GEOLOGY OF JASPER COUNTY.

BY

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CONTENTS.

INTRODUCTION.

LOCATION AND AREA.

Jasper county is in the fourth tier of counties from the southern and in the sixth from the northern border of the state occupying a central position from the east and west. It is larger than the ordinary interior Iowa county and is bounded by six surrounding counties. Story and Marshall lie to the north, Poweshiek to the east; Maskaska and Marion bound it on the south; and Polk county is the western boundary. It includes twenty congressional townships, in tiers of five townships east and west and four north and south. The lower tier has an offset to the east of approximately one-half mile by a correction line, and is divided into four civil townships whose boundaries are somewhat irregular on account of the diagonal course of Skunk river. The three eastern members, viz., Washington, Mound Prairie and Palo Alto, of the second tier from the south, likewise vary in size from the standard of thirty-six sections. The county, therefore, embraces an area of seven hundred and twenty square miles and contains a little less than one-half million acres.

HISTORY AND PREVIOUS GEOLOGICAL WORK.

The name Jasper was given to the area under consideration, and its present boundaries established, in 1846, some months before the admission of Iowa as a state. It was named after Sergeant Jasper of Revolutionary fame,* and was included in the "New Purchase" ceded to the government by the Sacs and Foxes in 1842. By the terms of this treaty, white men were allowed to enter the acquired territory in May, 1843, and in this year the first settlement was made at the present location of the town of Monroe. The present county seat was located early in 1846 and surveys of the county were completed in 1847.† No record is found of geological observations in the county previous to the work of the official survey by James Hall, pub-

* McGee: Pleistocene History of Northeastern Iowa, 11th Ann. Rep. U. S. G. S., p. 203.

† These historical facts were gleaned largely from "History of Jasper County" by Western Historical Co., Chicago, 1878.

lished in 1858*. In this report mention is made of exposures of Carboniferous rocks on Rock creek and North and South Skunk rivers, and of the fact that the Coal Measures underlie essentially the whole of Jasper county. Brief descriptions of the coal mines west of Newton are also included, the Slaughter coal bank near the present town of Colfax having then been worked for several years.

The final report† of the next authorized geological survey of the state, that by Charles A. White, published in 1870, contains a reference to the coal mines west and south of Newton, and the prediction was made that large supplies of coal could be relied upon for the future.

The State Mine Inspectors' reports from 1880 to the present time contain much information concerning the coal mining industry of the county.

McGee‡, in "Pleistocene History of Northeastern Iowa" describes the surface features and character of the superficial drift deposits of this area. Brief mention is also made of the irregular bedding and arenaceous character of the Carboniferous strata.

Since the organization of the present survey, geological work has been carried on in Marshall and Story counties to the north, Polk to the west and in Marion county to the south. The results of these investigations have been published in the Annual volumes of the Geological Survey.§

Much information regarding the Coal Measures and the coal mining industry is contained in Dr. Keyes' report on the "Coals of Iowa".‖ Data on the deep wells, and especially the mineral water wells at Colfax, are included in Professor Norton's report on the "Artesian Waters of Iowa".¶ A report on the clay interests of the county is embraced in Volume XIV of the Annual Reports of the Iowa Geological Survey.**

* Geol. Surv. State of Iowa, Vol. I. pt. 1, pp. 266 and 272, 1858.
† Geol. Surv. State of Iowa. Vol. II, p. 262, 1870.
‡ 11th Ann. Rep. U. S. G. S., pp. 223, 311, 508.
§ Geology of Marshall County, S. W. Beyer, Iowa Geol. Surv., Vol. VII, p. 199.
Geology of Story County, S. W. Beyer, Iowa Geol. Surv., Vol. IX, p. 155.
Geology of Polk County, H. F. Bain, Iowa Geol. Surv., Vol. VII, p. 265.
Geology of Marion County, B. L. Miller, Iowa Geol. Surv., Vol. XI, p. 127.
‖ Coals of Iowa, Ann. Rep. Iowa Geol. Surv., Vol. II, pp. 294-506.
¶ Artesian Wells of Iowa, Iowa Geol. Surv., Vol. VI, pp. 293-381.
** Clays of Iowa, Iowa Geol. Surv., Vol. XIV.

PHYSIOGRAPHY.

TOPOGRAPHY.

*General Features.**—The surface configuration of Jasper county is to be attributed almost wholly to the glacial drift. The topographic features are those resulting from the action of weathering and erosive agents on this superficial deposit. the drift materials respond comparatively readily to the cutting of streams, so that, although these deposits are geologically not old, the county in general is well drained and the land forms are those moulded largely by water action. This statement holds good for the major portion of the county but would scarcely be applicable in its strictest sense to the small area of Wisconsin drift in the northwest corner. In this area, covering parts of Clear Creek, Poweshiek and Washington townships, drainage is imperfect and the land surface still retains the characteristic imprint of the ice moulding of the last great glacier.

The remainder of the county is covered by the Kansan drift which is responsible for the general outlines of the surface features. It is true that the Kansan is entirely overlain by the loess, but this last deposit has conformed with such fidelity to the contours of the pre-existing surface that the drift is to be considered the determining factor. Exceptions to this are occasionally met, as in the case of the sand hills along the Skunk river; and a few points along this river where the outcropping Coal Measures give character to the topography.

We may therefore separate the county into two parts based on the character and age of its topographic features. The Kansan drift area, a mature topography; and the Wisconsin drift, a region of comparative youth.

* The surface features of Jasper county are treated in a general way in Pleistocene History o Northeastern Iowa, 11 Ann. Rep. U. S. G. S., pp. 223-225.

Kansan drift area.—The characteristics of the Kansan drift topography do not differ here from Marshall county to the north and Marion to the south, which have been described by Beyer and Miller respectively. So universally is this drift covered with the loess that the contours are today largely expressed in this pebbleless, silty material. It might thus be appropriately designated loess-Kansan topography, since the relief of the county is due to erosion in the drift itself, while the conspicuous features are generally attributable to the mantle of loess.

Essentially nine-tenths of the county is included in the loess-Kansan area. In this territory the extreme range between points whose elevation is accurately known is 310 feet. The level divide on which Newberg, and to the north, Gilman, in Marshall county, are located, has an altitude of 1,060 feet above the sea. The elevation of Prairie City, which is likewise built on a flat divide separating the Skunk and Des Moines river systems, is 920 feet. Lynnville has an elevation of 938 feet. The town of Collins, some three miles over the line in Story county, is 997 feet above tide, while Monroe, near the

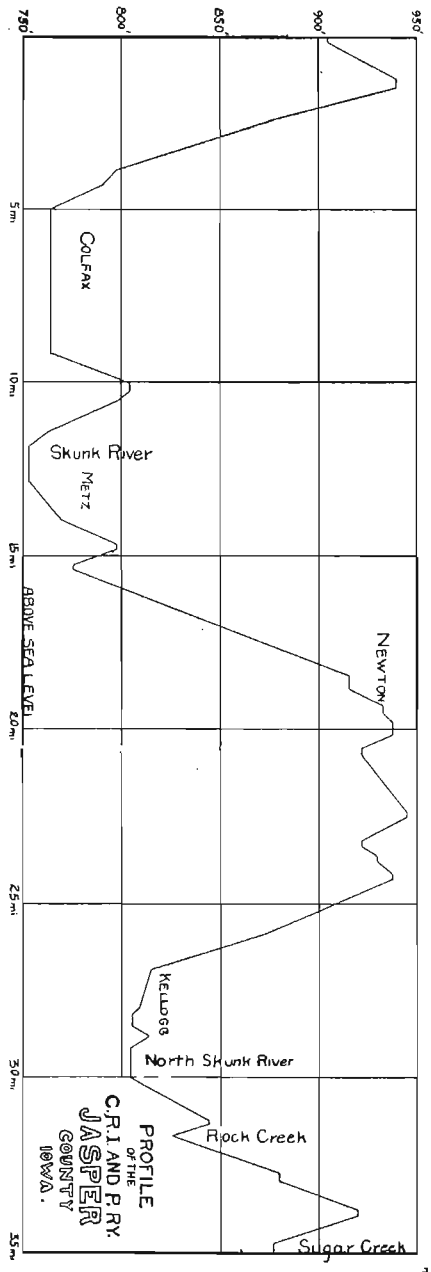

FIG. 19. Profile of the Chicago, Rock Island and Pacific railroad across Jasper county.

south edge of Fairview township, Jasper county, has an altitude of 909 feet. Skunk river, at the Chicago, Rock Island & Pacific crossing is 753 feet, which is the lowest recorded point. The general slope of the area is therefore to the south, and the trend of the major streams is towards the southeast.

The relief ranges from a few feet on the level divides, which are not deeply dissected by the streams, to 150 feet or more between valley floor and adjacent hilltops in the more dissected areas. Such strong relief is conspicuous in Rock Creek township where Rock creek and its branches have cut deeply into the drift. Cherry creek in Newton township, and Clear and Mud creeks in Independence and Clear Creek townships have also deepened their valleys to such an extent in keeping pace with the parent streams that the topography in these parts is decidedly rugged. Along the south border of the county in Fairview and Des Moines townships the features are abrupt, but the relief is not so great.

Viewed broadly, it appears that the surface of the Kansan drift after the retreat of the glacier was a fairly level plain. The irregularities found today are those only that would result from the work of the streams in developing a drainage system, and from the deposition of the superficial covering of loess. The divides which separate the headwaters of the members of the several drainage systems represented are conspicuously flat and are remnants of the original drift plain. Many of the hills along the larger streams, and especially on the western borders of their valleys, are flat topped and the general aspect of the sky line is that of an interrupted straight line. This is especially noticeable along the North Skunk river in Richland township, and may be observed at many other points along this and other streams in the county.

The general levelness of the drift surface has been in places modified by the loess which covers it. In some cases its influence has been to moderate and subdue the ruggedness of the strictly erosional surface. In others, the relief has been exaggerated. But over the whole of the Kansan drift area, as has been noted, the chief topographic forms existing before the loess was deposited are not obscured, but rather preserved. It is to

be observed that the loess is present as a continuous mantle over the level divides as well as a capping to the most prominent hills, and a veneer extending low down the hillsides into the stream valleys. The original abruptness is thus somewhat mellowed and a characteristic type of land surface developed. The forms have a rounded and pleasing fullness of contour that is not readily mistaken.

In the more hilly parts of this area the bowldery clay of the Kansan is frequently found outcropping on the middle slopes of the hills. Its angle is usually different from that maintained by the loess, thus causing a break in the general symmetrical outline of the hill. At a few points in the narrow belt of Red Rock sandstone, which extends from northeast to southwest nearly across the county, the underlying ledges of this rock give a characteristic stamp to the surface features. This is especially noticeable along the north border of the North Skunk valley just east of Kellogg, and the west boundary of Skunk river west of Reasnor southward into Fairview township. In the mining districts where the coal-bearing strata frequently outcrop along small streams and in road cuts, and where the drift is thin, the argillaceous sandstones and sandy shales are often responsible for the principal elevations. South of Newton, in Palo Alto township, and eastward from Monroe in Fairview and Elk Creek townships are areas notable in this particular.

At various points along both the east and the west banks of Skunk river valley are found prominent sand hills and ridges. These are distributed from the Wisconsin drift area in Poweshiek township to the exit of the river from the county in Elk Creek township, but are more numerous to the east than to the west of this stream. They range from low, flattened ridges of dune-like character that stretch out into the valley itself, to the more prominent elevations that form the valley walls. The sand hills are universally capped with loess sometimes thin, but often in sufficient amount to impart to the topography the characteristics of the loess bluffs as developed along the Missouri river. In places the sand seems to grade upwards into the loess. The importance of these feat-

ures is great. In the northeast ¼ of section 33, Elk Creek township are small areas of shifting sands. The roads are everywhere sandy and in places little can be accomplished towards tillage of the land. Again in the south part of section 13 of the same township, south of Reasnor, where sand has been removed, are observed fields which the shifting sands are gradually rendering valueless. Just south of Colfax, back of the loess bluffs on which a portion of the town is built, are areas of very sandy loess which works up in the country roads and makes traveling anything but agreeable. The origin of these sand deposits will be spoken of under Geological Formations.

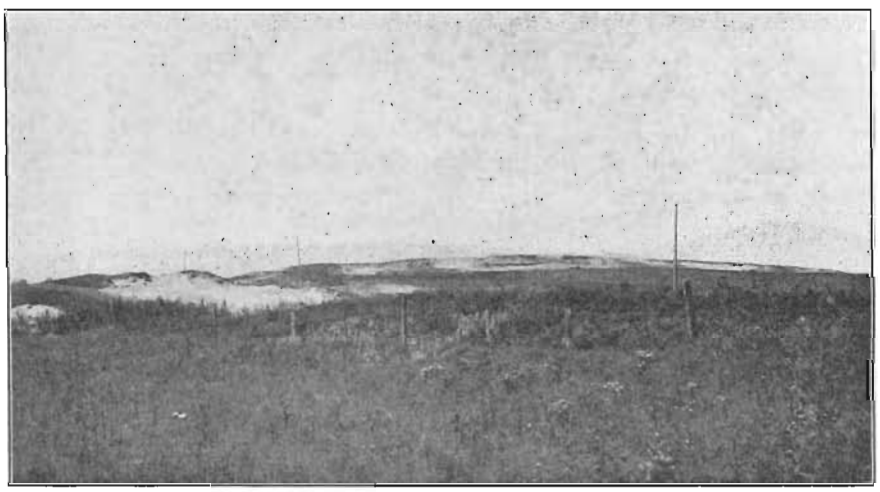

FIG. 20. Moving sands in the valley of Skunk river, southeast quarter of section 13, Elk Creek township.

A discussion of the topography would be incomplete without referring to the river valleys and their flood plains. They appear to be features of post-glacial development largely. All of the principal streams are skirted by alluvial flood plains of greater or less width and, although subject to occasional inundation during high water, afford some of the most fertile farming land in the county.

Iowan drift plain.—The border of the Iowan drift as located by Dr. Beyer * in Marshall county lies north of the Iowa river, and only the northeast corner of that county is covered by the till of this age. Prof. T. E. Savage † has shown that a considerable area in the southern part of Tama county is to be included in the Iowan drift plain and that it probably extends into southern Marshall and southward into Poweshiek county. The plain mapped as Iowan in southwestern Tama county is coextensive with the flat divide on which Gilman in Marshall county and Newberg in Jasper county are situated. Topographically this region appears to possess the characteristic Iowan surface. Wherever exposures can be examined, however, it is found to be covered with loess, and in this particular as well as in the monotonous level of its surface, is not different from similar stream divides in other parts of Jasper county. To the south and west where the plain gives way to the erosional type of topography, and wherever, in the plain itself, sections are available, the material beneath the loess is typical Kansan drift.

Aside from the criterion of topography, the presence of unweathered granite bowlders is regarded as confirmatory of the Iowan age of this drift plain in Tama county. The large, fresh, pink and grey granites are especially characteristic of this drift, and where typically developed are an ever present feature. In Jasper county bowlders are seldom seen except along some of the minor stream cuts where the drift underlying the loess outcrops on the lower slopes. In these instances the prevailing type is the red granite, and from position alone is presumably genetically related to undoubted Kansan drift. In fact, at no point in the county was there observed a drift section which presented the characteristic facies of the Iowan. It is true that over the section included in Hickory Grove and Mariposa townships more outcropping bowlders can be counted than over any other of equal area in the county; yet only in a single instance was there seen one of such unusual size and freshness as to suggest an origin other than the Kansan

* Iowa Geol. Surv., Vol. VII.
† Iowa Geol. Surv., Vol. XIII.

drift, with which it appeared to be associated. Near the northwest corner of section 29, Hickory Grove township, is a coarse-grained, red granite, whose dimensions are approximately thirty feet long by twelve feet high by eleven feet through above ground. It is so situated on the slope near a sharp gully that the larger portion of the rock may yet be below the surface. Undoubted Kansan drift is exposed in the road fifteen to eighteen feet above the bowlder. In species, dimensions and freshness it is very unlike those characteristic of the Kansan, and it seems safe to relate it in origin with the

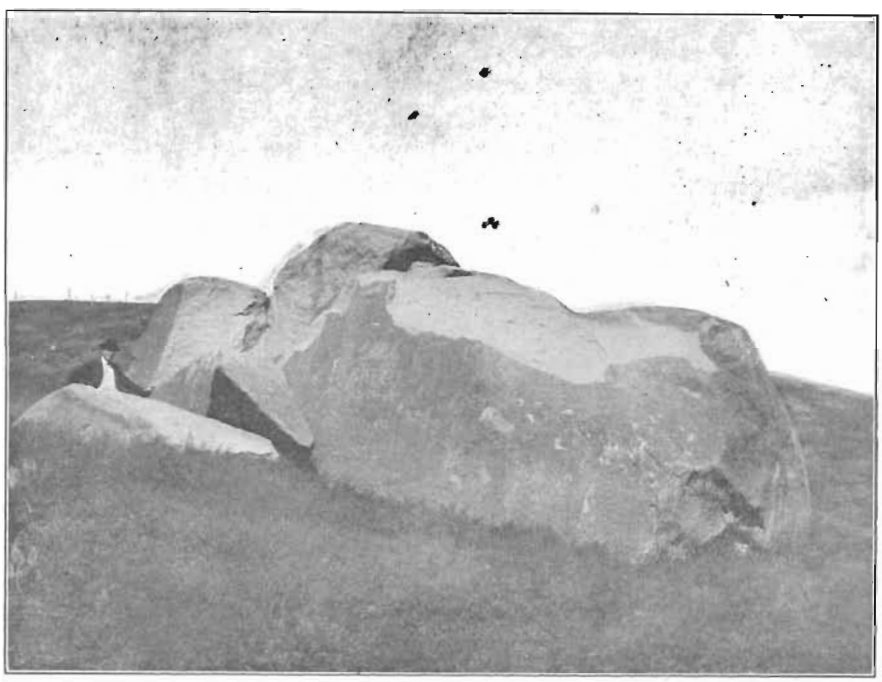

FIG. 21. Granite bowlder in the northwest quarter of section 29, Hickory Grove township. Dimensions approximately 30x11x12 feet.

Iowan drift sheet. In section 24, Kellogg township, a moderately large, red granite was observed, but this showed the effects of weathering to such a degree that but little could be concluded as to its age.

The facts at hand are not sufficiently definite to permit of the location of a positive border to the Iowan in Jasper county. The surface features are not such as require the presence of this drift to account for them, for, as has been shown, areas similar in every way are to be found in other parts of the county where Iowan drift would be out of the question. Sections through the loess do not bring to light at any point drift materials referable to the Iowan. The bowlders, some of which are in species and condition unlike those predominating in the Kansan drift, afford the strongest evidence of the possible extension of the Iowan ice over this region. It should also be observed that the pink and grey granites are the typical bowlders of the Iowan, although red granites are known to occur. All those observed in Jasper county are of the red or pink variety. The presence of the bowlders is perhaps best explained by attributing them to the Iowan glacier. If the ice once stood over this area it was in all probability very thin and the material carried small in amount. Being near the extreme limit of ice movement, wasting may have progressed so far that little erosive power remained and the transported rock detritus was insufficient to exert an appreciable influence on the nature of the pre-Iowan land surface.

Wisconsin drift area.—The portion of the county whose topography depends upon this new sheet of drift is comparatively small. The features which it exhibits are as a rule not especially pronounced, in which respect this area differs from the characteristic development of the Altamont moraine in the north-central and northern parts of the state. Although the border of the Wisconsin ice rested here during the period of maximum southern extension in the state, morainal features are found at but one point. This is in the south part of Clear Creek township, sections 27 and 28, 33 and 24, where a series of kame-like knolls and elongated ridges have displaced Indian creek from its earlier course. The thickness of the ice and the amount of material carried appear not to have been large.

