GEOLOGY OF DALLAS COUNTY.

BY

A. G. LEONARD.

GEOLOGY OF DALLAS COUNTY.

BY A. G. LEONARD.

CONTENTS.

INTRODUCTION.

SITUATION AND AREA.

Dallas county is located just south and west of the center of the state. It is in the fourth tier of counties from the southern boundary, and is fifth in number from the Missouri river. Townships 78 to 81 north and ranges XXVI to XXIX west of the fifth principal meridian are included within the

limits of the county. It thus embraces sixteen congressional townships, and has an area of 588 square miles. A correction line causes a slight increase in the length of the southern tier of townships. The county is bounded on the north by Boone and Greene, on the east by Polk, on the south by Madison and on the west by Guthrie.

PREVIOUS GEOLOGICAL WORK.

The first geologist who visited Dallas county was Mr. O. H. St. John, who in 1867 made a hurried exploration of this and neighboring counties. A brief statement of results published in a preliminary report* mentions the occurrence of the coal measures within the county. The coal seam at Redfield is noted, and mention is also made of the thick bed of sandstone present at this place.

A more extended account of the geology of the county, written by Mr. St. John, was published in the final report of the Survey.† It is devoted largely to a description of various exposures along the Raccoon river and its chief tributaries. The Upper, Lower and Middle Coal Measures of White are shown to occur in the county.

The presence of the Wisconsin drift in Dallas county is referred to incidentally by Upham,‡ who traced the limits of the Wisconsin lobe in adjacent counties and states, who stated that its border probably extends across the southwestern part of the county.

Keyes visited the exposures at Van Meter and De Soto and has published the sections occurring at those localities.§ Numerous references to the coal beds of Dallas county are also contained in the report on Coal Deposits.‖

*First and Second Ann. Rep., State Geologist, pp. 84-87. Des Moines, 1868.

†Geol. of Iowa, Vol. II, pp. 13-46. Des Moines, 1870.

‡Geol. Nat. Hist. Surv., Minn., Ninth Ann. Rept., 1880, p. 307. Minneapolis, 1881.

§Iowa Geol. Surv., Vol. I, p. 98. Des Moines, 1893. Bul. Geol. Soc. Am., Vol. II, p. 281 1891.

‖Keyes: Iowa Geol. Surv., Vol. II, pp. 253-267. Des Moines, 1894.

PHYSIOGRAPHY.

TOPOGRAPHY.

The surface features of Dallas county may be briefly characterized as those of a drift plain which for the most part has been but slightly modified by erosion. Over the larger portion of the area the original surface of this plain has been little affected by the action of streams, and it is the absence of erosion effects that at once strikes the observer. It is only in the southern townships of the county that the original plane has been much cut up by rivers. Here broad valleys with numerous side ravines have been carved in the soft, superficial deposits. The southern part of the county, therefore, presents a much more diversified and a rougher appearance than the northern area.

While the line separating these two topographically distinct regions cannot be sharply defined, since they merge more or less into each other, it may be said that in a general way the boundary follows the Raccoon river. Its greatest divergence from the latter stream is from Van Meter east to the county line and between these points it lies from two to three miles north of that stream. West of Van Meter for a distance of four or five miles the boundary approaches the river quite closely. Throughout most of its course in Adams township, and as far as the bend at Cottonwood mill, in Union township, it lies from one to two miles north of the river. From this latter locality to a point about one mile south of Linden it follows the Raccoon quite closely. At no place does it seem to have crossed over to the south side of the river except at a point about two miles northwest of Redfield, to be mentioned later.

The region north of this line, including more than three quarters of the county, furnishes an excellent example of a drift topography and is sharply contrasted with the region

lying to the south which exhibits a characteristic erosion topography. It will be necessary, therefore, to consider the two regions separately.

The peculiar topography of the northern area reaches its typical development in Washington, Lincoln and Dallas townships, and also along Beaver creek. The surface is that of a flat or very gently rolling plain. Away from the immediate neighborhood of the streamways the eye sees on either side nothing but long stretches of level country reaching out to the horizon. There is, however, one striking feature in the landscape and that is the presence of shallow, saucer-shaped depressions in the drift, which are usually filled with water. These small ponds or lakelets are in some parts of the county extremely common, as, for example, south and west of Perry, in Dallas and Spring Valley townships, where one may often see a dozen or more at one time. They vary in size from those a few rods in diameter to others many acres in extent. Associated with these depressions are low, gently rounded swells, which may be compared to inverted saucers. Hence this peculiar configuration of the drift has been called "saucer topography."

The evidence is abundant that the retreat of the Wisconsin ice sheet, which once covered all of Dallas county nearly as far south as the Raccoon river, took place in comparatively recent times, geologically speaking. The surface now has much the appearance that it presented when at the close of the last ice invasion it was first exposed to the action of atmospheric and aqueous agencies. It has, as a rule, been little modified by the action of streams, and erosive processes have not gone far enough to thoroughly drain the land, except in the immediate neighborhood of the water courses. Hence the numerous lakelets have not yet been drained, and it is not uncommon to find one of these ponds within a few rods of a well developed valley, as in the case of one observed

near the deep gorge of the Des Moines river, in the northeast corner of the county.

This drift topography, which reaches such typical development over the northern part of the area, is not so well marked farther south, in Colfax and Adel townships, and, as the Raccoon river is approached, it gives place to the erosion topography of the region south of the border of the Wisconsin drift. The surface features are in the latter region due to the action of running water and to weathering. The flat surface left by the retreat of the earlier ice has been carved and modified by these agencies until the country presents quite a rough and hilly appearance. The streams have cut their channels through the thick Pleistocene deposits and well into the underlying coal measures. They flow in deep, broad valleys with abruptly rising sides. There is everywhere evidence that the drift here has been exposed to erosion longer than in the northern region. The surface is well drained, and nowhere do we find the saucer topography so characteristic of the younger drift. The principal streams have broad and deep valleys, which are cut to a depth of from 150 to nearly 200 feet below the general level of the upland. For these and other reasons to be mentioned later, the Kansan drift of the south is known to be considerably older than the Wisconsin drift of the northern portion of the county.

Along the larger streams of the district bottom lands of greater or less extent have been formed. Thus, for example, the Raccoon river east of Van Meter has broad bottoms, from one to two miles in width, the stream for the most part keeping quite close to the bluffs on the south side of the valley. As a result of this tendency of the river to follow the south escarpment, there is at various points along its course a marked difference between the north and south sides. On the south the bluffs rise abruptly from the water's edge to the height of from 160 to 180 feet, while on the north the rise is much more gradual, being often accomplished by a gentle

slope merging gradually into the upland. The southern escarpment is commonly covered with timber, while the opposite slope is dotted with cultivated fields.

TABLE OF ELEVATIONS.

The following table gives the elevation of the towns of the county, with others near its borders, together with that of a few other important points. The figures have been taken from the profiles of the Chicago, Rock Island & Pacific, Chicago, Milwaukee & St. Paul and Des Moines Northern & Western railroads.

	FEET.
Adel	885
Booneville	869
Bouton	961
Commerce	845
Dallas Center	1,074
Dawson	1,044
De Soto	904
Dexter	1,144
Earlham	1,116
Jamaica	1,040
Kennedy	952
Linden	1,123
Madrid	1,005
Minburn	1,051
Ortonville	1,039
Perry	969
Redfield	952
Waukee	1,032
Woodward	1,069
Van Meter	876
D. M. & N. W. track at bridge over Mosquito creek	937
D. M. & N. W. track at bridge over Panther creek	920
C., M. & St. P. track at Des Moines river bridge	861
C., M. & St. P. track at Beaver creek bridge	939

From the above table it will be noted that the general elevation of the upland plain is between 1,000 and 1,100 feet, and

that the streams have cut their channels nearly 200 feet below this. The highest part of the county is in the southwest corner, in Union and Linn townships, where the plain reaches an elevation of more than 1,100 feet. At Dexter, which has the greatest elevation of any point whose altitude is known, the surface rises nearly 1,150 feet above sea level.

DRAINAGE.

With the exception of several townships in the northeast corner, Dallas county is drained entirely by the Raccoon river and its tributaries. The Coon river, as it is commonly called, crosses the county near its southern border and is formed by the confluence of the North, Middle and South Raccoon rivers. A portion of the courses of all three of these streams lies within the area. The north branch enters it near the northwest corner, flows east for five or six miles and then turning, takes a general southerly course through the central part of the county until it joins the main stream at Van Meter. About two and one-half miles from the west county line, in Union township, the Middle Raccoon empties into the South Raccoon from the north, between eight and nine miles of its course falling within the limits of the county. The principal tributaries of the Raccoon are Mosquito and Panther creeks, which enter from the north, and Bulger and Bear creeks flowing in from the south. East of the North Raccoon there are two small tributaries, Sugar and Johnson creeks, which drain Boone and part of Van Meter townships. The valley of the former stream is marked by a well developed alluvial plain nearly one quarter of a mile wide and extending up the stream over a mile from the Raccoon valley. Mosquito and Panther creeks have courses nearly parallel to the North Raccoon, namely, a little east of south, and like the latter stream they have very few branches. In some portions of their courses these three streams are not more than three or four miles apart.

Bear creek drains portions of Union and Adams townships

and enters the Raccoon nearly opposite the mouth of Panther creek. Bulger creek enters Adams township from the south, and flowing north and east drains a portion of Adams and Van Meter townships. It flows through a rather broad valley with gentle slopes and has cut its channel well into the Missourian limestone and into the shales and sandstones of the Des Moines stage. Walnut creek, though its course lies mostly in Polk county, has its source in, and drains, Walnut township.

Through the extreme northeast corner of the county the Des Moines river has cut a narrow trench fully 140 feet deep. Beaver creek, a tributary of the Des Moines, drains part of the region between that stream and the North Raccoon. It has a broad and shallow valley, bounded in some parts by low bluffs twenty-five to thirty feet high, while in other portions of its course the bottoms merge into the higher land on either side.

Concerning the origin of the present drainage system of Dallas county it may be said that some of the streams evidently flow in preglacial channels, others in valleys formed since the advent of the ice. To the former class belong apparently the Raccoon river (including the South and Middle Raccoon) and its two tributaries from the south, Bear and Bulger creeks. All these streams have well developed valleys with rock walls capped by drift. The Raccoon, as already stated, has along a large portion of its course a broad flood plain which of itself would signify a valley of considerable age. At various points along all three streams the Kansan drift and loess are seen to follow down the sides of the valleys and also to occupy the bottom. These streams flow in valleys excavated in the coal measures probably just previous to the ice invasion. Upon the disappearance of the ice sheet these preglacial valleys were left filled with drift which upon settling would leave shallow depressions or swales in the surface. These would then naturally become channels for the present streams, which belong therefore to the class of resurrected rivers. The remainder of the streams of the county appear

to be postglacial in age, with the possible exception of the North Raccoon, which is, at least in the lower part of its course, probably preglacial. For several miles above its confluence with the main stream it has a very broad valley with an extensive flood plain, and the sides are composed, in part at least, of rock. At Adel the valley again broadens out and is bordered by rather low bluffs.

The Des Moines river, with its narrow and steep-sided valley, bears evidence of being postglacial in age, and the same may be said of Beaver, Mosquito and Panther creeks. Their channels are excavated almost wholly in drift and are evidently of comparatively recent origin.

STRATIGRAPHY.

General Relations of Strata.

Two great systems of strata are represented in Dallas county, the Carboniferous and Pleistocene. The loose deposits belonging to the latter system are made up of clay, sand and gravel, and cover the indurated rocks to the depth of 100 feet and more. At no place are the indurated rocks exposed except along streams. The Upper Carboniferous beds are divided into an upper and lower division. The strata of the Upper or Missourian stage occur only in the southwestern corner of the area, the larger part of the county being covered by the beds of the Des Moines stage.

The Pleistocene deposits are also divisible into an older and newer drift. The former or Kansan drift with its covering of loess appears only to the south, since over the greater portion of the county it is itself covered by the younger Wisconsin till. The following table will show the relations of the strata.

Synoptical Table of Formations.

GROUP.	SYSTEM.	SERIES.	STAGE.
Cenozoic.	Pleistocene or Quaternary.	Recent.	Alluvial.
		Glacial.	Wisconsin
			Iowan.
			Kansan.
Paleozoic.	Carboniferous.	Upper Carboniferous or Pennsylvanian.	Missourian.
			Des Moines.

STANDARD SECTIONS.

The sections which follow are given with the view of showing the general characteristics of the coal measures as they occur within the county. The best exposures are found along the Raccoon river, and these are described first.

In a small ravine on the south side of the valley and about one and a half miles from the Polk county line (Tp. 78 N., R. XXVI W., Sec. 35, Nw. qr.) the following section occurs.

SECTION I.

		FEET.	INCHES.
7.	Drift		
6.	Shales, black		8
5.	Shales, gray, sandy below	2	
4.	Sandstone	4	
3.	Shales	6	
2.	Limestone, dark blue, fossiliferous, in three layers separated by marly partings	2	4
1.	Shales, exposed	2	

The limestone layers with marly partings (No. 2) are doubtless the same as those found in the Commerce section* about three miles to the northeast.

* Iowa Geol. Surv., Vol. I, p. 97. Des Moines, 1893.

At Booneville the following beds are found outcropping in the bluff.

