quarter east of the Knight is the Waddle mine (Sec. 16, Nw. qr.). The shaft is 120 feet deep to a coal that runs quite uniformly about five and one-half feet in thickness. The bed possesses a good "slate" roof, and shows undulations equal in amplitude to the height of the coal. Three low seams were encountered in the new air shaft above the one worked. About twelve acres have been mined out at this point. Small mines once operated about two miles south of the Waddle (Sec. 20, S.  $\frac{1}{2}$ , and Sec. 28, N.  $\frac{1}{2}$ ) are no longer in existence. Prospecting near here yielded negative results.

*Keb.* For many years there was at Keb one of the largest mines in the county. Two coals are present, the upper having a quite uniform thickness of about four and a half feet and the lower averaging a few inches more. The distance between the two seams is about twenty feet, though it varies considerably and is in places only three to four feet. The upper seam has a clay parting one to six inches thick and lies about sixty feet beneath the surface.

Good coal has been found in some prospects between Keb and Rutledge, but is cut out in many places by erosion channels.

About a mile southeast of Keb, near the center of section 2, the Standard Coal Company is supplying a local trade from a sixty-foot shaft sunk in 1904. Only two acres of the forty-acre lease have been mined out, aside from some that was tapped about twenty years ago. An upper seam is eighteen inches thick, while the bed worked lies forty-five feet lower and is four feet six inches thick. The latter is quite regular in occurrence, except where small "rolls," six feet or less in width, sometimes cut the coal down to as little as one foot.

*Rutledge.* The Phillips Fuel Company has operated large mines north of Ottumwa, chiefly in section 12 of Center township, for twenty-five years. Three seams are recognized in this area, the lower two being workable in places. A general section of the strata is shown in figure 74, the record of the shaft of old Phillips No. 4. Prospecting carried on a short distance west of No. 4 showed that the coal beds became quite inconstant in that direction, but on the north the second seam is economically important.

Phillips Number 5 is one-fourth mile northeast of old Number 4, at Rutledge, a station on the Chicago, Milwaukee and Saint Paul railway. At this point the second seam is worked, as its thickness is from thirty to forty-four inches and it is less cut into by Carboniferous erosion channels than is the third. At the present time, however, a large barren area is giving considerable trouble in Number 5 workings and its width and orientation are being determined. There are 2,700 feet of tail rope on the main north entry. The shaft is 140 feet deep, its mouth being but a few feet above the level of the railroad tracks at the station. Hoisting is done by a first-motion Ottumwa double engine, cylinders 18x32 inches, supplied by five boilers having a total available horse-power of 375. The tipple is so arranged that lump and nut may be loaded in one car while another is receiving slack. It is said that thirty-five per cent of the coal mined is graded as slack.

Phillips No. 7 is about one mile southeast of Number 5 and works the seam formerly utilized at No. 4. In portions of No. 7 workings the second and third seams run close together and are mined as one; but in such situations the rock is usually poor

and a weak roof often makes it necessary to leave up all or part of the higher coal. The third seam presents numerous irregularities, such as old erosion channels running in all directions. The shaft of the mine is 110 feet in depth. The Phillips Fuel Company ships most of its product north, little being sold in Ottumwa.

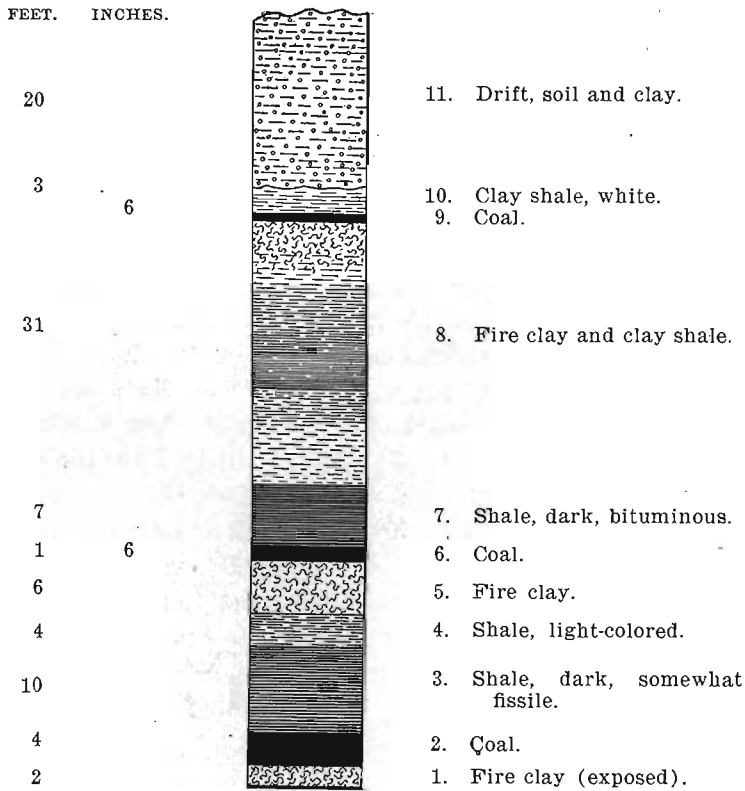


Figure 74. Section of shaft of Phillips No. 4. Ottumwa.

*Ottumwa.* The Spring Hill mine is located within the city limits, near the northern boundary and on a tributary of Harrow's branch. There are two seams of coal, the upper three and one-half and the lower four feet thick. The lower seam is reached at a depth of forty feet and lies not far above the Saint Louis limestone. The latter outcrops along the creek less than three-quarters of a mile below the shaft.



The Black Diamond mine, now operated by the Roseland Coal Company, is one and one-third miles northwest of the Spring Valley, near the plant of the Ottumwa Brick and Construction Company. Two seams of coal have been mined, and usually where one thins out the other grows thicker. The upper averages forty inches and the lower four feet and more. A tramway 900 feet long carries the loaded cars from the sixty-foot shaft to a short spur from the Chicago, Milwaukee and Saint Paul railway, the motive power being by a tail-rope operated by a separate haulage engine. Hoisting is done by steam power. The mine has shipped large quantities of coal, but at present is turning out only a few tons per day and has nearly exhausted the available coal in its territory.

A short distance from the Black Diamond is the Clover Hill mine, operated by the Ottumwa Brick and Construction Company, which consumes about one-half the product. Some coal is shipped and the remainder is sold in the city. The top seam lies at a depth of thirty-two feet at the shaft and is two feet thick; while the coal worked is twenty-six feet lower and varies from four and a half to six feet, with an average of five feet. The company reports that entries have been driven 2,000 feet east, 3,000 north, 1,000 south and 2,000 west and from them an area of about forty acres has been mined out. Sufficient coal remains to supply the mine for at least three years more. The bed shows a barely perceptible dip to the south. A tramway 2,600 feet long runs due south from the shaft to the railway spur mentioned above. The tipple has two chutes with hopper scales for local use and one with track scales for weighing the product shipped. A steam hoist is used. The sequence of strata near the shaft is:

	FEET.	INCHES.
6. Drift .....	14	
5. Soapstone shale .....	5	4
4. Shale, dark .....	9	4
3. Coal .....		6
2. Shale, gray .....	8	6
1. Coal .....	6	
	<hr/>	<hr/>
Total .....	43	8

WAPELLO COUNTY

*South Ottumwa.* Slightly more than a mile south of the southern corporation limit of Ottumwa, two mines are operating to supply the city trade. Two seams, only the lower of which is workable, are present and are separated by no great vertical interval. South of the mines is an area of coal land of unknown extent, but drilling done less than a mile east, west, and north showed that in those directions the seam is badly cut up by barren strips. Of the two mines, that nearest the city is the slope of the Star Coal Company (Tp. 71 N., R. 14 W., Sec. 2, Se. qr., Ne.  $\frac{1}{4}$ ). The slope is 450 feet in length, with a twenty per cent grade. A short tramway extends north from the slope mouth to the wagon road and cars are hauled by tail-rope a distance of nearly half a mile from the interior of the mine to the tippie. The seam worked is from four to five feet in thickness. About twenty-five feet above it in the air shaft is a fourteen-inch coal. Southwest of the Star is the Dempster mine (Sec. 1, Sw. qr., Sw.  $\frac{1}{4}$ ), opened in 1906. The mine is now in course of development. The gin hoisting shaft penetrated the following strata, as reported by Mr. Dempster.

	FEET.	INCHES.
6. Soil and drift .....	12	
5. Blue clay .....	30	
4. "Slate" with thick rock band.....	35	
3. Coal (thirteen inches in air shaft).....		3
2. "Slate" .....	11	6
1. Coal .....	4	4
	93	1
Total .....	93	1

One mile east (Keokuk Tp., Sec. 6, Sw. qr.), coal **was** formerly mined. A seam four and one-half feet thick lies 130 feet beneath the surface, while five feet above is an equally high seam. The Saint Louis limestone outcrops at a level fifty feet above this coal in the bed of the river at Ottumwa, two miles north, cutting off the Coal Measures in that direction.

*Sugar Creek.* Mining on a small scale has been undertaken at numerous points on Sugar creek and its tributaries, east of Ottumwa (Secs. 21 and 22), and some is still taken out there, as well as in the river bluffs near the creek mouth, by strippings and by small local mines which lead a desultory life. At the

old Colgan mine, about one mile below the debouchure of Sugar creek (Tp. 71, R. 13, Sec. 4, Ne. qr.), the following section was obtained.

	FEET.	INCHES.
7. Sandstone, massive, cross-bedded.....	50 to 60	
6. Shale, black .....		6
5. Coal .....	1	2
4. Fire clay and argillaceous shale.....	15	
3. Coal .....	2 to 3	
2. Fire clay and black shale.....	1 to 10	
1. Coal .....	4½ to 5½	

		FEET.
9. Soil .....		2
8. Sandstone, coarse grained, massive, yellow and brown.....	20	
7. Coal, rather slaty.....	1½	
6. Fire clay .....	4	
5. Shale, very dark, bituminous, some- what fissile and dark below.....	3	
4. Shale, gray, argillaceous.....	6	
3. Shale, black, bituminous.....	2	
2. Coal .....	3	
1. Fire clay (exposed).....	1	

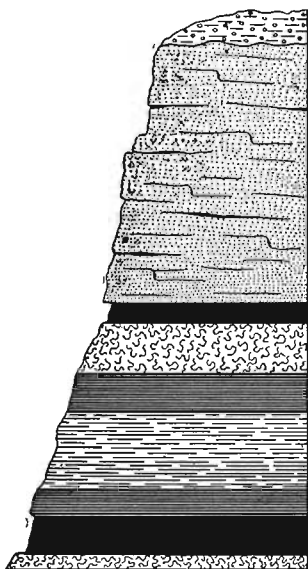


Figure 75. Bluff in Sugar creek. East of Ottumwa.

*Bidwell.* East of Bidwell station and about three miles west of Ottumwa (Center Tp., Sec. 20), the Bear creek mine shipped coal from a bed four and one-half feet in thickness. The seam outcrops in the valley and lies only about thirty feet above the Saint Louis limestone. This mine is not now in operation, but may possibly be reopened. At Bidwell, eight prospect holes were put down and apparently good coal was found. A prospect shaft was sunk one-half mile northwest of the station and the coal rights of the surrounding territory were purchased; but the matter has been dropped, perhaps to be taken up again later. It is said that there are several hundred acres of coal here,

from four to five feet thick and about 118 feet below the lowlands. If this information is correct, development of this basin may be expected at no distant date. A drilling on the Sweeney farm, near the Bear creek mine, is reported to have penetrated the strata listed below. No workable coal was encountered in this particular boring and the depth to which the Coal Measures extend is surprising, though not at all improbable.

DRILLING BY PHILLIPS FUEL COMPANY.

	FEET.
11. Clay and sand.....	75
10. "Slate," hard, blue.....	20
9. Coal .....	½
8. Fire clay .....	4½
7. Sandstone, compact .....	6
6. "Slate," gray .....	50
5. Rock, blue, hard.....	3
4. "Slate," black .....	10
3. Rock, blue, hard .....	5
2. "Slate," black .....	3
1. Sandstone, gray .....	4
<hr/>	
Total .....	181

*Willard.* The Appanoose mine, which did a shipping business at Willard for many years (Polk Tp., Sec. 33, Nw. qr., Ne. ¼), is now definitely closed. The shaft was ninety feet in depth to a four-foot seam, with an upper rather bony coal about ten feet higher. The bed worked was strongly undulatory, dropping forty feet in 1,800 south of the shaft and rising an equal amount in 2,200 toward the west. Contrary to the usual occurrence in such cases, the coal thickened toward the rise, while in descending toward the lower part of the basin on the east and south the seam ran out against an erosion channel filled with compact argillaceous material for a width of 350 yards or more. Two miles east of the mine, ten out of eleven prospect holes showed coal which was three and a half feet at a maximum. Sixty holes were drilled within a radius of two miles from the mine; coal was found in some of the tests, but appeared to be pockety and somewhat erratic in occurrence. Prospecting was also done between Willard and Blakesburg, but was not followed by exploitation. In Bear creek valley as a whole the coal presents

the aspect of a succession of extensive seams greatly cut up by old erosion channels. Prospectors differ as to the material in these so-called "faults" and it is probable that both contemporaneous and pre-glacial water action has played a part. In the majority of cases, perhaps, drift replaces the coal.

One and a half miles northwest of Willard, on South Avery creek, local mines are intermittently worked. The Newell mine (Sec. 29, Nw. qr., Ne.  $\frac{1}{4}$ ) opens by a fifty-foot shaft to a three-foot coal which outcrops in the bed of the stream. Hoisting is done by means of a steam equipment.

*Eldon.* Two miles east of Eldon (Sec. 25, W.  $\frac{1}{2}$ ) are two local mines, those of C. D. Sharp and W. McIntosh. These work a seam which is three feet six inches in thickness and lies about sixty feet below the surface. In Eldon itself are several small local banks, among which may be mentioned the Kern, Kelley, and Burns. The coal is reached by shallow shafts and shows only from twenty to thirty inches of coal. The roof of dark "slate" is usually adequate. Coal is also sometimes mined a bit over one mile west and northwest of town. An Eldon company recently drilled nearly fifty holes near Eldon, but are not yet prepared to publish the results. In most places they found at least a top seam of eighteen inches to three feet and a lower of six inches to two feet. Every boring penetrated one or more coals, of various thicknesses. It is said that some good coal land was located back from the railway but that near it nothing encountered justified exploitation.

*Laddsdale.* At Laddsdale, on the Davis county line, a shipping mine is operated by the Anchor Coal Co., also known as the Eldon Coal and Mining Company; on a short spur of the Chicago, Rock Island and Pacific Railway (Tp. 71, R. 12, Sec. 32, Sw. qr., Sw.  $\frac{1}{4}$ ). This is mine number 2 of this company, No. 1, which was situated one-fourth mile west, having been abandoned. The shaft is sixty-eight feet in depth and the altitude of its mouth is given by the company as 620 feet above sea level. The coal mined is of good quality for steaming purposes, being used in the railroad chutes at Eldon. Rolls in the roof and slips with a maximum displacement of eight feet are fairly common in the workings and the beds exhibit frequent changes of level. Entries

have been driven 3,000 feet northwest and southeast and 600 feet southwest and northeast. The old workings of Number 1 have now been headed, so that work will progress more rapidly in the future. Grades are so arranged in the entries that one mule can haul ten-car trips. A number of prospect holes drilled in sections 31 and 32 of Washington township at distances of 150 to 200 feet apart reveal that inconstancy of individual strata and rapidity of change in the appearance of the coals which is so characteristic of the Des Moines beds in the southern part of the Iowa field. Following are two sample drill records from this area.

LADSDALE SECTIONS.

A.

	THICKNESS IN FEET. DEPTH.	
24. Drift .....	12	12
23. Clay shale, gray and blue.....	13	25
22. Shale, black .....	3	28
21. Shale, sandy, gray.....	6	34
20. Clay shale, blue .....	10	44
19. Coal .....	1	45
18. Clay shale, gray and blue.....	24	69
17. Sandstone .....	1	70
16. Shale, black, carbonaceous.....	3½	73½
15. Coal .....	3	76½
14. "Rock" .....	1½	78
13. Clay shale, gray and blue.....	14½	92½
12. Coal .....	1½	94
11. Clay shale, gray and blue.....	6½	100½
10. Shale, sandy, blue.....	2	102½
9. "Rock," soft, blue .....	1½	104
8. Coal .....	1 1-3	105 1-3
7. Fire clay .....	2 2-3	108
6. "Rock" (limestone ?) .....	5	113
5. Shale, sandy, blue .....	6	119
4. Clay shale, blue and gray.....	16½	135½
3. Coal .....	2½	138
2. Fire clay .....	2	140
1. Clay shale, light blue.....	12	152

B.

20. Drift .....	20	20
19. Clay shale, blue .....	5	25
18. Sandstone .....	5	30
17. Clay shale, blue and gray.....	33½	63½
16. "Stone" (limestone ?) .....	2	65½

	THICKNESS	
	IN FEET.	DEPTH.
15. Clay shale, gray and blue.....	6½	72
14. Coal .....	1	73
13. Clay shale, gray.....	12½	85½
12. Coal .....	1½	87
11. Clay shale, gray and blue.....	18	105
10. Coal .....	2	107
9. Clay shale, blue .....	26	133
8. Shale, sandy, gray .....	5½	138½
7. Clay shale, blue and gray.....	19½	158
6. "Cap rock" .....	½	158½
5. Coal .....	2¼	160¾
4. Clay shale, gray and blue.....	8	168¾
3. Shale, sandy, blue.....	8	176¾
2. Sandstone .....	5½	182¼
1. Limestone (Saint Louis ?).....	1½	183¾

Two beds of coal were encountered in several of the holes at approximately the same depth, namely at seventy-two and 103 feet respectively, but varied considerably in thickness. At about 135 feet another seam was found in some drillings, and at 158 feet still another. Besides the four mentioned, other seams were struck at different depths in the various holes, no less than seven being penetrated in one boring and only three in one only 200 feet distant. If reservations be made for the irregularity of the beds, the following may be given as a summary of the coals in the territory of mine Number 2.

BED.	THICKNESS.	
	FEET.	INCHES.
Top seam (often replaced by drift).....	3	
Second seam (may be worked later).....	3	
Third seam (now being worked).....	3	10
Fourth seam (now being worked).....	4	2
Bottom seam .....	2	6

### JEFFERSON COUNTY

Since Jefferson county lies on the eastern margin of the Iowa coal field and Mississippian limestone outcrops in the valleys of its principal streams, it is not to be expected that the Des Moines will show any great thickness within its borders. Coal Measures form the youngest of the indurated rocks under the greater part of the county's surface; yet their greatest thickness, where deposited in depressions in the irregular sur-

face of the underlying Saint Louis, is probably little more than 200 feet. Their average is considerably less than this figure in all the townships, but is most in the southwestern section of the county, as shown in the accompanying plat prepared by Udden.

PLAT OF ESTIMATED AVERAGE THICKNESS OF THE DES MOINES IN THE SEVERAL TOWNSHIPS OF JEFFERSON COUNTY (IN FEET).

Polk 20	Black Hawk 15	Penn 30	Walnut 10
Locust Grove 30	Fairfield 75	Buchanan 20	Lockridge 40
Des Moines 50	Liberty 50	Cedar 20	Round Prairie 20

“It should be remembered that the figures given are estimates and that since both the upper and the lower limits of the formation conform to ancient erosion contours there are apt to be great local variations in its development. It is believed that the maximum development of the formation will not exceed three times the figures given, while at the same time it is known that excepting Fairfield and Locust Grove townships, the minimum limit is zero; that is, the Coal Measures have been entirely removed at some point in nearly all the townships.”\*

The Coal Measures have been removed from a small area in the northwestern corner of Polk township; from the greater

\*Udden: *Geology of Jefferson County, Iowa Geol. Surv., Vol. XII, pp. 355-436; Des Moines, 1902.* Material has been taken from this report for the succeeding pages of this chapter without further acknowledgment, and also from Keyes: *Coal Deposits of Iowa, Iowa Geol. Surv., Vol. II, pp. 393-402; 1894.*



part of the region north of Walnut creek, as far west as Veo; from the valleys of Skunk river, of Rocky branch, of Turkey creek, and of Rock creek; from the valley of Cedar creek, as far west as section 29 of Cedar township; and from several small areas in various parts of the county where local elevations of the Saint Louis prevail. The most productive coal basins are located at the base of the Des Moines, near its contact with the Saint Louis. The points where mining has been undertaken have in almost all cases been in the valleys of the numerous water courses; while the upland region is virtually unexplored by prospectors. Systematic search with the drill on the divides, especially on those that lie near known productive valleys, would undoubtedly result in the proving of workable basins heretofore unknown. The boring of merely a few holes would as undoubtedly result in failure; for Jefferson county coal appears to be extremely "pockety" and barren areas are apparently numerous. It might be necessary, therefore, to continue the search over considerable territory before the coveted basins were found. Those townships in which the Coal Measures are thickest offer the greatest opportunity for locating coal in one or more of numerous horizons present; yet the best horizon seems to be contained in the base of the formation, which can be reached by shallower drillings in those localities where the Coal Measures are more attenuated. Consideration must also be given to the fact that where the measures are thin, the roof over the coal is apt to be insufficient for extensive mining.

Owing to the early settlement of the region and to the appearance of coal in outcrops in the deeper valleys, coal mining in Jefferson county began at an early date in the history of the state. In 1860 its production, 6,143 tons, was second only to that of Wapello, and it retained a high position as a producer throughout the following decade. In 1870 the output had not increased, being 5,300 tons, though the statistics for 1880 show an advance to 46,150 tons. Succeeding years witnessed a gradual decline due to the closing of the larger mines at Perlee, until in 1890 only 8,123 tons were reported. According to reports of the Iowa and United States Geological Surveys, recent production has been:

## JEFFERSON COUNTY

309

YEAR.	TONS.	YEAR.	TONS.
1898.....	1,025	1903.....	6,447
1899.....	3,700	1904.....	9,810
1900.....	3,650	1905.....	3,379
1901.....	1,248	1906.....	3,744
1902.....	10,284	1907.....	4,000

The present output is quite small, not more than 2,000 tons annually, and only a few mines are in operation, even during the winter months. A summary of our present knowledge in regard to Jefferson coal may be found in succeeding pages.

*County Line.* Coal is known to occur along Black creek and its tributaries, two miles south and southeast of County Line and further down the creek. Seams ranging from three feet to five feet six inches have been reported in sections 20, 29, 30 and 32 of Des Moines township as well as in portions of sections 28, 21 and 33. The coal lies at shallow depths and usually possesses a shale roof, which is gray above and grades downward through black, fissile "slate" into bony coal. Small mines have been operated at various points along the streams, yet there has been little apparent endeavor to locate coal by prospecting under the higher lands, where it may reasonably be expected to occur.