The immature nature of this area is evidenced by the presence of marshy areas with occasional ponds, although these characters are far less common than they are further within

the Wisconsin drift plain. The change most noticeable in passing from the Kansan drift to the Wisconsin drift is the relative mildness of the topography of the latter. The loess covered Kansan is deeply incised and the relief is considerable, while over the Wisconsin drift these erosional features have been largely obliterated by filling and leveling, thus leaving a more level surface. This is especially noticeable in Clear Creek township near the north county line. At the edge of the Wisconsin area, the river valleys are narrow as a rule, and in some instances a partial filling of old depressions by the newer drift is evident. The filling has seldom been sufficient to obscure former valleys or to displace the streams. The border line between the two drifts is frequently marked by low, boggy slopes where springs are not uncommon.

The following table of elevations of various points over the county has been compiled principally from profile data of the different railroads.

LOCALITY.	ALTITUDE ABOVE SEA.	AUTHORITY.
Railroad bridge, North Skunk river	941	C. & G. W. Ry.
Baxter	1033	C. & G. W. Ry.
Ira	862	C. & G. W. Ry.
Railroad bridge, Clear and Indian creeks	848	C. & G. W. Ry.
Mingo	857	C. & G. W. Ry.
Divide between Indian creek and Skunk river	971	C. & G. W. Ry.
Valeria	876	C. & G. W. Ry.
Skunk river bottom W. Co. line	831	C. & G. W. Ry.
Mitchellville	905	C., R. I. & P. Ry.
Colfax	765	C., R. I. & P. Ry.
Skunk river at railroad bridge	753	C , R. I. & P. Ry.
Newton	916	C , R. I & P. Ry.
North Skunk railroad crossing	815	C., R. I. & P. Ry.
Kellogg	810	C., R. I. & P. Ry.
Rock creek	836	C., R. I. & P. Ry.
Sugar creek	877	C., R. I. & P. Ry.
Newberg	1063	Iowa Central Railway.
Murphy	846	Iowa Central Railway.
Sully	943	Iowa Central Railway.
Lynnville Junction	938	Iowa Central Railway.
Monroe railway station	909	Barometer.
Prairie City	920	Barometer.

DRAINAGE.

In the table of elevations the relative altitudes of different parts of the county are indicated. It is seen that the surface has a slight slope to the south. Baxter near the north border of the county, situated on the divide between the North Skunk and the Skunk river systems, is 124 feet higher than the town of Monroe, which is near the southern edge of the county and on the watershed between the Skunk and Des Moines systems. The slope of the last divide is shown by the difference in level between Prairie City, with an altitude of 920 feet, and Monroe with an elevation of 909 feet above tide. It is here but slightly over one foot per mile. From Baxter to Monroe it is more than six feet per mile.

The highest point in the county for which authentic record is to be had is near the northeast corner. Here the divide on which Newberg is situated is approximately 1063 feet above sea level. At the Chicago Rock Island and Pacific railway bridge over Sugar creek the altitude is 877 feet, while the general upland is about 100 feet higher. The divide between North Skunk river and Elk creek, in Lynn Grove township, which is followed by the Iowa Central Railroad, has an elevation of about 940 feet. The north-south slope of the surface in this part of the area is therefore essentially six feet to the mile.

Viewed broadly, Jasper county consists of a fairly level loess-Kansan plain, gently sloping to the south, into which the streams have worn their valleys. Truncating the northwest corner of this plain is the area of subdued topography, the Wisconsin drift; while the northeast corner may perhaps be somewhat modified by the Iowan till sheet. The fact, however, that the principal streams have northwest-southeast courses indicates that the inclination of the drift surface had little to do with determining their direction of flow. They, in general, show evidence of having been established in their present positions previous to the advent of the Kansan glacier. The smaller tributary branches are superimposed and have cut their channels in the materials of the drift alone.

The drainage of the county is effected largely by Skunk river, the North Skunk, and their branches. An area in the

southwest corner, embracing approximately a township and a half, discharges its surplus through several small tributaries directly into the Des Moines, which flows through Marion county a few miles to the south. Tributaries of the Iowa river encroach on the northeast corner of the county, and drain a few square miles in Hickory Grove township. The loess-Kansan area is perfectly drained, the head branches to the tributaries of the competing streams frequently interlocking across the divides. The Wisconsin drift is not so completely drained, and upland ponds and sloughs are not uncommon.

Drainage from any land area is said to be perfect when all portions of its surface have such slope that water that has fallen upon it will by gravity flow from it. It might be further added that the water thus flowing from the land is gathered into well established waterways or stream systems and carried outside of the area in question.

The amount of water draining from the land through surface flow is known as the "run off," and its quantity depends upon the amount of rainfall and on the character of the land itself. Water falling as rain is disposed of in three ways, viz., by evaporation into the atmosphere, by absorption into the earth, and by flowing directly into the streams. The quantities disposed of in these different ways vary according to several factors the most important of which are, angle of slope, geological structure of the rocks, character of the soil, presence or absence of vegetation, and nature of the rainfall. It is apparent that the greater the declivity the greater will be the tendency for water to flow at once into the streams during periods of precipitation. If the country rock is of a dense and non-porous nature the amount absorbed is less than if it is porous or has a jointed structure. Open-textured soils will not only take in moisture with avidity but will also give it up readily when conditions are favorable for evaporation. The denser clay soils absorb water slowly and by capillarity retain it longer, both against evaporative influences and the tendency to pass into the underlying rock strata, than do soils of open texture. It may be said that in general vegetation is a conserver of moisture. It not only prevents rapid and immediate

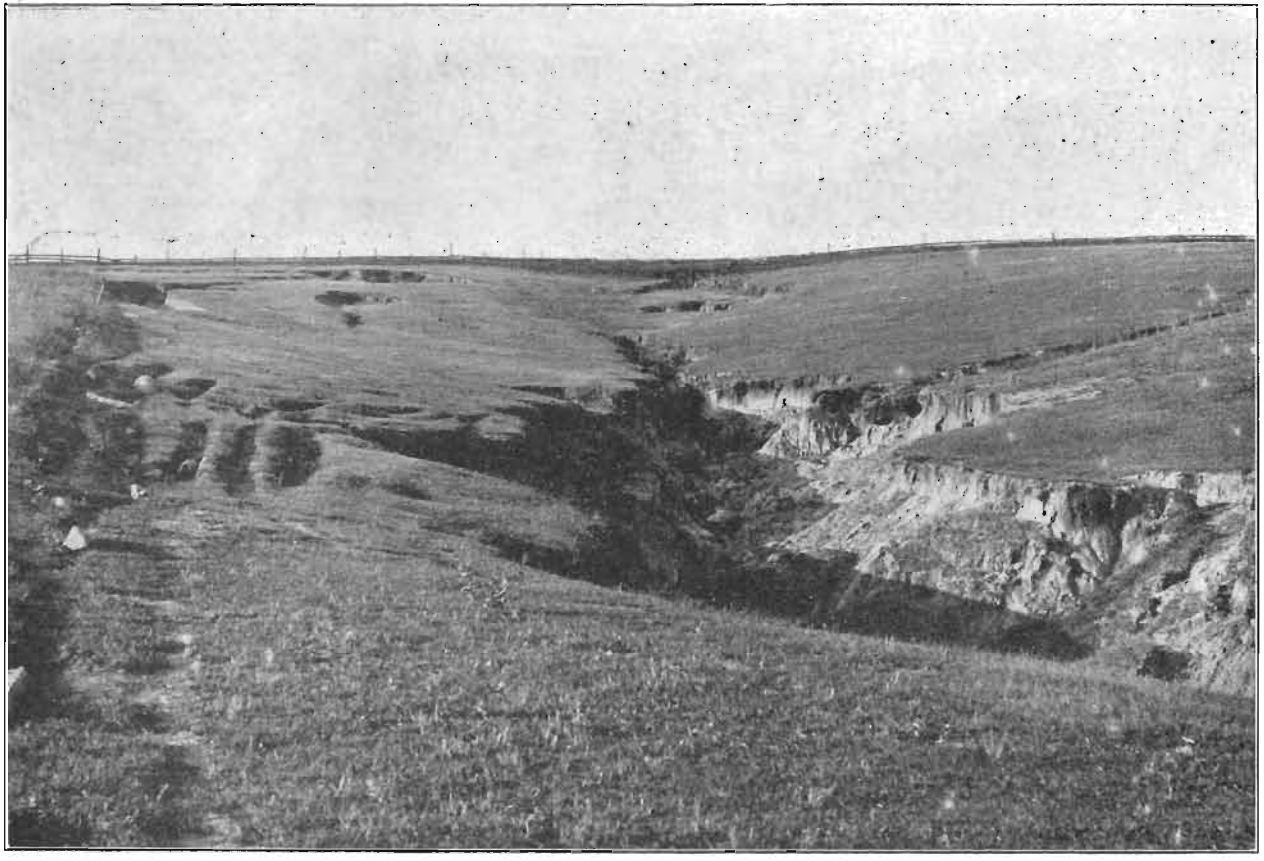

PLATE V. Trenching in the loess and Kansan drift, one-half mile east of Kellogg, in section 25, Kellogg township.

discharge, but accumulated vegetable mould serves as a damp surface blanket to the soil beneath; retaining the moisture and hindering evaporation. It is evident again that the run off is influenced by the nature of the rainfall. A quiet, light, continued rainfall will permit of far greater absorption by the soil and rocks than a heavy, torrential one. Where the total quantity of precipitation is perhaps moderate, economically it may be ample or deficient according to whether it falls in a few heavy showers or is distributed in the different seasons as numerous periods of light rainfall.

In the area under consideration, the slopes, from the standpoint of the disposition of the rainfall, may in general be considered moderate and the soils as a rule of the more porous types. This last is especially true of the loess soils, while perhaps less so of the drift and alluvial varieties. Assuming an average rainfall of thirty-one inches* for this county, there are falling upon its surface of approximately 460,800 acres, more than fifty-one billion cubic feet of water, or more than one billion and a half tons per year. Of this vast quantity, more than six hundred million tons pass into the drainage streams each year.† This is forty per cent of the total rainfall, or somewhat in excess of twelve inches. These figures, it is believed, may be accepted as representing the average run off from drift laden regions in central Iowa where the drainage lines are fully developed, as they are over essentially all of Jasper county.

The remaining nineteen inches of precipitation are absorbed by the rocks and soils from which the moisture for plant growth is drawn. Of this portion, however, a variable percentage is returned to the atmosphere by evaporation, while a greater or less amount sinks into the earth and drains away through subterranean passages. The actual volumes of water disposed of in these different ways are difficult of computation.

*Average of records for eight years, 1893 to 1900, inclusive, at Newton, as reported to the Weather Bureau by Mr. A. Lufkin. The extremes are 19.64 inches in 1894, and 44.9 inches in 1896.

†The data for this estimate are figures for the area of catchment and volume of flow in North Skunk, Skunk and other Iowa rivers, taken from Tenth Census, Water Power of U. S., Vol. XVII, p. 98. Also Water Supply and Irrigation paper No. 80, U. S. G. S., 1903.

The distribution of the precipitation by seasons, at Newton, is indicated in the following table. The three years, 1899, 1900 and 1901 are selected as representative. The data are compiled from the Monthly reports of the Iowa Weather and Crop service:

Months.	1899	1900	1901	Average.
January	.86	.37	1.00	.74
February	.75	1.36	1.80	1.30
March	.74	3.55	3.47	2.59
April	4.52	2.79	1.94	3.08
May	6.61	4.03	2.24	4.29
June	2.00	6.35	3.58	3.98
July	2.30	4.98	2.89	3.39
August	4.51	6.11	1.30	3.97
September	.50	3 73	2 98	2 40
October	.61	4.23	1 80	2.21
November	1.52	1.60	.83	1.32
December	2.34	.97	1.32	1.54
Totals	27.26	40.07	25.15	30 81

Snowfall is estimated as rain. While the actual amount of moisture is moderate, its distribution is such that it is ample for the growth of a variety of crops. This is of course made possible only because of the favorable range of the attendant weather conditions, among which the temperature is of chief importance.

Skunk river.—This river flows diagonally southeastward across the county, entering near the middle of the west boundary and making its exit into Marion county some four miles east of the middle of the southern boundary. It is the largest water way in the region, and with the branches that pay tribute to it, drains not less than two-thirds of the county. The fall of the river from Ames, in Story county, to Rome, in Henry, averages two and one-half feet per mile.* The estimated volume of water passing a point formerly known as Vowell's near the present town of Metz is eighty † cubic feet per second, amounting to nearly two billion gallons in the ordinary year. The flow of the river varies from season to

* Water Supply and Irrigation paper U. S. G. S., No. 44, p. 79.
† Water Power in U. S. Tenth Census, Vol. XVII, 1880, pt. II, p. 98.

season with the rainfall, and is not to be relied upon from year to year. Rapid rises are common during which its flood plain from border to border becomes one broad stream of water. Such inundation is not so common now as in earlier years.

The width of the valley of Skunk river ranges from one mile and a quarter to nearly three miles. Within the Wisconsin drift it is somewhat narrower than its prevailing width elsewhere. In its course through the Kansan drift area two points where the valley is much narrowed are notable. On entering Mound Prairie township the river flows close to the southwest side of the valley and exposes Coal Measure strata for some distance in sections 4 and 5. From this point it is deflected to the opposite valley wall, exposing, in section 3, the Des Moines shales and sandstones. The minimum width of the valley is in this region one and a quarter miles, while, both above and below, it rapidly broadens to from two to three miles. The constriction at this point appears to be due to the more resistant strata through which the stream has been compelled to cut its channel. The Coal Measures here stand higher and represent an outlier which disappears back from the river in both directions. Again in the southern part of Palo Alto township the valley is narrowed to about one mile across the belt of Red Rock sandstone. The constriction is here even more noticeable, and the river flows for one mile between Palo Alto and Fairview townships at the foot of abrupt bluffs of this rock capped with loess. Escarpments of brown, heavy bedded sandstone are also found to the east both above and below Reasnor. The narrowness of the valley can be accounted for only by the resistance to erosion offered by the comparatively hard sandstone.

The flood plain of the river is universally covered with alluvium. Borings made in the valley show it to be filled with alternating strata of river silt, sand, and occasionally gravel. The thickness of these layers above the country rock has not been ascertained. In no instance was record found of any borings in the valley penetrating to the indurated rock. At the locations cited, where the width of the valley is much lessened by the harder strata in its walls, the depth below the

present flood plain seems considerable and has not been reached in the valley proper. These facts indicate that the stream, in the earlier stages of its development, possessed great erosive power, at which time it channeled deeply into the Coal Measures, and, that since, through a change of level, it has partially filled in its old, and probably preglacial, valley. It is further suggested that the surface flow of the river today does not by any means represent all of the water drained away through its course. It may be confidently assumed that a considerable proportion of its discharge, moves beneath the surface in the porous sand and gravelly strata. This probably accounts for its uncertain flow, and for the fact that in certain seasons portions of it may even go dry.

As has been mentioned, a partial filling of Skunk river valley has taken place in the Wisconsin drift area. The deposits of material made by the Wisconsin glacier in Jasper county seem to have been light and were not accompanied by pronounced water action. The pre-Wisconsin banks are perfectly evident, and are covered with a thin deposit of the later drift. Typical Wisconsin material likewise occurs on the floor of the valley as low, irregular mounds or ridges. These often extend well out into the main depression. They may be observed all along the south border in Washington, and are conspicuous below Valeria in Poweshiek township.

The course of the river is in general meandering from one side of its broad flood plain to the other. As is common with the most of the rivers of Iowa that have a northwest-southeast direction of flow, the breadth of flood plain to the northeast side is usually greater than that to the southwest of the stream. In the lower part of its course in the county its channel is often extremely sinuous and unstable. In places, as in section 29, Palo Alto township, it may even fork or anastomose, as one channel becomes unable to accommodate the flow. Sand-bars are a common feature, although not so important as are the deposits of sand and silt to be found at numerous points, chiefly to the northeast side of the river.

The principal branches belonging to the Skunk river system, and which join this river in the county, are Indian, Prairie, Cherry and Squaw creeks. Those tributary streams of importance belonging to the system which join it outside of the county are Elk creek and North Skunk river.

Indian creek.—Indian creek, with several small branches from the north, effects the drainage of the northwest corner of the county, north of Skunk river. It is second in size only to the Skunk itself, and joins the latter stream just east of Colfax, where the blending of the two flood plains is responsible for the unusual breadth of bottom land in the southern portion of Sherman township. Above its confluence and outside of the Wisconsin drift, the width of the valley ranges from one mile to a mile and one-half. The stream is meandering in its valley and branches about three miles above its union with the Skunk, entering this river through two channels at points more than one mile apart. The width of the valley appears to be somewhat out of proportion to the size of the present stream. Within the Wisconsin drift area the valley is much constricted, and has been partially filled by the drift deposits. Where it enters from Polk county its flood plain is one mile in width. In section 28, Clear Creek township, Indian creek has been diverted from its pre-Wisconsin course, and from the northwest corner of this section to the middle of section 24, it flows in a narrow, gorge-like, drift bordered valley which it has excavated since the close of the Glacial period. The stream is here bounded by prominent drift hills to the east, and similar, though less conspicuous, elevations separate it from the old depression less than one mile to the southwest. This last depression can still be clearly traced, leading in both directions into the valley now occupied by the stream.

The most important tributaries to Indian creek are Silver and Wolf creeks, which join the parent stream in the Wisconsin area; and Clear creek with its branch, Mud creek, which follow courses parallel to and outside the border of the later drift. Silver and Wolf creeks are small streams following depressions excavated since the deposition of the Wisconsin drift. They have narrow flood plains that extend but short

distances toward their heads, and the few branches leading into them have eroded sharp V-shaped gorges in the glacial till. The beds of these streams are often very gravelly and the surfacing of alluvium on the flood plains is prevailingly thin.

Clear creek is a much older and longer established stream, its course being entirely in the loess-Kansan area. It has a well developed flood plain, and has reached base level throughout its course in the county. Broadening of the valley is now rapidly going on. The creek swings from wall to wall in a series of bold curves and is gouging out the sides of its valley. Much of the flood plain is thickly wooded, and bayous and cut-offs are common features. The alluvial material in this valley is of considerable depth, as it is also in the channel of Indian creek. Wells in Independence township are reported to have struck "slate" at forty feet, the upper strata being sand and silt. There are indications also that the river has at times exposed the shales where it impinges against its valley wall in western Independence township, but no outcrops are now visible.

Mud creek is a small tributary which takes its rise in the poorly drained area of the Wisconsin drift. It breaks through the drift margin at the south border of section 1, Clear Creek township, and thence flows in a narrow, alluvial valley to its union with Clear creek in section 24.

In northern Independence township Clear creek has deepened its valley 100 feet below the upland to the east; while to the west the adjoining hills rise 135 feet above the water. In section 35, Clear Creek township, it runs seventy feet below the hills to the east. The hills of Wisconsin drift, where Mud creek enters the county, have an elevation of eighty to ninety feet above the stream bed. At the south edge of section 1, where this creek leaves the Wisconsin area, they rise 110 feet, while the loess-covered Kansan to the east is but sixty-five feet above the water. Within the newer drift, Wolf creek has excavated a valley sixty feet below the level of the drift plain, measured in section 10. In section 17, the water level of Wolf creek is 140 feet below adjacent hills to the north. From

the north boundary of section 10 to the south edge of section 17, this stream has a fall of forty-five feet, being approximately eighteen feet per mile.