II. BOONEVILLE SECTION.

		FEET.	INCHES.
14.	Drift, overlain by loess	30	
13.	Sandstone	10	
12.	Shale, black, fissile	1	
11.	Shales, gray and red	10	
10.	Shales, black	1	
9.	Shales, gray	3	
8.	Coal		10
7.	Shales, gray	9	
6.	Limestone, fragmental, fossiliferous	2	
5.	Shales, gray	13	
4.	Limestone	2	
3.	Shales	16	
2.	Sandstone		3
1.	Unexposed to river	20	

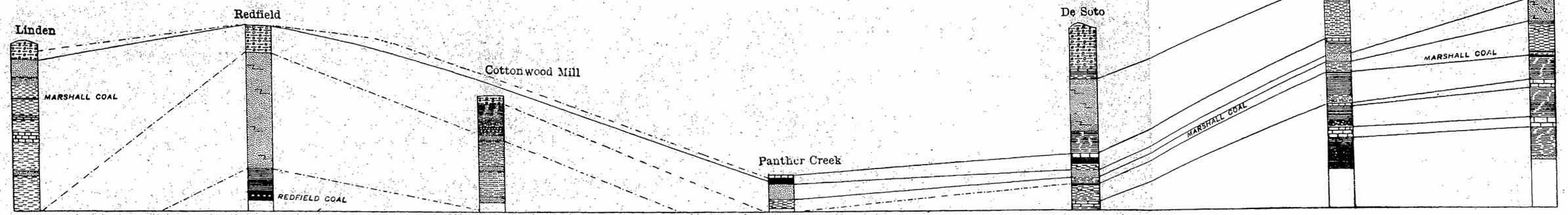
The two limestones (Nos. 4 and 6) outcrop across the river from Booneville, in section 32, where they are well exposed. At Booneville only the upper one appears. It carries numerous fossils, among which *Productus muricatus* and *Productus cora* are common.

The limestone bands of the previous section would be carried by their dip below the river level at this point and therefore fall below the base of the Booneville section.

In the bluff on the south side of the river one mile east of Van Meter (Tp. 78 N., R. XXVII W., Sec. 26, Nw. qr.) and in a ravine near the river a good section is exposed.

III. VAN METER SECTION.

		FEET.	INCHES.
17.	Drift		
16.	Sandstone, soft, gray with yellow mica	8	
15.	Shales, sandy, gray	15	
14.	Limestone, fossiliferous, compact	1	2
13.	Shales, bituminous, coaly below	1	4
12.	Shales, gray	4	
11.	Sandstone, heavily bedded, with lepidodendrons	4	
10.	Shales, sandy above	6	
9.	Coal		6



SECTION ALONG RACCOON RIVER IN DALLAS COUNTY.

		FEET.	INCHES.
8.	Shales, gray and red	12	
7.	Limestone, gray	1	
6.	Shales, gray	8	
5.	Shales, bituminous	2	
4.	Limestone, fragmentary	4	
3.	Shales, blue	6	
2.	Shales, bituminous, with concretionary layers above	2	
1.	Shales, blue, exposed	5	

The upper limestone (No. 14) carries many of the common coal measure fossils, including *Axophyllum rude*, *Productus costatus*, *Productus longispinus*, *Athyris subtilita*, *Spirifer cameratus* and corals. The lower limestone (No. 4) outcrops at several points along the railroad west of town. Number 7 is not well exposed at Van Meter but occurs on either side at Booneville and De Soto. In the high bluff at the mouth of Bulger creek a nine-foot ledge of hard and heavily bedded sandstone has been quarried. This bed is evidently the same as No. 11 of the above section, the sandstone having become thicker toward the west. The fossiliferous limestone (No. 14) near the top of the exposure has been traced in the field into a similar bed in Madison county, and it is known to occur also in Guthrie county. It forms one of the best marked horizons in the entire region. The limestone is always accompanied by the same succession of strata which occurs in the following order:

Limestone.
Black bituminous shales with coaly layer.
Gray shales.
Sandstone.
Gray shales.
Coal.

The limestone is not found at Booneville, the topmost bed exposed at that point being the underlying sandstone (No. 11 of Van Meter section).

The next exposure met with is at the mill, about four miles above Van Meter (Tp. 78 N., R. XXVII W., Sec. 18, Nw. qr.).

IV. VAN METER'S MILL SECTION.

		FEET.	INCHES.
8.	Drift	2	
7.	Shales, with vegetable material partially altered into coal	2	6
6.	Sandstone, buff, ferruginous above, in three ledges, shaly below, with plant stems	8	2
5.	Shales, gray	3	
4.	Coal		7
3.	Shales, gray	8	
2.	Limestone, blue very compact, fossiliferous, heavily bedded	2	7
1.	Shales, gray and red, exposed	12	

The six-inch coal seam (No. 4) is the Marshall coal of White and is the same vein as No. 7 of the Van Meter section. At both places there is a sandstone above the coal and a limestone below, each separated from the vein by shales.

At De Soto, two miles south of the above locality, a section is expose along Bulger creek, which at this point has cut into the bluff for a distance of nearly half a mile, furnishing an excellent outcrop.

V. DE SOTO SECTION.

		FEET	INCHES.
14.	Drift		
13.	Limestone, gray fossiliferous	1	
12.	Shales, variegated	2	
11.	Sandstone, soft, buff, shaly in part	24	
10.	Shales, gray, lower part ferruginous	10	
9.	Limestone, blue, compact, fossiliferous	1	9
8.	Shale, gray		4
7.	Shale, black, carbonaceous		10
6.	Clay	1	
5.	Sandstone, hard and compact above, thin bedded and shaly below, contains plant remains	6	6
4.	Shales, gray	2	
3.	Coal		8
2.	Clay shales, with lime nodules and much iron at one horizon	7	
1.	Limestone, fragmentary	2	

The most common fossil in the limestones of this section is, as usual, *Athyris subtilita.* It will be noted that the lower

beds (Nos. 1 and 6) are the same as those exposed along the Raccoon, two miles to the north. The strata here have a very perceptible westward dip, amounting to nearly forty feet to the mile. The sandstone (No. 5) has a hard eight-inch layer above and is filled with carbonized plant stems.

The next good exposures along the Raccoon river is on the north bank of that stream at the mouth of Panther creek (Tp. 78 N., R. XXVIII W., Sec. 16, Nw. qr.) where the following section occurs.

VI. PANTHER CREEK SECTION.

		FEET.	INCHES.
6.	Limestone, blue, compact, fossiliferous	1	5
5.	Shale, coaly	1	8
4.	Shale, yellow, sandy, with plant remains	1	
3.	Sandstone, hard, shaly above	6	
2.	Shale, gray, somewhat sandy	4	
1.	Unexposed to river	2	

The beds exposed at this place agree well with Nos. 6–10 of the De Soto section, and they may safely be correlated with those beds.

A short distance below Cottonwood mill (Tp. 78 N., R. XXIX W., Sec. 2, Ne. qr.) about fifty feet of strata are exposed in the bluff on the north side of the river.

VII. COTTONWOOD MILL SECTION.

		FEET.	INCHES.
11.	Drift	3	
10.	Shales, sandy, buff	10	
9.	Sandstone, yellow		6
8.	Shales, sandy, buff	1	
7.	Shales, blue	1	
6.	Sandstone, yellow, soft	3	
5.	Shales, sandy, buff and gray	10	
4.	Sandstone, soft, gray	3	
3.	Shales, sandy, blue	12	
2.	Sandstone, yellow	1	
1.	Shales, sandy	4	

There is a marked difference between the character of the beds of this section and those previously described. The limestone bands as well as the coal seams or bituminous shales

are entirely wanting and the shales are all more or less sandy. The entire section might not incorrectly be described as composed of sandstones which are shaly in places. There is great variation in the thickness of some members of the above section, the more heavily bedded sandstones thickening at one point and thinning out or disappearing entirely at another, and all within a distance of not more than 180 feet.

The sudden change in the character of the strata at this point is to be accounted for by the presence of an anticline whose axis extends approximately northeast and southwest. This gentle fold brings to the surface the lower beds of the Des Moines stage. Further evidence relating to the presence of a low anticline in this region will be discussed in another place in this report. Massive sandstones are exposed at numerous points along the river from the bend at Cottonwood mill to the mouth of the Middle Raccoon and up that stream as far as Redfield, at which point the sandstone again disappears. In the bluff opposite the latter town is exposed the following section.

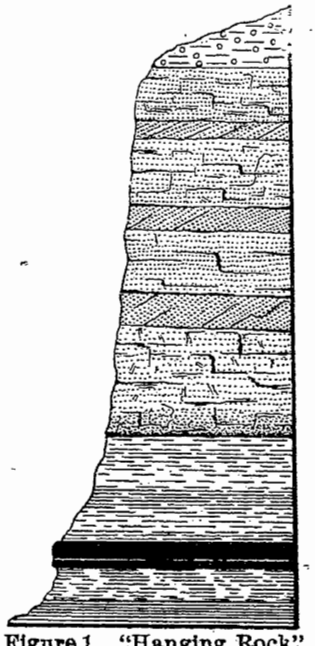


Figure 1. "Hanging Rock" section. Redfield.

VIII. REDFIELD SECTION.

		FEET.	INCHES.
7.	Drift	10	
6.	Sandstone, massive, rather fine grained, buff to dark brown in color	50	
5.	Shales, ash color to drab, somewhat sandy in places	10	
4.	Coal	2	
3.	Clay, drab color, fossiliferous		1
2.	Coal	1	
1.	Shale, somewhat sandy, drab, in places carbonaceous, exposed	5	

The massive bed of sandstone, wherever it outcrops, forms a steep escarpment, such as that seen in the bluff opposite the

FIG. 1. Hanging rock, coal measure sandstone, Redfield.

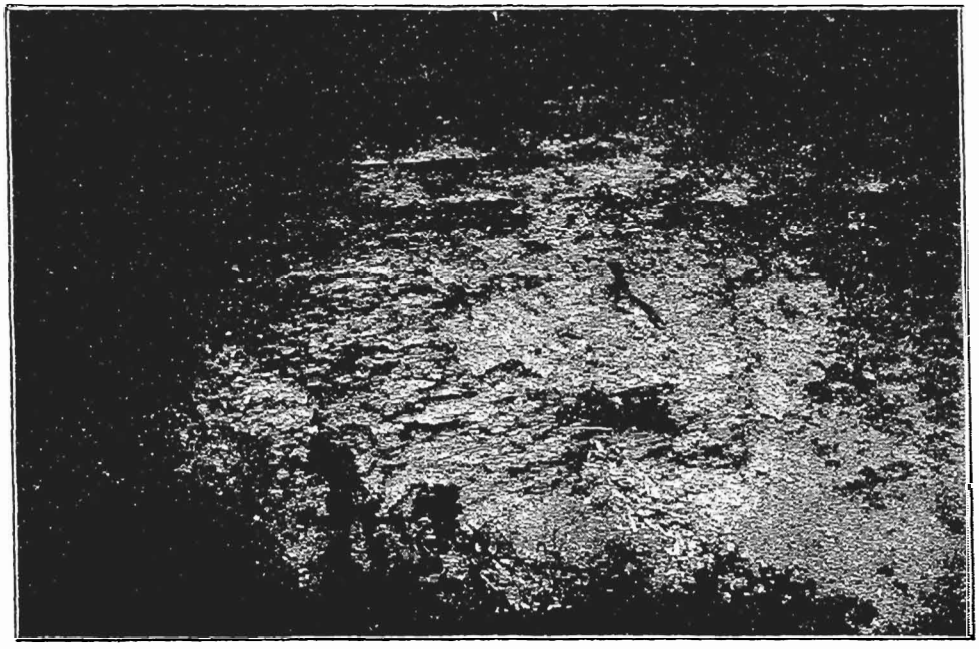


FIG. 2. Cottonwood mill sandstone, showing cross-bedding,

picnic grounds just south of Redfield, at what is called the "Hanging Rock." The stone is rather soft, and forms a continuous mass, undivided by bedding planes. Between two and three miles above Redfield, not far from the mouth of Mosquito creek, and also near the county line, in section 6 of Union township, there are several exposures, from which St. John* constructed the following section.

IX. COUNTY LINE SECTION.

		FEET.	INCHES.
27.	Black shale, overlaid by impure limestone....		
26.	Sandstone, shaly, yellow.....	5	
25.	Clays, sandy, laminated.....	4	6
24.	Marshall coal, impure		6
23.	Shales, yellow, blue	5	
22.	Limestone, compact, heavy bedded, buff.....	2	
21.	Clays, blue, with nodular band.....	4	
20.	Limestone, blue, earthy, two thin layers.....		
19.	Clays, blue and red.....	3	6
18.	Limestone, fragmentary, impure.....	4	
17.	Clays, blue.....	2	6
16.	Shales, alternating red and blue.....	55	
15.	Sandstone, gray, shaly, micaceous.....	2	
14.	Shales, alternating red, blue and yellow.....	44.	
13.	Clays, blue, gray, sandy above.....	8	6
12.	Sandstone, soft, heavily bedded.....	2	6
11.	Shales, blue.....	16	
10.	Sandstone, soft, red, gray.....	3	
9.	Clays, red, blue, nodular.....	10	
8.	Limestone, clayey, four layers, clay partings, very fossiliferous.....	8	
7.	Shales, light gray.....	5–10	
6.	Shales, calcareous.....		6–10
5.	Shales, blue and brown.....	1–8	
4.	Limestone, impure, nodular, sometimes wanting.....		8
3.	Shales, black.....	1½ to 3	
2.	Panora coal		4–8
1.	Clays, blue and ash color, exposed.....		3

It will be seen from the above that the massive sandstone has disappeared, and is here replaced by beds similar to those found east of the anticline at De Soto and Van Meter.