*Libertyville.* Near Lick creek, about three miles south of Libertyville, is a small area from which coal has been taken for many years. Mines in the southwest quarter of section 29 and the northeast of 31 have partially exhausted their territory and have been abandoned; but the J. C. Buchanan bank still works during the colder months of the year in the southeast quarter of section 30. The present shaft, sixty feet in depth, has been flooded by recent heavy rains, so that it may become necessary to excavate new openings for the next season's work. The seam worked is three feet thick, and is overlain with a black, calcareous and fossiliferous shale. The coal bed is not undulatory and dips gently to the west. A fourteen inch coal is reported to lie nine feet above the lower seam and to remain quite constant in thickness over considerable territory. The thicker basin is, however, more limited in extent; for Saint Louis limestone outcrops in the creek on the west

and drilling a short distance north and east of the Buchanan mine failed to locate the workable bed.

In the immediate vicinity of Libertyville, wells and prospects have penetrated barren strata. Several years ago Mr. Albert Gardner operated a shaft forty feet deep near the bank of Cedar creek, three miles east of Libertyville (Liberty Tp., Sec. 15, Ne. qr., Ne.  $\frac{1}{4}$ ). The seam mined lies eighteen feet below the creek bed. A general section of the Coal Measures based upon several explorations in this territory, is as follows:

GENERAL SECTION OF THE COAL MEASURES IN THE NE. QR. OF SEC. 15.

	FEET.
9. Limestone, concretionary .....	1-5
8. Shale, gray .....	5
7. Coal .....	0-3
6. Fire clay .....	0-4
5. Sandstone, hard, gray.....	0-5
4. Shale .....	30
3. "Slate" .....	1-3
2. Coal .....	3
1. Fire clay and shale.....	7

Not far from the old shaft mentioned above, a slope with a fall of nine inches to the yard was recently opened on the land of Mr. Bishop. Since prospecting operations had shown a good seam of coal in this vicinity and the slope encountered a mere "blossom," it was conjectured that an erosion "fault" had removed the better part of the coal. Acting upon this supposition, the parties interested then sank a ninety foot shaft on the neighboring hill with the intention of directing the work from it toward the slope; but as the shaft passed through only a similar "blossom," work was abandoned. A top seam of poor coal was seven inches thick in the shaft and twenty-two in the slope. Evidently only small basins have been located in this vicinity. On the north, the Saint Louis limestone outcrops in the lowlands of much of section 10 and the eastern part of section 9.

*Fairfield.* Essentially the only mining now conducted in Jefferson county is by a few coal banks on Cedar creek three miles due south of Fairfield, which supply the local country trade and haul some coal to Fairfield. As they work during

the winters only and have the simple horse-power equipment characteristic of mines of their class, their output is not large. The Bates and Spratt Coal Company have a mine a few rods south of Cedar Creek, just south of the bridge on the Fairfield-Birmingham wagon road (Liberty Tp., Sec. 24, Ne. qr., Se.  $\frac{1}{4}$ ). The seam is variable in thickness, ranging from two to five feet, and contains three grades of coal which are classified as such by the miners because of slight differences in practical heating and steam-producing qualities. The shaft is forty-seven feet deep and the coal lies at about the same elevation as the river bed. From five to twelve feet above the lower coal is a thin bed, fourteen to eighteen inches in thickness at this point. As shown by the following section, measured one-half mile northwest, and by other outcrops, it is a fairly persistent horizon.

EXPOSURE ON CEDAR CREEK.

	FEET.
7. Drift .....	4
6. Sandstone, buff, soft and shaly.....	4
5. Shale, argillaceous, dark blue.....	10
4. Coal .....	5-6
3. Fire clay .....	4
2. Shale, dark .....	8
1. Sandstone (exposed) .....	1

Coal in a horizon slightly higher has also been found in this vicinity. A short distance above the Bates mine is the sixty-foot shaft of the Fairfield Coal Company (Sec. 24, Ne. qr., Sw.  $\frac{1}{4}$ ). The coal at the two mines is essentially similar, and forms part of the very base of the Coal Measures. One-

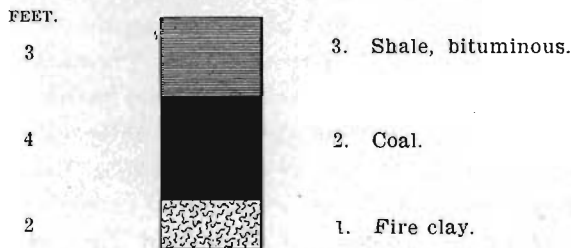


Figure 76. Coal bed at Bates & Spratt mine. Fairfield.

half mile southwest (Sec. 24, Sw. qr., Ne.  $\frac{1}{4}$ ) a drift has been driven into four feet of coal in the right bank of a tributary of the Cedar. Above it is a black fissile shale about nine feet

thick and then a sandstone. Some explorations have been made in this territory and the elevations of the coal seams were found to be quite variable; changing as much as forty feet in less than a quarter of a mile. Coal has been mined at several points within a mile below the Bates bank, in the valley of the Cedar.

A mine was formerly situated at the old Reed mill, near the Burlington railroad bridge across Cedar creek, two miles southwest of Fairfield (Sec. 3, Se. qr.). The sequence shown in the north bluff is:

	FEET.
7. Shale, gray .....	25
6. Coal .....	1
5. Sandstone, brown .....	1-5
4. Shale, black .....	1
3. Coal .....	1
2. Fire clay and shale.....	10
1. Coal (near the level of the creek bed).....	3

In the northeast quarter of the same section, prospecting has recently been prosecuted on the land of Robert Ratcliff, north of the Libertyville road. Here the lower coal, the one formerly worked at the mill, has thinned to half its former height; while the thickness of the top seam is increased to sixteen inches, and of the second seam to thirty inches. The coal in the upper beds is of good quality and may be developed at no distant date.

Another old mining district is located two miles west of Fairfield (Fairfield Tp., Sec. 27, Nw. qr., and Sec. 28, Ne. qr.). The principal coal seam occurs at depths varying from thirty to ten feet below the bottom of the streams, is from three to three and a half feet in thickness, and is overlain with a black shale containing large septaria. In this region, thin coals are frequent and some basins of workable extent and thickness probably remain undiscovered. Well records in both the southern quarters of section 28, Fairfield Tp., are said to show a thick seam of coal at about 160 feet below the upland level. One of the thin coals of this district is excellently well exposed in the north bank of the Cedar (Fairfield Tp., Sec. 32, Nw. qr.). This seam, which is here eighteen inches thick and thins lat-

erally is shown in the lower part of the illustration (Fig. 77).

*Perlee.* Perlee was at one time the center of the most extensive mining undertaken in Jefferson county. Until early in the eighties, the Jefferson County Coal Company and the Washington Coal Company took out considerable coal; later companies possessed less capital and operated on a smaller scale, while what mining has been done within recent years has consisted in working out the crop coal and in pulling pillars in old workings. On the Courtney land in section 27, Penn township, coal was hoisted through a shaft forty feet deep for two



Figure 77. Exposure of Coal Measure strata in the north bank of Cedar creek, section 32, Fairfield township.

years. The seam was four feet in thickness and the pocket still bears some good coal. Some coal also remains west of the Washington mines in section 32. Patches left unused by the Jefferson mines, a mile east of Perlee, were worked quite recently and the district in the immediate vicinity of Perlee is now pretty well exhausted. Most of the old coal banks have been located in sections 26, 27, 32, 33 and 34 in a seam which lies at about the level of South Walnut creek and but a short distance above the limestones underlying the Coal Meas-

ures. The latter formation is not of great thickness in Penn township, not much exceeding 100 feet at its maximum and being entirely lacking in much of the northern section. The Saint Louis appears in the valley of the lower parts of the various branches of Walnut creek near the scene of former mining operations. The principal seam worked lies in a series of pockets in a narrow and irregular basin about three miles long and a mile or less wide, covering altogether less than one square mile in an area trending northeast and southwest. Where utilized, the coal averaged three to four feet in thickness and was overlain with from six to eight feet of strong "slate," graduating upward into a thick shale. In places, however, the roof has been cut out and replaced by drift, while locally the seam itself has been removed by pre-glacial erosion. Shafts sunk to the principal pockets ranged from forty to one hundred feet in depth. The sequence of strata is illustrated in the accompanying figure of the section at one of the shafts operated by the Washington Coal Company, whose mines were in sections 32 and 33.

The following section of the indurated rocks in one of the Jefferson shafts near the Perlee station (Penn Tp., Sec. 33, Ne. qr., Sw.  $\frac{1}{4}$ ), shows a general correspondence with those in the Washington territory.

	FEET.
5. Shale, gray and clayey above, becoming black and fissile below .....	13
4. Coal .....	3
3. Fire clay, grading downward into gray clay shales.....	14
2. Shale, highly bituminous and coaly in places.....	3
1. Fire clay (exposed) .....	1

*Brush Creek.* For nearly fifty years mining has been intermittently prosecuted along Brush creek, in section 27 of Lockridge township. A considerable area near the center of the section has already been mined out. The seam worked is at a level slightly below that of the creek and is somewhat, though not seriously, disturbed by horsebacks and faults of small throw. One of the latest mines to be operated in the district

was that of the W. G. Smith Coal Company, the shaft of which penetrated the following strata :

	FEET.
6. Drift .....	54
5. Shale .....	1
4. Fire clay, yellow .....	3
3. Shale, black .....	9
2. "Slate," black .....	20
1. Coal (thirty feet below level of creek).....	4½

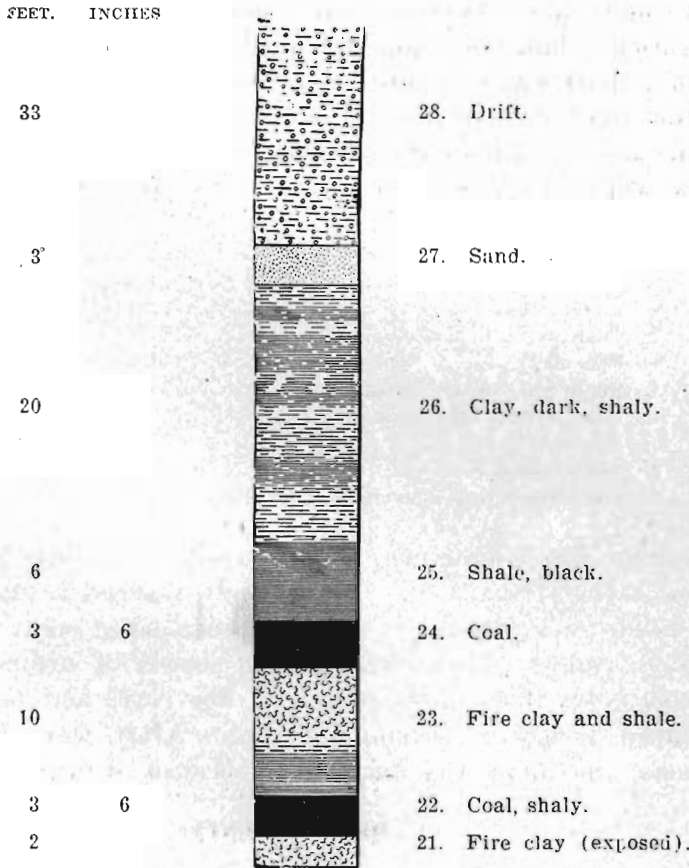


Figure 78. Section of shaft of Washington mine. Perlee.

On the south side of the shaft is a fault with a down-throw of five feet to the north; the fault plane dips north 32 degrees



and trends west 15 degrees S. The Smith Coal Company was expanded into the Big Four Coal Company, a steam hoisting plant was installed, and an effort made to develop the mine on a large scale; but after the burning of the shaft in 1906 operations were suspended. The quality of the coal was good, while the roof was firm in places, yet water entered in large quantities and gave considerable trouble. A shaft fifty feet deep was sunk one-fourth mile northeast by Mr. Smith and was worked on a small scale. One room was opened under the creek bed and indications that the seam extended northward were verified when a shaft was excavated in section 22 (Se. qr., Se.  $\frac{1}{4}$ ).

More than one coal horizon appears in this district, as shown by the section of the old McGregor shaft, west of the Big Four mine, which is given below (Sec. 27, Sw. qr., Nw.  $\frac{1}{4}$ ).

	FEET.
10. Drift .....	10
9. Clay shale .....	3
8. Shale, blue .....	8
7. Coal .....	2
6. Fire clay .....	2
5. Shale and "slate," bituminous.....	25
4. Coal, with a thin seam of pyrite.....	4 $\frac{3}{4}$
3. Fire clay .....	3
2. Shale, green .....	8
1. Hard black rock with shells (St. Louis ?).....	1

Coal has also been mined in section 36 of Lockridge township, where a shaft twenty-five feet in depth reached a seam forty-two inches in thickness. The latter consisted of eight inches of a tough cannel coal above, thirteen inches of ordinary bituminous coal, then three inches of fire clay, and below this eighteen inches of bituminous coal. After working a few seasons, the mine was abandoned because of water.

#### HENRY COUNTY\*

Not more than twenty square miles in Henry county are underlain with Coal Measures, and the deposits are extremely thin where present. The greater part of this area forms merely the attenuated edges of more important Des Moines outcrops

\*A complete description of the Coal Measures of this county has already been published by Savage: *Geology of Henry County, Iowa Geol. Surv., Vol. XII, pp. 284-288; Des Moines, 1902.*

in Jefferson county on the west and Lee on the south, while the remainder lies in small isolated patches. Before the prolonged period of erosion which intervened between the last retirement of the waters of the sea from this region and the invasion of the Pleistocene ice sheets, it is probable that Des Moines strata covered Henry county to a depth of many feet. Before the deposition of the drift, however, stream action and surface wash had removed all but that portion of the Coal Measures which lay in a protected position in depressions of the underlying calcareous formations, or which was situated at a distance from the area of most energetic erosion.

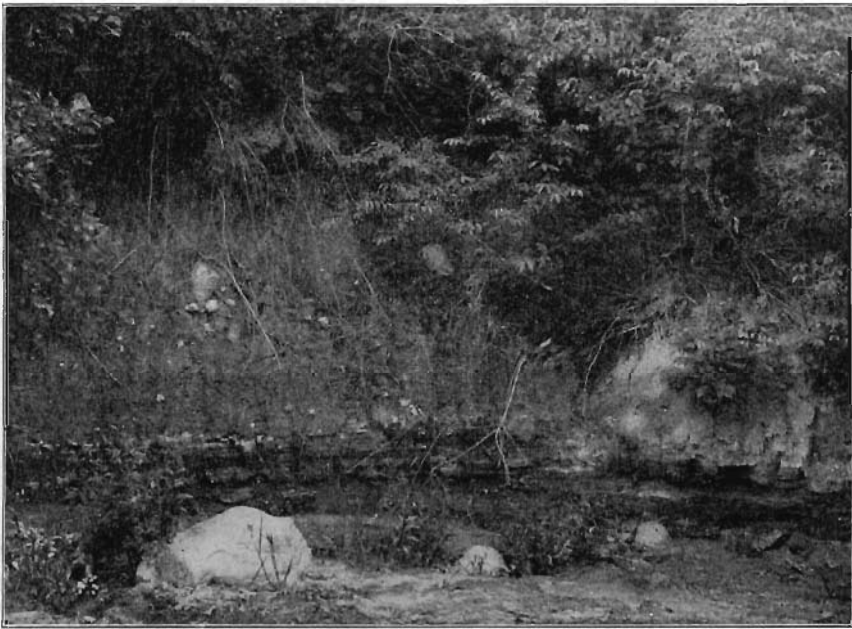


Figure 79. An exposure of coal in section 5 of Salem township. The coal bed is immediately overlain by drift.

Coal Measures may be found along the western boundary of the county in a strip less than one mile wide and about fourteen miles long extending from the southwestern corner of Salem township to a point north of the Chicago, Burlington and Quincy railroad. A similar narrow strip lies east and west along the greater part of the southern border of the county; while a few small outliers are erratically placed in

various parts of the southern six townships. The strata constituting the outcrops consist chiefly of yellow and brown sandstones with intercalated shales; although a few coals have been discovered and will be mentioned more in detail below.

Before the advent of several lines of railroad caused cheap fuel to be brought to every door from neighboring counties and from other states, some mining was undertaken; but nothing has been done for a number of years. In 1862, 100 bushels was taken out; in 1866, 10,035 bushels; in 1868, 20,300 bushels; in 1875, 120 tons, and in 1885, 196 tons.

*Rome.* West of Rome, near the Skunk river, a coal that has been mined in the past outcrops in the sides of neighboring ravines. The following is the section as reported by Keyes.\*

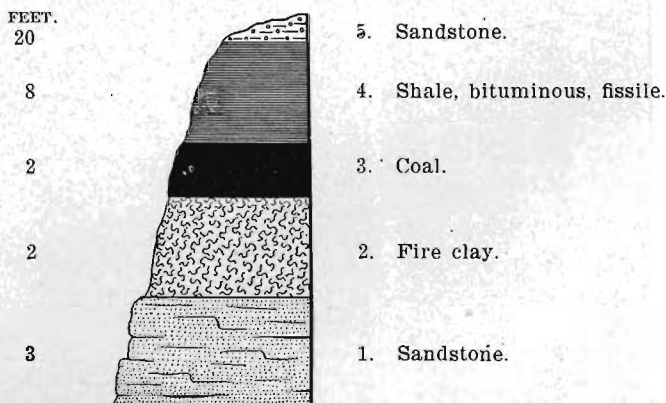


Figure 80. Outcrop west of Rome.

*Salem.* Four miles north of Salem, in section 5 of Salem township, rocks forming part of a small Coal Measure outlier outcrop at several places in a small ravine. Among these strata is a coal bed, as shown in the section given below.

	FEET.
3. Gravels and bowlder clay .....	3½
2. Layer of soft sandstone grading downward into a narrow band of shale .....	4
1. Bed of impure, earthy coal, rather soft and crumbling easily .....	3

A few rods farther down the stream there is an outcrop in which the coal is of better quality and is slightly thicker. The

\*Iowa Geol. Surv., Vol. II, p. 481; Des Moines, 1894.

coal is harder and contains less earthy matter than that of the above section, but is immediately overlain by the bowlder clay. Twenty rods north of the latter exposure, the Saint Louis limestone appears twenty-five feet above the level of the coal. One mile to the north, the opposite side of this limestone ridge is reached and a bed of coal very similar to that described may be observed in a stream valley in the central portion of section 32, Tippecanoe township. The seam is overlain by ten inches of shale, capped by four feet of soft sandstone. The coal is three feet in thickness and was formerly drifted for a distance of two or three hundred feet into the hill.

Coal is exposed in the wagon road five miles directly east of Salem and has formerly been mined. The Coal Measure outlier of which it forms a part is, however, a small one and all the workable part of the seam appears to have been removed.

#### DAVIS COUNTY

Although containing strata which have proved in neighboring counties the most productive in the state, Davis has as yet produced but little coal. That this state of affairs is due to factors other than the absence of workable coal basins, there can be but little doubt. Most of the county is covered by an exceptionally heavy mantle of glacial drift that effectually masks outcrops, and in only a few places have streams cut down to the indurated rocks beneath. It is significant that where exposures of the Coal Measures have been laid bare, coal beds have in many cases been discovered and there is reason to think that numerous basins exist in unprospected portions of the region. It is not likely that these are of great lateral extent, for the only persistent seam in the Des Moines stage of southern Iowa, the Mystic coal, probably fails to reach as far east as Davis county and the other coals of the lower Measures are more or less pockety in nature. Extensive prospecting is the only means of locating good coals, and this will be least expensive where the overlying drift is most feebly developed. In this respect the valleys of the northern tier of townships are most favorably situated.

The Coal Measures attain considerable thickness within the limits of the county, and the basal Saint Louis limestone out-

crops only in the northeastern corner of the county, near the Des Moines river. A few drillings have been continued to the limestone in other sections: At Laddsdale it was reached at 183 feet, near Carbon at 225 feet and at Bloomfield, as reported by Keyes,\* at 230 feet. At Sedan, in Appanoose county, the Saint Louis lies 382 feet down, at an altitude of 443 feet above sea level. The very uneven surface of the Saint Louis renders the depth at which it may be encountered in even adjacent prospects rather variable, yet it has a fairly consistent dip to the southwest of about eight feet per mile from the outcrop mentioned above to the Missouri state line.

Davis has never been a large producer and mined as much coal in Civil War days as during many recent years. Federal Census reports show that 577 tons were mined in 1860, 1,080 in 1870, 5,500 in 1880 and 3,825 in 1890. Recent production is given by the Iowa Geological Survey as follows:

YEAR.	TONS.	YEAR.	TONS.
1898.....	391	1903.....	2,160
1899.....	3,100	1904.....	543
1901.....	1,364	1907.....	1,300
1902.....	3,633		

During the year ending June 30, 1908, an increase was noted, due largely to developments at Carbon. The output was then 4,364 tons and the number of men employed, thirty-three. Below is brief mention of mines in existence in August, 1907.

*Carbon.* The only shipping mine in the county is the drift of the Soap Creek Coal Company. The drift mouth is situated one-half mile west of the station at Carbon, coal being conveyed over the intervening distance on a long tramway. This is a new mine at which but little work has been done. The coal is about three feet thick, including a two-inch clay parting which lies about four inches above its base. Beneath the coal is from two to three feet of fire clay, and above is a "soapstone" shale which forms rather a weak roof. The dip is to the south and west. A seam with a good roof, but only eighteen to twenty-six inches in thickness, outcrops fifteen feet below the one worked. Considerable prospecting has been done near Carbon and the

\**Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, p. 424; Des Moines, 1894.

parties interested report that the seam mined there underlies an area of ten square miles and that the lower coal mentioned above extends from three miles south of Carbon north into Wapello county. In one prospect seven feet of coal was found at a depth of 112 feet.

Two and one-half miles southwest of Carbon, in section 10 of Soap Creek township, is the small Wagner bank, operating in a twenty-two inch seam lying well above the creek level. Farther southwest is the Shanley drift in two feet of coal.

Three miles southeast of Carbon a four-foot coal underlies at least one square mile of territory. Other seams are also known. The old Dunn mine (Lick Creek Tp., Sec. 8, Nw. qr.), on the north bank of Soap creek, worked in five feet of coal about

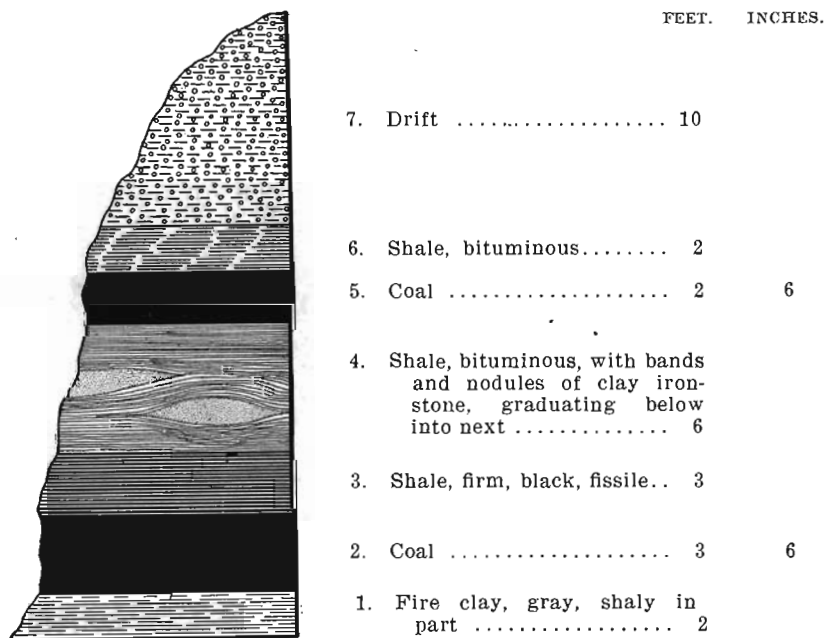


Figure 81. Bluff on Soap creek near old Brown Cannel mine. Carbon.

thirty-five feet above the creek level. The coal appears to thin out rapidly up the stream. A thick coal bed on the opposite side of Soap creek was once utilized by the Brown Cannel Coal Company. No mining is being done in this district at present.