At the west county line Indian creek has a depression of 110 feet. The hills in section 33, Clear Creek township, rise fifty to sixty-five feet above the flood plain. Indian creek, at the bridge on the east side of section 12, Poweshiek township, is 120 feet below the hills adjoining, both to the north and south.

FIG. 22.—Rapid erosion in Wisconsin drift. This gully, twenty-five feet deep, has been excavated in the past six years.

Prairie and Cherry creeks are streams of some importance flowing into Skunk river, and draining areas in Newton and Sherman townships principally. They have well developed flood plains in the larger portion of their courses, and have accomplished a considerable amount of downward cutting. West of the town of Newton, Cherry creek has exposed the shales and sandstones of the Coal Measures. Here the creek flows 125 feet below the upland. Its average depression is

about one hundred feet. Both of these streams have high gradients, and their headwaters are vigorously extending their drainage territory.

Squaw creek is a branch of minor importance entering Skunk river west of Colfax. It receives some small tribute from the Wisconsin drift area. In section 8, Washington township, one of its feeders has been diverted from its former course by the railroad. An example of unusually deep and rapid trenching is here to be observed. Within a few years this small stream has channeled into the Wisconsin drift in places twenty-five to thirty feet, forming a narrow gorge with precipitous walls for a distance of about one-third of a mile leading into the valley of the Skunk river. See figure 22.

Elk creek joins the Skunk river in Mahaska county, and drains essentially two townships, Elk Creek and Buena Vista. It has a mature valley, and numerous branches extend back to the divides towards the northeast and southwest. The latter commonly occupy sharp ravines or gullies carved in the loess and Kansan drift. Where Elk creek traverses the thin belt of Red Rock sandstone, in Buena Vista township, exposures of this rock occur, and some quarrying has been done near Murphy.

With the exception of Indian creek, North Skunk river is the largest affluent of the Skunk river in the county. It drains, however, a much larger territory than Indian creek, and with its various tributaries it is fully as important as is the parent stream. It maintains a uniform southeasterly direction from its entrance at the northwest corner of Malaka township to its exit from the county in the eastern border of Lynn Grove township. Its branches invade ten of the nineteen civil townships in the county, and drain more than one-third of the total area.

North Skunk river has a flood plain varying in width and ranging from less than one-fourth of a mile in Malaka township to more than three-fourths of a mile at points in the lower part of its course. The valley borders are not always well defined. From the general upland the flood plain is reached by gradual slopes, with low ridges, which often appear to extend into the valley, or even stand quite isolated in the depression itself.

These are always capped with loess and in position suggest portions of an earlier flood plain deposit that the river has since failed to remove. The material beneath the loess, as shown where the river has dissected these deposits, consists of iron-stained sand and gravel, in most places somewhat stratified. A section showing this character may be observed in the southeast ¼ of section 5, Richland township, where a thickness of fifty feet of a sandy, iron-stained drift deposit, capped with thirteen feet of loess, is exposed by the river. In other places, the material is typical, weathered bowlder clay. No evidence of terraces now exists, but such a feature may be obscured by subsequent loess deposition.

The characteristics of the valley in general appear to indicate the putting down of large quantities of partially sorted glacial detritus, probably during the retreat of the Kansan ice when the stream was overloaded. The removal of this material has since been but partially accomplished by the river. The bluffs bounding the valley rise gradually to fifty or sixty feet above the water. They are covered with loess and are more prominent along the west border.

The only tributaries of considerable size join North Skunk river from the east. In order, from the north they are, Snipe, Alloway, Rock and Sugar creeks, the last one meeting the parent river outside the borders of Jasper county. All of these streams have narrow flood plains which are developed but a few miles back from their mouths. Rock and Sugar creeks have cut more deeply, and they, with their branches, have made the relief of portions of Rock Creek township very pronounced. In section 7 Rock creek cuts through the Red Rock sandstone, and quarrying has been done at several points on both sides of the stream. To the west of North Skunk river the divide lies quite close to the channel, there being no tributaries of any length.

Des Moines river.—This system is represented by four small streams which together drain a little more than the southwestern township of the county. A curve in the course of Camp creek causes the stream to encroach upon Jasper county near the southwest corner of Des Moines township. It enters and

leaves the township at points not more than one mile apart. The stream has a well defined valley, but the area it drains is small. Walnut, Calhoun, Prairie and Brush creeks should also be mentioned as belonging to the Des Moines system. Walnut has done considerable downward cutting, and the Coal Measures are exposed at various places along its course. Coal is mined near the north border of section 22, Des Moines township. The shales and sandstones are also exposed along Calhoun creek, where coal has been mined in years past. West of the town of Monroe, along Brush creek, the Coal Measure clays are very near the surface, and are utilized at the Orcutt clay works. The area drained by this stream is insignificant.

STRATIGRAPHY.

General Relations of Strata.

The formations represented in Jasper county belong to two geologic groups which are separated by an unconformity. This break in the continuity of the strata indicates the lapse of an enormous period of time, equal in length to the whole of the Mesozoic era and the Tertiary period of the Cenozoic. During this interval the area under consideration was probably a land surface and subjected to the action of the denuding agents. The surface of the Paleozoic rocks was profoundly eroded previous to the deposition of the Pleistocene strata during the recent or Cenozoic era. The major time divisions represented therefore are the Paleozoic and the Cenozoic.

The strata deposited during these long and widely separated divisions of geologic time are classified in the following table:

GROUP.	SYSTEM	SERIES	STAGE	FORMATION
Cenozoic	Pleistocene	Recent		Alluvium Sands and silts
		Glacial	Wisconsin	Drift
			Iowan	Loess and bowlders
			Kansan	Drift
Paleozoic	Carboniferous	Upper Carboniferous or Pennsylvanian	Des Moines	Red Rock sandstone Shales and sandstones
		Lower Carboniferous or Mississippian	Saint Louis?	
			Kinderhook	Limestones and sandstones

The rock strata lying deeper than those included in the above table have been explored at but one point in the county. The Newton deep well penetrates to the Maquoketa shales of the Ordovician. No other drillings that go beyond the Mississippian were found. In the northeastern portion of the area wells are seldom sunk to indurated rock. Deep wells and the drillings of prospectors, however, invariably encounter a hard limestone overlain usually with a greater or less thickness of the shale or sandstone strata of the Des Moines stage. Few borings in the western part of the county pass through the Coal Measures.

The attitude of the Paleozoic strata is monoclinal, dipping at a low angle to the south and west. Aside from the small triangular area in the northeast corner, which is detached by projecting the line of strike of the Kinderhook in Marshall county, the county is probably completely covered by the sands and shales of the Des Moines stage of the Upper Carboniferous series. These rest presumably upon the Kinderhook rocks in the northern part of the county; while over the remainder of

the area deposits of the Saint Louis stage form the floor of the Coal Measures.

Figure 23 represents a geological section across Jasper county from Prairie City, in the southwestern part, to Newberg in the northeast, showing the attitude and relations of the different formations. The drawing is on a vertical scale of 350 feet to one inch.

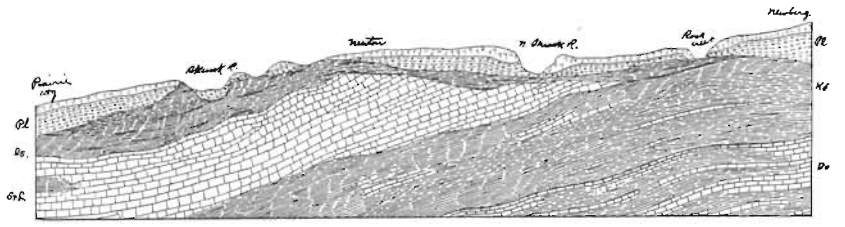

FIG. 23. Geological section from Prairie City to Newberg.
Pl. Pleistocene. St. L. Saint Louis. Ds. Des Moines.
Kd. Kinderhook. Dv. Devonian.

The following records of deep drillings will furnish a general idea of the thickness and depth of the various formations penetrated. The record of the Grinnell well, located in Poweshiek county, some two miles to the east of Jasper county, is also given:

*Grinnell Well Record.**

FORMATION.	THICKNESS.	DEPTH.	A. T.
Pleistocene	212	212	816
Saint Louis and Kinderhook	358	570	458
Devonian	370	940	88
Silurian	260	1,200	-172
Maquoketa	120	1,320	-292
Galena-Trenton	380	1,700	-672
Saint Peter	40	1,740	-712
Upper Oneota (?)	262	2,002	-974
New Richmond (?) at		2,092	

The glacial deposits are here 212 feet in thickness, and, according to Mr. Jones, rest practically on the upper surface of the Saint Louis. This would make the base of the Coal Measures approximately 816 feet A. T.

*Iowa Geol. Surv., Report on Artesian Wells, Vol. VI, p. 291.
Jones. A. J: Proc. Io. Acad. Sci., Vol. II, p. 31, 1894.

COLFAX WELLS.

In the town of Colfax and vicinity there are more than a dozen wells, all drawing their supply from the same horizon, and ranging about three hundred feet in depth. The aquifer appears to be in the Saint Louis limestone. No accurate records of these wells are available, so that the depth at which the Saint Louis is reached can not be definitely stated. The following is the general sequence, as given from memory by one who has had to do with the sinking of several of the wells:

5.	Sand and drift clay	80 feet.
4.	Slate	18 "
3.	Coal	1.5 "
2.	Sandstone, shale and sulphur bands	198 "
1.	Limestone, about	18 "

From this record the Coal Measures are about 217 feet in thickness, and the top of the Saint Louis limestone is about 544 feet above tide. From Grinnell, twenty-eight miles to the east, to Colfax, the dip thus approximates nine and one-half feet to the mile, between six and seven minutes of angle.

A series of coal prospect drillings put down in sections 28, 31 and 32 of Independence township, by Mr. W. P. Rippey, penetrated the following beds:

		FEET.
8.	Yellow to gray clay	0 to 20
7.	Blue bowlder clay	2 to 6
6.	Sand and gravel	80 to 90
5.	Soapstone, slate or sandstone	0 to 4
4.	Clay or slate, lime rock and sulphur stone	30 to 40
3.	Coal	.5 to 1
2.	Sandstone and sometimes "red rust" resting on hard rock.	
1.	Hard rock (limestone ?)	

The "hard rock" is probably the basement limestone and represents either the Saint Louis strata or the Kinderhook; more likely, perhaps, the former, as the Saint Louis limestone has been recognized by Dr. Bain in a drilling three miles north of Mitchellville, in the edge of Polk county*. This stratum has been penetrated to a depth of nearly 100 feet, in a hole sunk

*Geology of Polk County, Ann. Rep. Iowa Geol. Surv., Vol. VII, p. 322.

near the northeast corner of section 32 of Independence township, where it was found to consist of alternating layers of hard and soft rock. Occasionally a thin band is encountered, which is so resistant that it is difficult to drill through it. The presence of these bands is perhaps suggestive of the Kinderhook, as resistant layers of chert are a constant feature of that formation where it is exposed in Marshall county.

Mississippian Series.

Representatives of the Lower Carboniferous or Mississippian series, of the Carboniferous system are nowhere exposed in the county. In Marshall county to the north exposures of the Kinderhook strata are found along Timber creek near Ferguson, between five and six miles from the Jasper county line. The Coal Measures in Marshall county rest upon the Kinderhook beds; strata belonging to the Saint Louis stage being in general absent. As has been noted earlier, the Saint Louis limestone is recognized in the Grinnell deep well section. Mr. A. J. Jones* assigns to it a thickness of fifty-eight feet, and refers underlying argillaceous beds to the Augusta stage. Professor Norton, in his report on the Artesian Wells of Iowa, notes that the Saint Louis limestone is present, but does not separate this stage from the preceding one. The limestone in which the first flow of water is obtained at Newton is referred by Professor Norton† to the Saint Louis. This authority also expresses the probability that the source of supply in the Colfax wells is in the same formation.

The strata of the Saint Louis stage are typically exposed in Mahaska and Marion counties. In the latter a thickness of 270 feet of Mississippian rocks above the Kinderhook was penetrated in the deep well at Pella. At Mitchellville, in Polk county, Bain‡ has with some doubt referred forty feet of strata to the Saint Louis stage; while to the westward the formation rapidly thickens as the records of the Greenwood Park well and other deep drillings in and near Des Moines go to show.

*Iowa Acad. Sci., Vol. II, p. 32, 1894.
†Artesian Wells of Iowa. Iowa Geol. Surv., Vol. VI, p. 292.
‡Ann. Rep. Iowa Geol. Surv., Vol. VII, p. 291.

Taking a somewhat broader survey of the relations between the Coal Measures, the Saint Louis strata and the underlying rocks, it is found that, at no place in the counties to the southeast, along the strike of these strata, where the geology has been studied in detail, has the absence of the Saint Louis limestone been observed. To the northwest across Marshall and Hardin counties the rocks of the Des Moines stage rest upon beds older than the Saint Louis. In Webster and Humboldt counties the Saint Louis limestone is again recognized. It is thus seen that over the area mentioned the materials composing the Saint Louis strata were either never deposited, or were worn away before the Coal Measures were laid down. The first assumption seems probable in view of the fact that where observed in the Grinnell and Mitchellville wells these strata are thin in comparision with the corresponding strata farther south and west. A gradual thinning or wedging of the Saint Louis deposits is indicated, and beyond its limits the Des Moines strata overlap, and rest upon the older formations.

In Jasper county the area underlain by the Kinderhook rocks can not be definitely outlined as these materials are deeply buried beneath the glacial deposits; nor are any strata referable to the Augusta known. The area outlined as Kinderhook on the map is determined by projecting the line of the strike from outcrops in Marshall county. Neither can the border of the Saint Louis deposits be traced. It is not believed to be the country rock in any part of the county, but the interest that attaches to it comes from its wedging out and giving way to the Kinderhook as the floor upon which the Coal Measures rest. The line of overlap apparently has a northwest-southeasterly course, and can not lie far within the limits of the Coal Measures themselves.

Pennsylvanian Series.

DES MOINES STAGE.

All of the Paleozoic rocks exposed in the county belong to the Des Moines stage of the Upper Carboniferous series. As indicated on the Geological map, they cover the entire county, with the exception of the triangular area of Kinderhook in the extreme northeast corner. They consist of interstratified shales, sandstones, coal and occasional thin beds of limestone. Their character varies rapidly from place to place. With the exception of the Red Rock sandstone, none of the strata are sufficiently persistent over any considerable area to be relied upon in correlation. The shales are prevailingly sandy and grade laterally into argillaceous sandstones. The sandstone layers are in places calcareous and, especially in connection with certain coal seams, pass into arenaceous limestones. Limestones of the darker colored variety occur as lenses and concretionary masses in some of the coal basins. The coal beds are likewise of limited lateral extent, and are not found at any constant horizon.

The thickness of the Des Moines strata varies from nothing in the northeast to nearly 200 feet in the vicinity of Colfax. No data are to be had as to their thickness in the southern part of the county. A prospect hole three miles north of Mitchellville*, in the border of Polk county, passes through 160 feet of Coal Measure strata. In Marion county to the south, B. L. Miller† estimates the maximum thickness of the Coal Measures as 600 feet. Because of the uneven floor upon which they rest, however, their thickness will range within broad limits in even small areas.

In Jasper county the rocks of the Des Moines stage are universally covered with drift. Previous to the deposition of the glacial materials the land surface was irregular, and erosion has since gone on through long periods of time. The depth beneath the surface at which the Coal Measures now lie has been

* Geology of Polk County, Bain, Iowa Geol. Surv., Vol. VII, p. 322.
† Geology of Marion County, Miller, Iowa Geol. Surv. Vol. XI, p. 147.

determined largely by these factors. Exposures are not numerous, as a rule, but are found fairly well distributed over the southern half of the county. Although the best sections are to be observed along stream ways, natural outcrops are not lacking over the uplands away from the streams.

The following section is found east of the wagon bridge over Skunk river in section 32, Elk Creek township, where the river impinges against the east wall of its valley:

		FEET.	INCHES.
5.	Loess and Kansan drift	4	
4.	Shale, sandy and carbonaceous, and interstratified with thin bands of sandstone; plant stems preserved in sandstone	8	
3.	Sandstone, brown, compact		7
2.	Coal	1	6
1.	Fire clay and talus, to water	10	

The strata are here exposed for a distance of three hundred feet and have the attitude of a low anticline, the section given being measured near the center of the arch. The coal seam ranges from eight inches to one and one-half feet. The band of sandstone above the coal is not constant, being frequently replaced by arenaceous shale.

On the county line road, near the middle of the south side of section 31, Lynn Grove township, the Coal Measures, capped with drift and loess, outcrop in the following sequence:

		FEET.	INCHES.
5.	Clay shale, light in color, with sandstone and iron-stained concretions	17	
4.	Carbonaceous shale	3	
3.	Coal blossom		8 to 9
2.	Obscured by talus	30	
1.	Sandstone, shattered, iron-stained (in gutter at south side of road)	4	

Along the North Skunk river, from Lynnville northward into Richland township, the Coal Measures outcrop at several points. In section 3, Lynn Grove township, and section 33, Richland, along small branches leading into the Skunk river valley, the shales are exposed. Along the east side of the river, near the middle of the west side of section 35, Richland township, a fif-

teen-foot stratum of sandstone is quarried on a small scale. On the hill slope above the quarry, the base of which is but a few feet above the flood plain of the river, coal has been mined in shallow drifts. The quarry section is as follows:

		FEET.	INCHES.
5.	Weathered shale	5	
4.	White sandstone, soft, grading downwards into pink, brown and red	5	6
3.	Plastic, white clay		10
2.	Sandstone, red to brown, compact; containing many small cavities lined with plastic clay, or containing pulverulent, red ochre. Micaceous, with fossil lepidodendrons	15	
1.	Carbonaceous shale	1	6

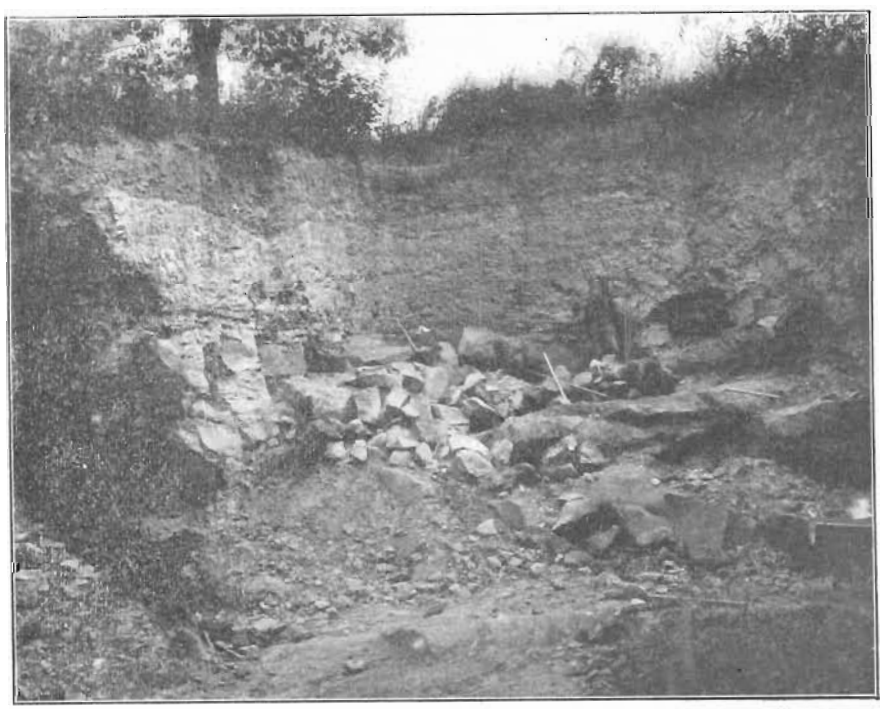

FIG. 24. Quarry in Coal Measure sandstone, north of Lynnville, section 34, Richland township.