*Geol. of Iowa, Vol. II, p. 28. Des Moines, 1870.

The last exposure within the county along the Middle Raccoon is at the old mill south of Linden, in Tp. 79 N., R. XXIX W., Sec. 30, Se. qr., where the following section appears.

X. LINDEN SECTION.

		FEET.	INCHES.
12.	Drift		
11.	Sandstone, buff, shaly in part	7	
10.	Shales, gray, sandy above	8	
9.	Coal		6
8.	Shales, gray	6	
7.	Limestone, gray, very fossiliferous	1	
6.	Shales, gray	6	
5.	Limestone, buff, eighteen-inch layer below, brecciated and yellow above	4	
4.	Shales, gray	12	
3.	Sandstone, gray	2	
2.	Shales, gray	13	
1.	Clay shales, red, exposed to river	2	

From the fossiliferous limestone, No. 7 of the above section, *Productus cora*, *Productus nebrascensis*, *Productus muricatus* and *Athyris subtilita* were collected. The coal vein is forty-six feet above the river, and is the Marshall coal of White. The beds here exposed correspond closely with those in the upper part of section 9 (Nos. 14–26), and they are doubtless the same. Near the top of the hill, about one-half mile south of the above exposure, there is a second vein of coal which has been mined for several years. The seam is from sixteen to eighteen inches thick, and lies sixty feet above the coal vein of the last section. This is called by White the Lonsdale coal.

There are few exposures within the county north of the Raccoon river. Aside from several outcrops along small tributaries of the North Raccoon near Adel, and a few other exposures along the Des Moines river in Des Moines township, our knowledge of the indurated rocks beneath the drift is derived largely from the records of wells and shafts of coal mines. The following section taken from White* gives a

*Geology of Iowa, Vol. II, pp. 36-37. Des Moines, 1870.

general idea of the character of the beds as exposed near Adel, along Hickory and Miller's branches.

XI. ADEL SECTION.

		FEET.	INCHES.
14.	Limestone, buff, fragmentary, earthy		6
13.	Shales, black, carbonaceous	1	
12.	Shales, blue, arenaceous	2	
11.	Sandstone, gray and red, with arenaceous, shaly partings	8	
10.	Clays, yellow and blue, arenaceous above	2 to 4	6
9.	Coal (Marshall)		1-4
8.	Shales, blue and yellow, containing ferruginous nodules, arenaceous above	10 to 12	
7.	Limestone, light buff, soft, contains the following species: *Rhynchonella uta*, *Derbya crassa*, *Chonetes mesoloba*, *Productus muricatus*, *Productus longispinus*, (rare) *Athyris subtilita*, *Spirifer cameratus* and others	2	
6.	Clay, variegated	12	
5.	Shales, black, carbonaceous	1	
4.	Shales, gray, with numerous fossils	1	
3.	Shales, blue	4	
2.	Limestone, rather compact, irregularly bedded, earthy, shaly above	4 to 5	
1.	Clays, blue, exposed	1	

Two miles south of Waukee, in section 6 of Boone township, an outcrop on Sugar creek shows the following beds.

XII. SUGAR CREEK SECTION.

		FEET.	INCHES.
9.	Drift	5	
8.	Shales, gray	4	
7.	Limestone, blue, compact, fossiliferous	1	
6.	Shale, black, carbonaceous, coaly in part	2	6
5.	Shales, gray		8
4.	Sandstone, gray, with plant stems	1	
3.	Shales, gray	4	
2.	Coal (Marshall)		3
1.	Shales, gray	1	

The above section corresponds well with the upper part (Nos. 8 to 15) of the Van Meter section. The three-inch vein of coal (No. 2) is the Marshall seam, and No. 7 is the upper limestone band. Sugar creek has cut its channel through

these beds, exposing them at various points along its course. Stone has for many years been quarried at the exposure just described, Nos. 4 and 7 being used.

In the extreme northeast corner of the county the Des Moines river has cut a deep and narrow trench down into the coal measures, but the sides are now overgrown with vegetation, and outcrops are few. Just above the bridge and in the bluff on the west side of the valley the following section occurs.

XIII. HIGH BRIDGE SECTION.

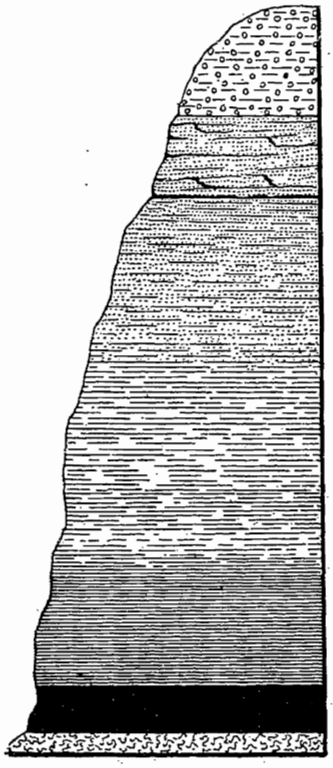


Figure 2. Bluff near Pritchard drift, High Bridge.

		FEET.	INCHES.
5.	Drift	4	
4.	Sandstone, thinly bedded	3	
3.	Shale, light colored, with sandy concretions, grading downward into bituminous	18	
2.	Coal	1	8
1.	Fire clay, exposed		4

The shaft of a coal mine at Dawson, a town on the Chicago, Milwaukee & St. Paul railway, furnished the following record of strata.

XIV. DAWSON SECTION.

		FEET.	INCHES.
11.	Soil	3	
10.	Yellow clay	13	
9.	Blue clay	64	6
8.	"Slate" gray	2	6

		FEET.	INCHES.
7.	Coal	1	10
6.	Fire clay	4	
5.	Sandstone	8	
4.	"Slate," gray	10	
3.	"Slate," black, oily	13	
2.	Coal	3	
1.	Fire clay	4	

Forty feet below the three-foot vein (No. 2) a third seam is reported with a thickness of 3½ to 4 feet.

In the southwestern corner of the county, in Union and Adams townships, the Missourian limestone is exposed at several points. The rock was at one time quarried quite extensively in section 28 of Adams township, and the section at these old quarries (Tp. 78 N., R. XXVIII W., Sec. 28, Sw. qr.) is as follows:

SECTION XV.

		FEET.	INCHES.
15.	Drift		
14.	Limestone, thin bedded, sandy, exposed	6	
13.	Unexposed	8	
12.	Limestone	4	
11.	Shales, gray, calcareous		8
10.	Limestone		9
9.	Shales, gray	4	
8.	Limestone, fragmental	2	6
7.	Shales, with nodules of iron	2	
6.	Shales, red, jointed	10	
5.	Sandstone, soft, shaly, exposed	3	
4.	Unexposed	40	
3.	Limestone	3	
2.	Shales, coaly	1	
1.	Shales, gray, exposed to stream	2	

The nine-inch ledge (No. 10) was the lowest rock removed. The quarry is located well up toward the top of the hill and the limestone does not appear to extend much farther to the east and north of this point. The base of the section (Nos. 1 to 3) is exposed along the small stream just west of the quarry.

Along the east and west road in section 32, and about one-half mile south of the above outcrops, the following beds are exposed.

SECTION XVI.

		FEET.	INCHES.
6.	Geest	1	6
5.	Limestones	11	
4.	Shale, gray	2	6
3.	Shale, coaly	2	
2.	Limestone		6
1.	Shales, gray, not well exposed	33	

The shales at the base of the above section contain several limestone bands near their lower part.

About one mile northwest of the old quarries in Tp. 78 N., R. XXVIII W., Sec. 20, Se. qr. an exposure along Bear creek showed no limestone at that point except a two-foot layer about eight feet above the creek. This section is here given for comparison with the two previous ones, and to show the change in the character of the deposits near the border of the limestone area.

SECTION XVII.

		FEET.	INCHES.
8.	Sandstone, gray	2	
7.	Shales, red and gray	8	
6.	Shales, gray, very sandy below	19	
5.	Sandstone, soft	12	
4.	Shales gray	1	
3.	Limestone, impure, earthy, gray	2	
2.	Shales, gray	2	6
1.	Shales, sandy above, exposed to creek	6	

Another exposure of the Missourian limestone is found at the quarries on Bear creek in sections 22 and 23 of Union township. At Brown's quarry (Tp. 78 N., R. XXIX W., Sec. 22, Se. qr.) the following beds were observed:

XVIII. BROWN QUARRY SECTION.

		FEET.	INCHES.
8.	Geest	1	3
7.	Limestone	10	
6.	Unexposed, probably shale	6	
5.	Shale, black, fissile		6
4.	Limestone, blue, compact, exposed		8
3.	Unexposed	25	
2.	Limestone, impure and fragmental below	3	
1.	Shale, calcareous and ferruginous, exposed	3	

The rock here quarried is No. 7, which is a blue to buff, compact and evenly bedded limestone. The individual ledges vary in thickness from eight to ten inches and are separated by marly partings three to four inches thick. At certain horizons there is an abundance of flint nodules which have a linear arrangement in rather well defined bands.

This limestone is also exposed in the southwest quarter of section 35 of Union township, just north of the Madison county line. It has a thickness at this place of twelve to fourteen feet and is underlain by blue shales. The rock has been quarried here for a number of years, the upper eight feet being removed.

WELL RECORDS.

Our knowledge of the character of the deeper strata of Dallas county is derived from the records of several wells which have been sunk through the heavy superficial deposits and penetrate to a greater or less depth the underlying coal measures.

The Marshall artesian well is located on the south bank of the South Raccoon in Tp. 78, N., R. XXIX W., Sec. 7, Se. qr. The record as given by Mr. Marshall is as follows.

		FEET.
5.	Shales, red and blue	65
4.	Sandstone	6
3.	Shale and slate, bituminous	200
2.	Sandstone, white	20
1.	Limestone (Saint Louis) penetrated	8

The well is located at the base of the bluff and no drift is here present. The well is thus entirely in the coal measures except the lower eight feet, which is in the Saint Louis limestone. The latter was reached at a depth of 291 feet.

A deep well put down in section 4 of Lincoln township furnished the following record.

		FEET.	INCHES.
6.	Yellow clay	40	
5.	Blue clay	50	
4.	Coal		8
3.	Shales, gray	60	
2.	Shales, black, carbonaceous	150	
1.	Sandstone	7	

The most noticeable feature about this record, as in the previous one, is the great thickness of the shales penetrated, 200 feet and more, without entercountering any sandstone or limestone beds or coal veins. There is a marked contrast in this respect between the records just given and that of a well drilled one mile southwest of De Soto, in section 25 of Adams township. The record of this well is as follows.

		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

		FEET.
46.	"Rock," hard	4
45.	Shale	4
44.	Sandstone	2
43.	"Rock," hard, white	19
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

The first 57 feet are through drift, and the coal measures were penetrated to a depth of 321 feet without reaching their base. Four veins of coal were encountered—namely, 1 foot at a depth of 98 feet; 2 feet at a depth of 239 feet; 1½ feet at 255 feet, and 3 feet at 350 feet below the surface.

The "rock" of this record is probably a hard shale or slate.

GEOLOGICAL FORMATIONS.

Upper Carboniferous.

DES MOINES.

The indurated rocks of Dallas county, with the exception of those occupying the small area in the southwest corner, belong entirely to the Des Moines stage of the Upper Carboniferous or Pennsylvanian series. The beds are made up of shales and sandstones, with occasional bands of limestone and veins of coal. The great bulk of the formation is composed of shales. These exhibit great variation in composition, and all varieties, from pure clay shales to sandy, calcareous, and carbonaceous shales are represented. Not infrequently the shales grow more and more sandy until they grade into a true sandstone.

The color of these shales is commonly gray or blue, though red and variegated shales may occur, as do also the black, carbonaceous varieties. The latter, as shown by well records, may reach a great thickness. There is one characteristic feature of the beds of this stage which strikes the observer at once, and that is the rapid change in the character of the rocks, both vertically and laterally. Shales are replaced by sandstones and sandstones give way to shales. Individual beds when traced any great distance are very liable to thin out and disappear entirely, or they may be found to increase in thickness from a few inches to many feet. This rapid variation in the character of the beds is well shown in two exposures, not more than twenty rods apart, found near the mouth of a small stream emptying into the Raccoon river in section

12 of Union township (Tp. 78 N., R. XXIX W., Sec. 12, Sw. qr.). The first of this section is as follows:

		FEET.	INCHES.
8.	Drift	12	
7.	Limestone, gray, sandy	3	
6.	Clay shales, gray	6	
5.	Limestone, blue		6
4.	Marl, gray, fossiliferous	1	
3.	Shales, bituminous, coal above	1	3
2.	Limestone, very fossiliferous		4
1.	Clay shales, gray, exposed to creek	2	

The second section, a short distance from the above, shows the following beds.

		FEET.	INCHES.
5.	Drift	10	
4.	Sandstone, yellow, ferruginous, showing cross bedding	7	
3.	Clay shales, blue	4	
2.	Coal		2
1.	Clay shales, exposed to stream	5	

The six-inch limestone (No. 5) of the first section thins out rapidly and disappears within a distance of ten feet. It is exceptional to find the limestone bands thus pinching out, since they are as a rule quite persistent and continuous over considerable areas.