*Floris.* Borings at Floris itself have revealed no coal, although one was carried to a depth of 210 feet. One-half mile northwest of the town, however, is an exposure of two coals on Soap creek (Lick Creek Tp., Sec. 15, Ne. qr.). The lower seam lies at the water level and is two feet thick. It is separated from the upper, which is three feet in thickness, by fourteen inches of shale and sandstone. These two beds coalesce to form a four to six-foot seam that has been worked a trifle at the old Howard shaft, situated not far from the outcrop. Pre-glacial depressions filled with drift probably interfere greatly with the continuity of the bed.

A number of quite small country banks, open only in winter, are operated along Salt creek, northeast of Floris. Two coal seams are commonly recognized here and lower coals are also present. The first seam is three feet and less in thickness and, because of its slight depth beneath the surface, often possesses insufficient cover. The second seam lies at the water level of Salt creek, about twenty-five feet below the first. It shows a thickness of from four to four and one-half feet, and is often overlain by black shale and a band of compact sandstone that makes a fair roof where well developed. The Hastings bank (Salt Creek Tp., Sec. 8, Se. qr., Nw.  $\frac{1}{4}$ ) and the Clark, one-half mile west, work the second seam. The Dye mine (Sec. 8, Ne. qr., Nw.  $\frac{1}{4}$ ), and the near-by Fite and Fayne banks, work the first seam.

Considerable mining has been done at Laddsdale, on the Chicago, Rock Island and Pacific Railway just north of the Wapello-Davis county line. Some, at least, of the coals described in the chapter on Wapello county as found there probably extend southward into Davis county. There are rumors that a shipping mine will be opened south of the county line, if the railroad can be persuaded to bridge Soap creek.

*Troy.* One and one-half miles east of Troy, just over the line in Van Buren county, Mr. Lunsford intends to sink a shaft in the near future. The strata found here are briefly mentioned in the chapter on Van Buren county.

*Lunsford.* Until the recent caving of the shaft caused it to be abandoned, a local mine was operated in the valley of Fabius

creek, one-fourth mile north of the Missouri line. The drift is 200 feet thick at this shaft. An eighteen-inch coal lies 226 feet beneath the surface and a seam thirty-eight inches thick was mined at 260 feet. Entries were driven eighty-five feet east, fifty feet west, 260 feet south, and 270 feet north. The coal thickened slightly to the north and west. The upper seam was found in a boring one and one-fourth miles northeast of the shaft, but no attempt was made to reach the thicker bed.

#### VAN BUREN COUNTY

Van Buren county lies on the eastern margin of the coal field and is quite generally underlain with Coal Measure strata. These deposits are commonly, however, rather attenuated and are far from continuous over the entire region, being absent in the immediate vicinity of the Des Moines river and lower Chequest creek and in the eastern portion of Harrisburg township. There are also numerous areas under the uplands where the drift rests locally upon the Saint Louis limestone in preglacial depressions. In some sections the Coal Measures may be characterized, therefore, as being merely outliers on the border of the main field. The coal basins so far discovered have been quite small and the mines have been located chiefly in the Des Moines valley and in the northern tier of townships. The mantle of drift in the southwestern half of the county has tended to completely conceal the indurated rocks and to prevent the discovery and development of the coals which probably underlie limited areas in that region. A basin of unknown extent is soon to be opened near the Davis county boundary and Chequest creek, and coal has been mined near Farmington, along Bear creek, and in thin beds near Keosauqua. Aside from these districts development has been confined to the region north of the Des Moines river.

In spite of the fact that most of the coal mined has always been used locally and that the coal basins utilized have not been of great extent, the early settlement of the county soon led to the development of outcropping coals. Thus in 1860 the annual production amounted to 4,252 tons, a sum exceeded only in Wapello and Jefferson counties. From this period to the



present, the annual output has varied from 1,000 to 45,000 tons. The tonnage of recent years, according to statistics gathered by the Iowa Geological Survey, is as follows:

YEAR.	TONS.	YEAR.	TONS.
1898.....	6,605	1903.....	12,361
1899.....	7,385	1904.....	8,005
1900.....	12,108	1905.....	6,192
1901.....	12,572	1906.....	12,137
1902.....	14,815	1907.....	15,374

The State Mine Inspectors' report shows for the year ending June 30, 1908, an output of 17,518 tons from eight mines. Sixty-six men were employed.

In the following pages of this chapter, the coal areas so far as known in August, 1907, are discussed in more detail.\*

*Business Corners.* About a mile north of Douds, three horse-gin mines supply the local trade and the railroad chutes at Douds and ship small quantities of coal to Keosauqua, Fairfield, Eldon, and other points. The coal of this district lies in pockets that differ but little in character, and averages about three and a half feet in thickness. A thin stratum of fire clay is found under the coals of the chief horizon; while from four to twelve feet of black bituminous shale, with intercalated bands of impure limestone forms the roofing material. Small basins appear to be quite numerous in the northwestern section of the county.

The present Ratcliff mine is entered by a shaft sixty feet deep adjacent to that of the former G. W. Findley bank (Village Tp., Sec. 14, Se. qr., Se.  $\frac{1}{4}$ ). The thickness of the seam worked remains quite constant at three feet eight inches, except at the west line of the lease, where it was five feet at the point at which work ceased. About ten acres have been mined out in strips extending to the north and west lines of the lease. In running north from the old Ratcliff shaft, a short distance south of the present mine (Sec. 23, Ne. qr.), the seam went to the rise until it dropped six feet along a fault plane, and then pitched downward at such a steep gradient that it was deemed advisable to sink a new shaft at the present location in order

\*Acknowledgments for material are due previous reports of this Survey—Keyes: *Coal Deposits of Iowa*, Vol. II, pp. 429-434; Des Moines, 1894, and Gordon: *Geology of Van Buren County*, Vol. IV, pp. 197-254. 1895.

to avoid the heavy haul toward the south. On the south side of the old workings the roof was insecure; while west of the former shaft no coal was found in a well sixty-four feet in depth.

The mine of the Findley and Sons Coal Company is situated near the center of section 14, where the coal is found to vary from forty inches to four feet in thickness. The bed is cut out in places and the plan of mining is to follow around the edge of the barren strips instead of tunneling through them. The shaft is sixty-six feet in depth and the coal lies but slightly below the bed of a neighboring water course. Recent drilling revealed forty acres of good coal tributary to the shaft. Three six-inch coals with local thickenings are found above the bed worked. The A. M. Felmelee mine is a short distance northwest of the Findley (Sec. 14, Nw. qr., Se. 1/4). The fifty-foot shaft was sunk in 1906 to coal which shows from three to four feet in thickness. It was intended to work from this shaft about thirty acres, of which less than two have been mined out. The bed dips northeast. On the south side of the territory the coal was deemed too soft and the roof too weak for profitable exploitation.

The sequence of strata in the northern portion of section 14, where mining operations have been conducted in the past, is shown in the following:

	FEET.
13. Clay .....	10 to 11
12. Shale, black, bituminous.....	11
11. Coal .....	1/2
10. Fire clay .....	2
9. Shale .....	3 to 4
8. Limestone, black .....	1
7. Coal .....	1
6. Fire clay .....	2
5. Shale, gray, with limestone masses.....	4 to 6
4. Coal .....	3 to 4
3. Fire clay .....	4
2. Concealed .....	8
1. Shale, blue, in well starting about twelve feet below the coal	22

The following section of the strata at the old Findley mine near Business Corners (Village Tp., Sec. 24, Ne. qr.) shows as close a correspondence with the preceding record as can be expected in so irregularly stratified a stage as the Des Moines.

	FEET.	INCHES.
12. Concealed .....	20	
11. Shale, blue, argillaceous.....	10	
10. Coal .....		6
9. Shale, arenaceous, with plant remains.....		10
8. Coal .....		6
7. Shale, becoming more argillaceous below.....	3	
6. Coal .....		6
5. Sandstone, with plant remains.....	1	
4. Fire clay .....	2	
3. Shale, black, fissile above, more compact below; the basal portion containing lenticular masses of black, calcareous rock .....	5	
2. Coal, sometimes partially cut out by the lenticular masses .....	3 to 4	
1. Fire clay .....	2	

Prospecting in section 13 revealed a continuation of the coal at the Ratcliff mine and this may be developed at no distant date. Some coal has been taken out on the Hinkle land in section 10, southwest quarter, and a little mining is still prosecuted intermittently. In the northeast quarter of the same section a coal outcropping in a higher horizon than any yet considered occurs not far below the plain level. An exposure in a branch at this point is:

	FEET.	INCHES.
12. Shale, black .....	8	
11. Coal .....	3	
10. Clay seams .....		2
9. Coal .....		8
8. Fire clay .....	4	
7. Concealed .....	30	
6. Shale, black, bituminous.....	8	
5. Limestone, black, compact .....		2-10
4. Shale, black, fissile.....	2	
3. Shale, black, argillaceous.....	2	
2. Coal .....	1	6
1. Fire clay .....	1	

A three-foot coal bed is known to be present south of the river, near Selma (Village Tp., Sec. 20), about seventy-five feet above the Saint Louis limestone. It has been worked in a small way. A small coal bank is located just south of the county line, on Lick creek (Lick Creek Tp., Sec. 6, Ne. qr.), where a shaft not quite fifty feet deep reaches a three-foot seam. Another coal horizon is present, but seldom bears workable coal. This coal is found also in section 5 and north on Lick creek in Jefferson county. Farther south (Sec. 17, Ne. qr.) the Mathias bank produces a little coal, but only a few rooms have been worked out. The section yielded by an opening on the hillside is:

	FEET.	INCHES.
7. Drift .....	37	
6. Coal .....		7
5. Limestone, brown .....	2	9
4. Limestone, blue .....	1	3
3. Shale, black, with limestone "bowlders".....	2	
2. Coal .....	3	
1. Fire clay .....	15+	

In boring for coal at Birmingham, the following record was obtained, the location being at the station of the Chicago, Burlington and Quincy Railroad, altitude 758 feet above tide.

	FEET.	INCHES.
14. Soil .....	2	
13. Clay, yellow .....	?	?
12. Sand, fine, white.....		4
11. Sandstone, gray .....	13	8
10. Coal .....	1	2
9. Shale, black .....	4	10
8. Shale, red, sandy.....	10	
7. Shale, black .....	4	
6. Coal, impure .....	1	
5. Shale, gray .....	1	2
4. Limestone, black, bituminous.....		10
3. Coal, impure .....	5	6
2. Shale .....	10	
1. Limestone, white .....	12	

The seams encountered were not regarded as workable here. Coal has been mined for local use, however, about two miles southwest of Birmingham and also three miles south and west, where a slope is now being reopened by Mr. Buckmaster (Lick Creek Tp., Sec. 25, Nw. qr.). The coal at the latter bank is three

feet and less in thickness and is roofed by a black shale capped with impure sandstone. In the northeastern corner of the county, in Cedar township (Secs. 13, 14, 23 and 24), small quantities of coal were taken out for a number of years, though nothing beyond pulling pillars and some superficial drifting has been done recently. An exposure (Sec. 14, Nw. qr.) shows the following stratigraphical arrangement:

	FEET.	INCHES.
7. Shale, black, fissile.....	1	6
6. Sandstone, ash-gray, irregularly indurated.....	1	
5. Coal, with lenticules of sandstone.....	2	
4. Shale, black, fissile, calcareous.....		10
3. Fire clay .....	3	
2. Concealed .....	5	
1. Limestone—in creek bed (St. Louis).....		

Locally this coal thickens considerably, for most of the coal is irregular in occurrence. On the south, in section 23, three feet of coal is separated from the underlying Saint Louis by only three feet of fire clay. A top coal is often present, separated from the lower by a short vertical interval. Not more than sixty acres have been worked out in Cedar Township.

*Bentonsport.* The C. Manning bank is now doing a good business three-fourths mile northwest of Bentonsport in what is evidently a small outlier of Coal Measure strata (Sec. 35, Nw. qr.). A slope and entry have been driven in about 900 feet to a seam which bears from three to three and one-half feet of coal and lies about fifty feet below the general level of the country. This coal does not extend far east of the wagon road through section 35, but in the south half of section 26 is an area of about 100 acres in which coal from eighteen to thirty-six inches thick appears to be quite generally present.

Northeast of Bentonsport, on a small branch of Honey creek (Harrisburg Tp., Sec. 20, Sw. qr.), is the A. R. Gardener bank. Two coals are found here, the upper being the one mined. It is two feet ten inches in thickness, free from impurities or irregularities, and roofed by five feet of heavy "slate." About seven rooms have been worked out and the pillars brought back to the entries. The lower seam was reached in two borings eighty rods north of the mine, where it lies twenty feet below the upper

and is four and one-half feet thick. East of the mine 150 yards the lower seam shows only one foot of coal; while the upper possesses no roof. Farther east, on Honey creek, the lower seam again thickens and has been mined by stripping.

The Whitmore bank is two and one-half miles south of the Gardener (Bonaparte Tp., Sec. 5, Ne. qr.). Horse and gin hoist the coal through a shallow shaft. Work was abandoned on the north side because of a miner's "fault." The sequence of strata at this mine is shown in figure 82. The fire clay under the lower coal is said to rest directly on the Saint Louis limestone.

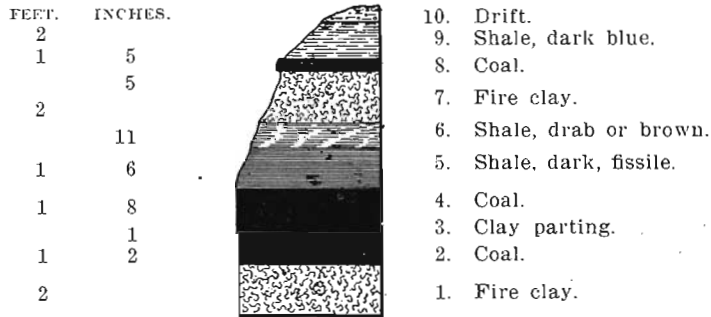


Figure 82. Seam at Whitmore mine. Bonaparte.

Mr. Whitmore worked out a basin seventy feet wide and of unknown elongation north and south in a small outlier in section 3, Bonaparte township. The coal varied between thirty and fifty inches in thickness and had a safe roof of "slate" over the part worked only.

Coal areas of limited extent are present in the valley of Bear creek, on the south side of the river, near Bentonsport. These basins appear to be in depressions of the Saint Louis limestone, and to be somewhat irregular in occurrence. The only mine now in operation is the small Bradford drift on a tributary of Bear creek, at which point the average thickness of the coal is thirty inches, with pockets of greater height. The dip of the seam is to the northwest, and near the drift mouth the coal lies about seven feet below the level of the stream valley. The roof is a "slate" of satisfactory strength except where one pre-glacial erosion channel, four feet in width, occurs. One-fourth mile north of the mine the limestone outcrops well up in the creek valley, cut-

ting off the Coal Measures. Three small seams of coal are reported from the center of section 12, and coal also has been found in the upper part of the river bluffs below the debouchure of Bear creek. At the old Boyer mine (Henry Tp., Sec. 3, S. 1/2), which has not been worked for five years, the following section occurs.

	FEET.	INCHES.
5. Coal .....		6
4. Sandstone, white, very compact, called "clod," sometimes changing to black shale.....	6 to 12	
3. Coal .....	3	
2. Fire clay .....		3 to 4
1. Sandstone .....	?	

Another coal bank is to be opened one mile west of the Boyer.

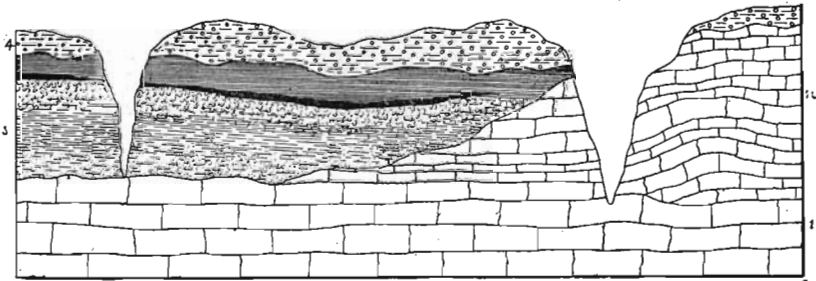


Figure 83. Section at Farmington showing Coal Measure deposits resting in depression in Saint Louis limestone. 1 and 2, Saint Louis limestone. 3, Coal Measures. 4, Drift.

*Farmington.* Several coal basins of limited extent occupy depressions in the Saint Louis limestone in the vicinity of Farmington. Each coal bed is usually underlain by fire clay and sandstone, but this sandstone occasionally fails, and then the coal rests directly upon the limestone. In some cases the fire clay and sandstone occur at the center, but wedge out at the edges of the basin. The following represents the succession as shown by drill records in a coal district, number 4 being the only workable horizon.

	FEET.	INCHES.
17. Drift clays .....	80	
16. Shale, black .....	6 to 10	
15. Sandstone, gray, coarse-grained.....	1	8
14. Coal .....	1	2
13. Sandstone .....		8
12. Coal .....	1	

11. Fire clay and shale, bluish.....	5	
10. Shale, blue .....	15	
9. Shale .....	2	6
8. Coal .....		6
7. Sandstone .....		3
6. Coal .....		1
5. Sandstone .....	1	8
4. Coal .....	4 to 5	
3. Fire clay .....	0 to 3	
2. Sandstone .....	0 to 6	
1. Limestone (Saint Louis) .....	1+	

The Cahill Coal Company is operating a seventy-eight acre lease one mile northeast of Farmington (Sec. 25, Sw. qr., Sw.  $\frac{1}{4}$ ). A seam from three to five feet in height lies sixty-five feet below the surface at the shaft. This pocket has been worked for a long period of time and is now almost exhausted. Hoisting is done with horse and gin, as at all the mines of the district. The larger portion of the output is consumed locally, although some is shipped to neighboring towns. North of the Cahill is the Knott mine, which supplies a local trade from a steep slope 100 feet in length. Very little of the product is shipped. On the Mannhart land, a pocket of twenty acres of coal is known, varying in height from forty to fifty inches.

A short distance southeast of Farmington is the 135-acre lease of the Hessler Coal Company. The shaft is seventy-five feet deep, and is located near the tracks of the Kansas City railroad (Sec. 1, Ne. qr., center of S.  $\frac{1}{2}$ ). The top of the seam worked is fairly level, but the surface of the underlying fire clay is uneven, causing the coal to exhibit changes in thickness from twenty-two to thirty-seven inches. Mr. Hessler reports that the entire lease is known to be underlain with coal and that it thins toward the north. A local trade is supplied. The bed worked and a seven-inch coal thirty feet higher outcrop in a neighboring creek and coal has been found as far west as the railroad. The interval between the two coals is bridged by "slate" and a little fire clay. Five shafts have been sunk at various times to this basin.

The Blue Jacket mine is a local bank about one mile west of the Des Moines river, near the Missouri line. Where worked the bed is four to five feet thick and coal is said to be present



under a large part of the lease of 105 acres. The shaft is forty feet in depth.

*Troy.* In Van Buren county, one and one-half miles east of Troy, Mr. Lunsford reports that a coal area has been found by drilling and that a shaft will soon be sunk. A boring headed on low ground encountered twenty-two inches of "slate" above an eight-inch coal at a depth of twenty-five feet, followed by sandstone, "soapstone" and "slate" to a depth of forty-five feet, where five feet of coal overlain by a hard, gray cap-rock was reached. Essentially the same strata were found in a hole drilled one-fourth mile distant. Years ago a small slope was worked in this district.

#### LEE COUNTY

The Coal Measures which covered Lee county at one period were, as a result of crustal movements, subjected to more severe erosion than were those of the region lying within the main part of the Iowa coal field, and were in greater part washed away before the drift was laid down upon them. There are within the limits of the county today only remnants of Des Moines strata left in the form of isolated outliers. Many of these are, nevertheless, of rather large size. The main body of outliers is in the northern and western sections of Lee county and is an offshoot from the Iowa field; but there are near Keokuk a few very small areas which are structurally more closely related to

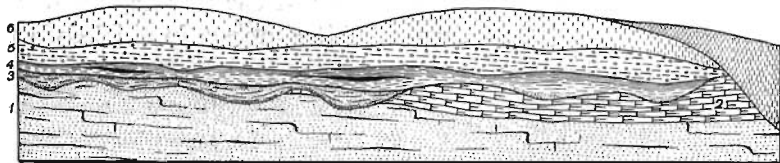


Figure 84. Unconformity of Coal Measures and Saint Louis limestone. Sonora quarry.

the Upper Carboniferous of the Illinois basin. In all parts of the county these beds are greatly attenuated and consist chiefly of a compact brown sandstone which commonly forms the basal member of the Des Moines in southeastern Iowa. In every case this stratum rests unconformably on Saint Louis limestone.



Coal Measure sandstone resting unconformably on Saint Louis limestone. Keokuk.

Owing to a lack of many coal seams of workable thickness and to the general absence of a good roof over those coals that do exist, Lee county has never been and never will be a great producer. Considerable coal has been taken out for local consumption, however, and some is still mined during the winter months. The mines are seldom permanent, often operating from new openings each season, and on account of the nature of the roof only narrow work is attempted. As examples of the production for early years may be cited the annual output of 315 tons in 1860, 10,650 bushels in 1868, and 500 tons in 1880. The tonnage during recent years is negligible. Complete accounts of the occurrence of Coal Measures in Lee county have been published by Keyes\* and have been drawn upon for material in the following detailed statement of the present status of the county as a coal field.

*Cedar and Harrison Townships.* With the exception of sections 28, 31, 32 and 33, the western half of Cedar township is probably underlain by Coal Measures. Similar beds appear in southwestern Harrison, but in neither township has workable coal been reported.

*Van Buren, Charleston, and Des Moines Townships.* The Harrison area is continued through Van Buren township as an irregular strip parallel to the Des Moines river and occupying fully one-half of the surface of the township. At Croton about fifteen feet of the basal sandstone caps the bluffs; while farther north and west, near Farmington, in Van Buren county, considerable coal has been mined near the Lee county limits. A narrow tongue of Coal Measures is continued into section 31 of Charleston township and into sections 1, 6 and 7 of Des Moines. In none of these three townships, however, has coal of economic importance yet been located.