Similar strata are exposed at intervals for about one-half mile south along this side of the valley.

Mr. J. D. Whitney* mentions sandstone outcropping in "low ledges along the North Skunk, below the junction with Rock creek." These are referred by him to the same horizon as the heavy sandstone exposed on Rock creek and on North Skunk river, east of Kellogg. The present study indicates that the sandstone noted by Whitney should be referred to the coal-bearing strata, while the sandstone along Rock creek belongs to the Red Rock sandstone formation which will be considered later.

About ten feet of sandstone are exposed near the middle of section 16, Richland township, on the west bank of the river a short distance south of the bridge, where a considerable amount seems to have been quarried, although no work has been done here for years. This rock probably belongs to the Red Rock sandstone.

In the region to the west of the belt of Red Rock sandstone, exposures are found along Skunk river below the junction of Indian creek, along Cherry creek west of Newton, and at various points in the northern part of Palo Alto township. In the southwest corner of the county the small streams, Brush, Calhoun and Walnut creeks, have exposed the Coal Measures along their courses.

A well at the McAllister clay plant in Newton, affords the following section:

		FEET.
4.	Soil, yellow clay and blue gravelly clay	100
3.	Sandstone	10
2.	Soapstone, clean; slate; one inch coal; fire clay, so-called	100
1.	Sandstone	15

One-half mile north of the Chicago Rock Island & Pacific railroad bridge over the Skunk river, in section 10 of Mound Prairie township, where the river runs close to the east valley wall, the following sequence of strata has been observed in coal mining operations, but the thickness of the various members can not be given because of their variability. Here a heavy mantle of Kansan drift and loess overlies the Coal Measures. The indurated rocks are frequently separated by a few feet of

*Geol. Surv. of State of Iowa, Vol. I, part 1, p. 272, 1858.

stratified sand and gravel from the drift materials. First beneath the drift, is a two-foot seam of coal. Beneath this are fire clay, shales and sandstones, thirty to thirty-five feet. A lower vein of coal, varying from fourteen inches to four feet in thickness, occurs near the water level and it is usually overlain by a thin band of sandstone. Large masses of calcareous clay-ironstone occur in connection with the coal seam. A carbonaceous shale lies above this sandstone roof, then a band of white sandstone which grades into sandy shales above. The complete section at this point involves some forty feet of Coal Measure strata.

In the northwest ¼ of section 4 of Mound Prairie township, west of the wagon bridge, the Skunk river flows at the foot of an exposure which shows in general the following sequence. The various layers change rapidly, both in character and thickness, when followed along the outcrop. The measurements given were made near the east end of the exposure.

		FEET.	INCHES.
6.	Sandy loess	15 to 18	
5.	Sandy clay-shale, grading into laminated sandstone	17	
4.	Sandstone	4	6
3.	Carbonaceous shale, coaly	1	
2.	Fire clay, with iron concretions	2	
1.	Arenaceous clay-shale, and talus, to water	6 to 8	

A shaft at the "Klondike" coal mine in the northeast ¼ of section 20, Mound Prairie township, was sunk through the following strata:

		FEET.	INCHES
8.	Clay, free from gravel	15	
7.	Black slate	5	
6.	Coal		8
5.	"Fire clay," including eight inches of sandstone	13	
4.	Flint rock ("cap rock")		10
3.	Black slate	35	
2.	"Corduroy" slate (white with streaks of limestone)	20	6
1.	Coal	4	8

The following is the section of a well put down on the farm of A. W. McDonald, in the southwest ¼ of section 8, Washington township:

		FEET.	INCHES.
10.	Yellow bowlder clay	100	
9.	Hard rock	1	
8.	Slate and shale	40	
7.	Coal	2	
6.	"Fire clay"	2	6
5.	Slate	18	
4.	Coal	2	6
3.	"Fire clay"	4	
2.	Magnetic sand rock, grey	8	
1.	Rock, brown	62	6

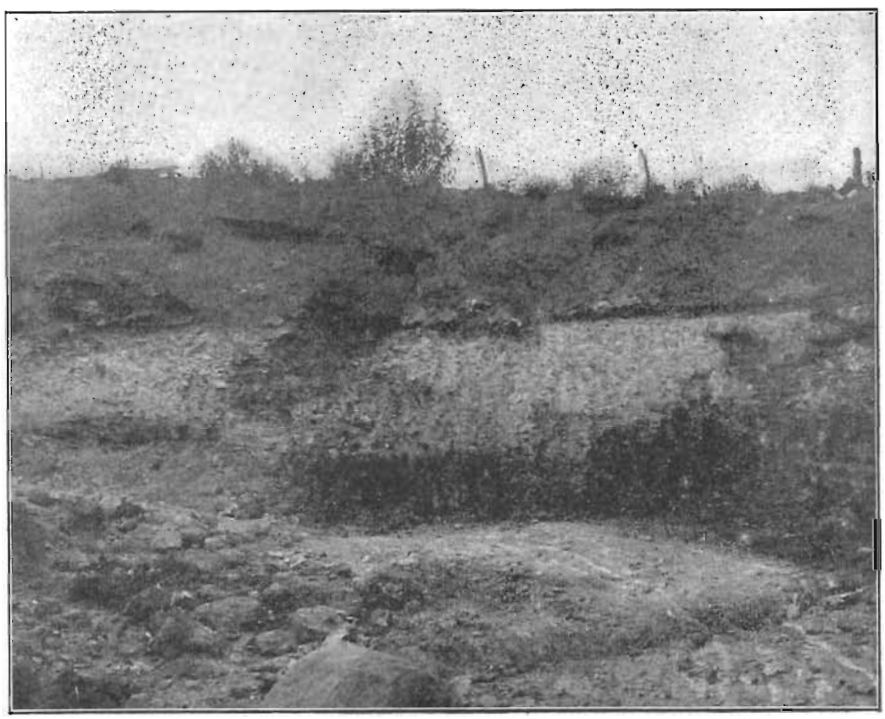

FIG. 25. G. H. Orcutt clay pit. One-half mile west of Monroe. Coal blossom and shale above a thick bed of fire clay.

At the G. H. Orcutt brick plant, one-half mile west of the town of Monroe, shale and fire clay of the Des Moines stage are made use of. The absence of the usual interbedded sandstone is especially noticeable. The pit section includes nine feet of fire clay below a thin band of coal blossom, the latter being covered with a few feet of loess-drift clay. See figure 25.

About five feet below the bottom of the bank is a ten-inch seam of coal. This crops out in a ravine a short distance below the plant. Beneath this coal the fire clay has been penetrated to a depth of twenty-five feet. The well at this plant is 197 feet in depth. No coal appeared in the well section, the lower ninety-seven feet being reported as through sandstone.

In sinking a shaft at the Wm. White mine in section 22, Des Moines township, the following strata were penetrated. The shaft is located on the slope at the west edge of the valley of Walnut creek.

		FEET.	INCHES.
6.	Gravelly surface clay	15	
5.	Sandstone		4
4.	Sandy fire clay	14	3
3.	"Cap rock" (limestone)	1	6
2.	Slate, jointed	2	
1.	Coal	4	

The foregoing sections will emphasize the variability of the Coal Measure strata. The localities in which exposures are most abundant represent areas of thin drift covering. In such areas the coal-bearing strata lie close to the surface, and in these regions the most of the coal mining has been done. The coal beds of the county that have been explored appear to exist in separate and isolated basins of limited extent. The lack of persistence of individual strata in general makes it impossible to accomplish much in the way of correlation between separated localities.

RED ROCK SANDSTONE.

This formation is included in the Des Moines stage of the Upper Carboniferous series, but it may be differentiated from the Coal Measures proper because of its uniformity, and the somewhat unique relation which it appears to bear to the other members of the series. In Jasper county it occupies a narrow, elongated area coextensive in direction and width with the territory covered by it in Marion county. While its boundaries could not be accurately traced, its probable limits have been mapped by a study of outcrops and well sections. The general trend is northeast-southwest, and in width it averages two and

one-half to three miles, tapering to the northward. No evidence of it was found beyond the exposures along Rock creek and its branches in sections 9 and 16 of Rock Creek township.

Outcrops of this rock are to be seen at various points near Reasnor, on both sides of the Skunk river; along Buck creek; on Elk creek near Murphy; along North Skunk river in the vicinity of Kellogg, and on Rock creek as noted above.

Mr. B. L. Miller * has briefly described the quarry exposure in the northwest ¼ of section 8, Fairview township, as follows:

		FEET.
4.	Soil	1
3.	Weathered, brown sandstone	9
2.	Heavy beds, yellow-grey, variegated	10
1.	Dark red sandstone, heavy bedded	8

Two small quarries are opened here and both the brown and the red stone have been taken out. Cross-bedding is very conspicuous in the upper part of the section. The change in color is gradual from the top downwards, and appears to be due to the degree of leaching and hydration which the rock has undergone. Chemical tests of the brown sandstone show a loss on ignition of 3.8 per cent, and 16.27 per cent of iron and alumina oxides. The dark variety pulverizes to a deep red and ocherous powder, and analyzes 31.5 per cent Fe_2O_3. At one point in section 21 of Fairview township a weathered outcrop of the red stone occurs from which the resulting ocherous iron oxide has been taken for mineral paint. In places in both the red and the brown sandstone bands or nodules of a dense, flinty character occur, which appear to be quartzitic in nature and origin.

The outcrop of this rock is practically continuous along the west border of the Skunk river valley from the exposure just described to those along Buck creek near Monroe. The hills bounding the valley are all supported by the sandstone, and where the river flows close to the west edge of its valley, west of Reasnor, the brown sandstone appears as a continuous ledge for some distance in section 10 of Palo Alto, and section 9 of Fairview townships. In the road across the south part of section 29, Fairview township, the sandstone is exposed on both

*Geology of Marion County, Ann. Rep. Iowa Geol. Surv., Vol. XI, p. 159, 1900.

sides of small stream near the center of the section, east and west. The drift covering is thin here and the rock is weathered into a friable sand which can be removed with the shovel. The sandstone outcrops again at the point of a prominent hill known as "Stony Point" in section 14, Elk Creek township, where the river flows near the east side of its valley. A thickness of about forty feet of heavy beds is exposed, having the usual texture and brown to gray color. Although quarrying has been done here, the section is much obscured and the red sandstone can not be seen in place. However, the presence of loose fragments, indicate that the dark red variety is present above the water level of the river. Fairly well preserved fragments of Calamite stems are to be found in the talus from the weathered top strata.

On the hill slope a short distance north of the town of Reasnor, fourteen feet of the sandstone may be observed in a small quarry; the prevailing color is brown, approaching a red, in places. The sand grains are at times so coarse and irregular in size as to give the rock a finely conglomeratic texture. Many of the largest grains are of a jaspery nature, and some, approaching a pebble in size, appear to be fragments of an earlier sandstone. Cross bedding is not uncommon. The base of this exposure is about sixty feet above the flood plain. In detail, this section is as follows:

		FEET.	INCHES.
7.	Loess, becoming fine sand on the hill-top...	4	
6.	Buff sandstone, micaceous		6
5.	Brown sandstone, cross-bedded.....	2	
4.	Heavy-bedded sandstone, conglomeratic	2	6
3.	Laminated, red and grey sandstone, cross-bedded.....	1	6
2.	Heavy bed of brown sandstone, containing ferruginous, sometimes hollow, nodules.....	4	6
1.	Like No. 2 to base of quarry.....	3	

In the northwest $\frac{1}{4}$ of section 21, Buena Vista township, on Elk creek, there is exposed in two small quarries a maximum thickness of twenty-two feet of the sandstone. It exhibits the same characters as in former sections as to bedding and color. Some of the red is to be seen but the brown variety prevails. In the Lanphear quarry the jaspery, quartzitic bands are quite pronounced, as are also the spheroidal nodules.

The latter frequently consist of concentric, ferruginous shells between which sandstone is intercalated. The greatest thickness of beds is found in the old Dooley quarry, where the ferruginous bands appear as firm crusts of siliceous limonite, separating the major beds of the section. The rock is coarse in texture, friable, and varies in color from gray to deep red. All the layers seem to be thoroughly impregnated with iron oxide.

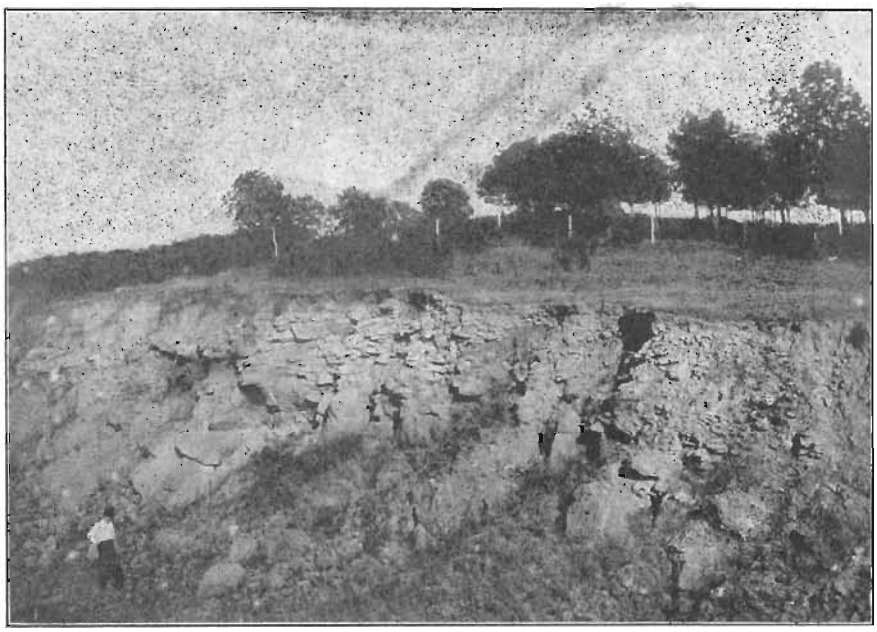

FIG. 26. Exposure of weathered, brown sandstone of the Red Rock formation, in section 30 Rock Creek township.

The Red Rock sandstone outcrops on both sides of the North Skunk river east of Kellogg. In the western part of section 30, Rock Creek township, a quarry face some six to eight hundred feet in length has been opened along a small creek. See figure 26. In the northeast ¼ of section 25, Kellogg township, the sandstone may be seen in the old railroad quarry. In the southeast ¼ of the same section along a small creek entering from the south, heavy ledges of the same strata are exposed. The maximum thickness here is twenty-five feet, while along the north side of

the river but sixteen to eighteen feet are in view. The nature of the sandstone is such as to leave no doubt of its equivalence with the beds on Elk creek near Murphy. The concretionary iron nodules are more common here, being frequently of considerable size, and partly filled with argillaceous material. The dense, siliceous bands are quite conspicuous, assuming often the appearance and properties of a partially hydrated hematite iron ore. They mark the lines of contact between heavy beds, and attain a thickness of several inches.

The quarry openings along Rock creek, in section 17 of Rock Creek township, are the most northerly exposures of this formation in the county. At the old Morgan quarry in the northwest ¼ of the same section the following strata may be seen:

		FEET.	INCHES.
5.	Kansan bowlder clay	8	
4.	Weathered, brown sandstone	1	6
3.	Ledge of buff sandstone	6	
2.	Shattered and cross-bedded sandstone	2	
1.	Reddish-brown sandstone in a heavy bed	4	

Prospecting in the neighborhood indicates the presence of the sandstone as far north as the edge of this section, and towards the northeast into section 8. The rock has been quarried near the middle of section 17 where the wagon road crosses Rock creek. In the northeast ¼ of the northwest ¼ of section 9, along a branch of Rock creek, a spring line appears to represent the base of the sandstone. A few feet only of crumbled sandstone are to be seen in place, but the evidence here, and in section 6 to the south, goes to indicate that this formation is very thin. No further trace of it is to be found towards the northeast.

The Red Rock sandstone appears to occupy a narrow, elongated depression in the Coal Measure strata. In general it stands higher than the Coal Measures outcropping on either side of it, but this may be accounted for by its more resistant character. It lies unconformably upon the Coal Measures and, at two points where it has been penetrated, the Coal Measure strata lie beneath it. At the Herwehe quarry west of Reasnor,

in Fairview township, a drilling passed through thirty-five feet of the sandstone below the base of the quarry before reaching the shales. At this point therefore the sandstone has a total thickness of at least fifty-nine feet. On the farm of Cyrus Nolan in the southwest ¼ of section 23, in Fairview township, the following is the section shown in a well:

		FEET.	INCHES.
6.	Brown sandstone	2	
5.	Clay	12	
4.	Slate	54	6
3.	Hard sandstone	1	6
2.	Coal (?)	4	6
1.	White sandstone	9	

FIG. 27. Herwehe quarry in Red Rock sandstone. Northwest quarter of section 8, Fairview township. Cross-bedding is conspicuous throughout the section.

The brown sandstone may be seen in place at the top of the well, and undoubtedly represents the attenuated, eastern border of the Red Rock formation.

In Marion county the Red Rock sandstone is known to rest directly upon the Saint Louis beds at a point near Elk Cliff. Elsewhere in this county, and wherever observed in Jasper county, Coal Measure shales underlie the sandstone. The thickness of this formation in Marion county is estimated at 100 feet. So far as can be ascertained, its thickness in Jasper county ranges from more than sixty feet as a maximum, near Monroe, to nothing in Rock Creek township where it disappears. The area occupied by it is tongue-shaped tapering to the north.

Mr. B. L. Miller* suggests contemporaneous erosion as the best explanation for the peculiar occurrence of this sandstone. It undoubtedly occupies a valley in the Coal Measure strata, and contemporaneous excavation appears adequately to account for such a depression. Some clue as to the direction from which the sand was brought in during deposition may perhaps be obtained by a study of the cross-bedding which is conspicuous in nearly every exposure. This structure is often clearly brought out by the presence of alternating laminæ of brown or dark red, and buff to light yellow sands. While the dip and the strike of the cross beds were not found to be constant in any two exposures, nor in any two beds in the same exposure, it was observed that the strike was prevailingly to the south of east and in a number of instances, where it could be accurately measured, proved to be at essentially right angles to the northeast-southwest direction of the depression which the sandstone fills. This is, of course, not corroborative evidence as to the origin of the depression itself but rather points to the fact only that much of the deposit was put down by water moving in a definite and constant direction; and the attitude of the bedding planes suggest as the agent a current of water flowing through this ancient valley.

*Geology of Marion County. Iowa Geol. Surv., Vol. XI, p. 154, 1901.

IOWA GEOLOGICAL SURVEY

MAP OF THE SUPERFICIAL DEPOSITS OF JASPER COUNTY, IOWA.

BY

IRA A. WILLIAMS.

1905.

Scale 1/125000

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

GEOLOGICAL FORMATIONS

- WISCONSIN DRIFT
- IOWAN DRIFT, OVERLAIN BY LOESS
- KANSAN DRIFT, OVERLAIN BY LOESS
- ALLUVIUM

INDUSTRIES

CLAY PLANTS, USING SURFACE CLAYS ▲

DRAWN BY F.C. TATE

CLEAR CREEK · INDEPENDENCE · MALAKA · MARIPOSA · HICKORY GROVE

POWESHIEK · SHERMAN · NEWTON · KELLOGG · ROCK CREEK

MOUND · PALO ALTO · BUENA VISTA

WASHINGTON · PRAIRIE · RICHLAND

DES MOINES · FAIRVIEW · ELK CREEK · LYNN GROVE

Clyde, Baxter, Newburg, Mingo, Ira, Rushville P.O., Greencastle, Valeria, Goddard, Kellogg, Newton, Turner P.O., Oswalt, Colfax, Dotson Sta., Metz, Severs, Murphy, Prairie Bell P.O., Prairie City, Kilduff, Sully, Lynnville, Reasnor, Fairmount, Galesburg, Vandalia, Franklin P.O., Romans Lake, Monroe

T. 81 N. · T. 80 N. · T. 79 N. · T. 78 N.

R. XXI W. · R. XX W. · R. XIX W. · R. XVIII W. · R. XVII W.

IOWA LITHO. CO.