Next to the shales in abundance are the sandstones. These may be somewhat soft and shaly, when they can be considered as sandy shales, or they may occur in beds varying in thickness from four inches to many feet. Commonly the ledges are not more than four or five feet thick. Their color is usually a gray or buff, though yellow, blue and other shades are not infrequent. In the vicinity of Redfield these sandstones are especially abundant. They are exposed along the Raccoon river for some five miles, extending from half a mile below Cottonwood Mill to Redfield. At the latter town the sandstone has a thickness of nearly fifty feet. It here forms a massive bed undivided by well marked bedding planes and makes a steep escarpment for some distance along the river. The limestone bands vary in thickness from a few inches to

three and four feet, though they rarely exceed two feet. As has already been stated these bands are very persistent and can be traced from one township to another or even across entire counties. They are for this reason especially valuable in correlating the beds of different sections and particularly the coal veins. Three or four well marked beds of limestone are exposed in the different outcrops within the county, separated by clay shales and sandstones.

One of these limestone bands has already been mentioned as forming a well defined horizon, not only in Dallas, but also in Madison and Guthrie counties. It is exposed along the Raccoon river at Van Meter, De Soto and at the mouth of Panther creek. At De Soto there is a thin bed of limestone about 40 feet above it. Two limestone layers occur below this horizon. This persistent limestone layer is No. 14 of the general section.

The coal veins, a number of which occur in the coal measures of the county, will be discussed elsewhere in this report.

The following general section shows the character and succession of the beds of the Des Moines stage as they appear in Dallas county:

GENERAL SECTION OF DES MOINES BEDS.

		FEET.
18.	Limestone, gray	1 to 4
17.	Shales, gray and red	2 to 8
16.	Sandstone, buff, soft, somewhat shaly	8 to 20
15.	Shales, gray, arenaceous, ferruginous below	10 to 12
14.	Limestone, blue, impure	1 to 2
13.	Shales, bituminous, coaly in part, separated from overlying limestone by gray shale band	1 to 2½
12.	Shales, gray	1 to 4
11.	Sandstone, usually hard, heavily bedded above, with lepidodendrons, imperfect plant remains, and charcoal fragments	1 to 10
10.	Shales, gray, arenaceous, above	4 to 6
9.	Coal (Marshall)	½
8.	Shales, gray, with nodular bands, ferruginous	6 to 12
7.	Limestone, fragmentary, very fossiliferous	1 to 2½
6.	Shales, blue and red variegated	6 to 15

		FEET.
5.	Limestone, gray to buff, fragmentary	2 to 4
4.	Shales, gray	12
3.	Sandstone	1 to 2
2.	Shales, gray and red in alternating bands	20 to 30
1.	Sandy shales and sandstones	60
	Redfield coal	

Thickness.—The thickness of the Des Moines beds in Dallas county can be determined with a good degree of certainty from several wells drilled in the southern part of the area. In the Marshall artesian well the Saint Louis limestone at the base of the coal measures was struck at a depth of 291 feet, or about 503 feet, A. T. As this well is located in the deep valley of the Raccoon the height of the coal measures in the uplands above must be added. This would give a thickness to the Des Moines beds of over 400 feet. The well is located only a mile or two north of the border of the Missourian limestone and the distance from the base of the latter to the Saint Louis may be placed at less than 500 feet and it probably does not exceed 450 feet.

In the Redfield well the limestone at the base of the coal measures was struck at about the same depth as in the Marshall well and would indicate a thickness of about 400 feet. The well drilled near De Soto went through 321 feet of coal measures without reaching their base, and at Van Meter coal is mined at a depth of 380 feet from the top of the coal measures at that point. At Des Moines the record of the Greenwood Park well shows that the beds have a thickness of 484 feet. At Boone they are only 260 feet thick.*

The coal measures were divided by White into the Upper, Middle and Lower, and all three divisions were mentioned† as occurring in Dallas county, the middle division being especially described from the outcrops along the Raccoon river. The present Survey has recognized only two divisions of the Upper Carboniferous, namely, the Missourian and the Des

*Iowa Geol. Surv., vol. V, p. 198.

†Geol. of Iowa, vol. II, p. 18. Des Moines, 1870.

Moines. The latter stage, or series as Keyes now regards it,* comprises the Middle and Lower subdivisions of White.

Bringing together all the knowledge of the Des Moines formation secured from well records, prospect holes and natural exposures the general succession in Dallas county is about as follows:

(1) At the base, and directly overlying the Saint Louis, there are between 100 and 200 feet of hales and sandstones. (2) These are followed by a shale and limestone member and (3) this in turn is covered by a shaly member. This last is not well developed in Dallas, but is quite well marked in Madison county, where it is 80 feet thick. In the southern part of the state a formation, probably the same as the middle limestone member, occurs and has been called the Appanoose formation.†

As suggested by Keyes‡ the succession is much the same in Iowa as in Kansas and Missouri, where we have the Cherokee shales, Henrietta limestone and Pleasanton shales.

While these divisions cannot be separated in mapping in Dallas, there appears to be the same general succession as further south and west.

MISSOURIAN.

The beds of this stage are confined, as already stated, to the southwestern part of the county, where they underlie a portion of Adams and Union townships. They are well exposed at several points where the limestone has been quarried quite extensively. The rock is blue or buff in color, very compact and non-crystalline. The individual ledges are from eight to ten inches thick, and are separated by marly partings. At certain horizons bands of flint nodules appear. From eight to twelve feet of these limestones are exposed at the quarries, and they apparently represent the base of the Missourian, and are thus the Winterset limestone of White§

* Amer. Geol., vol. XVIII, pp. 22-28, 1896.

† Bain: Iowa Geol. Surv., vol. V, p, 378.

‡ Proc. Iowa Acad. Sci., 1896, vol. IV, p. 22-25, 1897.

§ Geol. of Iowa, White. 1870. Vol. I, p. 246, 1870.

or the Earlham beds of the Bethany limestone, as more recently defined.*

Below the quarry limestone there are shales with occasional thin bands of limestone. These shales with intercallated limestones probably represent a period of oscillation of the shore line, when shallow water conditions favorable for the deposition of the Des Moines shales were gradually changing to deep sea conditions which allowed the formation of the Missourian limestone. If this were the case, it would be difficult to tell in the field just where the one formation ends and the other begins.

The following is a general section of the Missourian beds as they occur in Dallas county.

GENERAL SECTION OF MISSOURIAN BEDS.

		FEET.	INCHES.
6.	Limestone, blue to buff, compact, evenly bedded	10 to 14	
5.	Shale	6	
4.	Shale, black, fissile		6
3.	Limestone, blue-black, compact, exposed		6
2.	Shales	25	
1.	Limestone, impure, fragmental	6	

This limestone has been traced west in southern Guthrie county to the point where it disappears under the Cretaceous.† Its eastern limits have been determined by Tilton in Madison county, and from there it has been traced south by the present writer through eastern Clarke and Decatur counties to the Missouri line. The Winterset limestone of White is the equivalent of the Bethany Falls limestone‡ of the latter state and of the Erie limestone§ of Kansas, since their continuity has been established in the field. Tilton and Bain‖ retain the name Winterset for the third limestone member of the Bethany formation.

*Geol. of Madison county, Iowa Geol. Surv., vol. VII, 514.

†Geol. of Guthrie County. Iowa Geol. Surv, vol. VII. p. 1.

‡Trans. St. Louis, Acad. Sci., vol. II, 311, 144. 1832. Mo. Geol. Surv., Iron Ore and Coal Fields, pt. ii, p. 77 *et seq.* 1873.

§Univ. Geol. Surv. Kansas, vol. I, p. 154. 1896.

‖Geol. of Madison County. Iowa Geol. Surv., vol. VII, 517.

Pleistocene.

The indurated rocks of Dallas county are concealed beneath a heavy covering of drift. This deposit of clay, sand and gravel, left by the ancient ice sheets, everywhere conceals from view the underlying coal measures, except at certain points along the streamways where the superficial materials have been removed.

The greater portion of the county, as already shown, lies within the limits of the Wisconsin lobe, which extended as far south as the Raccoon river.

KANSAN DRIFT.

The oldest drift exposed anywhere within the county is the Kansan. In many parts of the state a still older drift is known to occur below it. It is exposed at Afton Junction, Union county, about thirty miles south, and evidence of it has also been found in Polk county and elsewhere. It is not improbable that this older drift occurs also in Dallas county, but any evidence of such an occurrence is wanting. The Kansan drift covers the southern half of Boone, Van Meter and Adams townships, the greater portion of Union and the southwest corner of Linn. Wherever exposed in road cuts or along streams it has a dull red or brownish appearance, due to the high state of oxidation near the surface. This oxidized condition is a marked characteristic of the deposit. When a considerable thickness of the till is exposed it is noticeable that at a depth of thirty to forty feet below the surface the color changes to a dark blue. This change is well exhibited in a high bluff exposure on the south side of the Raccoon in section 14 of Adams township. The entire bluff, which is here nearly 100 feet high, is formed of Kansan drift. The upper thirty or forty feet is red and oxidized and contains quite a number of small pebbles and some sand. Below this is a compact, blue bowlder clay, quite free from pebbles, though patches of sand appear in places. Sugar

creek, in the lower portion of its course, cuts into Kansan drift, and an exposure in section 15, of Boone township, showed the following varieties of bowlders: Granite, quartzite, limestone, hornblende, gneiss, diorite, diabase, gabbro and quartz. The red quartzite was especially abundant and chert was also common. The granite bowlders and pebbles were much weathered and rotted, crumbling readily in the hand. About a mile south, in section 22, several pieces of conglomerate, resembling the Cretaceous rock of Guthrie county, were found. These fragments were probably derived from a Cretaceous area to the north, which has either been carried away by erosion or else deeply buried under the drift. The nearest known outcrop of this rock is about twenty-five miles west in Guthrie county.

Surface bowlders are not as common in connection with the Kansan drift as they are with the newer Wisconsin. This is doubtless due partly to the fact that the former is in most places covered by loess, thus concealing any bowlders that may have been upon the surface. Occasionally a good sized one is found, as in section 18 of Union township, where a red granite bowlder, twenty-five feet long and half as wide, was seen.

The Kansan drift, as already pointed out, is much cut up by streams, and the surface is well drained. The valleys in this older drift have many branches and these in turn break up into smaller ravines, forming a well developed drainage system, and showing that the forces of erosion have been active for a considerable period.

The thickness of the Kansan drift varies in different places from sixty to 125 feet and more. A well drilled about five miles southeast of Redfield, in section 24 of Union township, passed through 123 feet of drift, the upper forty-three feet being yellow, oxidized till, below which was blue clay.

LOESS.

The Kansan drift is covered in most places by a sheet of loess. As this latter deposit is not found overlying the newer or Wisconsin drift, its presence or absence furnishes a ready means of determining which of the two drift sheets are present. The loess is characterized by its homogeneous structure, the fineness of its constituents, its buff color and the absence of all pebbles and bowlders. The deposit often contains numerous lime concretions, known as loess-kindchen, and fossils may be present in greater or less abundance. The loess is considerably younger than the Kansan drift, since the latter had been eroded quite extensively before the loess was deposited over it. That it is older than the Wisconsin drift is shown by its presence beneath that drift sheet. While no instances were noted in Dallas county where this was the case, buried loess with shells has been reported in wells, and Bain* mentions a number of localities in Polk county where the Wisconsin drift overlies the loess. The loess is, therefore, intermediate in age between the Kansan and Wisconsin drift sheets, and has been referred to the Iowan.† This correlation is based partly on the fact that the loess can be traced around the southern border of the Wisconsin to Marshall county, where it comes in contact with the Iowan, but chiefly on the fact that the conditions at the end of the Wisconsin invasion were not favorable to the deposition of loess, as is shown by the gravel trains. But at the end of the Iowan invasion there was a period of loess deposition. The Iowan drift sheet and the loess found along its border are known to hold an intermediate place between the Kansan and Wisconsin, and there would seem to be good reason, therefore, for considering the loess of Dallas county to be an equivalent of the Iowan. The thickness of the deposit varies widely. In places it thins out and disappears, while at other points it is known to be from ten to twenty feet thick, if not more. In

* Iowa Geol. Surv., vol. VI, pp. 444-447. 1896.
† Bain: Iowa Geol. Surv., vol. VI, p. 461. 1896.