*Marion Township.* Parts of two Pennsylvanian outliers occur in Marion township. One of these occupies the entire northeastern portion north of a line drawn at an average distance of one mile north of the Burlington railroad. A half mile east of Saint Paul some mining has been done in a desultory fashion in a thin seam that is extremely irregular in occur-

\**Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 484-489; Des Moines, 1894. *Geology of Lee County, Idem*, Vol. III, pp. 305-408; 1895.

rence. Another thin coal outcrops beneath several feet of black shale and light-colored clay less than a mile south, in the bed of a small ravine. In the south-central part of the township lies the north end of another outlier. In the south half of section 33 some mining has been conducted in a three-foot seam of coal which will be mentioned later.

*Pleasant Ridge Township.* Coal Measures may be found in practically all of this township except the southern tier of sections. The chief openings in this district have been made on Sutton creek, six miles northwest of Denmark, where coal has been mined by both strippings and drifts. One of the principal mines was the old Morris drift (Sec. 16, Ne. qr., Ne.  $\frac{1}{4}$ ) from which some coal has been hauled to West Point during several winters. The seam was seldom as high as twenty-five inches. Almost nothing has been taken from this land for many years. Two miles east, a thin seam has been worked in a similar manner. An outcrop near the road in section 14 (Ne. qr., Nw.  $\frac{1}{4}$ ) shows the section in the accompanying figure.

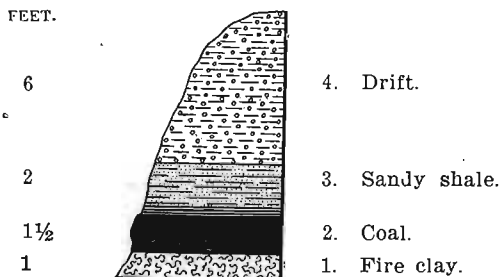


Figure 85. Outcrop northwest of Denmark.

This seam has an appreciable dip to the west and may possibly thicken in that direction. Coal may be present under much of the land lying between the two creeks near which the outcrops just mentioned occur, yet the tenuity of the seam and the weakness of the roof over it would hardly justify development.

*Franklin and West Point Townships.* The southern extension of the outlier in southern Marion township covers the older indurated rocks of the greater part of Franklin township between the Keokuk and Northwestern railway and the valley of Sugar creek. On both sides of the creek in section 4, Frank-

lin township, shafts and drifts as well as strippings have taken out considerable coal for local consumption. There are rumors that the seam may be reopened on a somewhat larger scale than before. The coal is from three to three and a half feet in thickness, dips to the west and south, and has a poor roof, as shown by the following section of an outcrop in the vicinity.

	FEET.
5. Drift .....	3
4. Shale, bituminous .....	1
3. Coal .....	3½
2. Fire clay, arenaceous.....	2
1. Shale, arenaceous (exposed).....	3

One mile southeast, a few openings have also been made. The limestone underlying the Coal Measures is exposed in the creek bottom and bears the relationship to the coal bed revealed in the sequence given below.

	FEET.
5. Drift .....	10
4. Coal .....	2
3. Fire clay .....	2
2. Sandstone, soft .....	5
1. Limestone, coarse, fossiliferous (St. Louis).....	2

Between Sugar creek and West Point is a small Coal Measure outlier covering about six square miles. Two miles southwest of West Point (Franklin Tp., Sec. 12), and in adjacent areas, some mining was undertaken in a bed of coal which seldom exceeds one foot in thickness. More recently a lower seam, showing the thickest coal yet found in the county, was uncovered by a washout in the bed of a small stream. This coal lies four feet and more below the seam formerly mined and is about the same distance above the Saint Louis. It varies between three and four feet in thickness. In 1906, Mr. Peitz sank a shaft to this bed (Sec. 12, Se. qr., Nw. ¼) and now takes out considerable coal during the somewhat widely separated periods when the mine is working. He kindly furnished from memory the following shaft record.

	FEET.
9. Soil and drift .....	9
8. Sandstone .....	4
7. Coal, upper seam .....	1
6. Fire clay .....	5
5. Coal, lower seam .....	3 2-3

The strata below the lower coal have been exposed in a neighboring well.

	FEET.
4. Fire clay, fine-grained .....	4
3. Limestone (Saint Louis) .....	2
2. Sandstone .....	20
1. Limestone .....	

*Jackson and Montrose Townships.* Separated from the outliers previously enumerated by a low anticline which brings the Keokuk and Burlington beds to the surface, there are in southeastern Lee county three small Coal Measure tracts, each about one square mile in extent. The most northerly of these is just west of Galland, in Montrose township, on the crest of the bluff. So far as known, it contains no coal. The other two outliers are immediately north and west, respectively, of Keokuk, on the summit of the bluffs. Near Rand Park, north of the city, a very little coal was taken out by means of drifts many years ago. The section in this vicinity is:

	FEET.
6. Drift .....	20
5. Shale, dark .....	6
4. Coal .....	1½
3. Fire clay .....	½
2. Sandstone, brown, coarse-grained .....	10
1. Limestone, brecciated (Saint Louis) .....	8

In the southwest corner of the city, above Nassau slough, operations have also been attempted on a small scale. The coal is of good quality, but lacking in quantity. The sequence of strata at the summit of the bluff is illustrated in figure 86.

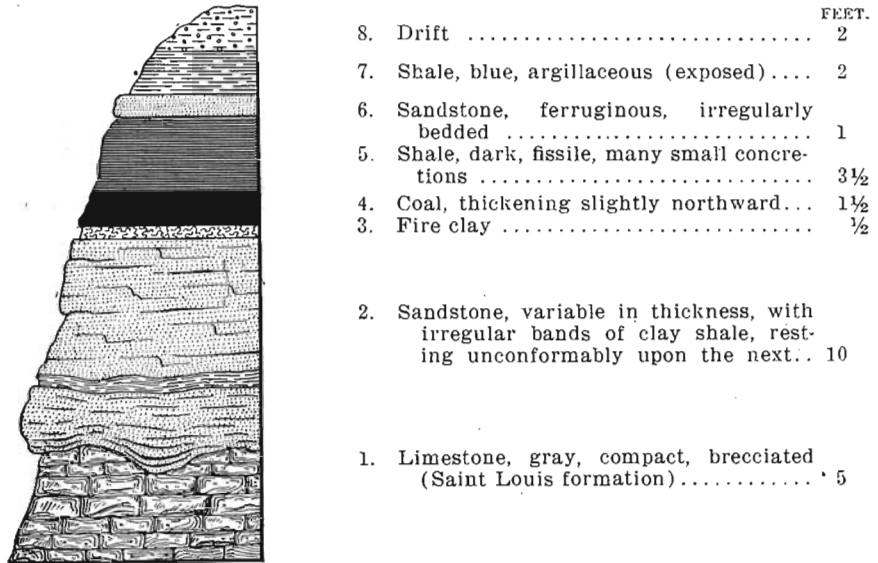


Figure 86. Top of bluff on Mississippi river at Nassau slough. Below Keokuk.

#### DES MOINES COUNTY

Upper Carboniferous strata are very poorly developed in Des Moines county, the greater part of those which were originally deposited having been removed by pre-glacial erosion. Only those Coal Measure rocks which lay in deep channels carved in the more resistant surface of the Mississippian formations remain in place at the present time, and these are entirely confined to the southwestern corner of the county. The most extensive deposits of Coal Measures lie in two small outliers on either side of Long creek, about two miles north of Augusta, at which point a thick buff to brown sandstone rises in bold cliffs. No coal has been found associated with this outcrop. Another area of Des Moines beds occurs in the extreme southwestern part of the county, about three miles and more southwest of Danville station, where they constitute outliers which extend a short distance into the southeastern corner of Henry county. Shale and a thin seam of coal accompany the sandstone in several parts of this area; but aside from the shale clays, nothing that can be considered of economic importance has been located. Coal Measures do not cover a total area of more than six square miles in Des Moines county.

The relationships of the Des Moines beds to the drift and to the older indurated rocks are illustrated in the accompanying cross-section along Skunk river. In this sketch, the numbers represent the following formations: 1 is the Kinderhook; 2 and 3, the Lower Burlington; 4, the Upper Burlington limestone; 5, the Montrose cherts; 6, the Keokuk; 7, the Warsaw shales; 8, the Saint Louis limestone; 9, the Saint Louis marls; 10 and 11, the Coal Measures.\*

It is probable that the Coal Measures are not quite so continuous or so extensively developed as shown in this section. They should appear only in the central and western districts, as heretofore described. The general relationships of the various formations, however, are correctly portrayed.

\*Keys: *Geology of Des Moines County, Iowa* Geol. Surv., Vol. III, p. 428; Des Moines, 1895.

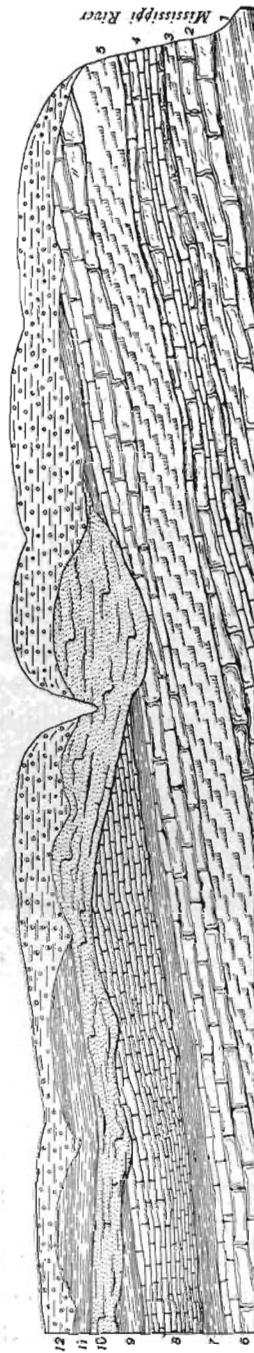


Figure 87. Cross-section along Skunk river.



## PART IV.

### COAL DEPOSITS OF EASTERN IOWA

#### GRUNDY COUNTY

A tongue of Lower Coal Measure strata projects eastward from the main Iowa coal field into the western half of Shiloh township and the northwestern corner of Melrose township of Grundy county, but no mining has been done within the limits of the district. The Eldora field, once quite productive, lies only a few miles west of the west county line and the absence of natural exposures in Grundy renders it probable that outliers of the Des Moines remain undiscovered beneath the upland surface; yet, nevertheless, it is not likely that extensive coal basins will ever be exploited in this region. The Coal Measures are probably thin where present, and the coal which they may possibly contain of poor quality. While prospecting operations would hardly yield legitimate returns, the incidental discovery of coal in well diggings may at some future time result in the development of coals of local importance.

#### LINN COUNTY

Of beds of Des Moines age that formerly covered a large part of Linn county only a few small outliers have survived the ravages of pre-glacial erosion. Of these Coal Measure areas, the best known lie between Cedar Rapids and Marion in sections 11 and 12 of Rapids township and consist chiefly of beds of ferruginous sandstone similar to those found in the Carboniferous outliers of neighboring counties. On West Otter creek Coal Measure sandstone and some coal are reported from section 19 (Nw. qr.) of Otter Creek township, where black bituminous shale was reached at a depth of only six feet from the

surface. The probabilities of finding workable coal seams in Linn county are very slight.

#### JONES COUNTY

A thin deposit of sediments was probably laid down over nearly the whole of Jones county during the Pennsylvanian period, but has since been almost completely removed by preglacial erosion. Loose fragments of Coal Measure sandstone, derived from an undiscovered ledge in the neighborhood, were found in a ravine in Fairview township (Sec. 24, Se. qr.) and were associated with clays derived from Des Moines shales. A bed of pebbly, ferruginous sandstone, probably of similar age, occurs three miles northeast of Oxford Junction. There are probably other small outliers of Coal Measure strata concealed beneath the surface cover of drift and loess, but it is not likely that these contain coals of even local importance.

#### JACKSON COUNTY

Although situated far from the main portion of the Iowa coal field and subjected to intense erosion after the formation of the Des Moines stage, the territory embraced by Jackson county contains a few remnants of Coal Measure strata. Since no coal has been found associated with these, however, and the prospect for finding workable beds is exceedingly small, these deposits are of little importance as fuel producers. Many of these Carboniferous outliers occupy channels in the Niagara limestone and they consist chiefly of sandstones with some shale. They are found in Monmouth, Brandon, Maquoketa, and Fairfield townships in isolated basins covering a few acres each. One of them, in section 13 of Maquoketa township, bears as much as fifty feet of coarse-grained sandstone. The largest individual basin is probably the crescent-shaped sandstone area on the south side of Beaver creek, south of Monmouth, which extends interruptedly for a distance of more than two miles in a southwest-northeast direction.

**POWESHIEK COUNTY**

The outer border of the main body of Iowa Coal Measures traverses Poweshiek in a somewhat irregular line running through or near Grinnell, Jacobs, Montezuma and Tilton. At any point south and west of this line it is possible that coal may exist, but north and east of it only the calcareous strata of the Mississippian formations outcrop. Up to the present time almost no workable coal has been found within the limits of the county, a condition due in part to a considerable thickness of drift which has discouraged prospecting, and to the active mining in neighboring counties which has produced a like effect by lessening the urgency of the market. Nevertheless, it is entirely conceivable that good coal basins will be located at some future time when an increased price for fuel renders the necessity for its discovery more pressing. The What Cheer district in Keokuk county, for many years one of the largest producers in Iowa, is located but a short distance from Poweshiek county and lies on the edge of the main Iowa field under conditions corresponding with those existing in this region. Coal is also mined near New Sharon in Mahaska county, almost on the south Poweshiek line, and in Jasper county, at no great distance from the west line. One of the unfortunate features to be considered, however, is that the base of the Coal Measures is found above the water level of Skunk river in places and that the drift probably extends down to the same level in numerous instances, thus cutting completely through the coal bearing strata.

In the late sixties some mining was done near Buck creek and Skunk river, in the southern margin of the county, and a production of 100 bushels is recorded in state census reports taken in 1866 and 1868. Since that period a little work has been undertaken from time to time in a desultory fashion. The old Watson drift in section 36 of Sugar Creek township, near the Iowa Central bridge over the Skunk, was driven several hundred feet into the hill on the south bank of the river. Recently attempts to utilize it were renewed, the entry being lengthened toward the northwest; but the bed dipped so strongly in the same direction that water entering the mine could not be easily

removed. Moreover, the coal was from fifteen to twenty inches thick only.

No coal has been reported from the many wells, some over 200 feet in depth, that have been sunk in southwestern Poweshiek, though in some at and near Searsboro and elsewhere thin seams were encountered. Prospecting for coal between New Sharon and Searsboro failed to show anything but thin coals. On what was formerly the McIntyre farm, two and one-half miles south of Montezuma (Jackson Tp., Sec. 19), several prospect holes were sunk and the discovery of a four-foot coal was reported. No exploitation was attempted and apparently no other drillings were made in the neighborhood. If this report is correct, prospecting operations along the line of the Rock Island Railroad south of Montezuma might prove profitable.

#### IOWA COUNTY

Although the What Cheer coal field, formerly one of the most productive in the state, lies at no great distance from Iowa county, the Coal Measures have been removed by pre-glacial erosion from most of the region now under consideration. Only a few independent outliers that cannot be considered of economic importance remain of once extensive deposits of Des Moines strata, and these contain practically no coal. The principal area of Pennsylvanian beds occurs in the northeastern part of the county, on the north side of the Iowa river valley. It embraces an elongated basin of coarse-grained, cross-bedded sandstone less than a mile in width and extending from Knapp creek in Johnson county westward to a point about three miles beyond the Iowa-Johnson boundary line.

#### JOHNSON COUNTY

Blocks of coal have been found in or immediately beneath the drift in Washington township and elsewhere in Johnson county; while Coal Measure outliers are known at several points. There are, however, but two noteworthy areas of Des Moines strata. One covers a few hundred acres in sections 2 and 3 in the northern part of Iowa City, occupying an old valley that was more than eighty feet in depth and consisting of shale and sand-

stone with a coal "blossom" one-half to an inch in thickness. The second Coal Measure outlier is a narrow elongated body lying along the north side of the Iowa river valley from Knapp creek west into Iowa county. It contains sandstone with some sandy shale. It is extremely unlikely that coals of even local importance will be found in this county.



Figure 88. Contact of Carboniferous with Devonian strata at the Sanders quarry north of Iowa City. The heavy ledges at the right are Devonian limestones; the rapidly weathering talus-forming beds at the left of the limestone are Upper Carboniferous sandstone. There is here seen a portion of the rocky cliffs that marked the right side of a pre-Carboniferous valley.

#### CEDAR COUNTY

Although essentially no coal has been laid bare in Cedar county, a few isolated areas of Coal Measure sandstone are known. These are only a few acres each in extent and cannot be considered of economic importance except for building purposes. Two such areas exist on Clear creek, in sections 28 and 29 of Pioneer township. Others occur near Rock run in sections 21 and 22 of Center township; on Rock creek in section 25 of Rochester township; and in the northeast quarter of section 1, near the town of Rochester. While the future may reveal other outliers, any coal that they may contain will be of slight significance.

CLINTON COUNTY

This county contains only a few scattered remnants of the Coal Measures and they are very limited in extent. Certain clays, silts, and sands in crevices and caverns of Niagara limestone are of Pennsylvanian age, as are also some outcrops of sandstone found in the northeast corner of Bloomfield township, on a small branch of Deep creek near Charlotte, and in sections 7 and 18 of Sharon township. A small outlier was explored by a well in Welton township (Sec. 33, Nw. qr.) where the following strata were penetrated.

	FEET.
5. Yellow and blue clay.....	50
4. Quicksand .....	20
3. "Slate," with thin coals in lower part.....	17
2. Sand, white .....	12
1. Limestone, yellow .....	4

Number 1 of the above is Niagara limestone, Number 2 a disintegrated Coal Measure sandstone grading upward into Number 3. Any coal bed found in this county will be of such limited lateral extent and lie so near the loose surface formation that it cannot be worked with profit.

MUSCATINE COUNTY

Muscatine contains the western portion of a large Coal Measure outlier that is in reality part of the Illinois coal field, from which it has been separated only by the recently formed valley of the Mississippi river. This Pennsylvanian tract possesses a width of from two to five miles and occupies much of the high-lying area reaching back from the border of the narrow valley of the Father of Waters. Its western extremity lies about three miles west of the city of Muscatine; its eastern is found in Scott county. In all, perhaps seventy-three square miles are covered by the Muscatine portion; although, because of the rapid rise of the underlying formations towards the north, it becomes greatly attenuated on the outer margin. As in the main section of the Iowa field, the materials of which the Des Moines strata of Muscatine county are composed consist chiefly of sandstones, shales, fire clays and coals, with local

developments of conglomerates, and with a few thin limestones, and these varieties grade laterally from one to another with remarkable suddenness. Unlike the Des Moines of the main Iowa field, which in all cases rests upon Mississippian rocks, the Coal Measures of this area lie upon the Devonian.

Although coal has never been found in quantities of economic importance in this county, considerable amounts have been taken out for local use. The coal basins are of limited extent, contain coal of rather poor quality, and are usually quite low.

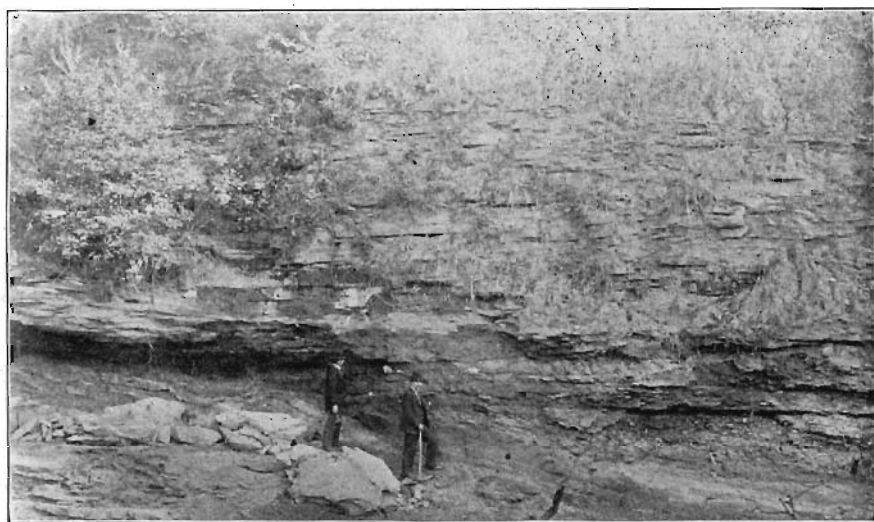


Figure 89. Basal conglomerate of the Des Moines, in the left bank of Montpelier creek, near the bluff of the Mississippi. Photo by Calvin.

What mining is now done is confined to small country banks that are in operation only during the winter months to furnish fuel for the immediate neighborhood. Before the better basins were mined out and improved transportation facilities brought coal from other states into direct competition with the local product, the coal industry was of relatively greater importance. Production during the early days of the county's settlement has been recorded as follows: for 1860, 1,785 tons; for 1865, 49,089 bushels, for 1870, 2,492 tons. These figures compare favorably with the outputs of other sections of the state at the same periods.

*Muscatine.* The Coal Measures of the county have been ably described by Professor Udden. In speaking of the occurrence of coal at the city of Muscatine, he writes:\* “In the northwest part of the city, near the adjoining corners of sections 26, 27, 34 and 35, a sandstone fifteen feet thick lies at an elevation of at least 125 feet above the river. Under the sandstone there is a small seam of coal, which appears in a creek southeast of the crossing of Logan and Cedar streets. In going up the main branch of Papoose creek the Coal Measures make their first appearance a short distance above the junction of Star and Cedar streets.” At this point one foot of coal again appears under a considerable thickness of sandstone and has been worked on a small scale a short distance north.

Hall describes the following section from the mural escarpment fronting the river at West Hill.

	FEET.
8. Thin-bedded sandstone, with shaly layers.....	19
7. Massive sandstone, with large concretions.....	10
6. Seam of coal or shaly coal, with under clay.....	4
5. Shaly sandstone, with shaly partings.....	8½
4. Thin-bedded sandstone, with shaly partings.....	5
3. Heavily bedded sandstone.....	6
2. Green shale .....	3
1. Distance to level of river (covered).....	20

The coal seam (number 6 of the section) is not very regular, but is divided into several smaller areas toward the river. To the west a short distance it becomes more regular and attains a thickness of thirty inches to three feet. A little farther westward it thins out entirely. From Muscatine east to Pine creek, coal, usually thin, has been drifted from the river bluffs at various places. Keyes† gives the section shown in figure 90 from the old Hoor mine, three miles east of Muscatine (Sweetland Tp., Sec. 30, Ne. qr.) and suggests the possibility of operating other mines here to advantage.