Pleistocene System.

Glacial deposits cover essentially the whole of Jasper county. Materials representing three ice invasions are present. They consist in large part of bowlder clays associated with gravels, sands and silts that have been partially reassorted by the erosive agents. As mentioned under Topography, the surface features of the county are in general due to the ice deposits. The maximum recorded thickness of the drift is 320 feet.

At some points beds of gravel and sand are found at the base of the Kansan drift. In fact, it is quite the usual thing for well drillers to report such beds immediately overlying the shales of the Coal Measures. It is possible that these may indicate an earlier or pre-Kansan drift. No exposures were observed, however, nor were accurate well data secured showing the presence of an earlier drift. The gravel beds could have been derived from the Kansan during its deposition.

Deposits referable to the Pleistocene system are, therefore, the Kansan drift, a possible thin veneer of Iowan, the loess, Wisconsin drift and post-glacial materials.

KANSAN STAGE.

Jasper county is included in the area covered by the Kansan glacier which extended southward far beyond the borders of the state, into Missouri and Kansas. The materials left by this sheet of ice comprise in general a heavy deposit of heterogeneous bowlder clay that mantles the whole county. The character of the drift is not constant. In places it becomes very gravelly and by its partial stratification shows the effect of running water in its deposition. Pockets and lenses of sand are not infrequent in the bowlder clay. The Kansan varies a great deal in thickness according to irregularities of the old land surface on which it was spread. It is not uncommon to find well sections in which a thickness of 200 feet of material referable to the Kansan has been penetrated. Notable areas where the drift is unusually thick are northern Newton township and in much of the northern part of the county.

Exposures of any considerable importance are rare. At occasional points along North Skunk the river has gouged out its valley walls, and sections of some interest may be observed. Near the southeast corner of section 5, Richland township, at the west bank of the river, is an outcrop thirty-seven feet in thickness of modified Kansan drift, capped with thirteen feet of loess. The drift is very sandy, the sand being mostly in pockets, although it is in part stratified. The whole section is brown and iron-stained and certain bands are quite firmly cemented with iron oxide.

In the southwest $\frac{1}{4}$ of section 8, Kellogg township, and southward into section 17, the river is skirted on the south by high bluffs of Kansan till and loess. In these bluffs exposures, sixty to seventy feet in thickness, of blue and oxidized till are seen, capped with twenty feet or more of loess. The bluffs rise immediately from the river and form a conspicuously abrupt topographic feature. Farther up the North Skunk river, in section 1 of Newton township, near the middle of the north side of the section, about forty-three feet of typical Kansan drift are exposed. The lower twenty-two feet are oxidized, blue bowlder clay.

Railroad cuts furnish occasional instructive drift sections. Figure 28 is from a photograph showing a hill of Kansan drift, covered with loess. At the contact of the loess and drift there is frequently found a band of iron-stained bowlders which conforms to the contour of the drift surface. These are large and small, but all above the sand grain in size. The ferretto is always conspicuously evident, which indicates a long period of weathering prior to the loess. If it is granted that winds have been instrumental in loess deposition, the bowlder bands may represent the heavier portions of the till which neither the wind nor rain erosion could easily remove; considering loess deposition to have been well under way while the drift surface was still largely unprotected by vegetation.

The number of classes of rocks represented in the bowlders of the Kansan drift is surprising. And yet when one reflects that some have been transported from even the more remote regions of Canada, there is little cause for surprise. A list of

the varieties picked from one exposure, not more than fifteen feet in vertical extent, includes the following which were recognized with the naked eye: chalcedonic quartz, white glassy quartz, jaspery flint, quartz porphyry, fine-grained gray granite, fine-grained pink granite, coarse-grained pink and gray granites, dark gray hornblendic gneiss, white, red and

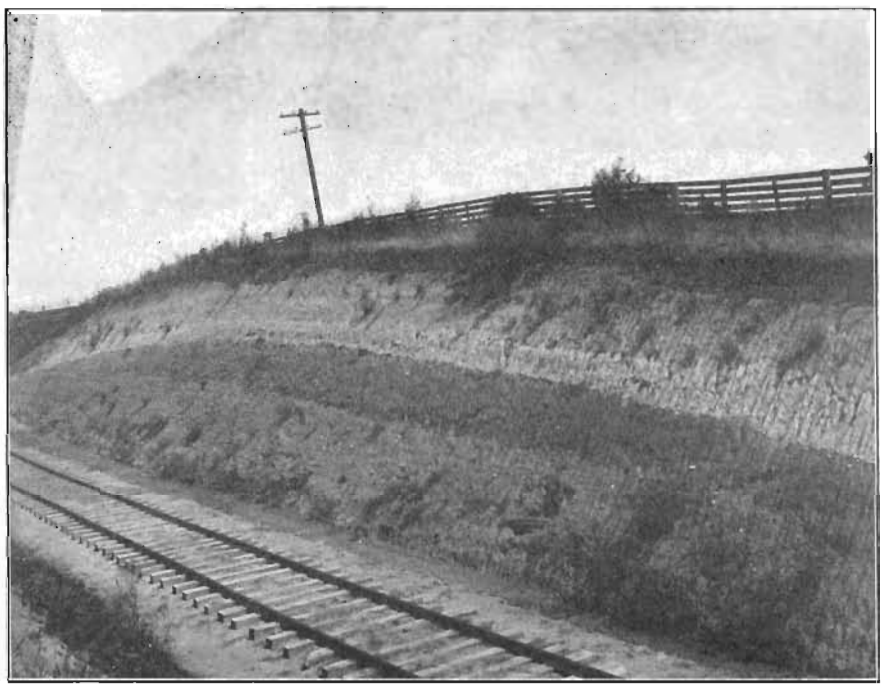

FIG. 28. Loess overlying Kansan drift, in cut along the Newton and Northwestern railway section 5 of Palo Alto township.

pink quartzites, weathered limestone, gray sandstone, clay ironstone and septarian nodules with calcite veining. Aside from those listed, at least a dozen varieties of the darker colored, more basic, igneous rocks were collected which would require microscopic examination for even an approximate classification.

IOWAN STAGE.

The observed facts concerning the Iowan drift in this county have been fully stated under Topography. No deposits of characteristic bowlder clay attributable to this ice sheet were found. Occasional large, fresh granite bowlders and the general monotonous, level surface constitute the basis for the inference that the Iowan ice probably spread over the northeast corner of the county.

LOESS.

The loess of this area exhibits the usual characteristics of that deposit. It is a fine-grained, silty material, which forms a continuous surface covering over the whole county outside of the area of Wisconsin drift. It is universally pebbleless with the exception of the lime carbonate concretions which in places are very abundant. The loess frequently grades downward into more sandy varieties, and even into fine sand, at times, which appears to be continuous with the body of the deposit. It varies in thickness from a scarcely recognizable veneer to a thickness of more than twenty-five feet. Although usually structureless, a banding is frequently noticeable, but the bands are not persistent or uniformly horizontal, and will not be mistaken for the characteristic stratification of strictly water-laid sediments.

As has been noticed in other portions of the state, the loess appears to bear a genetic relationship to the Iowan drift. Skirting the edge of this drift sheet, the loess hills are generally conspicuous and from this belt the loess is spread over all earlier formations to the southward beyond the boundary of the state. In Marshall and Tama counties loess overlies the Iowan drift near the border of this drift sheet.

It is found, further, that the loess materials are in general coarser near the Iowan border and grade into finer and finer silts as its distance increases. This rule will scarcely hold where, as in many instances, the loess bordering river valleys can be seen to have come partly from the flood plain itself.

There are certain features of the loess and its relation to associated deposits that may be mentioned. It was possible in a

few instances to view sections showing loess covering irregularities in the Kansan drift surface. As a general rule the topography of the underlying Kansan is preserved in the loess features of today. The thickest loess rests on the tops of the hills, but the capping of loess does not always cover symmetrically the earlier contours. Occasional road cuts, the best examples of which were observed along Rock creek in Hickory Grove township, show the greater thickness of loess on one flank of the old Kansan hills to such an extent that the highest points of the present surface come above the flanks, rather than over the old hilltops. Materials deposited by winds are heaped up largely on the opposite side of an obstruction from which the wind blows. Could a sufficient number of sections be studied, they might afford a definite clue as to the direction of the prevailing winds during loess deposition.

Another possible clue to the wind direction may be had from the fact that the thickest accumulations are found along the east and south borders of the river valleys. This distribution suggests northwest winds, and the great thickness of the deposits suggests a readily available source of supply. The broad, open flood plains of the rivers may themselves have afforded material transportable by winds. Dr. Beyer*, in his report on Story county, has pointed out that such accumulation is in places going on at the present time. This process can be observed at several points along the Skunk river where sands are shifting to such an extent that considerable areas are made barren of vegetation. The deposition of considerable quantities of material similar to that which makes up the mass of the loess is not, however, believed to be going on in this county at present.

Shells of land mollusks are found in the loess at various points. No effort was made to collect a complete series of the fossils in the loess. Prof. T. E. Savage has identified the following: *Succinia avara* Say, *Succinia ovata* Say, *Polygyra multilineata* Say, *Pyramidula striatella* Anth. The fossils were most abundant in the heavy deposits occurring along the principal waterways. In fact, few, if any, were seen in upland localities.

*Ann. Rep. Iowa Geol. Surv., Vol. IX, p. 213, 1898.

The best sections of the loess are to be observed in road cuts along the major streams. Figure 29 is a typical exposure at the southeast corner of section 20, Elk Creek township. Molluscan remains and calcium carbonate concretions are abundant in this exposure. Excellent sections are also to be observed along the Chicago, Rock Island and Pacific railway east of Colfax. Where the railroad leaves the flood plain of the Skunk river, in

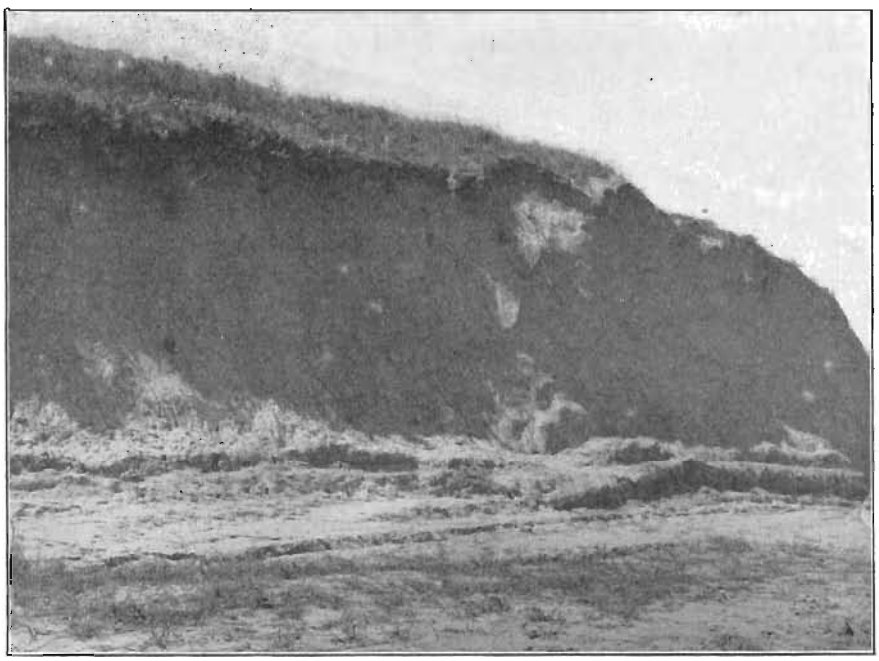

FIG. 29. Loess bluff twenty-five feet in height, containing numerous land shells and lime concretions. Near the southeast corner of section 20, Elk Creek township.

section 6, Mound Prairie township, a hill is dissected, exposing to view a thickness of twenty-five to thirty feet of loess. Fossils are especially abundant in all portions of the section.

Loess buried beneath the Wisconsin is to be seen at a few points near the border of this drift sheet. Such loess is in general of a bluish color, streaked with iron oxide. A typical exposure of this nature was observed near the northeast corner of section 7, Clear Creek township, in the valley of Silver

creek. Here, some 300 yards below the east and west road, fifteen feet of loess were seen beneath twelve feet of Wisconsin drift. The upper portion of the loess is filled with root casts of iron oxide, and seams of iron stains traverse it irregularly. The casts are hollow, with occasional exceptions where decayed organic matter is still in them, and are frequently from one to one and one-half inches in diameter. These features both disappear with depth, and the lower part of the section is clear steel-blue in color.

A similar phase of the loess was found on the farm of Mr. Andrew Engle, one-half mile north of Metz. Along a gully leading into the valley of the Skunk river a few feet of steel-blue clay, overlain by a foot or two of deep red clay, are to be seen, both covered with six to eight feet of soil wash from the neighboring hillsides. The blue clay has very fine and sharp grains. It has been utilized to a limited extent as a polishing agent for domestic purposes, and besides it possesses decidedly saponaceous properties.

WISCONSIN STAGE.

The Wisconsin ice deposited drift over a small area in the northwest corner of the county. The earlier topographic features were obliterated by the Wisconsin glacier, in part by the distinctive material that it deposited. Owing to its comparatively recent date, leaching and oxidation of this drift sheet have not progressed to the advanced stage represented in the Kansan till. It is to be remarked, too, that there is quite a marked difference in the degree of freshness between the Wisconsin till, as exposed in Jasper county, and the same drift in portions of Story and other counties to the north. The deposits in this area mark an early advance of the Wisconsin lobe.

The drift is composed of a promiscuous mixture of clay, rock flour, bowlders of all sizes and many varieties. While in the Kansan the more basic igneous rocks were the predominant types, in this later drift the granites and light colored varieties prevail. The drift has been locally modified by the action of water but in general it still retains the characteristic properties of glacial deposits. North of Indian creek, in the southern part

of Clear Creek township, the hills are of morainal character. They are knobby and the materials composing them are very gravelly. This may be observed in the roads crossing them and is quite apparent in some places by the scantiness of the vegetation. With this exception, the Wisconsin is a thin sheet of typical glacial till which is much attenuated at its borders. The flow of water during the melting of the ice appears not to have been great for the common extra-morainal features, gravel terraces and trains, are practically absent.

The thickness of the Wisconsin drift is not great. It is seldom possible to obtain reliable data from the wells in the area, but where exposed along stream-ways thirty-five feet is about the maximum thickness. On Silver creek, in section 7, Clear Creek township, exposures are to be seen. The upper fifteen to eighteen feet are oxidized to a buff or yellowish hue while below, the original blue color is preserved. It is very calcareous, effervescing freely with acid in all parts of the section. Good exposures are also to be seen along Wolf creek, at Valeria, and along an unnamed tributary of the Skunk river, previously mentioned, in sections 8 and 9 of Washington township.

POST-GLACIAL SANDS, SILTS AND ALLUVIUM.

Attention has already been directed to the occurrence of mixed sandy and silty deposits, especially bordering the Skunk river valley. The deposits appear typically as hills, in greatest number along the eastern side of the valley. In the region of Colfax, where the river has an east and west direction, abundant materials of this nature are found on the upland back from the river.

In Poweshiek township, over the Wisconsin drift area, similar materials skirt the flood plain and cover the hills to a distance of from one to three miles from the stream. The deposit here very much resembles the loess. There are no fossils, however, and the material is more sandy and works up in the road beds to depths of six or eight inches. In this region the source is undoubtedly the broad flood plain of the river, and the movement of the materials is still in progress. The de-

posit here is continuous with that outside of the Wisconsin area which covers, to a considerable depth in places, the adjacent uplands in the vicinity of Oswalt. Difficulty was found in accurately tracing the boundary of the newer drift in southern Poweshiek township because of the heavy mantle of this recent deposit.

In this portion of the county, as also in the region of Colfax, these deposits closely resemble the loess, in fact, it is impossible to make out clearly the exact relation of the two. In the town of Colfax, typical loess is used for brick making, while south of the town what appears to be a continuation of the loess is a very sandy silt which possesses little plasticity and is so loose in texture that vegetation can with difficulty gain a foothold.

At Goddard station, in Sherman township, a sandy phase of the loess is being removed by the railroad from the base of a hill bordering the Indian valley. Up the hillslope it grades into loess which overlies Kansan till. Similar materials are found at intervals southward along the east side of Skunk river. They are also conspicuous on the hills above Reasnor, and they continue in importance southward to the boundary of the county. In section 13, Elk Creek township, low sand ridges extend into the valley. These are also to be seen in section 29. In section 33 all of the hills are very sandy. Near the north border of this section a small stream has exposed a thickness of twenty feet of finely stratified and nicely sorted sand. The laminæ are horizontal, the sand being white, yellow, brown and red. The grains are rounded and uniform in size. Covering the sand, and separated from it by a perceptible dividing line, are eight feet of sandy loess. The sand is a purely water-laid deposit and bears no genetic relationship to the capping loess.

It is to be remarked that wherever the sands are exposed outside of the area of Wisconsin drift, they are covered with a layer of greater or less thickness of loess-like, silty material. It may be noted further that the sand deposits occur in two positions; as low ridges at the border of the flood plain, in which the sand is comparatively coarse; and along the upland sides of the bluffs which immediately bound the valley, where the

material approaches in nature what might be termed a sandy loess. These bluffs are in general prominent, and they are composed of loess containing fossils, and which retains the characteristically high angle of slope.

Mr. B. L. Miller* calls attention to the occurrence of sand ridges in Marion county. One such ridge mapped by him in the northeast corner of Marion county is similar in every respect to the deposits just described. The formation of the ridges is attributed by Mr. Miller to the action of southwest winds, "all of them being northeast of the place where the sandstone ledges have been cut through." The Skunk river cuts through the belt of Red Rock sandstone in the south-central part of Jasper county, but the relation between this region and the greatest development of the sand ridges specified by Mr. Miller does not obtain here. Nor do the sands themselves suggest such an origin. The Red Rock sands are prevailingly of a deep red or brown color; while the sand hill deposits are of the lighter shades, much of them white.

There seems little doubt that the wide flood plain has furnished much of these sands and silty products which the sweeping winds have caught up and deposited where they are now found. Evidence points to northwest winds. The fact that there is universally a surface layer of loess is suggestive as to the time of accumulation.

All of the streams of any considerable size flow through alluvial valleys. In the valleys of the major streams the alluvium has accumulated to great depths. It is a stratified deposit put down and distributed largely by the rivers themselves. Strata of sand and occasionally gravel occur, interbedded with the finer river silt.

At a few points, remnants of stream terraces are found. They are generally covered with alluvium and sometimes by the loess. At Valeria there is a flat bench of Wisconsin drift some twenty-five or thirty feet above the present Skunk river flood plain which is surfaced with a thin layer of river silt and extends from the west county line to a point some three-

*Iowa Geol. Surv., Ann. Rep. Vol. XI, p. 167, 1900.

quarters of a mile below the town. This appears to be a remnant of the old flood plain of the river, and represents a definite stage or halt in the down cutting of the stream.