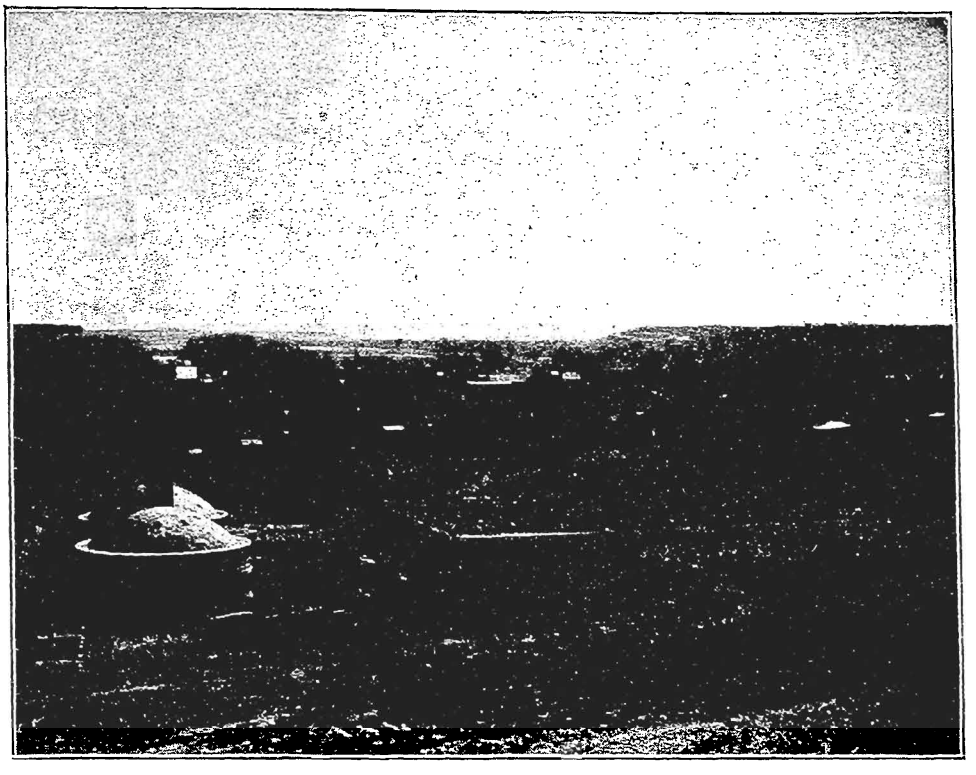


FIG. 1. Gorge of the Raccoon river cut in coal measures. Overlooking Van Meter.

FIG 2. Drift section on the Raccoon river southwest of Redfield. The open caves near the center of the picture mark the gravel horizon.

the bottom of the valley at Bear creek, in section 36 of Union township, ten feet of loess are exposed.

The best exposure, however, and one of special interest, occurs on the north side of the Raccoon, in section 7 of Union township. The section is as follows:

		FEET.	INCHES.
5.	Loess, sandy, stratified	13	
4.	Clay, with lime concretions		8
3.	Loess, sandy	6	
2.	Gravel, very ferruginous	7	
1.	Shale, gray	11	

No fossils were found in the loess. The interloessial clay contains no pebbles, but is a stiff, gray clay, similar in appearance to the clay of till. It shows little or no foreign material of any kind. The gravel underlying the loess bears evidence of considerable age, since ferrugination has gone on quite extensively and much iron is present. It contains rather a high percentage of Cretaceous material in the form of well-rounded, clear, quartz pebbles. The gravel is pre-Iowan in age, and seems to represent Kansan surface material reworked.

The most significant feature in the above section, however, is the clay interstratified with the loess. Cases of this kind are not common. An example of interloessial till is described by Todd and Bain as occurring near Sioux City.* The bowlder clay at that place contains pebbles and bowlders and differs in this respect from the South Raccoon exposure. The presence of the till in the loess is ascribed by the above writers to icebergs which, breaking off from the ice sheet, carried the till and dropped it where now found. Subsequently it was covered by loess. This theory would hardly seem to be applicable to the Dallas county region. There is no evidence of a body of water of sufficient extent and depth to float icebergs. While the presence of the clay in the loess is not easy to account for, its occurrence there, as well as the stratified appearance of the loess itself, would seem to prove beyond a

* Iowa Acad. Sci., vol. II, pp. 20-23. 1895

doubt that the materials were deposited in water. The most probable hypothesis is that the beds are secondary and represent the accumulations of side wash in the valley at the time that the river was ponded by the Wisconsin ice.

WISCONSIN DRIFT.

Much the larger portion of the county is covered by the newer or Wisconsin drift. As has already been pointed out this drift has undergone but slight erosion and the surface is for the most part flat and poorly drained. Wherever exposed the till has a fresher and less oxidized appearance than the Kansan. It is of a buff or light gray color, and its pebbles and bowlders do not show the extensive weathering exhibited by those in the older drift. Bowlders are also much more numerous over the surface of the Wisconsin, especially near the border. In the vicinity of Redfield bowlders are abundant both on the surface and also scattered through the gravel terrace at the mouth of Mosquito creek and below. Wherever excavations have been made in the terrace large numbers of good sized bowlders, a foot or more in diameter, are brought to light. Their abundance in the terrace at this point would seem to indicate that the borders of the Wisconsin ice sheet was not far distant, for they could not have been carried very far by the streams issuing from the ice front, but must have been soon deposited along with the gravel at no great distance from the border.

As already stated, there is no evidence of the Wisconsin ice having crossed the Raccoon river, except at a point two miles northwest of Redfield. On the south side of the Middle Raccoon, in section 6 of Union township, there is a thick bed of bowlders, and bowlders also cover the surface in large numbers. On the north side of the river the following section is exposed.

		FEET.
3.	Wisconsin drift	25
2.	Stratified sand and gravel, assorted drift	6
1.	Shale, black	4

IOWA GEOLOGICAL SURVEY

MAP OF THE

SUPERFICIAL DEPOSITS OF DALLAS COUNTY, IOWA.

BY

A. G. LEONARD

1898.

Scale 1/125000

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

- ALLUVIUM
- WISCONSIN DRIFT
- ASSORTED DRIFT
- IOWAN LOESS OVERLYING KANSAN DRIFT.

IOWA LITHO. CO. DES MOINES. DRAWN BY F. C. TRYE

Across the river, and only a short distance below the above exposure, another section showed the following section.

		FEET.
2.	Bowlder bed	15
1.	Shales, gray, exposed to river	15

No. 2 is composed almost wholly of good sized bowlders, with very little clay material. A large proportion of the rocks are limestone, but granite and gneiss is also quite common. While this bowlder bed cannot perhaps be said to form a true terminal moraine, it at least marks the limit of the Wisconsin ice and gives evidence that the Des Moines lobe crossed the river at this point. The bowlders were doubtless left by the ice where they now lie and were not transported by water or other agency. The river valley here shows evidence of being post-glacial and post-Wisconsin. The old valley was filled up with drift, and the river was forced to cut a new channel.

The thickness of the drift over the northern portion of the county, as shown by several well records, varies from 80 to 120 feet and it is not improbable that, in places, it reaches a greater depth.

ALLUVIUM AND TERRACES.

Many of the streams of the county are bordered by alluvial bottoms. Along the Raccoon river from Van Meter east to the county line an old flood plain is a marked feature of the landscape. It varies in width from one to two miles and extends up the North Raccoon for a considerable distance. It then narrows to about half a mile and again broadens out in the vicinity of Adel. Below Van Meter the South Raccoon is bordered along its entire course by a flood plain of varying width. The smaller streams of the county frequently have flood plains along the lower portions of their courses. Thus Sugar creek has well defined bottom lands, extending up more than a mile from where it enters the valley of the Raccoon.

Terraces.—Gravel terraces are found along the North, Middle and South Raccoon rivers, and also along the Des Moines. In the valley of the latter stream there is a well defined gravel terrace about twenty-five feet above the river. Just west of its bridge the Chicago, Milwaukee & St. Paul railroad has extensive gravel pits in this terrace. At various points along the sides of the gorge there are evidences of a higher terrace about seventy feet above the river. The latter is composed of drift and has been considerably eroded by small streams.

Along the North Raccoon a gravel terrace about twenty feet high is well developed. This is well shown just south of Adel, where the road runs over it for some distance. It is one-quarter of a mile wide at this point.

At Booneville, Van Meter and Redfield the terraces are well defined. Near Booneville two can be readily distinguished, the higher twenty feet and the other about twelve feet above the river. At Redfield and Van Meter the gravel terrace is about twenty feet above the river. As already noted, at Redfield there are numerous good sized bowlders mixed with the gravel.

The terraces owe their formation to the streams flowing from the melting ice sheet. These rivers were loaded with gravel and sand, which was carried some distance down stream and deposited. Terraces of aggradation, as defined by Salisbury,* would thus be built up. The high drift terrace along the Des Moines had a different origin and seems to mark a definite stage in the down cutting of the stream.

GEOLOGICAL STRUCTURE.

DEFORMATIONS.

The strata of the county have been for the most part but little disturbed from the nearly horizontal position which they occupied when deposited. They have a gentle dip to the southwest, but this is so slight that it is scarcely noticeable

* Ann. Rept. State Geol., N. J., 1892, 103-104. 1893.

in any single outcrop. The only marked deformation noted is in the southwestern corner of the county, in the vicinity of Redfield. The beds have here been forced into an anticline, whose axis appears to have a direction approximately north and south, though this could not be definitely determined.

This fold brings the deeper strata to the surface, and a massive sandstone and underlying coal seam outcrop near Redfield. The strata dip in either direction from the crest of the anticline. In following up the South Raccoon from Booneville, the same beds appear in the different outcrops until the bend at Cottonwood mill is reached, where a massive sandstone appears above the river, and the strata outcropping farther down the stream disappear. The same beds again appear a few miles above Redfield, along the Middle Raccoon, and are also found in Guthrie county. The same succession of strata thus appears on the east and west sides of the anticline.

An interesting outcrop is found in section 2 of Union township, about one mile south of the bridge. There is here exposed about twenty-five feet of rather soft blue or gray sandstone. The rock shows cross bedding, the bedding planes being inclined about 30° to the horizontal. Cutting these planes at an angle of nearly 25° are well developed cleavage planes. Since the planes of bedding are not very conspicuous, and hence are apt to be overlooked at first sight, these cleavage planes are easily mistaken for them. The forces that produced the pressure resulting in the development of this well marked cleavage were, perhaps, the same ones that produced the Redfield anticline, as these beds lie within the area of disturbance. Two sets of joints are also present. One set is nearly vertical, and at right angles to the face of the exposure; while the other set is approximately parallel to the face, and has an inclination of 75° or 80°.

ECONOMIC PRODUCTS.

Coal.

Dallas county ranks as one of the important coal producing counties of the state and for over thirty years this mineral fuel has been mined within its borders. Underlain as it is over nearly its entire area by the lower coal measure beds (Des Moines formation) with their numerous veins of coal, there is no reason why this industry should not reach even greater development than it has at present. Whereas now only surface seams are being worked in many places, it is very probable that by going deeper, other and thicker seams would be found which could be worked with good profit. At Van Meter, for example, two veins are mined at depths, respectively, of 285 and 305 feet, each one averaging three feet in thickness.

Coal occurs at a number of different horizons. Some of the veins outcrop along the streamways and others lie some considerable distance below the surface and are reached only by sinking shafts. They range in thickness from a few inches to three feet, and in several instances four-foot veins are reported.

The lowest horizon from which coal is mined within the county is at Van Meter, where the lower vein can be but little more than 100 feet above the Saint Louis limestone, and is therefore well toward the base of the Des Moines beds. The seam lies 370 feet below the heavily bedded sandstone exposed in the bluff one mile east of town. Six feet below this sandstone there is a coal horizon, but the vein—the Marshall coal—is here only six inches thick. Between fifty and sixty feet above the Marshall coal there is another coal horizon, the Lonsdale coal, which is the highest within the county. It is mined about two miles south of Linden, in section 31, Linn township, and less than a mile from the county line. Between these two extremes, the one last mentioned, or the Lonsdale seam, and that worked at Van Meter, there are a number of

horizons at which coal is found. The mines on the Raccoon below Cottonwood mill are in a vein above the massive sandstone exposed along the river between that point and Redfield. The old mines along the river just south of Redfield were a few feet below the sandstone.

The coal which has been mined at several points between Redfield and the county line, along the Middle Raccoon, lies considerably above the horizon of the Redfield vein.

That deeper coal veins are present in the southern part of the county is shown by the record of the De Soto well already given. At that point four veins of coal were encountered, as follows:

DEPTH.	THICKNESS.
98 feet	1 foot.
239 feet	2 feet.
255 feet	1½ feet.
350 feet	3 feet.

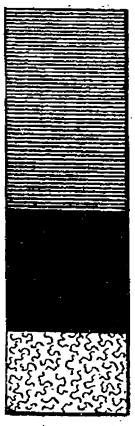
In the northern part of the county coal is mined at Dawson and on the Des Moines river. The veins worked at these points cannot be correlated with those in the southern part of the area.

In the following list of mines the attempt is not made to give all the locations where coal has been or is now being mined. It would be difficult to secure a complete list as many small local banks are abandoned and new ones opened from year to year. It is thought, however, that all those mines have been included which were in operation during the summer and fall of 1896, and also others now abandoned but of importance as showing the presence at certain points of seams of coal.

Raccoon Valley Mines.—In the vicinity of Commerce, just over the line in Polk county, there are a number of small drifts in the hillside. At one point a shaft has been sunk to a depth of 100 feet and a three-foot vein of coal worked for several years.

Van Meter is one of the important mining localities of the county. In the western part of town is located the mine

of the Platt Pressed and Fire Brick Co. The shaft, which is about 300 feet deep, reaches three veins of coal. The lower vein averages three feet in thickness, and twenty feet above is the middle vein which varies considerably, ranging from eighteen inches to four feet, with an average thickness of about three feet. It is this latter that is now being mined, the lower seam having been worked out at this point. From three to seven feet above the middle vein there is a third coal horizon. This coal is nowhere more than eighteen inches thick, and in places it thins out and disappears entirely. The two upper veins are separated by fire clay, which is used in the manufacture of brick by the Platt Pressed & Fire Brick Co. whose plant is located close by the mine. The two plants are worked in co-operation.