*Wyoming Hill.* Within recent years some coal has been taken from the Nettlebush mines near Wyoming Hill (Sweetland Tp., Sec. 27, Ne. qr.). The seam is about twenty-two inches in thick-

\**Geology of Muscatine County, Iowa Geol. Surv., Vol. IX, p. 304; Des Moines, 1899.* This report has furnished considerable material for the present chapter.

†*Coal Deposits of Iowa, Iowa Geol. Surv., Vol. II, p. 477; Des Moines, 1894.*



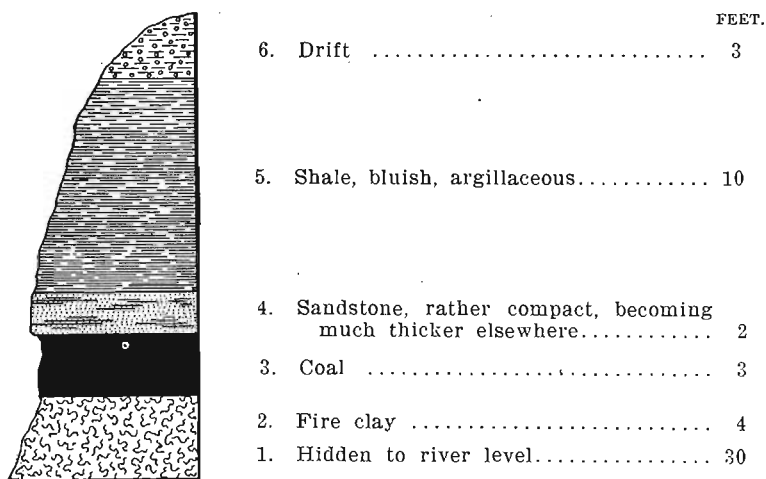


Figure 90. Coal at Hoor drift. East of Muscatine.

ness and is reached by drifts from the side of a ravine, about 120 feet above the level of the river. The coal is said to be of good quality and to possess a fairly strong roof of soapstone and "slate."

*Montpelier Township.* Thin coal beds have occasionally been mined at several places in this township; but in no case can the coal deposits be considered of much importance. In the bluff not far west of the mouth of Pine creek, coal has been taken from a bed lying 120 feet above the river. Above it is a black limestone, in part concretionary. At the point where the middle branch of Pine creek crosses the line between sections 7 and 8, a coal is found resting upon the Cedar Valley limestone and overlain by eight feet of shale capped with sandstone. At this same horizon coaly deposits are found at various places in the middle and east branches of Pine creek and on Lowrys run, Robinson creek and Montpelier creek.

#### SCOTT COUNTY

The Muscatine Upper Carboniferous outlier extends eastward a little over seven miles into Scott county, where it exhibits its richest phase. In spite of the fact that only about twenty square miles, or less than one-fourth of the total area covered by the tract is situated in Scott, this county has been and is to-

day a much more consistent producer than its neighbor on the west. Practically the whole of Buffalo township and much of Rockingham are underlain by Coal Measures; while the northern boundary of the outlier is found a short distance north of the south line of Blue Grass township. The characteristics of the Muscatine outlier in Scott county and its relationship to other forms are essentially the same as are those of its western extremity, already described. Several small Pennsylvanian outcrops have been recognized in other parts of Scott. "Le Claire township includes a valuable outlier whose shales are worked at Island City, and another lies deeply buried beneath the drift in the northwestern part of the township. Carboniferous deposits are reported in well records near Eldridge. They outcrop near the western and northern limits of the county, in Cleona and Liberty townships. About Davenport there are no quarries which do not show pockets of Carboniferous sandstone or shale. So many are these outliers that it is not difficult to believe that well nigh the entire county once lay beneath the Carboniferous sea, and was covered with a continuous veneer of its offshore silts."\*

So far as coal deposits are concerned, the smaller outliers are of little significance. They commonly represent merely surface irregularities of the old pre-Pennsylvanian land, such as channels, pits and crevices, which were filled with scourings from adjacent lands when the region was first depressed beneath the Upper Carboniferous sea. During the profound erosion which followed the re-emergence of the land from the waters, these deposits were protected and preserved by virtue of their position between compact rock walls.

Thin seams of coal are found in the outlier at Black Hawk and Island City; but it is only on Stillwater creek, west of Buffalo, and near Jamestown, north of the same village, that systematic mining has been undertaken. Of late years production has tended to decrease, owing to the exhaustion of the main "swamp"; yet a few new areas are being opened up and will continue to furnish coal for a limited number of years. Only a local trade is supplied, no railroad connections having been estab-

\*Norton: *Geology of Scott County, Iowa Geol. Surv., Vol. IX, p. 463; Des Moines, 1899.*

lished. The local demand is, however, considerable, and some coal is hauled as far as Davenport. Competition of Illinois coals has always been a detrimental factor. Coal has been mined in Scott county nearly sixty years; a glimpse of the progress of the industry may be obtained from the statistics quoted. In 1865, a production of 82,730 bushels is recorded by the state census. Federal census reports show that 17,325 tons were mined in 1870; 14,500 in 1880; and 9,446 in 1890. Figures given in the reports of the Iowa Geological Survey for later years are as follows:

YEAR.	TONS.	YEAR.	TONS
1899.....	7,348	1903.....	12,653
1900.....	28,728	1904.....	10,724
1901.....	13,857	1905.....	6,772
1902.....	10,358		

For the years ending June 30, 1906, 1907, and 1908, the State Mine Inspectors published these data.

YEAR.	TONS PRODUCED.	MEN EMPLOYED.	NUMBER OF MINES.
1906 .....	860	12	3
1907 .....	2,500	4	1
1908 .....	2,750	30	3

*Jamestown.* Professor W. H. Norton visited the Jamestown district in 1897 and shortly afterwards published the following succinct description: \* "The seam worked by the Jamestown mines lies in a trough about two miles long and 200 yards wide, trending from northwest to southeast, and reached at a depth of about ninety or 100 feet from the surface. In the center of this "swamp" as it is termed, the coal has a thickness of from four to six feet, but it thins as it rises to either side of the trough; where it lies some ten feet higher than in the center. In the James mine (Buffalo Tp., Sec. 3, Sw. qr., Sw.  $\frac{1}{4}$ ) it is worked on each side for 100 yards from the central axis, and at this distance it is reduced to a thickness of two and one-half feet. The trough rises from each end gently toward the center. Thus, at the James mine, the dip is toward the northwest at the rate of eight feet in 300 yards. Slight faults, rolls, and pinch-outs occur on each side of the axis, with the down throw on the swamp side, but nowhere do these seriously interfere with

\*Op. cit., p. 494 *et seq.*

mining. The farthest point toward the northwest to which this seam has been traced is Blue Grass township, Sec. 33, Se.  $\frac{1}{4}$ , where coal two feet thick is said to have been found, but to be unworkable because no roof overlies it. At the Williams mine (Buffalo Tp., Sec. 11, Nw. qr.) the swamp sinks to the southeast.

South of Jamestown there is an area where the coal is said to be in a comparatively flat and uniform seam. It has been mined on the farm of Mr. Charles Rowan, Buffalo Tp., Sec. 10, W.  $\frac{1}{2}$ , about eighty feet from the surface. Several seams, two and three inches thick, occur above the one mined. Wells show that the coal is underlain with fire clay sometimes to a depth, as is reported, of twenty-five or thirty feet, and at from 175 to 200 feet from the surface the drill passes into Devonian limestone. Towards the northwest coal is reported one and one-half miles south of Blue Grass, Buffalo Tp., Sec. 8, Nw. qr., where a well record gives it a thickness of twenty-one inches at a depth of 114 feet from the surface."

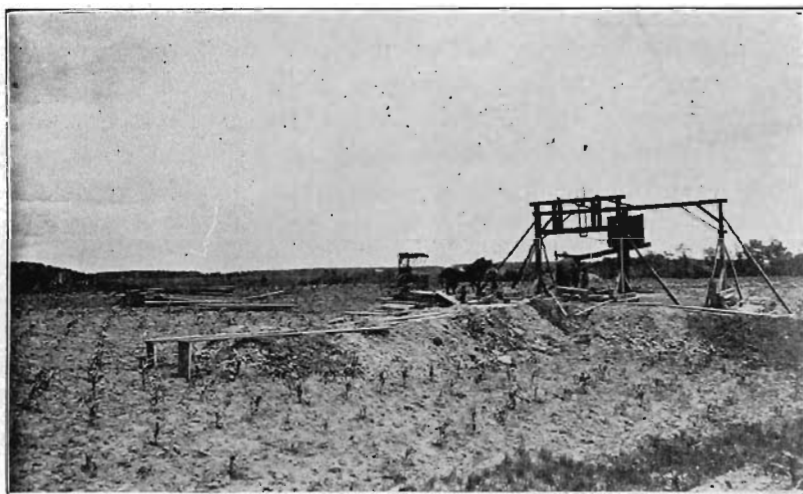


Figure 91. Sinking a shaft near Buffalo; showing the equipment of the Scott county mines.

Late in the summer of 1907 but one mine was working in the main trough described above, and the small mining camp formerly at Jamestown had been almost completely removed. The James Buckmeyer mine, until recently worked by Frank Winfield, is taking coal from the eastern edge of the trough a short distance southeast of Jamestown, in section 11. The seam was found to terminate rather abruptly at each end of the "swamp"

and is now rapidly approaching complete exhaustion. At the Buckmeyer mine the seam is only two feet four inches in thickness and lies fifty-two feet below the surface at the shaft. The dip is toward the west and south. A small single engine is utilized for hoisting purposes. The sequence of strata in this area is shown by the following section of an old shaft near the present mine (Buffalo Tp., Sec. 11, Nw. qr.).

	THICKNESS.	DEPTH.
8. Glacial clays .....	48	48
7. Soapstone .....	4	52
6. Sandstone, white .....	2	54
5. Shale, blue .....	5½	59½
4. Sandstone and shale.....	41½	101
3. Shale, slaty .....	1	102
2. Coal .....	3	105
1. Fire clay .....	2	107

The McCullough Brothers' mine is a slope to what is apparently a small separate basin, although other coal areas are found near it. The slope mouth is in the bottom of a hollow, a mile northwest of Buffalo (Sec. 16, Ne. qr., Sw. ¼), and is very little above the level of the seam, since the latter lies nearly at the level of the floor of the small ravine in which the slope is situated. The coal varies in thickness between thirty inches and three feet. The bottom of the "swamp" is located 100 feet west and ninety feet north of the slope mouth and is the focus towards which the seam dips from all directions. South of the wagon road that crosses the center of section 16, Buffalo township, a little coal is taken out during the winter by Mr. Kaucher from a seam similar to the one worked by the McCullough Brothers. In this vicinity, a well record shows two coal horizons (Sec. 16, Se. qr., Se. ¼).

	THICKNESS.	DEPTH.
9. Yellow clay .....	20	20
8. Soapstone .....	25	45
7. "Slate" .....	2½	47½
6. Coal .....	½	48
5. Fire clay .....	2	50
4. Shale .....	20	70
3. Coal .....	2½	72½
2. Fire clay .....	1	73½
1. Limestone (Devonian) .....	66½	140

*Stillwater Creek.* At one period, the district near Stillwater creek was an active producer for local trade. Mr. Webster has recently taken out some coal, yet the field is now practically deserted. The coal lies in small "swamps," is from two to four and a half feet thick, and lies at varying depths below the stream levels. As is usual with Scott county basins, the dip differs radically at different points, the seams inclining towards the centers of the "swamps." The roof commonly consists of a thin layer of bituminous, fissile "slate," overlain by an argillaceous shale of lighter color. The under clay is hard and arenaceous, often approaching in constitution an arenaceous shale, or even a sandstone.

*Island City.* An outlier of Coal Measures at Island City, in Le Claire township, which occupies an area about one square mile in extent, contains small pockets of coal. It lies in a channel cut in Niagara limestone, a little more than a mile wide where transected by the trench of the Mississippi, and more than 200 feet deep. The sequence of strata above and below the coal found is well illustrated in the following sections described by Professor Norton.

RECORD OF WELL OF MR. SARGENT, LE CLAIRE TP., SEC. 5, SE. QR.

CURB, 700 FEET A. T.

	THICKNESS FEET.	DEPTH FEET.
9. Soil .....	7	7
8. Shale, blue .....	67	74
7. Sandstone, gray .....	10	84
6. Shale, dark .....	10	94
5. Cap-rock, dark .....	3	97
4. Coal .....	5	102
3. Fire clay .....	12	114
2. Shale .....	105	219
1. Limestone at .....		219

OLD EXPOSURE AT CLAY PIT OF LE CLAIRE BRICK AND TILE COMPANY,  
ISLAND CITY.

	THICKNESS FEET.	DEPTH FEET.
7. Loess and till, unmeasured.....		
6. Cannel coal .....	2	2
5. Potter's clay .....	4	6
4. Coal .....	1	7
3. Fire clay .....	4	11
2. Shale, gray .....	2	13
1. Shale, black, to bottom of pit.....	20	33

*Cleona Township.* In addition to several small unimportant Carboniferous outliers in Lincoln, Sheridan and Liberty townships, there are a number in Cleona township, in one of which a small pocket of coal has been discovered.

## WELL RECORD, CLEONA TOWNSHIP, SEC. 4, SW. QR.

	THICKNESS.	DEPTH.
	FEET.	FEET.
4. Pleistocene deposits (drift).....	144	144
3. "Slate" .....	1	145
2. Coal .....	1	146
1. Limestone at .....		146

## PART V

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### COAL DEPOSITS OF WESTERN IOWA

#### POCAHONTAS COUNTY

Des Moines strata may probably be found under the drift and Cretaceous rocks of the southern part of Pocahontas county, but they are not thick and are considerably cut up by pre-Cretaceous erosion. Nevertheless, it is not at all impossible that coal basins of local importance may at some future time be located in this area. Prospect holes should be continued to the Mississippian limestones that underlie the Coal Measures. The Cretaceous itself contains a few lignites of slight economic importance.

#### PLYMOUTH COUNTY

It has long been a question whether the Coal Measures of Des Moines age extend beneath the drift and Cretaceous rocks of the northwestern portion of the state and, if they do, whether they contain workable coal basins. Without doubt Des Moines rocks were originally deposited for a considerable distance west of Webster, Greene, and Guthrie counties; but these may have been largely removed during the long interval of erosion previous to the Cretaceous period. Moreover, we cannot be certain that coal producing conditions prevailed over much of the region during Carboniferous time. Explorations so far made seem to indicate that only isolated outliers of the Coal Measures underlie the Cretaceous. Even should Carboniferous coal be located, only thorough prospecting can determine whether or not a workable basin be present. Several deep holes have been put down in the region—at Sioux City, Ponca (Nebraska), Hull, Sanborn, and Cherokee—with negative results, although they were sunk far below the level of any pos-



sible coal. Two drill records at Le Mars indicate that Cretaceous strata continue down to the basal gneiss, but a third hole penetrated a five-foot coal at 381 feet that may, perhaps, be part of an outlier of Des Moines age. Analyses show it to be of better grade than the lignites found among Cretaceous strata. A complete discussion of the coal possibilities of the region has been published by Bain.\*

#### CALHOUN COUNTY

The highest indurated rocks of this county belong to the Cretaceous system and contain in places thin beds of lignites that are of practically no economic value under present conditions. The eastern limit of Cretaceous strata lies along a north and south line situated about two miles west of the eastern boundary of the county. East of this line the highest indurated rocks are of Des Moines age and may contain valuable basins of coal similar to those of the Fort Dodge field. In the greater part of the county it is necessary to drill through a considerable thickness of drift, as well as through the Cretaceous, before the bituminous coal horizons are reached, and this fact, together with the uncertainty of finding workable coal at any given point in the Des Moines strata and the uncertainty that a thick coal when found is of sufficient lateral extent, have deterred prospecting operations. Some prospecting has been done within the limits of the county; but the results obtained are too indefinite to be cited here.

#### GREENE COUNTY

The highest indurated rocks in the two eastern tiers of townships of Greene county are of Lower Coal Measure age; farther west the eastern edge of the Cretaceous intervenes between the drift and the Des Moines. Little deep drilling has been undertaken in the western area, yet such as has been done appears to show that the thickness of the Cretaceous is not great and that the considerable thickness of Coal Measures lying beneath it is a legitimate field for prospecting. According to Professor

\**Geology of Plymouth County, Iowa Geol. Surv., Vol. VIII, pp. 361-365; Des Moines, 1898.*

T. H. Macbride bituminous coal has been reported by those sinking pipe for deep wells, in the following localities:

Tp. 85, R. 32, Sec. 28.

Tp. 84, R. 32, Secs. 1, 7 and 18.

The seams ranged from twelve to twenty-two inches in thickness and the depths quoted are from 150 to 175 feet. Since Cretaceous sandstones outcrop at depths of about 100 feet in the neighborhood of these wells and well-drillers claim that holes 160 feet deep go sixty feet in yellow sand, the amount of Carboniferous deposits above the coal cannot be great. Deeper prospects might reveal coal horizons bearing thicker coals. In prospecting care should be taken not to mistake the thin and valueless lignites of the Cretaceous for Carboniferous bituminous coal. It is possible that this mistake may have been made in the case of the wells just cited.

Aside from the unexplored coal bearing series beneath the Cretaceous, the possibilities of the Des Moines outcrop in the eastern section of the county are as yet far from exhausted. The once prolific field near Angus and Rippy may be only one of several similar areas; for extensive prospecting has not been attempted in much of the county. Recent developments in Boone county show that exploration beneath the uplands, where no natural outcrops occur, may lead to the discovery of profitable basins. Drilling is now in progress between Dana and Grand Junction. Some drilling has been done near Jefferson, and Mr. Carpenter, of the Big Five Coal Company of Moin-gona, reports an apparently workable three-foot coal within four miles of that city.

Though at present not ranking as a large producer, Greene county stood higher in the list before the abandoning of the larger mines of the Angus district. The earliest recorded production of coal was 1,200 bushels in 1866. Little was done until about 1880, when 8,559 tons were mined. The year 1885 witnessed an increase to 89,587 tons and 1890 a decline to 51,438 tons. The lessened output for recent years is shown in the following table:

YEAR.	TONS.	YEAR.	TONS.
1898.....	12,920	1903.....	24,296
1899.....	13,289	1904.....	28,213
1900.....	17,044	1905.....	20,058
1901.....	16,450	1906.....	19,816
1902.....	11,573	1907.....	16,289

During the year ending June 30, 1908, six mines produced 22,226 tons and employed seventy-five men.

In the following pages may be found brief mention of Greene county mining districts.

*Grand Junction.* An eighteen-inch coal is quite general in the vicinity of Grand Junction, but is mined at only one point. Just north of the town (Sec. 33, Sw. qr., Sw.  $\frac{1}{4}$ ) is the plant of the Goodwin Tile and Brick Company, where a shaft 140 feet in depth reaches the coal seam above mentioned. Beneath the coal is a considerable thickness of fire clay, only three feet of which is utilized. Above the coal are about two feet of black jack overlain by from twenty inches to twenty-five feet of blue argillaceous shale which, together with the fire clay, is used in making brick and tile and forms the principal product of the mine. The coal seam is strongly undulatory, with a maximum difference of twenty-five feet between the levels of the bottoms of the troughs and the crests of the rises. As a whole the bed

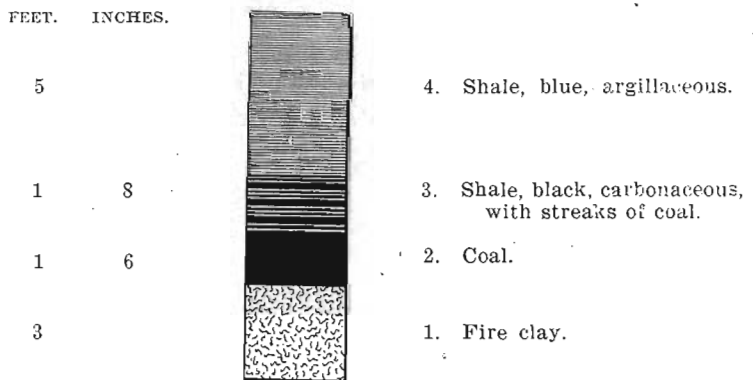


Figure 92. Coal bed in Goodwin mine, Grand Junction.

is regular in occurrence and free from obnoxious impurities. About twenty-three acres have been mined out during a long period of working, the fuel product being used chiefly in firing the kiln at the clay plant.

Prospecting is now being done on the E. S. Hillman land, one mile west and three miles north of Grand Junction. Workable coal is reported from all but one of the several holes bored, but more drilling remains to be done before definite statements can be issued.

*Ripsey.* Formerly a four-foot coal was mined at a depth of 125 feet a short distance east of the Ripsey railroad station, but nothing is now done at this point. The center of the mining industry of Greene county now lies three miles south of Ripsey, where three mines supply an important local trade. A number of years ago extensive mining was in progress in this area, as numerous old dump heaps attest. The sequence of strata is shown in the following drill record furnished by Craig and Dawson of Fort Dodge (Washington Tp., Sec. 26, Nw. qr.).

	FEET.	INCHES.
31. Clay .....	96	
30. Shale, argillaceous, light-colored .....	4	
29. Shale, fissile, black .....	3	6
28. Coal .....	2	6
27. Fire clay .....	1	6
26. Shale, argillaceous .....	9	4
25. Shale, fissile, black .....	1	
24. Sandstone, hard .....	4	10
23. Shale, fissile, dark .....	1	
22. Sandstone, hard .....	8	
21. Shale, dark .....	27	
20. Shale, sandy, soft .....	2	
19. Fire clay .....		6
18. Sandstone, soft .....	1	6
17. Shale, black .....	2	
16. Sandstone, soft, and shale .....	6	8
15. Coal, good .....	4	4
14. Fire clay .....		10
13. Sandstone, soft .....	4	
12. Fire clay, sandy .....	7	
11. Shale, fissile, dark .....	1	
10. Coal .....		2
9. Fire clay, sandy .....	5	4
8. Shale, dark, and sandstone .....	3	
7. Sandstone .....	4	8
6. Shale, argillaceous .....	19	4
5. Hard bands .....		5
4. Shale, argillaceous, white .....	1	6
3. Hard bands .....		5
2. Shale, argillaceous, oily .....	4	
1. Sandstone, hard .....	11	2

The thick coal, number 15 of the above section, appears to lie at a higher level than that now mined in adjoining territory. It may tentatively be correlated with the "lower vein" of the Angus area farther east; while the coal now worked perhaps lies in the horizon of the "middle vein" or the "niggerhead." Of the three mines now working south of Rippey, the Keystone is the most important (Sec. 27, Ne. qr., Ne.  $\frac{1}{4}$ ) and is relatively well equipped. A part of its product is hauled to Rippey and Dawson for shipment, the remainder is sold locally. At eighty-six feet the shaft reaches a coal that varies in the mine between three and six feet in thickness and is of good quality. No other seam is thought to exist under this land, as a well 230 feet deep on the same farm failed to penetrate thick coal.