Suggestions of former terraces are to be seen at intervals along the North Skunk river. Below the schoolhouse in the southeast corner of section 16, Malaka township, there is a narrow terrace ten to twelve feet above the water, and capped with loess. Low, alluvial terraces bound Indian creek to the west in sections 28 and 33 of Clear Creek township. Below Mingo they again occur. In section 10 of Clear Creek township, Wolf creek is skirted on the west by a drift terrace. This is seen again in the southwest $\frac{1}{4}$ of section 17 of the same township.

Soils.

The soils of Jasper county may be grouped into three fairly distinct types, drift soils, loess soils and alluvium. The materials of the glacial deposits are practically the sole source of all three varieties, but each represents a modification of the original till.

Soils belonging to the drift proper cover but a small proportion of the county. Outside of the Wisconsin drift area they are not important. On some of the steeper slopes in the loess-Kansan area, the Kansan drift outcrops near the base of the hills and contributes in some measure to the soil forming elements. This is evident in some places by the oxidized color and bowldery nature of the soil, and in others by the wet or spring line at the contact with the overlying loess. While it is rare that any effect on the vegetation or crops can be seen, nevertheless, cases are not lacking where quite distinct zones can be distinguished from the hilltop down the slope. These plant zones are determined by the zones of loess, Kansan drift, and wash or loam soils; the more luxuriant growths being on the lower portion of the slopes. The contained gravel and bowlders are not favorable to tillage.

The Wisconsin drift is covered with a soil, whose unoxidized character and moderate depth attest its newness. It is usually

of a yellowish-brown color where undisturbed, and it is not yet leached of its lime, which is present even close to the surface. Its color is in contrast to the deep red of the old Kansan soils. Drainage is not perfect so that as yet the productiveness of this new drift soil does not rival that of the loess and alluvium. Artificial drainage would improve it and permit the weathering agents to act more effectively.

The loess soils occupy much the larger portion of the area of the county. They form a porous, open-textured stratum through which water readily percolates. The loess is, however, prevailingly calcareous, and does not exhibit an advanced state of oxidation. Its loose texture causes it to erode rapidly on steep slopes where it is exposed without a covering of vegetation. The loess is typically of fine grain, but as has been pointed out, becomes decidedly arenaceous, and even grades into fine sand in certain localities in Jasper county. Chemically it is not widely different from ordinary clay, the presence of the alkalies and alkaline earths showing it to be made up of a variety of mineral substances. These minerals, in weathering, furnish a variety of elements for plant growth. The loess soils are of reputed fertility, and, especially where slopes are moderate, produce abundant crops of the leading cereals.

Many of the streams of the county are bordered by belts of alluvium. This material affords a very fertile soil, being made up of the loose fragments of soil, clay and humus that have been carried into, and distributed by the streams, over their flood plains. It is of a prevailingly dark color and is commonly underlain by strata of sand which afford it good drainage. The alluvial soils are eminently rich. On account of their position, spring cultivation is sometimes retarded somewhat, and such areas are subject to occasional inundation. These drawbacks are not usually serious, for the soil is warm, and in the river valleys some of the best crops in the region are grown.

The soil materials as they are loosened and weathered tend to accumulate on the lower slopes of the hills and, if at the border of a flood plain, to spread out in the shape of the alluvial fan. Such deposits show little, if any, stratification and, as they occur along all depressions and small streams, they con-

stitute an intermediate type of soil between the upland and the alluvium. To them the term loam has been applied. They are similar in composition and texture to the alluvium but are not so far removed from their original source. The loams constitute a very productive soil.

ECONOMIC PRODUCTS.

Coal.

The coal deposits of Jasper county have been exploited since the early 50's when the Slaughter bank was opened in section 32 of Sherman township. Coal was also mined along Cherry creek in Newton township at an early date. Whitney* stated in 1858 that considerable coal had been mined at both of these localities. Owen,‡ in 1851, mentioned the use of coal for blacksmith purposes from a "three-foot seam in Jasper county, near the Skunk river."

The first Biennial Report of the Iowa State Mine inspector,† in 1883, contains the following estimate:

"A majority of the superficial area of this county is barren of coal; the most of the coal lies in the southwest portion of the county, on North Skunk river and its tributaries, and the tributaries of the Des Moines river, but not more than the superficial area of one township is underlaid with coal of workable thickness."

Later exploitation has proved the extreme conservatism of these statements.

The number of producers did not increase rapidly until in the '80's, when, in 1885, there were twenty mines in operation. There are at present sixteen mines in the county which operate a portion or all of the year. The largest production for one year, for which statistics are to be had, is 293,255 tons, produced in 1892. From this the tonnage decreased to scarcely more than 100,000 in 1900, but the output is again increasing, so that 1904 has a reported production of nearly 275,000 tons.

* Rep. Geol. Surv., State of Iowa, Vol. I, pt. 1, p. 236, *et seq.* 1858.
† First Biennial Report State Mine Inspector, p. 33, 1883.
‡ Geol. Surv. Wisconsin, Iowa and Minnesota. p. 117. 1851.

The various sections of the county where productive coal beds have been worked will be designated by the nearest towns, and the occurrence of the coal and the mines in each district will be briefly described.

Lynnville district.—On the east side of north Skunk river, two miles north of Lynnville, coal has been taken out but no active mining work has been carried on for several years. There are three veins, an upper, two to four feet in thickness, a second, twenty-two inches, and a lower vein about sixty-five feet below the top one, eighteen inches in thickness. The top seam only has been worked. One shaft was sunk, but the coal was removed mostly through drifts. The coal is covered with fifteen to twenty feet of glacial clay and light blue shale, the latter affording a fairly good roof. The workable seam is about twenty-five feet above the river flood plain. Coal has been taken from it at a number of points southward along its outcrop. The coal mined here is said to have been of good quality, being especially low in sulphur.

On the west side of the North Skunk river, near the middle of section 3, Lynn Grove township, a coal seam outcrops in the bed of a small creek from the southwest. Prospecting has been done along this stream. There appears to be two veins, one near the water level, and the second seventeen feet higher up. As far as could be learned no coal has been mined here.

Along Rafferty creek, in sections 33 and 34, Richland township, coal mining began at the Meredith bank in 1860. This bank has not been operated for eighteen years. Two seams are reported, an upper, two feet and four inches in thickness at about the water level; and a lower, thicker vein that has not been exploited. Borings for wells close to the North Skunk river encounter the coal just beneath the drift, but back from the flood plain to the west, shales are interposed over the coal.

Coal has been mined in this district only along the streams where the outcropping beds have been easy of access. It is scarcely probable that workable coal would be found east of the old mines first described. The general dip being to the west, the southwest portion of Richland and the northwest

part of Lynn Grove townships appear to be more promising areas for prospecting.

Monroe district.—It is impossible with the few deep borings and meager records available to ascertain the extent of the coal basins in this district. In limited areas where correlation is possible the veins are found to be irregular, so that no attempt is made to check from one district to another.

In Fairview township a group of mines is located three or four miles east of Monroe. When first opened, a flourishing camp by the name of Draper sprang up, and in 1887 there were seven mines operating intermittently in this vicinity. The Jasper County Coal and Mining Company operated extensively here from 1887 to early in the '90's. Since that time there have been on an average three mines in operation supplying a small local demand.

There are two coal seams, an upper, running three and one-half to four feet in thickness, and a lower vein usually four feet or more in thickness. The early mines worked the thicker bed, but at present mining is done only in the top seam. The two beds are separated by from thirteen to thirty-five feet of shale and sandstone.

The Marshall slope is located near the center of section 33 and has been operated for twenty-five years. The upper seam, averaging three and one-half feet in thickness, is mined. It here has a dip to the north of one foot in twelve. Eighteen feet below is the second vein of four feet. It is a "shooting" coal and is not mined. Mining is done by the Longwall system and the coal is hauled to the entrance in cars, by mules. On an average eight men are employed eight months in the year. Some coal is shipped from Franklin.

One-fourth of a mile east of the Marshall bank is the Shaw slope now owned by Sharf Brothers of Monroe, but operated by Gilbert Shaw. Mining was begun twenty years ago, and the lower vein was formerly worked. The upper seam is four feet with a clay parting of four inches near the middle. It has a low dip to the northeast but not sufficient for the drainage of the mine. Seventeen acres are worked out with but one acre

left within the property limits. The method of mining is similar to the Marshall, all the coal being sold locally.

The Edwards slope is a short distance north of the Shaw mine, but has not been operated for some time.

In the southwest $\frac{1}{4}$ of section 26, is the Barnes slope. The seam is three feet three inches, increasing to four feet in thickness on the rise. It outcrops at various points along a small stream running through the center of the section. The other vein here lies thirteen feet lower down. The coal is divided by a thin clay-sulphur band which is quite persistent. The bank was opened twenty years ago. The Longwall method is used in mining, and operations are limited to four months in the year. The coal is known to underlie 160 acres. The cap rock to the coal seam is a firm band of arenaceous limestone, one and one-half to two feet in thickness, which affords a good roof. This is also a common feature at other mines in the district, although not a constant one.

Near the middle of the north side of section 26, J. M. McConoghey has recently opened a mine not far from the site of the old William Marshall mine. The mine is a slope into a four-foot vein. Sandy limestone overlies the coal. Rolls and partings are common. The seam dips to the southwest. A well defined, nearly vertical, fault running northwest-southeast, displaces the beds with a slip of two feet. Four or five men are employed eight months of the year. Car and man haulage is used and the output is disposed of locally. A lower seam, penetrated in a well at a depth of forty-five feet, is reported to be eight feet in thickness.

In the southwest part of section 36, the coal occurs in the hills bordering the Skunk river flood plain, and a small amount of mining has been done here.

There appears to be a considerable area in this part of the county that is underlain with coal. Some opposition to prospecting is met among property owners but when it is realized that the presence of a workable coal bed enhances greatly the value of farming land, such objection will soon be removed. Prospecting is now being done in section 27 by Shaff Brothers of Monroe.

West of Monroe, along Calhoun creek, in section 32 of Des Moines township, old drifts are seen in the hillsides, and a thickness of twenty to thirty feet of shales and interbedded sandstones may be seen outcropping in the road cuts. The drifts are known as the old Pattison mines, and no coal has been taken out for twenty years. The seam ran about four feet in thickness but water and poor roof caused its abandonment.

Newton district.—The working mines in this district are south of the city of Newton, the largest producers being located near the Monroe branch of the Chicago, Rock Island & Pacific railroad. A great deal of coal has been mined in this neighborhood during the past twenty years, and abandoned drifts, slopes and shafts are common features in the north-central part of Palo Alto township. These are also to be seen at points (indicated on the map) along the main line of the Rock Island railway in this township. There are at present four working mines in this district.

Snooks Brothers' mine is located near the center of section 9. The shaft is fifty-four feet deep, and the coal seam is three feet ten inches to four and one-half feet in thickness. Pinches and swells in the seam are common. The roof is "slate," and considerable timbering is required. The coal is mined by the room and pillar plan. It is hoisted by a gin operated by one horse. The shaft is in two compartments and two screens are provided for sizing. All the coal is disposed of locally. The mine is equipped with a small boiler for pumping when necessary. The mine is operated during but few months in the year. Seventy feet below this seam, six feet of coal are reported.

In the southwest $\frac{1}{4}$ of section 9, Carson Brothers opened a new mine in 1904. The shaft is seventy-five feet in depth, through blue clay and shale. The seam is four and one-half to five feet in thickness, and is underlain by fire clay, occasionally replaced by soapstone. The slate affords a good roof. The coal bed varies on account of rolls but in general has a low slope to the west. The gin hoist is used. An hour's pumping each day is necessary to keep the mine clear of water. Little coal has been taken from this shaft, it being operated only during the winter months. Twenty-five feet below this mine is a coal bed two and one-half feet in thickness.

Mr. A. Lister formerly operated a mine near the northwest corner of section 8, Palo Alto township, where about twenty acres were mined out in a vein three to four feet thick. The mine now worked is located near the southwest corner of section 3. The shaft is fifty feet deep and two veins are penetrated. The upper is but two inches in thickness while the one mined runs two and one-half to four feet. The two are separated by twelve feet of shales and fire clay. The seams run fairly level, but wedge out entirely 100 yards north of the shaft. The roof is jointed and north-south faults with displacements of one foot or so are frequently encountered. The coal is raised with a one-horse gin hoist. A local trade is supplied. It is necessary to pump three or four hours each day to keep the workings free from water. A 10-horsepower engine is employed, water being drawn by a four-inch belt to which are attached wooden blocks that fit closely and move vertically in a tight box. Ten to twelve men are employed during the winter months.

French Brothers have recently opened a mine in the southeast $\frac{1}{4}$ of section 15. In prospecting, a four and one-half foot vein was found in four holes, within a radius of 100 yards. The drift and loess are fifty-five feet. In addition there occurred thirty feet of soapstone or slate overlying the coal.

Coal has been mined in two or three drifts in section 7, Buena Vista township, on the land of A. C. Davis. The seam is said to be eighteen inches to two feet in thickness, and water causes much difficulty in mining.

Early coal mining on Cherry creek in section 32, Newton township, has been mentioned. Several old dumps are to be seen in this area, and although some prospecting has lately been done, no coal has been mined for thirty years. Two veins are present, separated by shale. One seam, one and one-half to two feet in thickness, twenty feet above the water, and the other a one-foot seam at about water level. The upper seam lies very close to the glacial drift covering, from which it is often separated by but a few inches of "slate" roof. Deeper drilling encountered no other seams.

From the data obtained at these different mines, it appears that the coal underlies a considerable area in northern Palo Alto

township, extending into Buena Vista to the east, and Newton to the northwest. Where exploited west of the town of Newton, and near Murphy, the seams are thinner and lie higher in actual elevation above sea level. This is in harmony with the strike of the coal-bearing measures. It suggests that the chances are not favorable for coal to the northeast beyond this general line of outcrop; although it may be found in isolated outliers of limited extent. Coal has been found both north and south of Kellogg, which may thus be attributed to detached areas of Coal Measure strata. A prospect hole one-half mile south of Kellogg penetrated six inches of coal at a depth of 129 feet.* It is reported that a shaft put down by a corporation organized in Kellogg, one mile northeast of the town, reached a four-foot vein of coal. Satisfactory corroboration of the details of this statement was not obtained. If coal exists here it is probable that it underlies only limited areas.

Beds of coal which can not with any degree of certainty be correlated with those of the Newton district, less than three miles to the east, have been mined in a small way northwest of the town of Metz, in sections 2 and 3 of Mound Prairie township. Two seams have been worked, both of which give natural exposures. The upper is fourteen inches to three feet thick, and lies almost immediately beneath the drift and about thirty-nine feet above the water in Skunk river. The lower vein runs eighteen inches to four feet in thickness and is at about water level. It is mined intermittently by Mr. A. H. Allfree. The coal thins out to the south, east and north, and is variable in depth. It is usually protected by a sandstone roof, large masses of calcareous ironstone, sometimes septarian in structure, frequently intervene, which cause the coal in places to pinch to a few inches. In the edge of the Skunk river flood plain a twenty-two inch vein was found at a depth of twenty-five feet below the level of the water.

Southwest of Metz, in the southeast $\frac{1}{4}$ of section 15, Mound Prairie township, a new mine was opened in 1903 by Good Bros. and Collins. It is known as the Fowles mine. The shaft is fifty-seven feet to the bottom of the coal, which runs four to

*Second biennial report of Iowa State Mine Inspector, p. 113. 1885.

four and one-half feet. The Coal Measures lie beneath twenty-five feet of loess and Kansan drift. The roof is "slate" but gives no trouble. The coal is hoisted with a gin, one horse lifting about 1,500 pounds from this depth. One entry has been driven sixty feet north from the shaft. Three men work during the winter months only. The coal is of a good domestic grade and does not clinker.

Prairie City district.—Coal has been mined in the past from country banks at several points over the southwest portion of the county. Those on Calhoun creek have already been mentioned. Near Walnut creek, in the northeast ¼ of section 34, Des Moines township, coal has been mined by a slope in a thirty-inch seam. Trouble with water and a poor roof caused its abandonment.

In the north ½ of section 22, on Walnut creek, are the William White and the C. M. Norris drifts. The White mine is to the west of the stream. The seam lies twenty-eight feet above the creek and averages four feet in thickness. It has a low dip to the southeast. Two feet of jointed slate overlie the coal, and are covered in turn by eighteen inches of limestone "cap rock." About two acres have been mined out. Four to six men are employed during five months of the year.

The Norris mine is located to the east of Walnut creek, and coal has been mined here continuously for twenty-two years. Thirty acres are mined out. The occurrence of the coal is in all respects similar to the White vein. A two-inch "sulphur band" in the coal is a constant feature in this mine. It is necessary to pump three hours each day to remove the water that has accumulated during the previous night. Seven men are employed six months in the year. The quality of the coal from these mines is said to be most excellent, and it is especially good for steam purposes. The output is disposed of locally.

In Vandalia the Cavitt and Pulver mines have operated up to two and three years ago, respectively. There are two seams, one, two and one-half to three feet in thickness, and twenty-five feet lower, a four-foot seam. The former has a shaft sixty-five feet deep, and the latter is a slope to the top vein. In a well

drilling in Vandalia, eighteen inches of coal were penetrated at a depth of thirty feet below this second vein. In the northeast corner of section 30, a small amount of coal has been taken from a drift in the hillside on the farm of A. Lufkin. The seam is twenty-two inches in thickness. Wells in the neighborhood of Vandalia seldom fail to find coal at moderate depths.

One-half mile east of Prairie City, at the north edge of section 1, a drill hole 185 feet deep, penetrated three and one-half feet of coal at the bottom. Mining was not undertaken on account of water.

Colfax district.—Colfax is the center of the most active and extensive mining operations in the county.

The first coal mining in the county was done at the Slaughter bank, one and one-half miles east of Colfax, in the southwest ¼ of section 32, Sherman township. The base of the seam is at about water level in the Skunk river, along which stream it crops out at various points in this vicinity. About thirty acres have been mined, the coal having been taken out through a number of drifts. The seam is six feet thick and dips to the south, two inches to the yard. The roof is slate and is fairly stable. Five years ago a shaft sixty-five feet in depth was sunk, back some distance from the outcrop. The mine was not operated in 1904. The present owners are Hanson and Harrington, who will open it this year. The Slaughter coal has long had the reputation of being the best in Iowa.

Prospecting for the coal in section 5, Mound Prairie township, between the present mine and the railroad, failed in some cases to find it. In others, the drift rested directly on the coal. It has here been removed by erosion, which has detached a small area of the Coal Measure strata from the continuation of the same to the southwest. A drilling sixty-five feet below the coal revealed no other veins.

Coal has been extensively mined along the north border of the Skunk river valley from a point, essentially due north of Colfax, to Valeria. The Jasper County Coal and Mining Company mined out about five hundred acres in sections 34 and 35 of Poweshiek township. Shafts Nos. 2, 3 and 4 (mine No. 1

was a slope), ranging in depth from forty-five to one hundred feet were sunk. The coal within lease limits was practically exhausted. The seam is about twenty-five feet below the level of the river and ranges from three to six and one-half feet in thickness, thinning to the north and finally running out. The roof was slate but this occasionally failed, being replaced by the overlying drift, which made mining very difficult.

In the vicinity of Oswalt several companies have carried on mining operations in this same bed since 1880, when mining was begun in the old Pittsburg shaft by Mr. V. E. Oswalt. The Valeria Coal and Mining Company and its successor, the Diagonal Coal Company, were the largest operators. Their mines have been abandoned for years. Insurmountable difficulties were met in the poor roof and the large amounts of water. Many acres of coal were mined out, but much was left in the workings on account of the improper methods of mining employed.