	FEET.
3. Shale, dark, argillaceous, somewhat fassile..	5.
2. Coal.....	3
1. Fire clay.....	2

Figure 3 Coal bed at Platt Pressed and Fire Brick Co.'s Mine. Van Meter.

South Raccoon Valley Mines.—Coal has been mined at numerous points along the South Raccoon, but most of the mines are abandoned. Two mines are in operation in section 12 of Union township. The vein worked here varies from fourteen to twenty-four inches in thickness, and becomes thicker toward the east. The seam dips quite rapidly to the east and a short distance from the shaft of the Caves' mine it passes below the river bed. The coal thins out to the north and west until, within a distance of about a mile, it disappears. Many mines have been opened in this vein during the past fifteen years.

Oliver Caves' Mine.—(Tp. 78 N., R. XXIX W., Sec. 12, Ne. qr., Nw. ¼.) The seam is twenty to twenty-four inches thick;

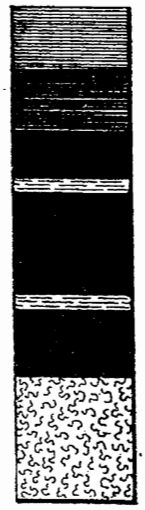
formerly worked by a slope. A new shaft has now been sunk 45 feet to the coal. The section at the shaft is as follows:

		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	...	....

M. V. Dawson Mine.—This is located across the river and a short distance west of the Caves mine (Tp. 78 N., R. XXIX W., Sec. 12, Nw. qr., Se. ¼). The vein is the same one that is mined on the opposite side, but is here worked by a drift. It has a thickness of eighteen to twenty inches. Both of these mines are in operation only during the fall and winter and supply local trade. During the busy season each mine employs from ten to sixteen men, and the output is in good demand.

The first mines in the county were opened in the vicinity of Redfield, and south of town in the valley of the South Raccoon a number of slopes and drifts show that coal has been quite extensively mined here. At the present time these mines are not worked. The vein is three feet thick and lies about twelve feet below the massive sandstone which forms the steep escarpment known as the "Hanging Rock."

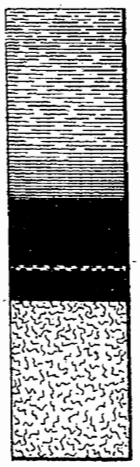
The old Leeper mine, which was operated more than twenty years ago, was a shaft sixty-five feet deep and worked a vein averaging three feet in thickness. The section at this point is as follows:



		FEET.	INCHES.
7.	Shale, rather massive and compact, exposed	2	
6.	Coal		8
5.	Clay parting		½
4.	Coal	1	7
3.	Clay parting		3
2.	Coal	1	
1.	Fire clay, exposed	2	

Figure 4. Bed of old Leeper Mine. Redfield.

Not far distant is the old Redfield mine, near which the following strata are exposed:



		FEET.
3.	Shale, bituminous in lower part	6
2.	Coal, two benches, two feet and one foot in thickness, separated by clay parting	3
1.	Fire clay, gritty	5

Figure 5. Coal vein at Redfield Mine. Redfield.

On the south side of the river, in section 12 of Union township, and near the Marshall artesian well, a one-foot vein of coal has been worked for several seasons. The seam lies forty feet above the river and has yielded considerable coal.

Middle Raccoon River Mines.—Along the Middle Raccoon, from Redfield to the county line, a large number of mines have been opened from time to time, and old drifts are frequently met with on both sides of the river. On Mosquito creek, just above its mouth, at the old Parker and Piatt mines, a thin vein of coal was early worked on a small scale.

For several years mining has been carried on at Samuel Mohr's place, in Tp. 79 N., R. XXIX W., Sec. 33, Sw. qr. The coal is about one foot thick, with a good slate roof. It has been worked at several points by means of drifts and slopes. Another vein about eighteen inches thick outcrops at various points along the hillsides bordering the small stream, in sections 28 and 29. This bank has been worked to some extent in the southeast quarter of section 29, just south of the railroad. Less than a mile west of here, on the C. C. Duck place, a twenty-inch coal seam has been mined in past years. The vein lies about seventy-five feet above the river, and it is doubtless the same one that is worked about a mile southwest, on the opposite side of the stream. It is also probable that this is the same seam that has been mined one mile to the east. Coal occurs in this neighborhood at two horizons above the river level, the upper vein lying sixty feet or more above the lower. The upper is the thicker vein of the two, and most of the mines are apparently on this seam, though a few work the lower one.

The Topping Mine (also known as Manor's coal bank), is located about two and one-half miles south of Linden (Tp. 79 N., R. XXIX W., Sec. 31, Ne. qr., Sw. ¼). It has been opened three years, and is still in operation. The vein, which is from sixteen to eighteen inches thick, is divided by two thin dirt bands. The coal has a sandstone roof, and is of good quality. It is sold quite extensively in Linden and the surrounding country. There is another mine about one-half mile south of here, just over the Guthrie county line.

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

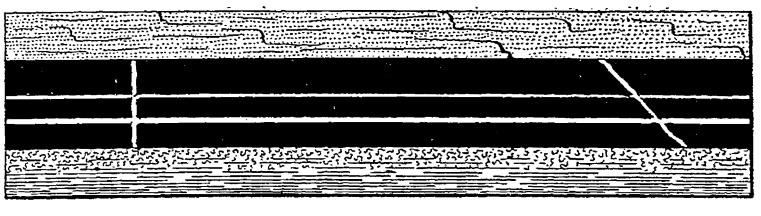
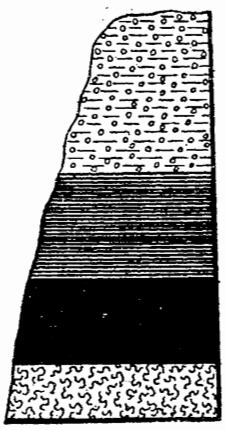


Figure 6. Clay seams in Topping Mine, south of Linden.

North Raccoon Valley Mines.—Four miles north of Adel coal has been worked for many years. Two seams about twenty feet apart are present in this vicinity. The upper one has a thickness of twelve to fifteen inches, and the lower varies from two to three feet. The Chaney mine, located in Tp. 79 N., R. XXVIII W., Sec. 12, Se. qr. Sw. ¼, is still worked to some extent for the local trade. The seam is here thirteen inches thick, and is overlain by several feet of bituminous fissile shales. In the bluff of a ravine on the Chaney place the following section is exposed.



		FEET.	INCHES.
4.	Drift	3	
3.	Shale, bituminous	2	
2.	Coal	1	6
1.	Fire clay exposed	1	

Figure 7. Section at Chaney Drift. Four miles north of Adel.

A short distance east of the Chaney mine is the Pittman bank, where coal was formerly taken from the lower vein.

About four miles north of here, and three miles southwest of Minburn, in section 24 of Washington township, a new mine was opened in the winter of 1896-97. It is on the land of Mr. Charles Scott, and was worked by George and Thomas Bott, of Redfield. The coal outcrops near the bottom of a ravine about a mile from the Raccoon, and lies from forty to fifty feet above the river. It averages two and one-half feet in thickness, though it is three feet in places. The seam is divided by one foot of fire clay. The top vein runs from eighteen to twenty-four inches and the lower vein from twelve to thirteen inches in thickness. A good slate roof covers the coal. The vein dips to the east. The coal is of good quality, and all that was mined found a ready market.

Dawson is at present one of the important mining towns of the county. The mine of the Chicago Coal Co., is located one-half mile east of town, on the Chicago, Milwaukee & St. Paul railway. The present shaft, which has a depth of 125 feet, was put down in November of 1895. At this point there are three veins, as follows:

DEPTH.	THICKNESS.
83 feet	1 foot, 10 inches.
118 feet	3 feet.
165 feet	3½ to 4 feet.

The shaft at present extends only to the three-foot seam, the lower coal having been reached by boring. The record of the shaft has already been given on a previous page. The mine has a good slate roof, with fire clay beneath the coal. It is worked on the longwall plan and ventilated by a fan. Nearly all the coal taken out is used by the railroad, though some is sold to the local trade. At the old shaft, located one-quarter of a mile west, four veins of coal are reported, there being two seams below the three-foot coal worked at the new mine. These were three feet and four feet thick respectively.

The Tudor mine is located near the river at the foot of the bluff just north of Dawson (Sec. 10, Nw. qr., Ne. ¼). It is worked by means of a shaft, which reaches the same vein that is mined by the Chicago Coal Co. The vein here varies considerably in thickness, ranging from one and one-half to three and one-half feet, and thins toward the west. The mine supplies the local trade. The section shown here is:

		FEET.	INCHES.
3.	Shale, bituminous	3	
2.	Coal	3	6
1.	Fire clay	3	

Figure 8. Coal seam at Tudor Shaft, Dawson.

Des Moines River Mines.—In the valley of the Des Moines river coal has been mined for the local trade at a number of different points, and at the present time several mines are being operated in this part of the county.

The oldest of these is the Strange mine (also known as the Tabor shaft), now operated by J. H. Watson. It is located near the wagon bridge (Tp. 81 N., R. XXVI W., Sec. 14, Sw. qr. Ne. ¼), and has been in operation twelve years. At a depth of forty feet the shaft reaches a two-foot vein. The roof is formed of a compact, impure sandrock eighteen inches thick, with black slate above. Below the coal there is four to six inches of bituminous shale underlain by fire clay. The longwall method is used in working the mine. There are several other openings in the same seam near the present shaft.

The mine of the Chestnut Valley Coal Co., operated by Ole Olsen, is about half a mile north of the Strange mine (Nw. ¼ of Nw. qr, Sec. 14). The opening is a new one, the first coal having been taken out in the fall of 1896. The shaft is 112 feet deep and passes through four veins of coal. A fifth vein is reported to have been struck by the drill at a depth of 171 feet.

The thickness and depth of the seams are as follows:

	DEPTH	THICKNESS.
1.	16 feet	12 to 14 inches.
2.	40 feet	1 foot 8 inches.
3.	87 feet	2 feet 4 inches.
4.	109 feet	2 feet.
5.	171 feet	4 feet.

The upper vein is exposed in the bed of a small stream near by. The third seam is the one being worked, though some coal has been taken from the fourth. The third vein is the same one that is mined at the Tabor shaft. Both of these mines supply the local trade.

PRODUCTION.

A majority of the mines of the county are operated by means of shafts and employ steam power. A few are fitted with gins run by horse power, and some are drifts or slopes. In 1897 the total reported production from seven mines amounted to 14,102 short tons, which, at an average price of $1.58 was valued at $22,281.16. This probably very closely approximates the true production.

Clays.

Dallas county contains an abundance of good clays. The coal measure shales and clays, which outcrop at numerous points within its borders, furnish the best of material for the manufacture of clay products. The drift clays are utilized to good advantage at several localities, as are also the alluvial deposits found along many of the streams. The loess of the southern part of the area would doubtless be found well adapted to the same purpose, as it has been used elsewhere with good success. The clays support a number of plants in different parts of the county.

Van Meter.—The Platt Pressed and Fire Brick Co. have extensive works at the foot of the bluff in the western part of town. The clay used is obtained partly from the coal mine near by and partly from near the top of the bluff above the plant. The section at the latter point is as follows:

		FEET.	INCHES.
5.	Soil	1	
4.	Sandstone		8
3.	Shale, sandy, gray	2	
2.	Sandstone, blue, compact	1	6
1.	Shales, red and gray, exposed in face of pit	15	

The clay shales obtained from the bluff are used in the manufacture of red brick. The clay for the buff and fire brick is obtained from the mine at a depth of 265 feet. Between the upper and middle veins of coal there are from three to seven feet of fire clay. The entire thickness between the two

seams is removed in places. The lower part of the section at the mine is as follows:

		FEET.	INCHES.
9.	Shale, argillaceous	90	
8.	Coal	1 to	1½
7.	Fire clay, impure, gray	2 to	4
6.	Fire clay, "hard clay," "Flint" fire clay		6 to 18
5.	Fire clay		6 to 18
4.	Coal	1½ to	4
3.	Sandstone	16	
2.	Shale, bituminous	1	6
1.	Coal	2 to	4

No. 7 is used for the buff brick, either alone or mixed with a small amount of No. 5. No. 6 is used for making first grade fire brick. The shale (No. 9) overlying the top coal makes a good quality of brick of a pink color. By a mixture of these several clays, a building brick of almost any desired color can be secured. Analyses of the three different grades of fire clay have been made for the company, with the following results:

	NO. 6.	NO. 5.
Silica, $Si O_2$	86.63	55.11
Alumina, Al_2O_3	10.92	26.71
Iron oxide, Fe_2O_3	.10	4.29
Lime	.....	.....
Sulphuric acid	.....	4.16
Water	2.32	9.69
Total	99.97	99.96

Analyses of Nos. 5 and 6 were by W. S. Robinson, chief chemist of Union Pacific railway, Omaha, Neb.

ANALYSIS OF NO. 7.