A short distance northwest of the Keystone, the Buckeye Coal Company reaches coal lying at about the same level by means of a shaft 103 feet in depth (Sec. 22, Se. qr., Se.  $\frac{1}{4}$ ). The bed contains from four to five feet of coal overlain by four to twelve inches of black jack and underlain by a few feet of fire clay over a hard sandstone basement. In places the fire clay is filled with geodes bearing calcite crystals. The roof proper is a thick black shale, which, with the other beds, dips east of northeast. In the workings, which are east of the shaft, faults have occasionally changed the level of the coal one foot or less.

The shaft of the Snake Creek Coal Company is situated east of the Buckeye, on the same piece of land (Sec. 22, Se. qr., Se.  $\frac{1}{4}$ ). It is 141 feet deep, making the elevation of the coal seam much lower than at the Buckeye shaft, although the workings of the two mines are connected. The coal averages four and a half feet in this mine and dips to the northeast. About three rooms are affected by a large sandstone mass enclosing bits of coal, probably the result of Pennsylvanian erosion. The Snake Creek is the only plant in the district operating a steam hoist.

*Angus.* Some years ago Angus was the center of a very important coal industry extending over territory embracing portions of Boone, Dallas and Greene counties. Many large mines were operated and mining was vigorously prosecuted until a large portion of the field was exhausted. So little is now being

done in this region that it is difficult to ascertain the exact relationships of the various coals, but the following statement is probably approximately correct. Generally speaking, there are four coal horizons, though all of these seldom bear coal at any one point and rarely is more than one workable from a single shaft. The uppermost seam, known as the "riding vein," is very erratic in its appearance and is twenty-two inches or less in thickness. The second bed is best developed westward toward the Coon river and is known from the "boulder" roof often overlying it as the "niggerhead." A characteristic section of it is:

	FEET.	INCHES.
5. "Boulder" roof .....		
4. Black jack .....		6
3. Coal, with streaks of black jack.....	2	
2. Coal, good .....	1	6
1. Fire clay .....		

Below the "niggerhead" is the "middle vein," also with considerable black jack, and below that the "lower vein." Each of the lower three seams may run as high in thickness as four or five feet.

The only mine now open in the Angus district, aside from the banks south of Rippey already mentioned, is that of the McElheny Coal Company (Tp. 82, R. 29, Sec. 36, Ne. qr., Ne. ¼). A local trade is supplied from a gin shaft seventy-five feet in depth. The bed mined is four to four and one-half feet in thickness, and is gently undulatory. Streaks of pyrites appear irregularly, but most commonly about six inches from the base of the coal. Both the "middle" and the "lower" seams are said to be present here, separated by a variable, though slight, vertical interval that is bridged by a micaceous sandy shale and fire clay. The "lower" coal gives out on the south, where the higher seam overlaps it. The thickness of the "middle vein" varies greatly, often in short distances.

**CARROLL COUNTY**

At only one point in Carroll county have rocks of Carboniferous age been found to outcrop and these are somewhat doubtfully referred to that system. Throughout the remainder of the county the Coal Measures are covered not only by a great thick-

ness of drift—from 100 to 200 feet on an average and in places as much as 500 feet—but also by about 100 feet of the Cretaceous in the eastern portion of the county and by 200 feet or more of the same rocks in the western portion. Owing to the fact that the contact surface between the Cretaceous and the Des Moines is extremely irregular in level, the depth at which the latter may be reached cannot be exactly postulated for any given area. The Carboniferous outcrop referred to above lies about one mile southwest of Carrollton (Newton Tp., Sec. 1, Sw. qr., Ne.  $\frac{1}{4}$ ), on Middle Coon river, and consists of an unknown thickness of gray, sandy shale covered by about three feet of brown fine-grained limestone.

The limestone outcrop greatly resembles certain rocks belonging to the "Middle" Coal Measures of Guthrie, Dallas and Madison counties, so that we may tentatively conclude that there are present in Carroll county several hundred feet of Des Moines strata that may possibly bear basins of thick coal and are therefore suitable for exploration with the drill. Since the lower part of the Des Moines is the most productive in other parts of the state, it would be best to continue test holes not only through the drift and Cretaceous, but also for some distance into the Coal Measures, thus making the expense of prospecting considerable. Even after thick coal has been penetrated in one prospect it would be necessary to drill on all sides of it in order to determine the lateral extent of the coal basin found. The horizon of the coals mined farther east probably lies about 170 feet below water level at Coon Rapids. Whether or not prospecting in this county would yield results is an open question, but the strategical position of the region for marketing its fuel product would make the discovery of coal within its borders particularly remunerative. Prospecting should be undertaken only by companies prepared to expend a large amount of money and to weather many preliminary disappointments; for coal, if present, will not be in continuous beds over an extensive territory, but will be in more or less independent basins, as is the case in the mining counties on the east. For a more complete discussion than it is possible to give here, the reader is referred to that published by Bain.\*

\**Geology of Carroll County, Iowa Geol. Surv., Vol. IX, pp. 97-101; Des Moines, 1899.*

**GUTHRIE COUNTY**

The western three-fourths of Guthrie county is underlain by the Cretaceous, a system that in some parts of the United States carries heavy deposits of coal, but in Iowa bears only thin pockets of lignite. The surface rocks of Penn and the southeastern portion of Beaver townships belong to the Upper Pennsylvanian, or Missouri, a stage which is coal bearing to a limited extent, but not at all in the lowest portion, which is all that is represented in Guthrie county. The Lower Pennsylvanian, or Des Moines, stage immediately underlies the drift in Richland, Cass, and eastern Jackson townships, and it is to this that we must look for important coal deposits. As will be mentioned farther on, many of the principal streams of the county have cut down through the overlying formations so as to expose the Des Moines in the bottoms of their valleys. Neither the Cretaceous nor the Missouri is very thick in this region; so that to reach the Des Moines it would not be necessary to drill any great distance through overlying formations. The elevation above sea level of any given horizon in the Des Moines varies within only narrow limits in different parts of the county.

According to Bain\* the Des Moines strata of Guthrie and neighboring counties fall naturally into four groups: (1) Shales, predominantly sandy, characteristically free from coal, with an occasional development of arenaceous limestone. The thickness of this group varies from forty to 100 feet and decreases rapidly from Stuart north. (2) Shales, sandstones and limestones, with three coal horizons. This group is characterized by the great persistence of its individual members. (3) Sandstone and sandy shales with the Redfield coal at the base. (4) A lower series of shales, sandstones and thicker coal seams characteristic of the greater portion of the Des Moines formation.

The coals now being worked within the county may be all classed with group (2) and belong to one of the three coal horizons, termed in descending order, the Lonsdale, Panora and Marshall coals. All three horizons have been recognized at Panora: the Lonsdale as a thin bed in the top of the hills, the Panora as a seam twenty feet above the river, and the Marshall

\*Iowa Geol. Surv., Vol. VII, p. 443; Des Moines, 1897.



as the coal at present worked and lying thirty feet below the river. What is probably the representative of the Marshall horizon has been extensively worked by a group of mines at Fanslers, eight miles farther up the Middle Raccoon river. The coal here does not correspond well in its characteristics with the lower bed at Panora, yet stratigraphically it appears to occupy the same position. The coal mined north of Stuart on Deer creek is found only a short distance below the base of the Missouri and is either the Lonsdale or a seam not far below that horizon. The limestones and one of the sandstones belonging to group (2) are indeed remarkably persistent from outcrop to outcrop along the streams; but it seems probable that early geologists placed too much emphasis on the persistency of the coals. It is true that where coal is found it can often be readily assigned to one or another of the three horizons quoted, yet mining operations show that the continuity of the coal between two points apparently in the same horizon has its limits and that these limits are not always wide ones.

Almost no deep prospecting has been attempted in Guthrie and several reasons may be advanced for this state of affairs. As already indicated, it is necessary in order to reach the lower Coal Measures under much of the county to first drill through the barren Cretaceous or Missouri rocks. While the strata are not very thick beneath the valley lowlands, the additional expense entailed has discouraged prospecting. Then, too, even where the highest indurated rocks belong to the Des Moines the drift is often thick. This is especially the case in the otherwise attractive territory north and east of the Middle Raccoon river. To obtain the best results prospect holes should be carried into group (4), the lower division of the Des Moines; for it is in this that the heaviest coal beds may be expected. To locate such beds would demand drilling to depths of between 250 and 450 feet, according to the altitude of the surface at the head of the bore. A few of these coals have already been discovered in isolated prospects which will be given later; but the additional work necessary to prove a field has not been undertaken.

Guthrie has never ranked as a large producer. The mines have been, and are, small, local affairs, usually with horse-gin

hoists. The life of individual shafts is in general not long, but as soon as one is abandoned, another is sunk in the same field, so that the total production of the county suffers little loss. In 1860 the output was 289 tons with a value of \$550.00. The production became 12,675 bushels in 1866 and 24,500 bushels in 1868. The production for later years has not varied between very wide limits. According to the reports of the Iowa Geological Survey, the figures for 1902-1907 are as follows:

YEAR.	TONS.
1902 .....	2,300
1903 .....	4,708
1904 .....	9,149
1905 .....	15,413
1906 .....	12,063
1907 .....	13,840

The report of the State Mine Inspectors for the year ending June 30, 1908, is:

Number of mines .....	10
Amount of coal of all kinds produced.....	13,143
Total number of employes .....	104

The value of the product is relatively high, as the average price per ton at the mines (\$2.61 in 1907) is higher than in any other mining county in the state.

In the description of the various fields given below, geological data and accounts of former mining localities now abandoned or idle are freely drawn from former reports of this Survey by Keyes\* and Bain.† Those interested in a fuller exposition of geological phenomena are referred to the author last named.

#### NORTH RACCOON DRAINAGE.

*Jamaica.* Near Jamaica, in the extreme northeastern corner of the county and on a small creek which joins the north branch of the Raccoon river in Dallas county, the Greenbriar Coal Company has operated for more than nineteen years. A seam which averages two feet four inches in thickness lies at a depth of about seventy feet. The longwall plan of working is employed,

\**Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 243-253; Des Moines, 1894.

†*Geology of Guthrie County*, Iowa Geol. Surv., Vol. VII, pp. 413-437; Des Moines, 1897.

mining being done in the underlying fireclay. Natural ventilation is considered sufficient and hoisting is with horse and gin. Above the coal are forty-seven feet of black "slate" which makes a fairly good roof. Three miles east of here, near Dawson, in Dallas county, three workable coal horizons have been recognized and may be found described in their proper place in this volume.

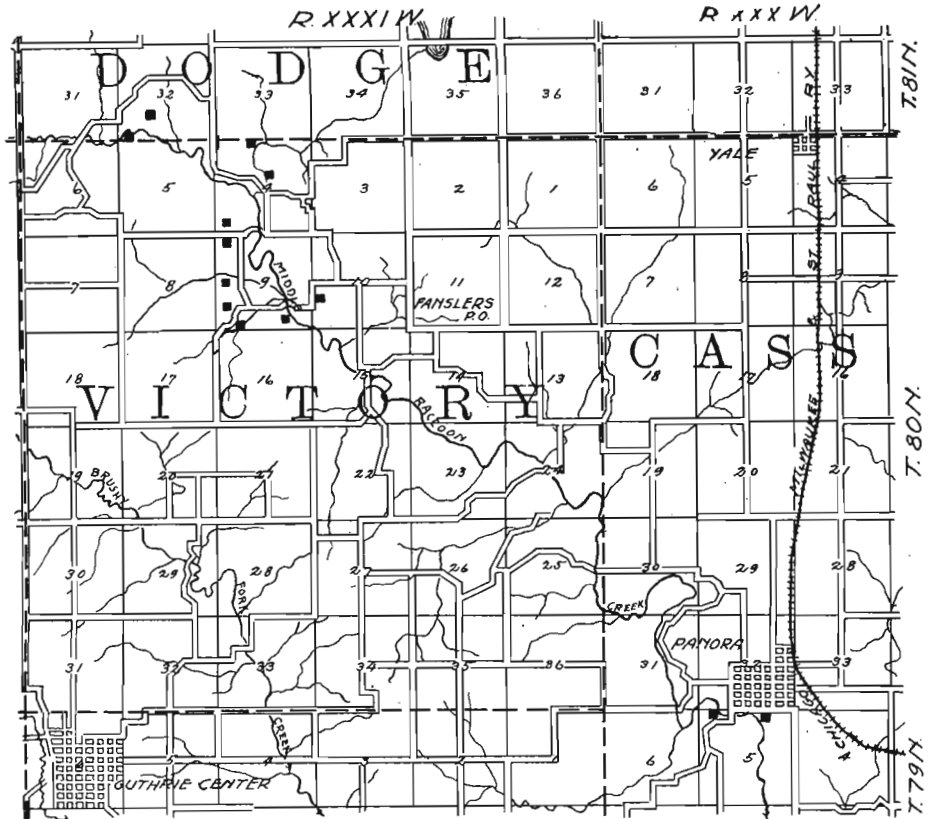


Figure 93. Map showing mines in the Panora and Fanslers districts, Guthrie county.

Very probably the coal at the Greenbriar lies in the same horizon as one of the beds at Dawson. The coal near Rippey, in Greene county, and Angus, in Boone, may also possibly have some stratigraphic connection with it. The fact that a number of holes put down for gas and water in Richland township have passed through no coal should not discourage further prospecting.

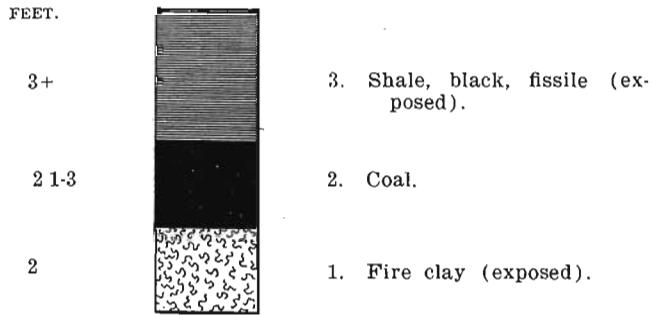


Figure 94. Coal bed at Greenbrier mine, Jamaica.

MIDDLE RACCOON VALLEY.

*Bayard.* Throughout most of its course in the county, the Middle Raccoon river has cut entirely through the overlying cover of Cretaceous rocks and exposed in the bottom of its valley the coal bearing strata of the Des Moines formation. Most of the Guthrie mines are situated along this stream at and above Panora. The highest point on the river at which Coal Measures outcrop is southwest of Bayard at the western edge of section 24, Orange township. Near here in the early days, drifts and slopes reached a seam eighteen inches thick, lying about two feet above the river. Later shafts were sunk to a lower bed twenty-eight feet below the water level. For a distance of about five miles down the river, drifts have been run in from both sides of the valley to the upper seam just mentioned. At the old Wales bank (Highland Tp., Sec. 33, Ne. qr.), this bed lies twelve feet above the river and is sixteen to eighteen inches thick, while between it and the base of the Cretaceous are at least twenty-seven feet of Des Moines strata. Near here, on the opposite side of the river, the following section has been measured just above the water level.

	FEET.
5. Incoherent reddish sands.....	10
4. Yellow and blue shale.....	3
3. Black and gray calcareous shales.....	1
2. Coal .....	1-1½
1. Blue shales .....	

A dip in a northeasterly direction of ten inches in a hundred feet carries the top of the Coal Measures beneath the level of the

Raccoon beyond the point at which the road leading due south from Bayard crosses the stream, and they do not reappear for a distance of about two miles down the river. After they do again come to the surface they may be found in the bottom of the valley at all points lower down the Raccoon.

*Fanslers.* No mining was being done in the district described above during the month of September, 1908, but near Fanslers a number of shafts were being made ready for the winter trade. All supply only a local trade and hoist coal by means of the primitive horse-gin. Longwall is the plan of work used. Mines have been operated in this district for a long period, but they change hands frequently and the location of the shafts is shifted every few years. They are idle in summer and each produces from 200 to 500 bushels a day in fall and winter. The location of the coal banks open in the early fall of 1908 is as follows:

NAME OF BANK.	LOCATION.	DEPTH OF SHAFT, FEET.
Sipe Brothers.....	T. 80 N., R. 31 W., Sec. 10, Sw. qr., Nw. $\frac{1}{4}$ ..	80
Middleton or Black Diamond .....	T. 80 N., R. 31 W., Sec. 9, Se. qr., Se. $\frac{1}{4}$ ....	116
Scott .....	T. 80 N., R. 31 W., Sec. 9, Sw. qr., Sw. $\frac{1}{4}$ ....	96
Mansell .....	T. 80 N., R. 31 W., Sec. 9, Sw. qr., Sw. $\frac{1}{4}$ ....	110
Butler and Gibson.....	T. 80 N., R. 31 W., Sec. 9, Sw. qr., Nw. $\frac{1}{4}$ ....	67
Renslow.....	T. 80 N., R. 31 W., Sec. 9, Nw. qr., Nw. $\frac{1}{4}$ ....	87
Hughes & Son.....	T. 80 N., R. 31 W., Sec. 4, Sw. qr., Sw. $\frac{1}{4}$ ....	66
Thomas .....	T. 80 N., R. 31 W., Sec. 4, Nw. qr., Se. $\frac{1}{4}$ ....	115
King .....	T. 80 N., R. 31 W., Sec. 4, Nw. qr., Ne. $\frac{1}{4}$ ....	70
Clark .....	T. 81 N., R. 31 W., Sec. 32, Sw. qr., Ne. $\frac{1}{4}$ ....	70
Coe.....	T. 81 N., R. 31 W., Sec. 32, Sw. qr., Sw. $\frac{1}{4}$ ....	70

All the mines are working the same vein, in which practically all former mines have operated. A possible exception may have been the old Thomas bank (T. 80, R. 31, Sec. 6, Ne. qr.), which opened a pocket three feet thick. The thickness of the coal at the present mines is remarkably uniform: the Middleton and Sipe banks show about two feet while the others are content with a few inches less. A variation of more than two inches in any one mine is rare. The bed is quite constantly characterized by a so-called "sulphur band," usually merely a streak of impure coal, or black jack, from a half to two inches thick, lying about six inches above the base of the coal. Often this streak is sufficiently carbonaceous to burn with more or less difficulty, but in

some mines it is replaced by hard calcareous or sandy rock containing lenses of iron pyrites which occasionally constitute the major part of the band. Calcite in transparent films along cleavage cracks and in thicker bands commonly horizontal in position is present in all parts of the seam, yet not in sufficient quantity to interfere with the quality of the coal. Occasionally clay seams run through the coal in branching dendritic streaks in such number as to cause a disagreeably large yield of ash on burning, and in a few cases they are so abundant as to destroy the value of small portions of the bed. There is a general southerly dip which is rather erratic, being as much as ten feet in three hundred at the Sipe bank, but inconspicuous at others.

Above the coal is a four-inch layer of "draw slate." This is a compact, calcareous rock which comes down with the coal on mining and is sometimes rendered hard and firm by great numbers of shells of brachiopods of the species characteristic of the Des Moines stage. Above the "draw slate" is a succession of shales, very carbonaceous at their base. Generally a thin coal bed, eighteen to twenty-two inches thick, is found about forty feet above the one worked. Although it does not appear to be universally present, its absence may often be accounted for by pre-glacial erosion. The seam has not been commercially important because of its poor roof and the softness of the coal. At the Mansell bank a seam not usually present in this region is reported. It is said to lie fourteen feet above the coal mined and to be three feet thick. It is the intention to run a slope up to it from the present workings. Two and a half miles above the Mansell, at the old Scott bank (T. 81, R. 31, Sec. 31, Se. qr., Sw.  $\frac{1}{4}$ ), two coals have also been reported, as shown in the following section.

*Panora.* Between Fanslers and Panora, a little mining has been intermittently attempted along the Middle Raccoon. About half way between the two points (Victory Tp., Sec. 24, Nw. qr., Se.  $\frac{1}{4}$ ) the old Clark mine at one time supplied a local trade. Farther south on the west side of the river (Sec. 25, Sw. qr., Ne.  $\frac{1}{4}$ ) a shaft was sunk twenty feet in 1892, to a bed eighteen

to twenty inches thick. There was a clay bottom and a roof of thin, black, fossiliferous shale. Clay seams were frequent and rolls not uncommon. Still farther south, on the same side of the river (Cass Tp., Sec. 31, Nw. qr., Se. 1/4), coal was taken by means of a shaft from a thin seam which lies fifteen feet above water level. The seam probably occupies the horizon of what has been termed the Panora coal.

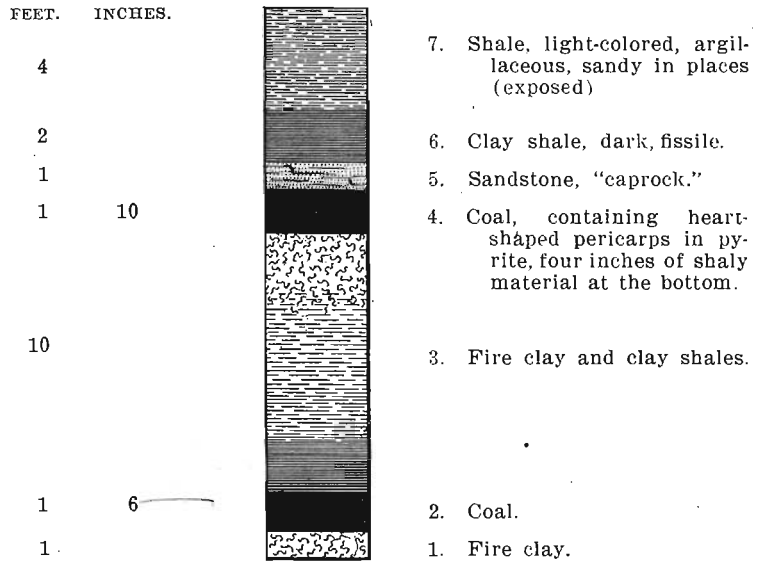


Figure 95. Section of former Scott shaft, Fanslers.

At the present time two mines are producing coal in the Panora district and both are located near the town. On the west side of the river, just north of the wagon bridge leading southwest from town, is the Reese shaft, now, after nearly twelve years of service, worked by the Lord and Love Company. Twenty to twenty-five feet above the river is a thin coal, probably lying in the Panora horizon. The strata found in the Reese shaft afford a section from about this horizon down to that of the coal now mined, thirty feet below water level.

REESE SHAFT SECTION.

	FEET.
9. Drift .....	6
8. Limestone .....	1
7. Argillaceous shale, red .....	7

6. Shale, soft .....	2
5. Sandstone, white to gray, with flakes of mica.....	30
4. Bituminous shale, fossiliferous, becoming a cannel coal below .....	10
3. Coal .....	12-3
2. Fire clay .....	8
1. Sandstone .....	10+

The fire clay forming the bottom in the mine is rather soft, so that its thickness of from eight to ten feet at this point tends to cause "squeezes" in the workings. The thickness of the coal at the present face is less than in the shaft section quoted, being quite uniformly sixteen inches. Clay seams in bands and branching streaks sometimes become so plentiful as to destroy the value of parts of the coal bed and in all places they give much trouble. The seam is fairly free from "sulphur," however. Longwall is the plan of working, the present face being west and north of the shaft. The output is hoisted by means of horse and gin.