There are at present but two working mines in the Oswalt district. Warrick Brothers' mine is located in the southwest $\frac{1}{4}$ of section 34, on the Colfax Northern railroad. The shaft is seventy feet deep to the base of the coal, which is five feet ten inches thick. The coal is overlain by slate which, on account of its jointing, is a dangerous roof. Rolls occur in which the coal thins down to three feet. From the foot of the shaft the seam dips to the north for 300 feet, then rises rapidly till it meets the overlying sand, beyond which it can not be worked. A dip to the southeast from the shaft is also noted. Almost constant pumping is required to keep the mine free from water. The mine is equipped with a gin hoist. The coal is transferred to cars by teams, and an average of four cars per year is shipped. The mine is in operation the year around, employing on an average six men.

The Clover Hill mine, owned by Martin Mindham, is located one-half mile southeast of the last. The shaft was sunk in 1901, and about one acre of coal is mined out. The top of the shaft is thirty feet above the water in Skunk river. The shaft is fifty feet to the coal. The strata penetrated are:

		FEET.
5.	Soil and yellow clay	20
4.	Blue bowlder clay	4½
3.	Coal	1½
2.	Soft slate	25
1.	Coal	4

The vein dips to the north for a distance and then rises. The roof is poor and water is troublesome. The shaft is a two compartment "quarter shaft," to provide for ventilation. The gin hoist is used. One to two cars per week are shipped, and an equal amount is disposed of locally during the six months of operation. The Burris and Davis mine is located on the Pritchard farm, in the northeast ¼ of the southwest ¼ of Washington township. A shaft just being put down at this point penetrates the following strata:

		FEET.	INCHES.
13.	Yellow clay, a little gravel	18	
12.	Blue shale	25	
11.	Soft, bituminous shale	2	
10.	Coal		9
9.	Fire clay	4	
8.	Slate, hard, black	30	3
7.	Coal		6
6.	Fire clay, light gray, arenaceous	4	
5.	Slate	16	
4.	Sand rock	4	
3.	Shale, carbonaceous, pyritiferous	25	6
2.	Coal	4	
1.	Fire Clay		

Several prospect holes have been drilled which indicate the presence of the coal under a considerable area. The shaft is eighty feet above the level of Skunk river. The coal seam thus lies about fifty-five feet below the water in this stream. Beneath this vein no coal was found within thirty feet. The shaft will be a two-cage, quarter shaft. It appears probable that this vein is the southwestward continuation of the one mined at Oswalt, on the opposite side of the Skunk river valley, and the same as formerly mined at the old Cooke shaft, a short distance east of Mitchellville in Jasper county.

There are three producing mines in the vicinity of Severs P. O., three and one-half miles southeast of Colfax. Two are operated by the Colfax Consolidated Coal Company and are

reached by the Colfax Northern railroad, and one by Hanson and Harrington, near the northeast corner of section 20, Mound Prairie township.

The last named is known as the "Klondike" mine. The shaft is seventy-two feet to the bottom of the coal. The seam is four feet eight inches thick. The mine was opened seven years ago and about three acres of coal are mined out. The bed dips to the southwest, on an average of one inch to the yard, although it is somewhat undulatory. As a rule, the coal thickens down the dips and thins on the rises. The shaft section is given on page 314.

The shaft is a two-compartment, quarter shaft, but a separate shaft is now sinking to serve as an air and man way. The coal is mined on the room and pillar plan. Shooting from the solid is the practice. The coal is cleaned in the mine and the slack is sent out separately and sold for steam purposes Each room is numbered and the miners are paid for the lump coal by the ton as it is sold over the local scales. One man averages four tons of coal per day. The coal is hard and is a good domestic fuel. Six men are employed during six winter months.

Hoisting is done with a 20-horsepower, Tarrant Marine Engine Works engine. Three hours pumping is necessary to remove fifteen hours' accumulating water. The pump used is a No. 2 Cameron, throwing thirty-five gallons per minute.

As stated earlier, the Jasper County Coal and Mining Company formerly operated mines in the vicinity of Oswalt. Shaft No. 5 of this company was located at Anderson in section 14, Washington township. Fifty to sixty acres were mined out and the shaft was abandoned in 1900. Shaft No. 6 in section 13 was completed this same year. In 1901 a consolidation of the Jasper County Coal and Mining Company and the Colfax Coal and Mining Company was effected, the latter having already its shaft No. 1 in section 17, Mound Prairie township. This last mine then became shaft No. 7 of the Colfax Consolidated Coal Company as the united company is called.

No. 6 is 150 feet, and the coal is three and one-half to six and one-half feet in thickness. The seam is undulatory but has no

pronounced dip in any direction. The roof is "slate" and is fairly stable except where streaked with thin bands of limestone. The latter, which are only one-half to one inch thick, render the roof unreliable in places. The coal is mined room and pillar plan, double entry, with mule and wire-rope haulage. Pumping is done two to three hours each day to keep the workings free from water. Hoisting is done by an 80-horsepower engine, and the coal is run over a one and three-eighths inch screen. At the lower end of the screen is a picking table where bony coal is sorted out, the latter being charged against the miner sending it up. Ventilation is accomplished by means of a fan in a separate air shaft. Eighty acres have been mined from this shaft. An average of 150 men are employed throughout the year.

Shaft No. 7 is on lower ground but works the same seam and is but fifty-five feet deep. The coal is said to run three and one-half to seven feet, and is similar in all respects to that of No. 6. The equipment and methods of mining at this plant are similar to that at No. 6. Water gives some trouble where the roof breaks. One hundred and twenty acres have been mined.

Two shifts are worked in these mines—one going in at 7:30 A.M. and working till 11:30; and again at 12, staying in until 4 P.M. Shot firers go in at 4 o'clock and complete their work at 6, when the night shift goes in and works eight hours.

The output of these mines is all shipped; a spur of the Colfax Northern railroad connects the mines with the main line of the Rock Island at Colfax, and the Great Western at Valeria. The coal is of fair quality. The following is an analysis of a sample of the coal from mine No. 6. The calorific power of the coal is also given. For the purpose of comparison the same data are included for four other well known Iowa coals:

COMPANY AND LOCALITY.	MOISTURE AT 110° C.	VOLATILE COMBUSTIBLES.	FIXED COMBUSTIBLES.	TOTAL COMBUSTIBLES.	ASH.	SULPHUR.	CALORIMETER B. T. U.
Colfax Consolidated Coal Co., Colfax, Iowa	9.34	39.19	39.08	79.27	12.89	2.84	11,206
Whitebreast Fuel Co., Hilton, Iowa	.....	40.61	48.21	88.82	11.18	3.26	13,396
Centerville Block Coal Co., Centerville, Iowa	.....	37.79	54.85	92.64	7.36	3.29	12,681
Platt Pressed and Fire Brick Co., Van Meter, Iowa	.....	40.54	51.04	91.58	8.42	3.68	11,941
Corey Coal Co., Lehigh, Iowa.	....	37.98	47.98	85.96	14.04	5.90	12,431

This company controls about one thousand acres of coal land in Mound Prairie and east Washington townships, and the whole has been pretty thoroughly prospected. Workable coal is found to underlie considerable areas in this region. In the northwest ¼ of section 20, Mound Prairie township, shaft No. 8 has just been completed. A vein of five and one-half feet is penetrated at a depth of 180 feet. Entries now being driven have progressed 400 feet from the shaft and active mining will begin as soon as the plant equipment and transportation facilities are in readiness.

Following is a section in a drill hole put down on high ground near shaft No. 8. The churn drill is used by this company in all of its prospecting.

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

Clay.

Jasper county is well supplied with material for the manufacture of the more common clay wares, building brick and drain tile. The loess has proved suitable for brick and drain tile in various parts of the state. For the manufacture of paving brick, sewer pipe and other vitrified wares, and for pressed brick and hollow blocks, the loess is not suitable. Since the processes in the manufacture of the latter named wares are

somewhat more elaborate, the clays used must possess good plasticity, must stand higher temperatures, and be tough and resistant when finished. Clays of correct composition and possessing the essential physical properties for these wares have been found only in the older formations,—the shale clays, clay shales and fire clays. Those of Jasper county belong exclusively to the Des Moines stage of the Carboniferous, and, as will be pointed out, are favorably exposed in but few localities. In general, the shales of the Coal Measures in the county are sandy and the outcrops to be observed show, almost universally thin beds of shaly sandstone and clay ironstone nodules which make them unsuitable for clay manufacture. Beds of shale of considerable thickness and of uniform character are reported in the sinking of coal shafts in various portions of the area. The fire clay seams which underlie the coal beds may also prove worthy of attention.

Lynnville.—Newby & Macy operate a plant for the manufacture of brick and tile in the southeast part of the town. The clay is a mixture of hillside wash and alluvium, and is taken out near the edge of what is said to have formerly been an old lake. It is free from concretionary lime. A nine and one-half-foot bank is open. Three feet of black soil overlie six and one-half feet of yellow clay. The clay is drawn up a trestle in cars by a winding drum. No definite proportions are observed in the mixing. The plant is provided with a 30-horsepower Ottumwa engine and a 60-horsepower Chicago boiler. The Brewer auger machine is used, with a hand-operated, side-cut delivery table. Brick and tile are made. Of the latter, three-inch, three and one-half-inch, four, five six and eight-inch in size, according to demand. The clay stands drying well without checking. The drying is done in a two-story shed with a capacity for 120,000 four-inch tile. The Warren trucking system is used. The dryer is provided with coils for the utilization of exhaust steam. Ventilation is secured through lifting side-doors. Brick dry in three to four weeks, while but two weeks are required for tile. The burning is done in one Stewart kiln, and one of the ordinary type of round, down draft kilns. The latter has a capacity of 80,000

brick and is equipped with Swift coking furnaces. Tile can be burned in four and one-half days, about two days of which are required for water-smoking.

The outcrops of shales two miles north of Lynnville have been mentioned under the title Geological Formations. A small amount of exploration would, it is believed, locate in this vicinity beds of workable thickness and of suitable nature for the manufacture of clay products.

Monroe.—The plant of G. H. Orcutt is located on Brush creek, one-half mile west of the town. Coal Measure clays are used. The bank consists of a few feet of loess-like drift clay and ten inches to one foot of coal blossom overlying nine feet of fire clay. A ten-inch vein of coal is present five feet below the base of the pit, and this is again underlain by fire clay. Following are the chemical analyses of two samples, one taken in the pit, ten feet from the surface; the second, by a boring about ten feet below the bottom of the pit.

	10 FEET FROM SURFACE. PER CENT.	20 FEET FROM SURFACE. PER CENT.
SiO_2	67.25	70.65
Al_2O_3	18.00	15.90
F_2O_3	4.58	4.23
CaO	.60	.65
MgO	.30	.25
Na_2O	lost	.90
K_2O	2 03	1 00
H_2O at 105°C	.29	.....
Loss at red heat	6.18	5.53
SO_3	.:6	.83
Total	99.79	99.94

It will be noted that the fluxes are not high in either sample, with the exception of iron oxide, but are present in too large amounts to allow of classification as a fire clay. Physical tests were made of these clays, and of two others taken five and twenty-five feet, respectively, from the surface, with results as follows:

SAMPLE.	LINEAR SHRINKAGE IN DRYING.	TENSILE STRENGTH OF DRY CLAY. POUNDS PER SQ. IN.
5 feet from surface	8. per cent	143
10 feet from surface	8.5 per cent	133
20 feet from surface	6.8 per cent	165
25 feet from surface	7.5 per cent	122

This last clay melts at slightly above cone 3, about 1200° C., (2192° F.). The others are all more refractory, the two upper ones burning to a strong buff color. The shrinkage in drying is below the average and there is no tendency to cracking. Their strength and plasticity are high. It should be possible to combine these clays so as to produce a good vitrifying body for paving brick and other vitrified wares.

The buff burning clay was first used for pottery at this plant, and a superior article was produced. Since the clay is plastic and moderately refractory it could be "thrown" with facility, and it will also take a good Albany glaze. At present brick, drain tile and sidewalk tile are made. The clay is picked, and hauled in dump carts to the works where it is put through a seven-foot, American Clay Working Machinery Company dry pan, when dry; and into Brewer rolls when it comes from the pit in a plastic condition. The clays are mixed in the proportions in which they occur in the bank. A Freese auger machine of 25,000 capacity, with side and end cut-offs are used for brick; and a Brewer cutting table for tile. Power is supplied by one 40-horsepower Nagle and a 45-horsepower Lennox boiler, and a 45-horsepower Nagle engine.

The wares are dried in open sheds, and on a floor underlain by small sized sewer pipe laid in gravel, through which exhaust steam is passed. Burning is done in two round kilns: one sixteen feet in diameter, equipped with inside stacks and four fire holes; and the other twenty-four feet, outside stacks and six furnaces. The former holds 18,000 brick, and the latter 50,000. First class products are made here, the blending of the carbonaceous top shale with the fire clay giving the ware a good red color. Five to six hundred thousand brick, some of which are shipped, are made annually, and tile is produced according to the demand.

Kellogg.—Brick and tile are made here by James Holdsworth. The clay is secured south of the Chicago, Rock Island & Pacific track and appears to consist of worked-over loess and Kansan drift. It is hauled by wagon and placed in a soak-pit with layers of sand. A moving belt carries it to a double-shaft pug-auger machine. A hand operated side-cut is used for brick, and a rotary wire cutter for tile. The ware is dried on slatted floors, and burned in two round, down draft kilns.

Newton.—The McAllister Brick and Tile Works is located at the east edge of the city, on the Iowa Central track. The raw material is yellow loess grading into the bluish variety, lying unconformably on a pebbly drift wash. The cut is fifteen to eighteen feet in depth, the whole section being utilized. The clay is drawn to the factory in cars. A New Brewer, No. 9A stiff mud machine is used. An automatic rotating cutter is used for tile and a hand lever cut-off for brick. The auger machine has a rating of 40,000 brick per day. There are five dry sheds, two of these having two floors each and are provided with steam piping. The total drying capacity is about 70,000 three-inch tile. Tile dry in three weeks. A thirteen and one-half-inch tile shrinks in length to one foot in drying. Care is exercised to prevent checking. Two Cooke patent kilns are on the yard. These are round, down drafts and are sixteen and eighteen feet in diameter. The kilns are constructed without bag walls, the gases from the furnaces passing beneath the floor to a central chimney which extends about two-thirds the height of the kiln chamber. The gases then pass downward through the ware and out through openings near the floor into four stacks built into the kiln wall. Firing is done from one side only, in four fire boxes. These kilns are quite satisfactory, the smaller, however, giving the more even burn. The ware produced is strong and durable. It withstands temperatures in the kiln which partially vitrify it, which is unusual with this type of clay. Only tile were made in 1904. There was some demand for sidewalk brick. The plant is operated six months, April to September each year, employing on an average five men.

In west Newton are the brick yards of C. Shamburg and William Henning. Both are located north of, and close to, the Chicago, Rock Island & Pacific track. The so-called "red oak" clay is the raw material at both plants. Banks of ten to twelve feet are open, exposing typical loess passing into the bluish variety below. This lower portion contains lime balls and grades into a sandy joint clay, brown to drab in color, which can not be used. The clay is hauled to soak pits in one-horse carts. The Shamburg yard is equipped with a Creager & Sons' five-mould, soft mud machine; seven rack and pallet dry sheds holding 56,000 brick; and four rectangular cased kilns holding 75,000 to 100,000 brick each. One week is required for drying, and eleven to twelve days for burning. Wood is used for water-smoking and to finish off each burn.

The Henning plant consists of a Horton Manufacturing Company six-mould, soft mud machine; twenty dry sheds; two cased kilns each of 140,000 capacity; and two round, down draft kilns with capacity of 80,000 and 85,000 each. Six men are required to operate the brick machine, besides the sand boy and one man to shovel from the soak pit. 10,000 brick can be made in seven hours.

Baxter.—Brick have been made for sixteen years on the William Henneman yard, three miles west of Baxter, in the southeast $\frac{1}{4}$ of section 17, Independence township. Loess is used, and examination of a cut fifteen feet in depth shows it to be unusually free from concretionary lime. The clay varies from the yellow color into the gray-blue below. A Henry Martin six-mould, soft mud machine is used. The brick are burned in two open kilns of twelve and eighteen arches. Three kilns per year are made. There is a strong demand for brick in this section, the output of this plant being hauled to Mingo, Ira and Melbourne and Collins in adjoining counties.

Colfax.—Although parties have operated clay plants at several points in this vicinity, the yard of H. Harrington, in the southeastern part of the town, is the only one now in operation. Loess is the raw material and a bank is open in which are exposed twenty-five feet of yellow loess grading into the drab and blue below. Lime concretions are quite plentiful in the upper

portion, and shells of mollusks are abundant. Root casts of limonite occur in the upper, oxidized portions. The clay is carried on cars to three semi-circular soak pits made of brick, eleven to twelve feet in diameter and four and one-half feet deep. The brick are made of soft mud in a Henry Martin, six-mould machine. The latter is mounted on a truck so it can be moved from one soak pit to another on a rail track. Drying is done in open sheds on pallets. The brick are burned in three open kilns and one round, down draft. The product is of fair quality. The plant was not operated in 1904 but the management intends to make brick the coming season.

Stone.

Quarrying has been done at several points in Jasper county in the belt of Red Rock sandstone, which affords the only extensive deposits of building stone in the region. Sandstone from the coal-bearing strata has been quarried at three known localities, section 34, Des Moines township; in a railroad cut in section 30, Fairview; and two miles above Lynnville, in the valley of North Skunk river. At the latter place only is quarrying at present carried on in the county. The exact location is the northeast $\frac{1}{4}$ of the northeast $\frac{1}{4}$ of section 34, Richland township. The quarry section at this point has been given on page 312. The sandstone is brown to red in color and is micaceous with small cavities containing fine red ochre or ocherous clay. The total thickness of salable stone is fifteen feet. Considerable stripping of the overlying shales is required. The quarry is worked by William Northcutt. Three hundred perches per year is the output. The stone is durable, and supplies the local demand for cellar and foundation walls.

Stone from the Red Rock formation has been quarried in a number of places in section 17, Rock Creek township. The old Morgan quarry on the land of G. M. Henning was open forty years ago. A face twelve feet in height is exposed, consisting of a heavy bed of brown stone separated from a four foot stratum of compact, reddish-brown sandstone, by two feet of

shattered rock. Similar strata have been worked both above and below this quarry in the valley of Rock creek and its branches.

One mile east of Kellogg the brown sandstone has been quarried quite extensively in the past by the railroad company. Fifteen feet of the sandstone are open to view. Large plans appear to have been made here for the development of these quarries, but no work has been done for years.

Detailed descriptions of the quarry exposures near Murphy and Reasnor have been given under the description of the Red Rock sandstone. Considerable stone has been removed from the Dooley and Lamphear quarries in section 21, Buena Vista township. The latter is now worked intermittently for local use. Both the red and brown varieties are quarried.

On the hill slope one-half mile north of Reasnor, sandstone has been quarried. One mile south of Reasnor, at "Stony Point," the brown sandstone has been quarried in the past.

The most extensive quarrying operations in the county were formerly carried on at the old Kemper quarry in section 8, Fairview township. The rock was quite widely known as the Monroe red sandstone, although both red and brown stone were taken out. John Reinhart took stone from here forty years ago, and worked the quarry for twenty-five years. E. G. Kemper produced, in seven or eight years of his possession, some cut and dressed stone, and at one time employed as many as twenty men. Considerable stone was shipped. The present owner, A. Herwehe, has put out very little stone in the last two years, although there is a fair demand locally.