Silica, $Si O_2$ (combined)	29.94
Alumina, Al_2O_3	25.74
Quartz, $Si O_2$	23.27
Lime, Ca O	.48
Magnesia, Mg O	.98
Iron oxide, Fe_2O_3	7.07
Alkalies, K_2O, N_2O	4.30
Water and organic matter	10.19

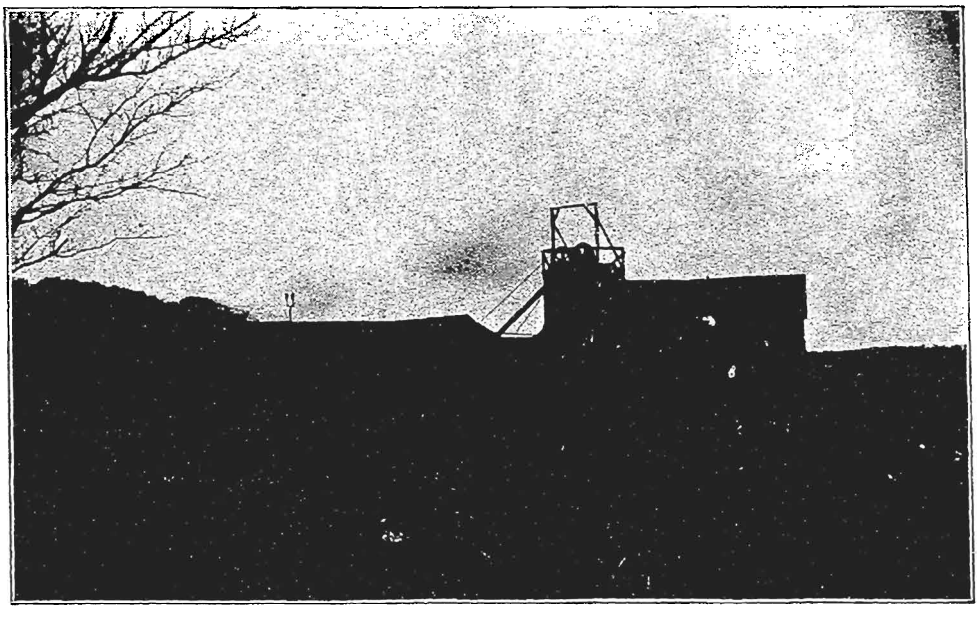


FIG. 1. Top works of the Chicago and Van Meter Coal Co.'s mine, Van Meter.

FIG. 2. Brick works and kilns, Platt Pressed and Fire Brick Co., Van Meter. The pit from which part of the clay is taken is in the middle distance of the view.

Analyzed by Charles Ferry, Troy, N. Y.

No. 6 makes a first-class fire brick, which will withstand a temperature of nearly 3,000° Fahr.

Aside from the necessary sheds and power house, the plant consists of a four-mould Simpson dry press, an E. M. Freese & Co.'s "Mammoth" stiff-mud machine, two nine-foot dry-pans made by the Des Moines Manufacturing and Supply Co., a Johnson & Cregier smooth-roller crusher and a twelve-foot pug-mill. There are two Andrews steam dry-sheds, four forty-horse-power boilers, a 150-horse-power engine and six round, down-draft kilns with a capacity of 500,000. For front brick, the Simpson press is used; for ordinary building brick, the Ohio. The works have a daily capacity of 20,000 pressed brick and 60,000 stiff-mud brick. Nearly 20,000 fire brick, which are repressed by hand, can also be produced daily.

The product consists chiefly of buff pressed brick and fire brick. Some pressed brick of terra cotta red color are also made. The output of the plant is deservedly one of the most popular in the state. So far the fire brick have been made on the dry-press, but it is proposed to hereafter to make them up as a stiff mud. The company is also arranging to manufacture Roman brick and to make some additions and improvements to its plant.

Adel.—The R. M. Kearnes & Co. Brick and Tile factory is located northwest of town, just outside the city limits. It was established fifteen years ago. The clay is obtained from a bank about half a mile west of the works. At this point the section is:

		FEET.	INCHES.
3.	Shale, variegated, siliceous and micaceous, with hard, ferruginous, clayey concretions.....	14	
2.	Coal, impure, clayey, and with calcareous layers		4
1.	Shale, light gray to white at top, variegated below, the bottom being brick red to brown, more or less micaceous.....	??	

At the west end of the section, which is 100 feet long, drift clays rest directly upon No. 1. The bottom clay (No. 1) is the

best, and the upper portion of it affords a white brick, but is not used alone. When the works were started, a "Centennial" machine was put in and used for a number of years, when a "Decatur Leader" was substituted. The latter was in turn replaced by a brick and tile mill made by Freese & Co., of Galion, Ohio. The clay needs to be thoroughly ground and pugged in order to give good results.

Drain tile from three and one-half to ten inches in diameter is the main product, only a few brick being made. The clay is dried in closed sheds with swinging doors, and burned in three round, down-draft kilns with a capacity of about 20,000 three-inch tile. These are water-smoked and burned three and one-half days.

Two miles east of Adel is the brickyard of C. Finn. Common "white oak" clay to the depth of eighteen inches is used. Sand brick have been made here and in this vicinity for a number of years. The product is burned in temporary kilns.

Redfield.—Half a mile west of town, on the west side of the Middle Raccoon river, is the yard of W. B. Cooley, who began making brick here in 1893. The yard is located at the foot of the hills that rise rather abruptly from the bottom lands along the stream. The clay used is taken to a depth of from six inches to three feet. It is a sandy wash material, derived mainly from the siliceous till which covers the upland and slopes. The brick are sand-rolled, and when burned they have a good, cherry-red color. Near the river at Redfield a plant was erected a few years ago for the manufacture of brick and tile from the coal measure shales. Owing to unwise management, rather than from lack of suitable material, the industry proved a failure.

A new plant has recently been built at Redfield, having moved here from Jefferson in the summer of 1896. This is the Goodwin & Meyer Brick and Tile works, which are located in the north part of town, near the Des Moines Northern & Western railroad. A short switch runs to the factory. When the works were visited, they had just been completed, and no

brick had yet been burned. The clay is obtained from the coal measure shales which outcrop in the hillside close by the works. Here are exposed about twelve feet of blue clay shales, overlain by four feet of red clay. The entire thickness is used, and it is necessary to strip off only a few feet of soil and drift in order to reach the clay. The latter has been carefully tested and found well adapted for making a good quality of brick and tile. Both dry-press and wet mud brick are made. For the former a Frey-Sheckler brick machine is used. The plant is also provided with a dry-pan made by the Des Moines Manufacturing and Supply Co. for grinding and powdering the clay. There is a large two-story drying shed, besides buildings for machinery and boilers.

De Soto.—The De Soto Brick and Tile works, operated by McKissick & Blackman, are located in the eastern part of town, near the Chicago, Rock Island & Pacific railroad. The clay is obtained from near the top of the hill on the south side of Bulger creek, and nearly half a mile south of the plant. Fifteen feet of gray, slightly sandy coal measure shales are exposed in the clay bank. Underneath these there is a ten-inch band of blue, compact limestone. No stripping is necessary, as all the clay is used up to the grass roots. A Bennett machine is used in the production of structural brick and drain tile. The sizes of the tile range from three to eight inches in diameter. They are dried by air in ordinary sheds and burned in three round, closed kilns.

Minburn.—The Minburn Brick and Tile works, which are operated by Martin Myers, lie on the edge of the North Raccoon valley, a mile west and a little south of the station. This factory has been in operation at intervals for over seventeen years, but only on a small scale until the last few seasons. In 1893 fire destroyed the works, but they were rebuilt the following year. A "Decatur Leader" is used along with Brewer conical rollers. The product is dried in a large drying shed and burned in two down-draft kilns. The output consists mostly of tile, ranging in size from three to twelve inches.

Drift clay from near the surface is used to a depth of two to four feet. The top is ashy gray in color, and is known as "timber soil;" under this are eighteen inches of black, more or less gumbo-like clay, and the remainder is ordinary yellow bowlder clay. Some pebbles and rarely a lime concretion occur. A little sand is mixed with the clay to prevent checking. The product has a good red color and finds a ready market. In this section of the county the demand for the larger sizes of tile is constantly growing.

Perry.—About two miles northwest of town is the D. A. McBride brickyard, located in Tp. 81 N., R. XXVIII W., Sec. 5, Se. qr., Se. ¼. Alluvial clay is used to a depth of three feet and is mixed with an ashen and black clay taken from a former swampy area. These are used in the proportion of two of the former to one of the latter. The black clay is not siliceous and contains much humus. It shrinks considerably when used alone. This swamp clay also affords an excellent material for burned clay ballast.

Adjoining the McBride yard is another operated by C. McKean. In both of these yards sand-rolled brick are made. The material used at the latter place is very similar to the alluvial clay used at the adjacent plant. It is largely a redeposition of the drift clay which is found on the slopes, but the more clayey portion has been removed, to the detriment of the material. The brick are burned in temporary kilns and have a good color when not burned too hard.

Dawson.—The Omaha Brick and Tile Co. established a large plant just east of the station at Dawson, on the south side of the Chicago, Milwaukee & St. Paul railroad, and near the mine of the Chicago Coal Co. The plant is well equipped with sheds supplied with steam pipes for drying the product; tracks and cars for conveyance to and from the two capacious, rectangular, patented, down-draft kilns; a Frost dry-pan and a large Penfield brick and tile machine, with convenient apparatus for hauling the raw material. The plant was completed in the spring of 1890, and work was extensively carried on

until July, 1891. Various causes have been assigned for the closing of the factory, but it was certainly not due to any defect in the clay or in the quality of the product made. Light colored structural brick and fire brick were manufactured. They are said to have been of first class quality, and found a ready market. Shales are exposed at the water level a short distance northwestward, and these might be utilized, as well as other workable beds near by.

Madrid.—Wilson Bros. have a small brickyard about a mile and a half southwest of Madrid (Tp. 91 N., R. XXVI W., Sec. 1, Sw. qr., Nw. ¼). Common brick were moulded by hand until several years ago when a "New Quaker" was put in. Arenaceous bowlder clay from the upland is used to a depth of two feet. Below, the clay is more sandy and gravelly. The brick are burned in common kilns and are of fair color.

PRODUCTION.

In 1897, according to the reports made to this office, Dallas county ranked twelfth in the production of clay goods. The items were as follows.

Common brick, number	1,033	
Common brick, value		$ 9,631
Total brick, number	2,145	
Total brick value		16,684
Total clay value		35,107

Building Stones.

Both the Missourian limestone and the sandstone and limestone beds of the Des Moines stage furnish good building material. The limestone is quarried at several points in Union and Adams townships along Bear creek and its tributaries.

Bear Creek Quarries.—In the southeast quarter of section 22 of Union township is the quarry of Charles Brown, which has been worked for forty years. The section at this place has already been given. From ten to twelve feet of limestone is

exposed in the face of the quarry. The rock is of a blue or buff color and is in beds of eight to ten inches in thickness. Many of the layers are separated by marly partings three or four inches thick, and at certain horizons flint nodules are abundant. The stone is readily worked, and no blasting is necessary in its removal. It is cut vertically by joints and divided horizontally by the marly partings, so that the rock is readily broken into blocks that can be handled. The limestone is very compact and of excellent quality. It is used quite extensively in Redfield, Dexter and the surrounding country.

Stone has been quarried at other points along Bear creek in this immediate vicinity. About two miles south, in the southwest quarter of section 35, near the county line, is the quarry of James Fry. It has been worked for twenty-five years. From twelve to fourteen feet of limestone are here exposed, the beds being the same as those quarried farther north. The stone is used in Dexter and also supplies the country trade.

There were formerly extensive quarries in section 28 of Adams township, operated by Laird & Royce. A switch from the Chicago, Rock Island & Pacific railway extended to them and large quantities of stone were shipped. Most of it was used by the railroad for ballast and construction. The quarries were located on a small tributary of Bear creek, about two miles south of its confluence with the major stream. They were well up toward the top of the hill, and though not worked for a number of years, much stone has been quarried here in the past. About two miles south, and just over the line in Madison county, are the large Earlham quarries, where the Missourian limestone has been extensively worked for many years.

The sandstone of the Des Moines stage, which outcrops along the South Raccoon in the vicinity of Redfield, is quarried in the southeast quarter of section 3 of Union township.

The quarry belongs to Mr. W. F. McGuire, and has been worked for fifteen years. The section here is:

		FEET.
5.	Drift	
4.	Sandstone, soft, buff, heavily bedded	8
3.	Sandstone, blue, compact, hard	7
2.	Clay shales, sandy, blue	4
1.	Sandstone, exposed to river	8

Number 3 is the only rock quarried. At the quarry it has a thickness of seven feet, but it thins out rapidly, and about thirty rods east it is only one foot thick. The stone is of excellent quality and is scarcely affected by weathering agencies. It is used extensively in Redfield and is shipped to Fonda, Waukee and other points on the Des Moines Northern & Western railroad.

Talbot Quarry.—This quarry, which is about four miles northwest of Redfield, in the southwest quarter of section 29, Linn township, was opened in 1893. It was connected by a switch with the Des Moines Northern & Western railroad, about a mile distant. The section at this place is as follows:

		FEET.	INCHES.
11.	Soil	3	
10.	Clay, sandy, buff	8	
9.	Shale, black, fossiliferous	2	
8.	Coal, with clay parting	1	8
7.	Fire clay	3	
6.	Shale, gray, with lime concretions	4	
5.	Limestone, hard, compact, blue, fossiliferous above, mostly in solid ledges	7	
4.	Shale, light gray	21	
3.	Limestone, gray, brecciated above	1	6
2.	Shales, gray, not fully exposed	1	6
1.	Shale, black, fissile, coaly below	1	6

The rock quarried was the heavy bed of rough limestone (No. 5). Almost the entire product of the quarry was used as crushed stone. It was shipped to Des Moines and employed in the concrete foundations of the brick pavements. The crusher used was manufactured by Fraser & Chalmers, Chicago. As shown from the section, the amount of stripping

that was necessary was very considerable and added greatly to the cost of quarrying. Work at this quarry has been stopped for several years. A coal seam above the limestone here has been worked at several points.