On the opposite side of the river, adjacent to the plant of the Pentycost Brick and Tile Company in the southern part of Panora, is the O. K. mine. It is a shaft 100 feet deep with coal quite uniformly eighteen inches in thickness. Eight acres have been worked out longwall without revealing any particular dip. Mining is done here at the rate of about one acre a year, and, since anything but a very short haul pays poorly in such a thin bed, this shaft will probably be abandoned within another year. A horse and gin are found sufficient to hoist the coal for the merely local trade supplied. The fire clay bottom heaves slightly, but on this side of the river the sandstone lies only two feet below the coal and checks any serious trouble. A "sulphur band" very much like that in the Fansler coal previously described divides the coal bed proper from the clay. Above the bed is from two to four inches of "draw slate" which comes down with the coal. Above this is a black shale roof which requires little attention. The upper, or Panora, coal was not noticed in excavating either the hoisting or air shaft, but the horizon is represented in the neighboring clay pit by two feet of very carbonaceous shale. In former days some drifting was done into the Panora coal at favorable points in this district.



Farther down the river, at the mouth of Bays branch, where a few small mines were once located, the following section of the Panora and its associated strata is exposed in a bluff.

	FEET.
7. Drift .....	4
6. Limestone, impure .....	3
5. Shale, dark drab .....	8
4. Limestone, impure, bituminous.....	½
3. Shale, black, carbonaceous.....	1½
2. Panora coal .....	1
1. Shale, light-colored and variegated, exposed.....	10

Practically the same section was found directly opposite Panora.

Half way between Panora and the Dallas county line (T. 79, R. 30, Secs. 16 and 21) several small mines were operated during the nineties. The seam, where reached by the drifts and shallow shafts, was from twelve to twenty inches thick. Clay seams gave trouble locally. A coal of very pockety nature was occasionally encountered at a slightly lower level. Traces of old drifts and dump heaps may be seen farther down the river. Near the county line, two miles southwest of Linden, Dallas county, a seventeen-inch seam was at one time opened by several mines (T. 79, R. 30, Secs. 36 and 25). The coal was divided into three benches by two thin bands of soft argillaceous shale. A similar seam has been found a short distance east, in Guthrie county.

#### BRUSHY FORK VALLEY.

Aside from the lower mile of its course and one isolated area in Seeley township, Brushy Fork flows over Cretaceous rocks. These are in no place very thick, so that it would be unnecessary to drill to any great depth below the bottom of the valley before reaching the coal bearing strata of the Des Moines stage. About six miles southwest of Bayard (T. 80, R. 32, Secs. 5 and 6), the same low anticline which causes the Carboniferous to be brought to the surface along the Middle Raccoon river above Rocky Bluff makes an exposure of the same rocks on Brushy Fork. Des Moines strata may be traced in the valley for a distance of a mile and a half or more and in this territory a thin

seam has been mined now and then by means of shallow shafts. The coal corresponds in level to that mined on the Middle Raccoon south of Bayard.

## WICHITA CREEK VALLEY.

For a distance of two and a half miles above the junction of Brushy Fork and Wichita creek, Carboniferous strata outcrop in the valley of the latter stream, but beyond that point finally disappear under the Cretaceous system. Coal is occasionally removed during the winter months at the upper end of the outcrop, about two miles below Guthrie Center. The bed is eighteen inches thick and lies about ninety feet below the surface. A bed perhaps representing the same horizon was found at a depth of 132 feet in a drilling made just south of the Raccoon, one mile west and a half mile north of the courthouse at Guthrie Center. This bed was said to be twenty inches thick, while a second seam four feet and five inches thick, with a roof of soft white clay, was found sixty-five feet below it. About five feet below the second seam a third bed, associated with black clay, was reported. The first forty feet of the boring passed through drift, the next forty-four feet through a soft sandstone, probably Cretaceous in age. While no records could be procured of the other borings which confirm these statements, the information was obtained from apparently reliable sources.

## RACCOON VALLEY.

The South Raccoon proper has cut down to the Carboniferous rocks along its entire course; above Dale City through the Cretaceous and below that village through the Missouri. Near Dale City, the following drilling made by John Lonsdale & Sons revealed several coals, the more important being at 264 and 318 feet.

## DALE CITY SECTION.

	FEET.	INCHES.
69. Drift .....	12	
68. Shale, red, blue and brown.....	19	
67. Sandstone, light gray .....	3	
66. Shale, gray .....	11	7
65. Shale, gray, dark .....	10	7

64. Coal .....		2
63. Fire clay .....		4
62. Shale, with impure coal in alternate layers.....	1	10
61. Yellow stone .....		1
59. Shale, dense, gray, with traces of coal.....	4	9
59. Shale, dense gray, with traces of coal.....	4	9
58. Sandstone .....	1	4
57. Shale, blue .....	4	
56. Shale, dark gray .....	14	4
55. Sandstone, white .....	6	6
54. Shale, blue .....	2	
53. Limestone .....		2
52. Shale, yellow .....	1	4
51. Limestone .....		9
50. Shale, gray .....		3
49. Limestone .....		9
48. Shale, blue .....	2	
47. Limestone .....	1	4
46. Shale, brown .....	2	
45. Shale, blue, black at bottom.....	3	7
44. Limestone, gray, very hard.....		10
43. Slate, black .....	2	
42. Coal .....		4
41. Shale, light blue.....	15	
40. Shale, brown .....	2	6
39. Shale, variegated .....	7	
38. Shale and limestone in thin layers.....	3	4
37. Shale, variegated .....	8	
36. Shale, blue .....	25	3
35. Shale, yellow .....	1	9
34. Limestone, buff .....		4
33. Shale, gray, blue-black at bottom.....	6	0
32. Coal .....	1	4
31. Shale, blue fire clay at top.....	6	10
30. Limestone, gray .....	1	3
29. Sulphur band .....		2
28. Sandstone, fine-grained .....	11	
27. Limestone, very hard .....	3	1
26. Sandstone, white .....	2	6
25. Shale, variegated .....	4	9
24. Sandstone, gray .....	7	2
23. Shale, gray .....	3	9
22. Sandstone, gray .....	3	9
21. Shale, blue-gray.....	10	10
20. Shale, gray .....	23	
19. Coal .....	2	6
18. Fire clay .....		6
17. Shales, light and gray .....	17	10
16. Sandstone .....		8
15. Shale .....	1	3

14. Limestone, brown .....	2	
13. Shale, dark .....	1	2
12. Black stone .....		2
11. Slate, bluish black .....	5	8
10. Sulphur band .....		1
9. Shale, blue .....	1	5
8. Shale, blue and gray fire clay at top.....	17	8
7. Coal .....	3	4
6. Shale .....	1	6
5. Coal .....	1	
4. Shale .....		8
3. Coal .....		10
2. Shale, light and dark .....	17	5
1. Shale, dark blue .....	2	

Two miles below Dale City attempts have been made to mine the Lonsdale coal, but no systematic work has been inaugurated.

#### BEAVER CREEK VALLEY.

Coal Measures are exposed in the valleys of Beaver creek and its main tributaries as far west as section 33 of Beaver township, three miles above Glendon. A thin seam, probably the Marshall, was formerly exposed on Spring branch (Tp. 78, R. 31, Sec. 3, lot 12). A lower bed, said to be two feet six inches thick, was once worked at a depth of 100 feet and a bed four feet six inches thick was reported sixty to seventy feet still lower. Farther up Spring branch and on Beaver creek west of Glendon, thin beds have been occasionally tapped by small drifts and shafts.

#### DEER CREEK VALLEY.

A coal which is probably the Lonsdale has been mined along and near Deer creek at several points. Two horse-gin mines were being opened for an important local trade in September, 1908. The smaller of the two is located one mile west and one and a half miles north of Stuart (Penn Tp., Sec. 19, Se. qr., Ne.  $\frac{1}{4}$ ), in the deep valley of Deer creek. The bed, worked long-wall, is here from twenty-two to twenty-six inches thick. The circular face is about 500 feet in circumference. Under the coal is a hard, dry fire clay and above it three feet six inches of black, bituminous shale overlain by soapstone. The shaft is 110 feet deep.

A half mile or more north (Sec. 18, Se. qr., S.  $\frac{1}{2}$ ), on the north branch of Deer creek, is the shaft of the Deer Creek Coal Company. The seam here is quite uniformly two feet in thickness and dips steadily about one foot in twelve to the south. The same face, about 2,000 feet of which has been opened, has been worked for ten or twelve years, but the present shaft, fifty-eight feet deep, has been in existence only two years. The coal is of good quality and yields a fair proportion of lump. The roof is sandstone in some parts of the mine and "slate" in others. Where there is a "slate" roof, the seam is usually rather dirty. This mine is being rapidly placed in condition to supply a large local trade. The same coal has been opened at other points in this vicinity. At the old Lonsdale mine, one-half mile west of the Deer Creek, the bed worked lay thirty feet below the base of the lowest Missouri limestone and was only twenty inches thick. Two thin clay bands separated the seam into three benches.

## STUART.

Near Stuart, thick seams have been somewhat doubtfully reported as found in drillings made for water. The following record of a boring made by the Stuart Prospecting Company on the Savage and Dosh farm should, however, be fairly accurate.

## STUART SECTION.

	FEET.	INCHES.
40. Drift .....	4	
39. Sand, water vein .....	4	
38. Drift, water vein .....	145	9
37. Sand .....	6	
36. Drift .....	16	
35. Sand, water vein .....	3	9
34. Limestone .....		3
33. Sand shale, light; pyrite bands.....	92	
32. Clay shale, light .....	3	
31. Limestone, fossiliferous .....		8
30. Shale, blue .....		10
29. Limestone, fossiliferous .....	1	2
28. Shale, blue .....	5	
27. Limestone .....		8
26. Shale, black .....	1	2
25. Coal .....		6
24. Shale, bituminous .....		11

AUDUBON COUNTY

377

23. Coal .....		10
22. Shale, light .....	3	
21. Sandstone .....	8	
20. Shale, blue, red and brown.....	31	
19. Clay shale, light .....	5	10
18. Black shale .....	4	
17. Rock, gray .....		7
16. Black shale .....	2	8
15. White shale .....	6	
14. Black shale .....	2	
13. Blue clay shale .....	3	
12. White clay shale .....	4	
11. Blue sand shale .....	6	
10. Red clay to brown clay.....	35	9
9. Gray sand shale .....	4	
8. Brown clay shale to red and blue clay shale.....	14	
7. Blue clay shale .....	29	
6. Black shale .....	1	8
5. Coal .....		4
4. White clay shale .....	3	
3. Blue clay shale .....	10	
2. Blue sand shale with water vein.....	29	
1. Limestone, blue .....	1	
	490	4

AUDUBON COUNTY

Cretaceous deposits underlie practically the whole of Audubon county beneath a heavy cover of drift. Little is definitely known of the deeper formations; yet it is probable that the most productive facies of the Coal Measures, the Des Moines stage, may be found directly under the Cretaceous in the northern portion of the region; while in the southern part rocks of Missourian age occupy that position. In the northeastern section of the county the Des Moines can probably be reached at a depth that does not prohibit prospecting, for strata of that age outcrop along Middle Raccoon river in Guthrie county only five miles east of the Audubon boundary, and again near Carrolton six miles north of Audubon. Since the lower part of the Des Moines is usually the most productive, it would be advisable to continue prospect holes some distance into the lower Coal Measures. In the greater part of Audubon county workable coal horizons lie at such great depths that prospecting cannot be encouraged under present conditions of the Iowa fuel supply.

## ADAIR COUNTY

Under the drift of the greater part of Adair county are rocks of upper Coal Measure, or Missourian age; but in the western third of the region these are covered by Cretaceous strata of no great thickness. Only thin coal seams have ever been discovered in the Missouri, so that it is not a promising field for deep prospecting; while the Cretaceous of Iowa carries only lignites that are not of economic importance. Beneath the Missouri, however, are the more abundantly coal bearing beds of the Des Moines, presenting several hundred feet of strata that may contain at any point basins of coal of limited lateral extent. Throughout the greater part of the county the depth to which prospecting would necessarily be carried in order to reach the best coal horizons appears to be prohibitive under present conditions; yet in the valleys of the northern and northeastern portions, the Des Moines can be found nearer the surface. Thin coals have been reported from the northeastern section and parties are now preparing to prospect it.

Thin coals, belonging probably to the Missouri stage, have been encountered at several points near Bridgewater. Mr. James Hendry reports the following record of a drilling made on the highland near his residence (Washington Tp., Sec. 8, Ne. qr., Sw.  $\frac{1}{4}$ ).

	FEET.
Soil and drift .....	164
Sandstone .....	18
Rock, hard .....	1
Shale, fissile, dark .....	?
Coal .....	1 $\frac{3}{4}$

The thicknesses of the coal and the roof "slate" are in some doubt, although twenty-one inches is thought to be approximately correct for the former. Other drillings made on the lowland within one-half mile of the above prospect found the coal split into thin beds separated by layers of shale.

Near the residence of Henry Rose, two miles north of Bridgewater (Jackson Tp., Sec. 29, Ne. qr.), a coal two and one-half feet in thickness was claimed by the driller to have been penetrated at a depth of 290 feet in boring for water. A well sunk

for Henry Hyda, about five miles east of Bridgewater (Summerset Tp., Sec. 31, Se. qr.), reached a thin coal seam at about 300 feet.

A number of prospects were made near Fontanelle with doubtful results. A number of residents emphatically state that good coal five feet or more in thickness was encountered 380 feet below the level of the railroad track, near the Fontanelle station; while others just as emphatically declare that no coal was found. The Craig and Dawson Coal Company of Fort Dodge drilled in the creek bottom, about one mile below Fontanelle, to a depth of 409 feet. The record of this prospect shows a coalless alternation of the Missouri shales and thin limestones to the bottom of the hole, indicating that workable coal horizons, if present, must be looked for at still greater depth.

The only coal mined recently within the limits of the county was taken from a depth of about 260 feet, six miles directly south of Adair, in the northwestern corner of the region under consideration. A roof of bituminous shale covered a two-foot

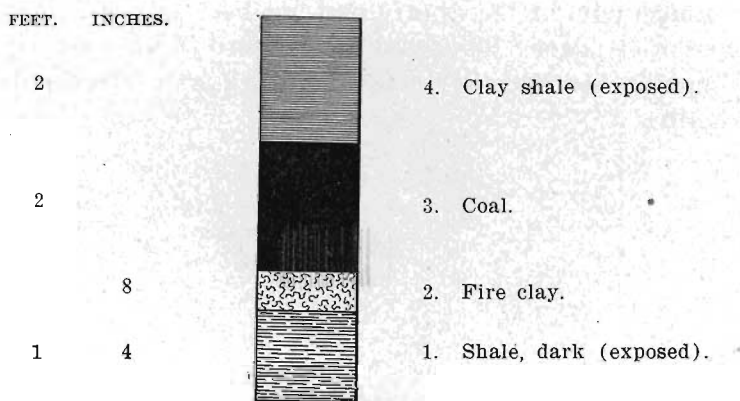


Figure 96. Coal bed south of Adair.

coal bed. A local mine was operated more or less continuously for about fifteen years until accumulating troubles with ventilation and other difficulties caused it to be closed. It may, perhaps, be again opened.



**CASS COUNTY**

Like many of its neighbors, Cass county offers few exposures of the indurated rocks beneath the drift, so that our knowledge of the stratigraphy of the region is limited. The Cretaceous is present except in the valley of the Nishnabotna river as far up as Atlantic and in the southeastern half of Noble township and the western portion of Edna. Where the Cretaceous is lacking, the beds immediately beneath the drift are Missourian. In a deep well drilled at Atlantic the top of the Missouri was reached at 125 feet and the base of the Des Moines at 850 feet, showing that 725 feet of Coal Measures exist at that point. While coal may possibly occur in any part of the Coal Measures, the thick seams are found in other parts of the state well toward the base, and it is not known that coal producing conditions prevailed as far west as Atlantic during even lower Coal Measure time. The chances for finding thick coals at practicable depths in Cass county are, therefore, not particularly bright.

The coal mined in counties south of Cass extends into the southern part of the county and has been mined to some extent north of Briscoe. This coal is discussed in another part of this volume in the chapter on the stratigraphy of the southwestern counties.

## PART VI

## COAL DEPOSITS OF SOUTHWESTERN IOWA\*

The mines of the southwestern field, including Adams, Taylor and Page counties, are all in the Upper Coal Measures, the Missouri stage. The coal worked is the Nodaway seam although a bed six to fifteen inches thick and known as the Linquist or Nyman coal has been worked in a very small way in Page county. The Nodaway seam is very persistent, both in its extent and its thickness. While its area is not fully determined the fact that it is mined at New Market and Henshaw in western Taylor county; at Nodaway, Carbon and Briscoe in western Adams, and at Clarinda, Shambaugh and Coin in Page county shows that it underlies a very considerable area. It is also worked extensively at many points down the Nodaway river in Missouri. Its thickness varies from sixteen to twenty inches and its quality is quite uniform over large areas. It is considered by Professor Calvin to be a submarine deposit. This conclusion is based on its large areal distribution, its practically unvarying thickness and other characteristics and the manner in which the coal is interstratified with marine sediments. The stratigraphic relationships are discussed at length by Dr. Geo. L. Smith in another part of this volume.† The map accompanying Dr. Smith's report shows the line of outcrop of the Nodaway coal.

The following table shows the figures of coal production in this field during 1908.

County	Tons	Value	Average price per ton	Average No. men employed	Average No. days worked
Adams.....	17,492	\$42,235	\$ 2.47	83	141
Page.....	11,364	31,993	2.82	59	124
Taylor.....	15,833	33,881	2.12	67	211

\*Notes on some of these mines were contributed by Dr. S. W. Beyer. The descriptions were written by the Assistant State Geologist.

†"The Carboniferous Section of Southwestern Iowa."

As to the possibilities of finding coal at greater depth in these regions it is not at all likely that any will be discovered except by prospecting very far below the bed worked. Even then it is problematical whether the strata which are most productive farther east will be found to be coal bearing in this section of the state. A hole was drilled at Carbon in Adams county with a core drill to a depth of 873 feet but without finding a trace of coal. The strata penetrated were chiefly calcareous shale, limestone and sandstone. Other prospects are described in Dr. Smith's report.

#### TAYLOR COUNTY\*

Coal has been worked in Taylor county for over forty years. The earliest mining, so far as known, was carried on near Henshaw in the bluffs of the East Nodaway river. Mines have been operated in this vicinity more or less intermittently until quite recent years. These mines have never been of more than local importance and since there is no railroad within six or eight

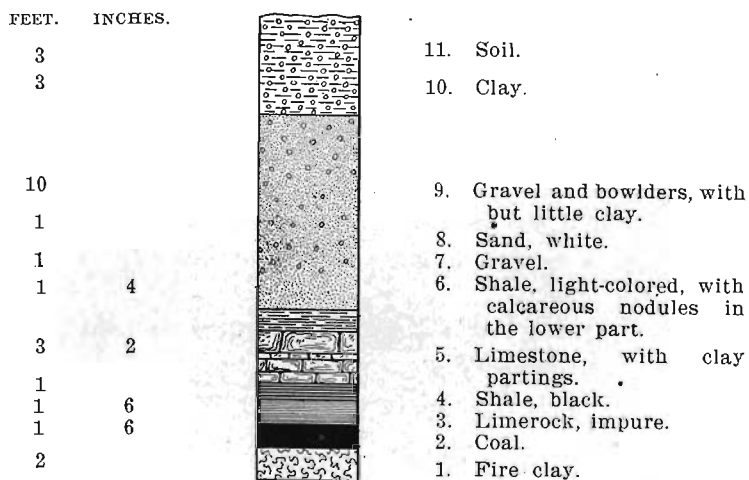


Figure 97. Section at Beynon shaft, near Henshaw.

miles the output has been marketed in the district where produced. Some coal has also been taken out a few miles farther south, east of Hawleyville, Page county. Figure 97, the section

\*Keyes: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 457-461. 1894.

of a mine which was one of the important producers of the district will give an idea of the strata present. This mine was opened about 1887. Some of the openings were drifts in the bluffs while others were shafts of depths ranging from twenty to eighty feet.

At present mining in Taylor county is confined almost entirely to the vicinity of New Market. Mines were opened here for local use in 1883 and since then the district has gradually increased in importance until it is one of the leading producers in the southwestern counties. At present (1909) three mines are operated the year around while three others are worked during the winter.

About one mile east of New Market, on the Chicago, Burlington and Quincy railroad, is mine number 1 of the Campbell Coal Company. The coal is reached by a shaft 150 feet deep. It is about eighteen inches thick and is fairly even and flat. The roof is composed of black or gray shale and "cement" or "bastard" rock. It is generally fairly good, especially where formed by the black slate. The section is given by Dr. Smith in his paper which will be found elsewhere. The mine does not make much water, except for the drip at the shaft. Mining is carried on here, as in other mines of the district, in the bottom, since this is fairly easy to remove. The system used is long wall and the coal works fairly easily. Owing to the thinness of the seam the roadways are blasted out of the bottom with dynamite and are gradually heightened by the falling of the roof during the summer. Haulage is effected below entirely by men as it is not practicable to make the roadways high enough for mules.

Ventilation is by furnace as in nearly all the mines of the Nodaway seam. These mines do not require much air and so are generally in better condition than is possible in larger mines. Natural ventilation usually suffices during the winter and is relied on entirely in some of the smaller mines. The Campbell mine is one of the farthest in of any working the Nodaway seam. The average miner will get out about two tons of coal per day. At present miners are paid 4½ cents per bushel in summer and 5 cents in winter. Wheelers receive about 1¼ cents per bushel, or 25 to 37½ cents per ton, for loading and

pushing. The cars used will hold 800 to 1200 pounds. The capacity of the mine is from 400 to 600 bushels per day. Campbell Number 2 is used only as an air shaft. In time it may be used as a producer since the company owns twenty-five acres of coal contiguous to it.

About one-fourth of a mile east of the Campbell property is the mine of the Union Coal Company, formerly owned by Tomlinson and Pace, and originally opened by Benjamin Anderson. There have been three shafts sunk here, but only one of these is being used at present. The section at the most westerly of the Anderson shafts may be taken as typical of all the others in the vicinity. Numbers 2 to 6 are given in the cut.

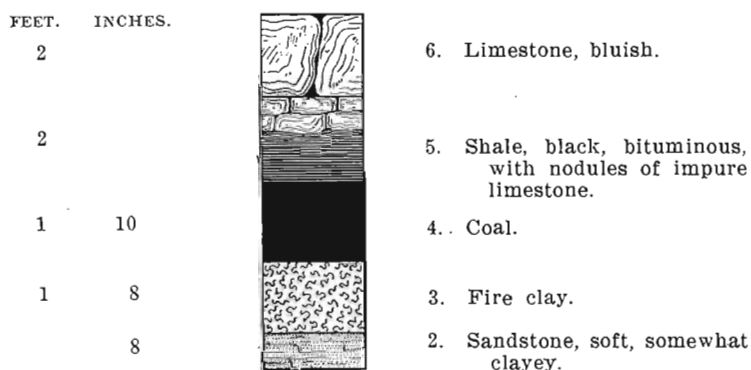


Figure 98. Seam at Anderson shaft, New Market.