The following description of the sandstone points out its chief characteristics: *

"It is a moderately coarse-grained stone, with some range of color and texture and corresponds in general with the Red Rock stone which has been more widely marketed. . . . . As will be seen from the tests, it is an excellent stone and might be used to advantage in all structures similar to those in which brownstone has been used so extensively in the east. Under the microscope it seems to be made up of rather coarse

* H. F. Bain: Ann. Rep. Iowa Geol. Surv., Vol. VIII, p. 398.

and rounded grains of quartz cemented by a matrix of red-brown, iron-stained material which, judging from the analysis, is largely ferric oxides, but contains also some aluminous material. The sand grains are rarely in contact; the interstitial areas being usually as large as the cross-section of the individual grain."

The chemical analysis of this stone as given on page 412 of Doctor Bain's paper, is as follows:

SiO_2	84.35 per cent.
Al_2O_3	8.62 "
$FeO + Fe_2O_3$	5.59 "
CaO	.88 "
H_2O + loss	.43 "

A sample of the deep red variety collected by the author analyzed 31.5 per cent of alumina and ferric oxide.

The following composite table gives the results of physical tests of the stone. For comparison data are included for the Lake Superior sandstone, a building material of established reputation. The figures for the Monroe sandstone are taken from "Iowa Building Stones," by Bain in Volume VIII, Iowa Geological Survey Reports; those for the Lake Superior rock from Buckley's "Building and Ornamental Stones of Wisconsin."

	CRUSHING STRENGTH. POUNDS PER SQUARE INCH.	PER CENT OF ABSORPTION.
Monroe sandstone	3,600 3,700	8.64
Lake Superior brown stone	2,001 up to 6,500	4 4 to 15.1

In the Wisconsin drift area and in portions of the northeast townships of the county that have been influenced by the Iowan ice sheet, fresh granite bowlders are abundant and are used for walls and foundations for residences and farm buildings. When shaped and dressed these rocks make very attractive walls, and are eminently durable as well.

Sand.

Attention has been directed to the extensive deposits of sandy loess bordering the Skunk river valley on the east. In places these deposits are practically pure sand and have been utilized for building purposes. On the hilltops one-fourth of a mile north of Reasnor sand has been excavated. In the southeast ¼ of section 13, Elk Creek township, a good grade of clean sand is available. The finest deposit of sand observed in the county is open near the north edge of section 33, Elk Creek township. The sand is stratified and clean, although overlain by several feet of loess. The wind blown sands have, in general, rounded grains and are therefore not as satisfactory where bonding power is essential as are those of angular grain. Where durability and resistance to weather are the chief functions of the filling material, as in ordinary mortar, and for moulding sand where not even these factors are essential, the sands available in Jasper county are quite satisfactory.

Road Materials.

The greatest need for serviceable road materials is felt in those districts, already named, which are covered with fine sand and sandy loess. A mixture of the more plastic loess with such sand in roadbeds would furnish a fair foundation for a surfacing of gravel, crushed rock, or burnt clay ballast. The gravelly Wisconsin drift clay affords a good grade of material for road building, providing proper drainage is accomplished. A gravel pit is opened in section 23 of Clear Creek township.

Available gravel deposits are not well distributed over the county, nor are those observed in the most acceptable locations. A small clayey gravel outcrop is to be seen at the bridge over the North Skunk river in the northwest ¼ of section 35, Malaka township. It apparently lies beneath the Kansan drift and rests unconformably upon the alluvium of the river bottom. A few feet of sand and gravel are exposed in a stream cut in the northwest ¼ of section 4, Poweshiek township, lying beneath

four feet of partially sorted Wisconsin drift. At a few points in the northeast ¼ of section 27, Kellogg township, and in the northeast ¼ of section 22, gravels are exposed along the river valley. They underlie considerable thicknesses of sandy loess and Kansan drift; but if utilized in conjunction with these materials they are valuable deposits. In the southeast ¼ of section 5, Richland township, thirty-seven feet of modified sandy, iron-stained Kansan drift are exposed, covered with ten to twelve feet of loess. The deposit is accessible and may prove of value for road building purposes.

The Red Rock sandstone might be made use of in places for road materials, but crushed rock of this nature has not proven durable as compared with gravel or limestone. The life of a sandstone roadbed is very limited, as the stone does not pack or cement well, and continues to crush under traffic until reduced to sand, with its undesirable qualities.

Clay suitable for making burnt ballast may be found in nearly every portion of the county. No fixed list of qualities is essential to such a clay, nor is it necessary for the usual properties, plasticity, strength and refractoriness to be possessed. The alluvial clays along the streams make a good grade of ballast. The fine-grained "gumbo" phase of the loess, when properly calcined, also furnishes excellent material for road construction.

Ocher.

A deep red ocher has been quarried in the southwest ¼ of the northeast ¼ of section 21, Fairview township. It occurs at the apex of a ridge of the Red Rock sandstone, where the rock is badly weathered. The material itself is impalpably fine, and greasy to the feel, but is intermixed with sand grains. It appears to be the residuum of red iron oxide (Fe_2O_3), the cementing matter remaining from the decay of the sandstone. To be utilizable it would require to be washed free of the sand. It is possible that deposits more nearly free of sand might be located by prospecting along the lower slope of the

hills in this neighborhood. No data were obtained with regard to the production or the disposition of the ocher taken out. It is believed that it might prove of value as a pigment for the manufacture of paint.

Ores of The Metals.

Nuggets of metallic copper are occasionally found in the drift. They are frequently a few pounds in weight and are more common in the Kansan drift than in the later deposits. Several specimens of this nature have been picked up on the farm of Mr. H. Barnes in section 26, Fairview township. A small specimen of ore containing beads of copper and native silver was presented as having been found in the borings from a well on this farm. A sample of vein quartz carrying metallic gold is said to have come also from this well. These samples do not indicate the existence of any amount of similar ore in the region, but are fragments only that have been broken from the parent rocks in localities to the north and carried to their present location by the glaciers which have moved over the region under consideration. The copper ore mentioned has probably come from Keweenaw Point, Michigan, where such materials are known to occur.

The presence of zinc and lead ores in the Coal Measure strata is occasionally reported. Zinc sulphide, sphalerite, is known to occur as concretions similar to iron carbonate and iron sulphide and "clay ironstones," in the shale beds connected with the coal seams. This ore of zinc may be confused with siderite, the carbonate of iron, but specimens have been examined which leave no doubt as to the identity of the mineral and its occurrence in this way. Small cubes of galena, lead sulphide, are also found in ironstone nodules along with iron sulphide and carbonate. These sporadic occurrences of zinc and lead in the Coal Measure beds mean no more as to the presence of minable quantities of these ores than does the occurrence of iron pyrite, for example, in similar surroundings, indicate the probability of workable deposits of this ore. Lead and zinc deposits of importance are not known to occur in this form, nor associated with rocks of this nature.

Water Supply.

The potable waters of the county are drawn largely from the porous strata of the glacial and alluvial deposits. Shallow wells in the loess covered regions obtain a supply in the sands at the base of this deposit, or from beds of gravel and sand which are very commonly found at the base of the Kansan drift. When the latter is the source of supply the wells must be sunk to depths as great at times as two hundred and fifty or three hundred feet. In the river valleys an abundant and durable supply of water is usually obtainable in the sand strata at moderate depths, seldom more than forty feet.

Springs issuing from the Coal Measure strata are not uncommon. The water is, however, often so charged with sulphuric acid as to make it valueless, where it comes from beds associated with coal seams. Two instances may be cited of springs which flow from Coal Measure strata and furnish never failing supplies of good water. In the northeast $\frac{1}{4}$ of the northwest $\frac{1}{4}$ of section 9, Rock Creek township, is such a spring flowing from near the base of the Red Rock formation. A spring on the farm of Mr. P. W. Mowry in section 34, Des Moines township, furnishes an abundant supply of most excellent water. Several springs are found in some localities issuing, in many instances, at the contact of the porous loess with the Kansan drift. These afford intermittent and often serviceable supplies for farm purposes.

Flowing wells of moderate depth are to be obtained in certain portions of the county. In all instances the aquifer is some member of the older formations below the Carboniferous. There is a small artesian area where flows are obtained along North Skunk river in sections 26 and 35, Malaka township. There are six flowing wells in this vicinity, two being located on the Riverside Stock Farm in section 35. The water will rise four feet above the level of the flood plain. A number of other wells at higher levels have permanent artesian supply but do not flow. The wells are 145 to 175 feet deep, the water coming from lime and sandstone beds below Coal Measure shales, which are seldom more than six or eight feet in thickness. Occasionally flows

are to be found in other parts of the county, in wells that do not penetrate below the drift, but in which the water rises under hydrostatic pressure, are common.

Attempts have been made in the larger towns to secure increased and more permanent supplies of water by deep drillings into the pre-Carboniferous formations.

The water supply for the city of Newton was formerly drawn from two wells, 1,400 and 1,800 feet in depth. Although a record was kept of the strata in these wells it is not at present available. Professor Norton states* that the supply comes from the Saint Louis beds, reinforced by lower flows from the Maquoketa. While usable for domestic purposes, the water was very corrosive in boilers. The following mineral analysis of the water was made by Dr. J. B. Weems.

	SOLIDS, PARTS PER MILLION.
Silica (SiO_2)	36.70
Ferric oxide and alumina (Fe_2O_3, Al_2O_3)	16.5
Sodium chloride (NaCl)	302.
Sodium sulphate (Na_2SO_4)	2386.76
Magnesium sulphate ($MgSO_4$)	435.86
Calcium sulphate ($CaSO_4$)	1104.89
Calcium carbonate ($CaCO_3$)	87.96
Carbon dioxide (CO_2)	81.30
Total	4451.97

The sanitary analysis of the water is as follows:

	PARTS PER MILLION.
Free ammonia	2.27
Albuminoid ammonia	.186
Chlorine	.183
Nitrogen as nitrites	0.00
Nitrogen as nitrates	0.00
*Solids on evaporation	4716
Solids on ignition	4193
Solids at 180°C	4519

The source of Newton's present water supply is in the Skunk river bottom, five and three-fourths miles southwest of the city, in Mound Prairie township. Eight sand points are driven fifty feet into the alluvial materials of the flood plain, and the water

* Artesian wells of Iowa, Iowa Geol. Sur., Ann. Rep. Vol. VI, p. 232, 1896.

is drawn from a bed of gravel. The wells are distributed over an area of about 150-foot radius and valves are so arranged that one or all may be pumped from at the same time. The supply is abundant and the quality excellent. The following sanitary analysis of two samples of water from a nearby well drawing from the same aquifer was made by Doctor Weems, May 10, 1903:

	PARTS PER MILLION.	
	1	2
Free ammonia	1.152	.26
Albuminoid ammonia	.288	.08
Chlorine		10.
Nitrites	Tr.	Tr.
Nitrates	8.	5.
Solids on evaporation	246.	298.
Solids on ignition	116.	222.
Oxygen absorbed in 15 min	.06	.24
Oxygen absorbed in 4 hours	.12	.36

The pumping station is located at the wells. The water is forced to the city through an eight-inch pipe line and is lifted approximately 190 feet to the bottom of the supply tank. The latter is supported on a fifty-six foot tower, is sixteen feet deep, and thirty feet in diameter. The present needs of the city are met by pumping four hours per day but the demand is rapidly increasing.

Prairie City formerly drew its water supply from the sands and gravels at the base of the drift. The well was eighty-five feet deep and the supply was ample. So much trouble was given by quicksand that it was found necessary to drill deeper and case the whole to shut out the sand. Drilling was continued through the winter of 1904 and 1905 and at present has reached a depth of 390 feet. A detailed record of the strata passed through was not kept. Examination of cores from different depths gives data which will warrant the following divisions. The record of the railroad well kept by Mr. B. W. Brown was also made use of in this connection.

1. Loess and drift .....85 ± feet.
2. Coal Measure shales and sandstone.....140 ± feet.
3. Limestone .....65 ± feet.
4. Coarse, white sandstone.....2 ± feet.
5. Compact shale.....63 ± feet.
6. Dense, gray, mg. limestone, penetrated....35 feet.

No. 3 is probably the Saint Louis. The shot drill is used, the core down to three hundred and twenty feet being five inches in diameter; four inches, to three hundred and fifty-five feet, and two and one-half inches, to the present depth.

Mineral Waters.

In and near the town of Colfax, flowing wells are obtained at depths of two hundred and sixty to three hundred feet. The quality of the water obtained has given Colfax a wide spread reputation for its mineral water. The water comes from the Saint Louis strata. In sinking the wells three water bearing strata are usually penetrated, but the lowest, reached in the neighborhood of three hundred feet in Colfax, furnishes the mineralized water. An approximate section is given on page 307. The water will rise ten to twelve feet above the Skunk river flood plain.

In the town of Colfax more than a dozen of these wells have been sunk, and are found distributed chiefly among hotels, sanitariums and bottling works. Detailed data regarding four of these wells are given in Professor Norton's "Artesian Wells of Iowa", page 293. There are four bottling works in Colfax: Fryes Bottling Works, Fellows' Bottling Works, Gordon Bottling Works, Crisman Bottling Works. From these establishments are annually shipped to all parts of the country thousands of gallons of the mineral water. The principal hotels also ship large amounts of the water. The estimated output from one of the larger bottling works for one year, exclusive of that sold locally, totals 20,000 gallons.

The water as it comes from the wells contains a small percentage of carbonic acid gas (CO_2) as is shown in the mineral analysis on page 365. This is not sufficient, under atmospheric conditions, to hold the dissolved salts in solution. In bottling,

the water is therefore impregnated with carbon dioxide under a pressure of sixty pounds to the inch. Special pieces of machinery are designed for this work. One man can fill eighteen cases, 432 quart bottles in one hour. The water is shipped also in jugs, demijohns, kegs and barrels. By the addition of artificial syrups, tinctures and flavors, a variety of commercial

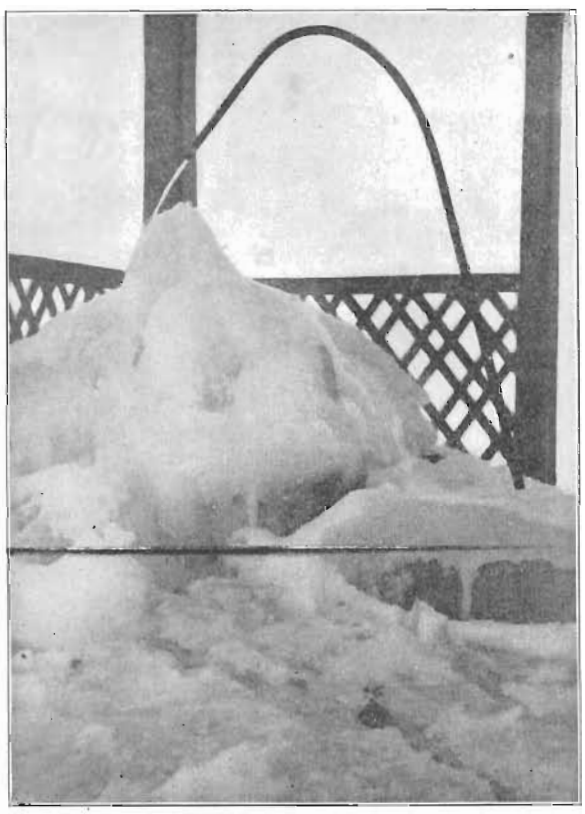

FIG. 30. View of the sanitarium mineral well, in winter, Colfax, Iowa.

beverages is produced: lemon sour, ginger ale, wild cherry phosphate, are examples.

The following analysis was made by Prof. L. G. Michael, of the Iowa State College. The sample was kindly submitted by Dr. J. B. Sherbon, of the Grand Hotel, at Colfax. Five gal-

lons of the water were collected and at once hermetically sealed at the well in a stoneware jug.

AMES, IOWA, March 1, 1905.

The following is a report on the water from Colfax well:

GRAMS PER LITRE.		GRAINS PER IMP. GAL.	
CO_2	7.76	NaCl	3.76
SiO_2	0.1275	Na_2SO_4	83.01
Fe	0.00575	K_2SO_4	0.54
Cl	0.034	$MgSO_4$	26.68
CaO	1.0268	$CaSO_4$	32.44
MgO	0.131	$CaCO_3$	99.63
K_2O	0.0042	$FeCO_3$	0.83
Na_2O	0.5458	SiO_2	8.75
SO_3	1.2448	Lithia	——
		*CO_2	594 86

LOUIS G. MICHAEL,
Survey Chemist.

A strict classification of this water would be calcic-saline chalybeate, following the divisions given by A. C. Peale in the 14th Annual Report of the United States Geological Survey. It would also be classed as a "carbonated" water because of the carbon dioxide it contains. When the water is allowed to stand in the atmosphere, or is heated, a coating of iron rust forms in the containing vessel. The precipitation of iron salts also necessitates occasional cleaning of the casings in the wells. Decrease of pressure and the escape of CO_2, along with aeration, cause the precipitation of the iron which probably exists in solution as the carbonate and sulphate.

There is at the present day much speculation among physicians and scientists as to the exact therapeutic value of the different mineral waters. A review of the best information extant on the "Therapeutics of Artesian Waters" is to be found in Professor Norton's "Artesian Waters of Iowa," page 386 *et seq.* A terse summing up at the close of an extended article on the Mineral Waters of Indiana, by Robert Hessler, M. D.,† includes

*CO_2—Weight of gas given off the water when boiled.

†23th Ann. Rep. Indiana Geol. Surv., 1902, p. 159.

the following statements, which are quoted as indicating the trend of the conclusions being reached by investigators in the modern school of "curative physik":

"Mineral waters add nothing to the nutrition of the body which may not also be obtained from the daily food."

"Although the curative range of our mineral waters is quite limited the number of every day ailments in which they are indicated is large, and many of these mineral waters may be used with good results."

"Sharp distinctions must be made between curative and palliative treatment, and between being benefited and being cured."

"The indications for the use of pure water, and of water only slightly mineralized, are many, those for the use of heavily mineralized waters are comparatively few."

Water Power.

The moderate fall of the larger streams of the county renders available a supply of energy which might be utilized. Data regarding the elevation, slope, volume of flow and available head in both Skunk rivers are given in Part II, Tenth Census of the United States. At present the mill at Lynnville is the only one run by water power.

IOWA GEOLOGICAL SURVEY

GEOLOGICAL MAP OF JASPER COUNTY, IOWA.

BY

IRA A. WILLIAMS.

1905.

Scale 1/125000

1 ½ 0 1 2 3 4 5 Miles.

1 ½ 0 1 2 3 4 5 Kilometers

LEGEND

GEOLOGICAL FORMATIONS

DES MOINES (Coal Measures)

RED ROCK SANDSTONE

KINDERHOOK

INDUSTRIES

COAL MINES ABANDONED

COAL MINES IN OPERATION

CLAY PLANTS USING SHALE

STONE QUARRIES

T. 81 N.

T. 80 N.

T. 79 N.

T. 78 N.

R. XXI W. R. XX W. R. XIX W. R. XVIII W. R. XVII W.

CLEAR CREEK · INDEPENDENCE · MALAKA · MARIPOSA · HICKORY GROVE · POWESHIEK · SHERMAN · NEWTON · KELLOGG · ROCK CREEK · WASHINGTON · PRAIRIE · MOUND PRAIRIE · PALO ALTO · BUENA VISTA · RICHLAND · DES MOINES · FAIRVIEW · ELK CREEK · LYNN GROVE

Clyde · BAXTER · Newburg · Ira · Mingo · Greencastle · Valeria · Goddard · Oswalt · NEWTON · KELLOGG · Rushville P.O. · Turner P.O. · COLFAX · Dolson Sta. · Metz · Severs · Murphy · Wilson · Prairie Bell P.O. · PRAIRIE CITY · Kilduff · Sully · Lynnville · Reasnor · Fairmount · Galesburg · Vandalia · Franklin P.O. · Romans Lake · MONROE

DRAWN BY F.C. TATE

IOWA LITHO. CO.

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