A three-foot ledge of rough gray limestone has been quarried on a small scale near the switch in section 28 of Linn township. Underlying the compact, fossiliferous limestone bed there are exposed about twenty-five feet of shales.

The limestone and sandstone bands of the coal measures have been quarried to a greater or less extent at a number of other localities in the county. At two points near Adel, in sections 21 and 28 of Adel township, a three-foot bed of sandstone has been worked and considerable stone removed. Rock has been obtained from several small quarries near Van Meter and has also been taken out along Bulger creek near De Soto. Two miles south of Waukee, in the northwest quarter of section 6, Boone township, the coal measures are exposed along Sugar creek and a ledge of sandstone has been quarried for local use.

PRODUCTION.

The stone production of Dallas county was not reported for 1897.

Road Materials.

At a time when the movement toward the improvement of country roads is beginning to assume considerable importance, the question of good road materials is one of special interest. Dallas county is well furnished with such materials. The Missourian limestone and the calcareous beds of the coal measures afford rock suitable for crushed stone, while along many of the larger streams there are terraces from which gravel may be secured in abundance.

As already stated, the limestone of the old quarries in section 28 of Adams township was used quite extensively for ballast on the railroad, and the rock from the quarry four miles northwest of Redfield was also utilized as crushed stone.

Almost any of the limestones of the county would furnish suitable material for macadamizing the roads. The gravel of the terraces can also be used for the improvement of the highways. These beds have been opened at several points in the county, and worked on an extensive scale by the railroads for ballast. The Chicago, Milwaukee & St. Paul railroad formerly had large gravel pits in section 11 of Des Moines township, only a short distance west of their bridge over the Des Moines river. The Chicago, Rock Island & Pacific railroad has for many years been making extensive excavations in the gravel beds at Van Meter, and the Des Moines, Northern & Western has also taken out large quantities of gravel from its pits about a mile northwest of Redfield.

Gravel beds are known to occur at many points along the North Raccoon, as for example at Adel and various points between Dawson and Perry. The drift in some places contains quite clean beds of gravel, though these are as a rule well toward the base, and hence difficult to reach unless the overlying till has been removed by erosion.

Natural Gas.

The presence of natural gas in the county has been known for a number of years. It was discovered near Dawson in 1888. It had been found two years before at Herndon, eight miles west of Dawson, and the wells yielded a good flow of gas. They were first mentioned in the report of the state mine inspector* for the years 1886 and 1887, and the presence of gas at Herndon was also noted by McGee in the Eleventh Annual Report of the United States Geological Survey.† In 1892, Call, in the Monthly Review of the Iowa Weather and Crop Service, also referred to the gas wells at Dawson and Herndon, and gave as the probable source the vegetable matter buried in the drift. Other localities in the state where natural gas has been found are Letts, Louisa county; Stan-

* Report State Mine Inspector, 1887, pp. 169-170.
† Eleventh Ann. Rept., 1889-1890, pt. i, p 595.

hope, Hamilton county, and in Polk county about seven miles northeast of Des Moines. From these various occurrences it will be seen that it is not an unusual thing to find gas in the drift of the state.

The Dawson wells are three-quarters of a mile south of town. Five holes have been drilled, one being put down in 1888 and the other four in 1891. They have a depth of from 110 to 115 feet, passing through drift clay into a bed of sand and gravel. The gas occurs in the gravel layers below a compact blue clay. A coal shaft just east of Dawson shows sixty-four feet of this blue clay, overlain by a yellow clay. During the summer of 1896 the first well, which had been bored eight years before, was tested to find the pressure, with the result that this was ascertained to be twenty-four to twenty-five pounds to the square inch. The gas burned with a flame fifteen to twenty feet high. It was piped into town, and for a time supplied one of the houses with fuel. It was also used in the kilns of the brick plant a short distance east of the station. Three of the wells still have a good flow, but are no longer used. An analysis of the gas from the first well shows its composition to be as follows:

Hydrocarbons and nitrogen	95.35
Carbon monoxide	2.50
Carbon dioxide	1.60
Oxygen	0.55
	100.00

In this connection mention should perhaps be made of the gas found in large quantities in the water supply of Perry, six miles east of Dawson. Perry secures its supply from four wells located in the southern part of town. These wells have a depth of 115 feet. Gravel is struck seventy feet below the surface and the lower forty-five feet is through this material. The amount of gas in the water is so great that Mr. J. W. Rodefer has for some time been experimenting for the purpose of extracting it for use in heating and lighting. He has succeeded in doing this on a comparatively small scale and

the gas thus separated is used to furnish fuel and light to his office. Could it be extracted by a sufficiently inexpensive method and in large enough quantities, this natural gas contained in its water supply would furnish Perry with a convenient fuel.

There are two possible sources of the gas of the drift: (1) it may have been derived from the underlying rock and the drift then serves simply as a reservoir for its accumulation and storage, or (2) it may have been derived from the vegetable accumulations of the drift and thus have its source in the Pleistocene deposits where it is now found. The latter source is much the more common, and in most instances there is slight doubt that the gas has been derived from the decomposition of the vegetable remains in the drift. But examples of the latter serving only as a reservoir are occasionally found. Thus Orton* mentions several such instances in Ohio, and it is possible, though not probable, that the gas at Dawson may have been derived from the underlying coal measure shales. To collect gas from such a source the gas-bearing rocks must be overlain by porous beds of drift. Then during the long periods while they hold this relation the porous beds become charged with gas where the conditions of level are suitable. As already stated, the gas at Dawson is found in a stratum of sand and gravel which is apparently at the base of the drift and overlying the coal measures. It is possible, therefore, that the gas originated in these black carbonaceous shales and has passed up into, and accumulated in, the gravel and sand beds above, where it is prevented from escaping by the covering of blue clay.

But while the above source is a possible one, it is far more probable that the gas at Dawson, as elsewhere in the state, has had its source in the vegetable accumulations of the drift. It is not necessary to suppose that it has been formed directly in the place where it is now found. It may have originated from the decomposition of vegetable material some consider-

* Geol. Surv., Ohio, vol. VI, pp. 772-775.

able distance off, and later have diffused itself laterally through the gravel until reaching a place favorable for its accumulation.

An interesting and significant fact concerning the distribution of the Iowa gas wells is that they are found not far from the border of the upper or newer drift sheet of the region. Thus, for example, at Dawson and Herndon the wells are only a few miles back from the edge of the Wisconsin lobe, and at Letts, in Louisa county, the Illinois ice seems to have extended only a short distance to the west. Orton mentions the same fact concerning the distribution of the wells in Ohio, where they are found along the border of the glacial deposits, or back twenty to forty miles.

The most favorable conditions for the preservation of forest beds and like accumulations of vegetable material would seem to be near the edge of the ice, where this was the thinnest and where during its advance there would have been less disturbance of the materials beneath. During its advance a comparatively few miles of the ice sheet would pass over the drift near the border, while back fifty or seventy-five miles the ice would be considerably thicker and a vastly greater bulk of ice would pass over the surface, with the result that the underlying deposits would be greatly disturbed. The forest bed, if present, might in such cases be carried away or be mingled with the clay of the drift.

Concerning the origin of the natural gas little need be said. It is now generally admitted by all geologists and most chemists that the various bitumens, including natural gas, are genetically connected with, and are closely allied to, marsh gas, and that they are produced by the natural decomposition of organic tissue. Natural gas closely resembles in composition the inflammable marsh gas which is often observed coming from the muddy bottom of stagnant ponds. The following analysis, giving the mean results of seven analyses made for the United States Geological Survey, by Prof. C. C. Howard, shows the composition of natural gas.

Marsh gas	93.36
Nitrogen	3.28
Hydrogen	1.76
Carbon monoxide	.53
Oxygen	.29
Olefiant gas	.28
Carbon dioxide	.25
Hydrogen sulphide	.18
Total	100.03

Marsh gas, the principal constitutent, is a simple compound of carbon and hydrogen in the proportions of 75 per cent of the former to 25 per cent of the latter.

The natural gas at Dawson and other Iowa localities is then simply the product of the decomposition of the vegetable remains buried in drift.

Some years ago an effort was made to find gas at Redfield and a deep hole was bored. A record of the strata penetrated was kept and has been examined by a member of the survey force. This record differs in no essential particular from the records of other deep wells that begin in the same geological formation and reveals nothing not previously known concerning the general geological structure and stratigraphy of the state. It lends no encouragement to the belief that the underlying rocks are gas-bearing.

Water Supply.

Dallas county has an abundance of good water. The supply is derived chiefly from the sands and gravels of the drift, though in some instances water is obtained from the coal measures.

There are several artesian wells in the county. The Redfield well, which has a depth of 1,500 feet, was put down with the hope of finding gas and oil. The well is on the "picnic grounds" beside the river, just south of town. A flow of water was struck at a depth of 280 feet, and other veins were found at various depths below this. A stream now flows from the well, but it is not utilized, being allowed to run into the

river near by. The water contains considerable iron, and there is quite a deposit of this mineral along the course of the small stream. Reference has already been made to the artesian well belonging to Mr. Marshall, in section 7 of Union township, and its record has been given. As in the Redfield well, water was struck at a depth of 280 feet, in a white sandstone at the base of the Des Moines shales. The sandstone was twenty feet thick, and lay upon a limestone that probably belongs to the Saint Louis. The pressure at first was sufficient to throw a one-quarter-inch stream nineteen feet high, and, though it has naturally diminished somewhat, the pressure is still strong. The four wells which supply the town of Perry, though they are no longer flowing wells, are still to be considered as true artesians. The water for a time came to the surface and flowed, but after a number of wells were sunk in the neighborhood and the water was pumped by the city, the head was lowered and now stands five or six feet below the surface. The water in this locality comes from a heavy bed of gravel lying seventy feet below the surface. This gravel layer is penetrated to a depth of forty-five feet and contains an abundance of water. There is a large area in the northwestern part of the county, including parts of Lincoln, Dallas, Spring Valley, Washington and Colfax townships, where, below the blue clay of the drift, there is a bed of sand and gravel. It averages about eight feet in thickness and carries much water. While this well-marked sand layer is absent in other parts of the county, the Pleistocene deposits nevertheless have a number of horizons where water is present in sufficient quantity to supply the needs of all, except, perhaps, in very dry seasons. The sandstones of the coal measures can usually be relied upon to furnish considerable water, but the expense of drilling wells to any very great depth in these will prevent the sinking of many such so long as the drift wells are adequate.

Soils.

The soils of the county are formed almost entirely from the two drift sheets that cover the region. Over a portion of the southern tier of townships the Kansan drift with its covering of loess has given rise to a very productive soil. Wherever the loess forms the surface the soils have a buff or light gray color and do not have the appearance of very great fertility, though as a matter of fact they are well supplied with plant foods and are well adapted for fruit raising and for corn. These loess soils have the property of absorbing moisture very readily and of retaining it for a considerable period. They are free from the pebbles and bowlders often so abundant in the drift soils.

The Wisconsin drift forms the surface material over much the larger portion of the county and gives rise to a soil of much fertility, as the prosperous appearance of the farms bears ample testimony. In many parts of the region, however, the surface is so flat and poorly drained that the land needs to be thoroughly underdrained before the soil reaches its greatest productiveness.

Though it covers but a comparatively small part of the area of the county the alluvium probably forms as rich a soil as any in the region. The old flood plains along the streams have been covered by the sediment carried in the waters of the rivers and deposited along their courses. In many cases these alluvial bottoms are now occupied by rich pastures that furnish grazing to numerous herds of cattle. In other instances the rich fields of waving corn give evidence of the fertility of these bottom lands.

From what precedes it will be seen that the soils of Dallas county are of three kinds, dependent upon the geological formation that forms the surface. These are (1) the soils of the Wisconsin drift, (2) the loess soils of the Kansan drift area, and (3) the alluvium.

ACKNOWLEDGMENTS.

This report would be incomplete without acknowledging our indebtedness to those who have so cheerfully furnished information and in this way materially assisted in its preparation. To Prof. Samuel Calvin and to Mr. H. F. Bain the writer is under special obligations for many valuable suggestions and for assistance freely given at all times. The writer is also indebted to Mr. J. L. Hightower, Mr. J. W. Rodefer, Mr. Marshall and the many other friends of the Survey who have shown their appreciation of the work by furnishing information as to well records, mines, etc. In the preparation of this report use was made of the notes on clay collected by Mr. E.H. Lonsdale, as also of those of Mr. A. C. Spencer on building stones, and the notes of Mr. A. J. Jones on the coal mines.

To each and all of the above persons the writer takes pleasure in making due acknowledgment.

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF DALLAS COUNTY, IOWA.

BY

A. G. LEONARD

1898.

Scale 1/125000

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

GEOLOGICAL FORMATIONS

MISSOURIAN

DES MOINES

INDUSTRIES

MINES

CLAY PITS

GAS WELLS

QUARRIES

IOWA LITHO. CO. DES MOINES. DRAWN BY F. C. TATE