	FEET.
10. Soil and drift clay .....	20
9. Sand and gravel.....	2
8. Clay, tough, dark gray.....	24
7. Shale, light gray .....	80
2 to 6 given in figure 98.	
1. Shale, bluish, with thin layers of limestone.....	12

The mine is located on the Chicago, Burlington and Quincy and does a shipping business. Horse power is used for hoisting and in all essentials the mine is similar to the Campbell. The coal is 150 feet deep and one of the shafts is utilized for air and escape purposes.

One-fourth mile west of the Campbell mine is that of the New Market Coal Co. formerly owned by Wm. Browning, and also

located on the Burlington. The equipment of this mine is very simple and is similar to that of the others in the district. The coal seam and associated strata show the features common to the district. The mine is 156 feet deep.

Besides these three shipping mines there are three small mines about two miles east of New Market, north of the railroad, but without connections with it. These were put down by Wm. Welsh, N. Easter and John Carmichael. They are operated only during the winter. The coal and the methods and equipment used for working it are similar to those found elsewhere. Some difficulty has been experienced here on account of water.

Mining is done in the New Market district either under the royalty plan or by purchase of coal rights. In the former case the amount paid is one cent per bushel while under the latter system about \$30 per acre is charged. All the mines of the county are nonunion. It is quite difficult to get miners to work the mines on account of the low vein. Otherwise a much larger production would be maintained.

#### PAGE COUNTY\*

Professor White mentions the fact that coal was mined in Page county as early as 1866.† The bed worked, he states, was the same as that worked in Adams and Taylor counties, and was opened up near Clarinda. This has been the center of mining in this county ever since. The principal mine in operation at present is that of Johnston and Company, about three miles west of town. This is a shaft mine, 185 feet deep, and is the only one in the district which uses steam power. It is equipped with a small vertical hoisting engine, with mine car and wagon scales and has storage capacity provided for 500 tons. Arrangements at top and bottom are very simple. The mine is quite dry, save for the drip at the shaft. The seam varies from sixteen to twenty inches with an average of about seventeen. It is fairly uniform in character and thickness, and the bottom is quite even. The long wall system of mining is employed here

\*Keyes: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 453-456. 1894.

\*Calvin: *Geology of Page County*, *Ibid.*, Vol. XI, pp. 397-460. 1900.

†C. A. White: *First and Second Annual Report of Progress of the State Geologist*, v. 50, Des Moines, 1868.

as in all the mines of this district. The coal is undercut from twelve to twenty inches, the mining being done in the bottom shale. This is rather more difficult to mine than is that at New Market. Nearly all the dirt is disposed of below. The height of the roadways is increased by taking up the bottom and this along with the other waste material is used to build pack walls for the protection of road- and air-ways.

All tramming is done by hand as the entries are too low for mules. Cars of ten bushels capacity are used. Only lump coal is produced. There are no facilities for grading or cleaning the coal except by hand picking. The capacity of the mine when in full operation is about forty to fifty tons daily.

As with the New Market mines so here also the mines are non-union. Miners are paid from  $5\frac{1}{2}$  to 6 cents per bushel, wheelers receive  $1\frac{1}{2}$  cents per bushel, day men at bottom receive \$2.00 to \$2.25 and those on top about \$2.00 per day. The royalty paid varies from  $\frac{3}{4}$  to  $1\frac{1}{2}$  cents per bushel. The usual royalty is one cent. All of the coal is sold and consumed locally and most of it is hauled to Clarinda. The delivery charge is two cents per bushel. None of the Page county mines have railroad connections.

The Van Arsdall, or Swisher and Maley, mine is located about two miles south of west of Clarinda. The present shaft is 146 feet deep and is equipped with horse hoist. The old shaft was 135 feet deep. The coal and the methods of securing it are similar to those of the Johnson mine. The full daily capacity of the mine is from twenty-five to forty tons, depending on whether or not the horses are relayed on the gin. The coal stands storage fairly well. The storage capacity is somewhat less than that of the Johnson mine. Ventilation is effected by furnace as in all the mines of the Clarinda district.

The equipment of the mines in the Nodaway seam compares favorably with that of similar mines over the state. The safety devices in use conform in character to the requirements of the law and the operators keep their mines in good working condition. Second openings have been made at all the larger mines and are kept in available order. The natural conditions also

are conducive to the safety of the miners and hence serious or fatal accidents are of rare occurrence.

There are two other mines about two miles southwest of Clarinda, the Berry and the Wingert mines. The equipment and general conditions about the mines are about the same here as at the Van Arsdall mine. The underclay is more difficult to cut in the Berry mine than in those mentioned previously.

Mining was carried on a number of years ago at the Shambaugh mill, about two miles southeast of Clarinda. Drifts were carried into the bluffs on the east side of the West Nodaway river (East River Tp., Sec. 7, Se. qr., Nw. ¼) and considerable coal was taken out. This locality has been abandoned for years.

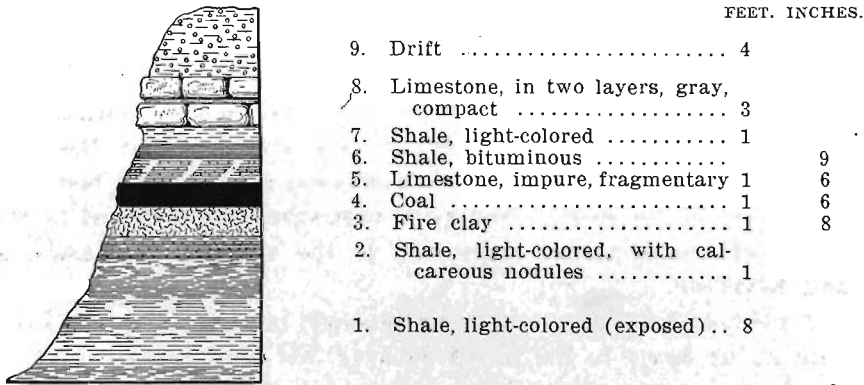


Figure 99. Bluff at Shambaugh Mill, on West Nodaway river, Clarinda.

There has been considerable activity in the neighborhood of Shambaugh, six miles south of Clarinda. Some of the openings here were slopes and some were shafts. Twenty-eight or thirty years ago Samuel Pinkerton, William Aiken, William McLean and others were operating the principal mines in the county. Later the seat of operations moved to Clarinda and in recent years Shambaugh has not been a producer.

About three years ago the Coin Coal Company sank a shaft at Coin. This is the deepest mine on the Nodaway seam, which it reaches at 230 feet. Steam power is used for hoisting and a jet furnishes ventilation. This is the only mine in southwestern Iowa using this method of furnishing air.



Northwest of Clarinda about ten miles, in the valley of the Middle Tarkio river, coal was mined a number of years ago on the land of Charles Linquist (Fremont Tp., Sec. 24, Nw. qr., Nw.  $\frac{1}{4}$ ). The coal was first discovered at the base of a low hill near the river. Tunneling was attempted, but here the "cap rock" was too badly weathered to form a good roof. A shaft was then sunk to the seam, which is from six to eighteen inches thick. Several thousand bushels were taken out, but owing to the unsatisfactory conditions it has not been exploited extensively. It is underlain by a fire clay and has as a roof a three-foot band of limestone with intercalated shaly partings. Above this come the materials of the drift. This is the Linquist coal, called also the Nyman, from the locality of that name near by. It lies 185 feet or more above the Nodaway vein.

#### FREMONT COUNTY\*

Fremont county occupies the southwest corner of Iowa and is underlain over its entire extent by the strata of the Missouri stage. A heavy mantle of drift and loess conceals the bed rock over most of the county and good exposures are confined to the bluffs of the Missouri river and to the vicinity of Hamburg and Riverton.

A phenomenon unique in Iowa geology, in the shape of a fault with an upthrow to the north of over 300 feet, brings some of the deeper strata of the Missouri stage to the surface in northwest Fremont county.† Along the bluffs of the Missouri river southeast of Bartlett (Scott Tp., Sec. 14 and 23) a bed of coal outcrops which shows a thickness of ten to eighteen inches. This rests upon fire clay and has a roof of blue or gray shale. These features, together with its associations, ally it with the Nodaway coal and Dr. Smith, who has made an extensive study of this part of Iowa, has no hesitancy in declaring it to belong with that seam.

About four miles south of this outcrop, two miles south of Thurman, coal was found in a prospect shaft. It was fourteen inches thick and rested upon shale with a six-inch band of lime-

\*See on the geology of Fremont county Keyes: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, p. 452, 1894. Udden: *Geology of Mills and Fremont Counties*, Iowa Geol. Surv., Vol. XIII, pp. 126-182. 1903.

†On this fault see the chapter below by Dr. Smith.

stone forming the cap rock. Dr. Smith identifies this with the Nyman coal, and as it presents the same features that are shown by the seam in Page county the correlation may be accepted as certain. Between this locality and the one north of Thurman, therefore, lies the fault which has caused this displacement and has brought the Nodaway coal above the level of the Nyman seam.

A seam of coal is seen in a creek valley about two miles east of Hamburg, in the southwest part of the county, at a locality known as McKissicks Grove. It is here less than a foot thick, is underlain by shale and has a soft limestone roof. It has also been penetrated in several wells and prospects, where a thickness of fifteen to twenty inches is reported a few feet below the base of the drift. This coal also is considered by Dr. Smith to be the Nyman coal.

Several attempts at exploration of these coal beds have been made, but nothing satisfactory seems to have been accomplished. The coal near Hamburg is said to be of good quality and its nearness to the surface makes exploitation easy. It is possible that some workable pockets may be found and utilized. Its thickness is locally equal to that of the coal mined in Page county to the east but since it lies above the general level of the eroded surface of the Coal Measures it must be discontinuous and hence exploration is bound to be attended with a great deal of uncertainty. The Nodaway coal seems to be of inferior quality and the steep dip of the strata away from the fault soon carries it far beneath the surface. Summing up all the conditions it does not seem probable that prospecting either of the beds will ever be attended with any degree of success.

#### MILLS COUNTY

Mills county, like Fremont to the south, has a heavy deposit of loess and drift overlying the indurated rocks. These latter belong to the Missouri stage, with the exception of a little sandstone of Cretaceous age in the northeastern part of the county. No exposures of coal are known, and as has been stated before, the Nodaway coal soon disappears to great depth and is of inferior grade. The Nyman coal may be found under conditions

similar to those existing in Fremont but nothing is known of this.

#### MONTGOMERY COUNTY\*

Montgomery, like its neighboring counties, has a deep covering of drift over the uplands, and hence the rock exposures are confined to the water courses. These have, however, cut into the indurated rocks to a larger extent than is true farther west. A considerable portion of the county is covered by Cretaceous sediments which now extend as long tongues or outliers over the uplands, but have been eroded from the stream valleys. Beneath all of these lie the strata of the Upper Coal Measures. These are known to carry one or two thin seams of coal, one of them the Nodaway vein. The relationships of the other seam, which Lonsdale states was reported to be six inches thick and about 100 feet above the Nodaway vein, do not seem to be very clear.

The Nodaway seam has been known and worked in the northeastern part of the county for many years. The principal opening in this region was the Westrope mine. (Douglas Tp., Sec. 1, Se. qr., Sw.  $\frac{1}{4}$ ). The vein was at one time exposed

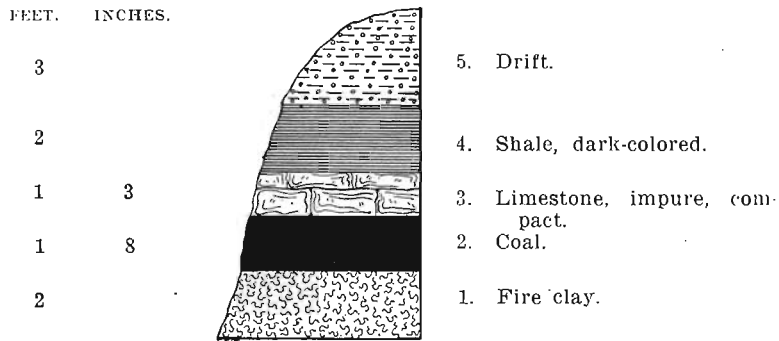


Figure 100. Coal bed at old Westrope mine.

in a small runnel opening into the West Nodaway. The coal has an average thickness of about nineteen inches. As early as 1857 slopes were driven into the hillsides and a considerable

\*See Keyes: *Coal Deposits of Iowa*, Iowa Geol. Surv., Vol. II, pp. 443-445, 1894. Lonsdale: *Geology of Montgomery County*, *Ibid.*, Vol. IV, pp. 402-408, 446-448, 1894. Lonsdale does not seem to have been aware of the identity of the Nyman coal and confuses it with the Nodaway.

amount of coal removed. From 1875 to 1880 mining was here carried on quite extensively for this region. At one time as many as fifteen men were employed at the mine, the daily output being upwards of 400 bushels or nearly sixteen tons. Since 1881 no mining has been undertaken at this locality nor elsewhere within the county. It will be noticed that in the section given above the usual shale roof of the Nodaway vein is separated from the coal by a bed of limestone. This phenomenon seems to be more common in the northern part of the area occupied by the Nodaway coal than in Page and Taylor counties, although there are several phases, from heavy bedded limestone through thin limestones and shales to thick shales.

#### ADAMS COUNTY\*

The Upper Coal Measures underlie all of Adams, but in the northwest one-third of the county they are overlain by the strata of the Cretaceous. There has been only one bed of coal found in the county, the Nodaway, and this is exposed and mined only in the west one-third. A short distance east of Carbon, probably not over one-fourth mile, the roof thins out and the coal becomes soft and worthless. It does not extend much farther. Carbon has always been the center of the greatest activity and Adams has, during most of the years for which figures are available, been the leading producer of southwestern Iowa. As early as the days of the Civil War coal was being mined in the banks of the Middle Nodaway near Carbon, and the industry has been prosecuted to the present day. It is probably making a conservative estimate to say that over 350,000 tons have been removed; a very considerable quantity when it is recalled that the vein averages only sixteen inches in thickness, that there is not a railroad mine in the county and that until two or three years ago no coal was ever shipped by rail from any of the mines in the county.

Mines have also been operated for about thirty years near Briscoe. Some of these shafts were from sixty to ninety feet deep. At the Plowman shaft (Lincoln Tp., Sec. 2, Nw. qr., Nw.  $\frac{1}{4}$ ), a section of which is given below, the coal was found at twenty-six feet.

\*Keyes: *Coal Deposits of Iowa*. Iowa Geol. Surv., Vol. II, pp. 445-450. 1894.

## COAL DEPOSITS OF SOUTHWESTERN IOWA

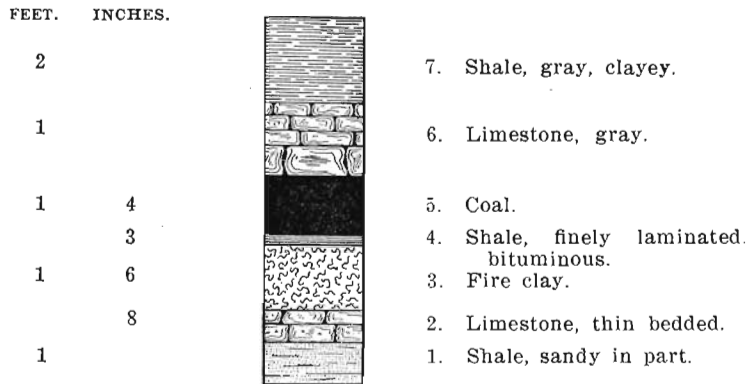


Figure 101. Coal bed in Plowman shaft, Biscoe.

At present one mine is being worked here, that of H. K. Demirjean. This is a shaft mine 119 feet deep and uses horse hoist. Ventilation is effected by furnace and an escape shaft five by six feet is provided. All the mines of this vicinity have shown about the same thickness of coal and a similar sequence of strata. The absence of the roof shale and the consequent juxtaposition of the coal and the cap rock is worthy of note.

The early mines of the Carbon district were located west of town, for the most part along the river. At present these are all abandoned and operations are being carried on by shafts located north and south of town. The accompanying section will give an idea of the strata encountered in this district.

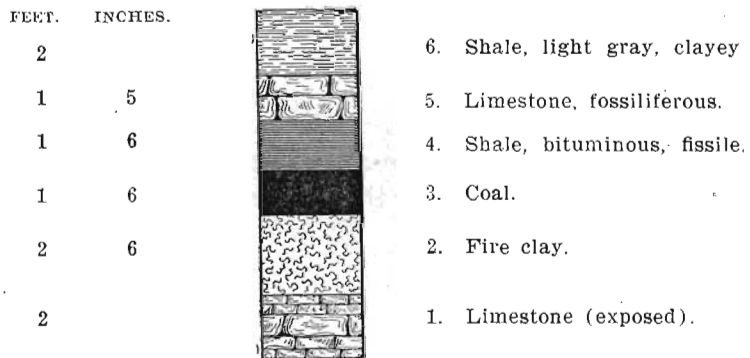


Figure 102. Vein at old Syfert and Jones mine, Carbon.

The mine of Jones, Smith and Tindall is located about one-fourth mile south of the village. The shaft is 110 feet deep,

five by nine feet in area and with two compartments. The cages are very simple and without safety devices. Horsepower is used for hoisting and a manilla rope is used instead of the customary wire rope. The plant is equipped with wagon scales but as the mine has been open only since April of the present year (1909) mine car scales have not yet been installed. An average output of 500 bushels per day can be maintained during the busy season, from September 1st to April 1st. Storage sheds of 4,000 bushels capacity will be provided. The coal has a uniform thickness of eighteen inches and lies fairly flat. It is essentially nonpyritic and can be stored for several months even during the summer season. At present most of the work being done is confined to entry driving. Twenty to twenty-five miners will be employed.

The shaft of J. F. Ruth, one-half mile northeast of Carbon, was opened in March of 1907. It is sixty-five feet deep to the coal and this and the equipment used for handling it are essentially the same as those of the Jones mine, except that the cages are supplied with covers and safety catches. Mine car scales are in use and storage capacity for 500 tons is provided. The mine is fully opened up and for the present season thirty men are employed. The capacity is about twenty tons per day although as much as forty tons is raised at times.

The mine of J. F. Wild is just being sunk. It is located on the north edge of town a third of a mile southwest of the Ruth mine. The shaft will be seventy feet to the coal and it is hoped to have the mine opened up ready for the winter's trade.

The Houck mine No. 2, near Carbon, was operated last winter by Wild and Barker, but a cave-in in the shaft has put an end to operations.

About five miles northwest of Carbon is the village of Eureka, north of which several mines have been operated. The earlier ones were slopes and the later ones shafts. A considerable amount of coal was removed but in recent years not much has been done here. At present the only mine which is open is the Dixon or Houck shaft, which is being operated by McKee Brothers during the present season. The shaft is thirty-five

feet deep and during the winter season ten or more men are employed. The capacity of the mine is about twelve tons.

Coal from the Carbon mines finds a ready market in the vicinity while some is hauled by team to Corning and even as far as Massena, Red Oak and Lenox, distances of twenty and twenty-five miles.

A comparatively new field has been opened up within the last few years near Nodaway in the southwest corner of the county. As early as 1903 James Spargur operated a mine near here and at present two mines are being worked.

One mile northwest of town is the shaft of Daugherty and Son, 102 feet deep. It has been operated since 1905 and at present eight to twenty miners are employed. The coal here is similar to that at Carbon, but is somewhat lighter, especially where it thickens. A dip of four feet per 100 to the southwest aids the pushers in getting the cars to the shaft. Mine car and wagon scales are provided and hoisting is effected by a double engine which operates a single three-foot drum by friction clutch. Power is supplied by a vertical boiler. The shaft has but one compartment and at present the cage is without cover or catches, although these will be provided. No storage sheds are provided and the surplusage over local needs is shipped on the railroad, chiefly to Villisca and other nearby towns. This is not profitable, however, and is resorted to chiefly to keep the miners in steady employment. Last winter the shipments averaged a car per week. The proprietors own the coal rights to eighty acres adjacent to the shaft.

One-fourth mile northwest of the Daugherty shaft is that of Frederick Weil. This is a double compartment opening five by ten feet in diameter and 124 feet deep and is operated by a one-horse gin. The coal here runs from fourteen to twenty-four inches, with an average of eighteen or less. Fourteen men are employed at present, but as many as twenty are used in the winter. This and the Daugherty mine are generally run all summer to supply the small demand. The daily capacity of the mine is about twenty tons, all of which is consumed locally.

At both of these mines the succession of strata is the same. Overlying the clay is a black, somewhat fissile shale which grades laterally into a gray shale, called by the miners the bastard. It is slightly more crumbly than the black shale, but either one makes a good roof. The thickness varies from eighteen to thirty inches. Above it is the "cap rock," a bed of limestone one or two feet thick. Below the coal is a "fire clay" perhaps two feet thick and underlying this the "bottom rock," about the same thickness.

Mining in the Adams county mines is comparatively safe and accidents are very rare, owing to the thin seam, the method of working the mines and the uniformly good roof.

The coal is mined exclusively by the long wall plan and work is done in the underclay. About four inches is taken out and the cut is made from twelve to eighteen inches deep. The coal is too soft to allow the use of powder. In most of the mines all the coal is taken out, even that around the shaft. Here cribbing is resorted to in order to support the roof. No mules are used in any of the mines as the roof is too low. Man-power is used for bringing the coal to the bottom. The cars used will hold from eight to fifteen bushels, their capacity depending on the height of the roadways and the ability of the pushers. In order to give the necessary height to the entries and the roadways two or three feet of the underclay is taken up, usually down to the bottom rock. Roadways are driven every forty feet off the entries and each miner, or in some cases two miners working together, cuts out twenty feet on either side of the road.

In the Carbon district miners are paid seven cents per bushel and hire or do their own wheeling. In the Nodaway mines the diggers receive six cents, or seven cents for cutting the rib, and wheelers are paid a cent a bushel. Coal sells for ten cents per bushel at the mines. Although it stands storage quite well it will lose about twenty-five per cent in weight. The operators work on the royalty plan and pay on the average one-half cent per bushel.

The equipment is very simple at all the mines, the Daugherty mine being the only one with steam hoisting apparatus. In



former years the workings were extended only a short distance from the shaft or slope mouth and were then abandoned and new openings made. Recently, however, better methods have been instituted; separate air shafts and manways have been installed and the equipment has steadily improved. Nevertheless, it is not practicable to run entries more than about 300 yards as the distance becomes too great for men to push the coal. Ventilation is effected during the summer by means of stoves in the bottoms of the air shafts. Natural ventilation suffices during the winter. All the mines are dry except near the shaft. With the exception of those of the Nodaway district the mines are idle during the summer, but in winter they are taxed to their capacity, and indeed, beyond. At times as many as 175 men have been employed in and around the mines.