GEOLOGY OF SCOTT COUNTY.

BY

W. H. NORTON.

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INTRODUCTION.

Scott county is not only one of the most populous and wealthy of the counties of Iowa, but it is rich also in geological phenomena of peculiar interest and importance. Although it comprises an area of only 447 square miles, there outcrop within its borders the consolidated sediments of various stages of three great geological series—the Silurian, the Devonian and the Carboniferous. In a number of localities these are of special industrial value, and furnish mines of coal and clay and quarries of building stone and lime. As the frontiers of three geological systems of indurated rocks lie within the county, so within the same narrow limits the borders meet of three great sheets of drift, which record three distinct invasions of continental glaciers in late geological time. In various forms of topography, due to the action of different geological agencies, Scott county is equally rich. Unscored plains of alluvium and of glacial drift, past plains now maturely dissected by valleys of erosion, rocky gorges of young rivers, billowy hills of frontal loess moraines,—all these varied contours give the landscape a diversity of beauty and a wealth of geologic interest.

Few counties in Iowa offer better facilities for geological investigation. Fronting on the Mississippi and bounded on the north by the Wapsipinicon, the eastern and northern townships have been so far dissected by these master streams and their tributaries that numerous exposures are afforded of the indurated rocks as well as the unconsolidated Pleistocene deposits. The excavations made in the years since the early settlement of the county have added to the natural sections of gorges, scarps and hillside ledges, many artificial geological sections in mines, wells, quarries, and railway cuttings.

It is not strange, therefore, that Scott county long since attracted the attention of geologists. In the course of the early surveys of the Mississippi valley made by David Dale Owen* the geological areas of the county were roughly delineated, and fossils were described and figured from Davenport and Buffalo.

The survey of Hall and Whitney† describes accurately the "limestone of the Rapids of LeClaire," and devotes twelve or more pages to the discussion of the higher rocks of the county. Out of thirty-eight species described by this survey from the Devonian, eighteen are listed from Scott county and six from the opposite bank of the Mississippi at Rock Island. Since that time the fossils of the county have been patiently collected and carefully preserved, as the fine cabinets of the Davenport Academy of Science, Rev. Dr. W. H. Barris and Mr. Asa Tiffany testify. Their rich fauna has been described by Barris, by Hall, by Worthen, by Meek, and by Lindahl. Aspects of the glacial deposits of the county have been treated by McGee, McWorther, Pratt, Calvin, Bain, Leverett, and Udden, and of the older formations by Barris, Tiffany, Calvin, Udden, Norton and Keyes.

Topography.

The topography of Scott county is due to the action of many forces acting through vast periods of time, and it is not always an easy matter to disentangle the complex causes of its various forms of relief. All topographic forms may be divided into two classes, those of construction and those of erosion. To the former class belong the hills of the Iowan frontier, some aggraded valley floors, and the uneroded remnants of the drift plains. To the latter class belong all other reliefs in the county; for, with these exceptions, every hill

*Rept. Geol. Surv. of Wisconsin, Iowa and Minnesota, Philadelphia, 1852.
†Geol. of Iowa (Hall), vol. I, p. 73 seq., p. 278 seq. 1858.

and valley, every bluff and precipice, strath and streamway is due to the corrasion of running water in rill and river, to rain wash, and all the various processes known as weathering.

CONSTRUCTIONAL RELIEFS.

Iowan Drift Plains.—In northeastern Iowa there is associated with the Iowan drift sheet a topography which is strikingly distinct and in part entirely unique. There is the bowlder strewn drift plain, with its gentle undulations, its sags and swales due to initial inequalities in the ice-moulded surface of the till, its drainage so immature that storm water lingers upon it in sloughs and shallow lakelets, its soil peaty and black because of the rapid accumulation of humus consequent on the comparative inefficiency of the agents which, in mature districts, remove it almost or quite as rapidly as it forms. The Iowan drift plain is but slightly represented in Scott county. It comes well down to the Wapsipinicon flood plain on the Clinton county side, but to the south of the flood plain it occurs only in a narrow belt in the northern part of Winfield and Butler townships; and over a considerable portion of this belt, this drift-plain is in part effaced by the peculiar hills characteristic of Iowan areas which are next to be noticed.

The Paha.—Paha are boat-shaped hills or long narrow ridges with northwest-southeast trend, and are composed in part of water-laid sand and silt and in part of ice-moulded till. These unique relief forms are found in Iowa and Illinois along the entire southern margin of the Iowan ice invasion. They are not confined, however, to the limit of its advance, but occupy a large part of the area of its southern extension, the "land of the paha" as it has been termed by McGee* to whose first descriptions and interpretations but little has been added by later students.

The "land of the paha" lies largely to the north and west of Scott county, and the great paha hills and ridges of Cedar

*Pleistocene History of Northeastern Iowa, 11th Annual Rept., U. S. Geol. Surv.

and Jones are here but feebly represented. Still, the paha of the Iowan frontier, which stretches from the east bank of mud creek north of Allen Grove, through Winfield and Butler townships, north of Donahue and Long Grove and through Walnut Grove, and on nearly to the Mississippi at Princeton, are typical in form, in orientation and in composition and structure. That the paha are hills of construction, and are not the wasted remnants of a once level upland, is best seen from a station a little to the south of their belt. Looking from such a station toward the south, the east, or the west, one sees everywhere a dissected upland carved into valleys and hills of erosion. Everywhere an even sky line, the original level of the upland meets the eye. But turning to the north the sky line changes. It undulates in gently convex curves which rise definitely above the surrounding region. The paha here overide the upland for a narrow zone along its northern margin. This is seen more clearly by contrast whereever, as in section 26, Butler township, the paha are interrupted for a short distance and the upland descends unmodified to the Wapsipinicon flood plain. In some of the adjacent sections the paha abut against the steep northern edge of the upland, while in Winfield and Allen Grove townships, where the upland descends gently to the north, they are built in part upon it and in part on the Iowan drift plain which continues the gentle descent to the Wapsipinicon flood plain. But whether they occur on the bowlder dotted Iowan drift plain or override the margin of the loess mantled Illinoian upland, in all cases their contours and their trend are not under the control of any streams which might be supposed to have carved them out of an initial land mass. The paha are indifferent to any erosional divides. They may indeed form divides between streamways, but here the streams are under the control of the hills, and have been diverted from their arborescent courses to courses parallel, and with the northwest-southeast trend so characteristic of paha regions. Or the paha may lie athwart the natural divides, as in section 19 of Butler and 24 of Winfield townships.

In shape the paha may assume the forms of long, low swells, sometimes simple and comparatively even topped, but usually complex and lobate, the crest line rising in long, boat-shaped summits, and falling in low, broadly concave cols. Of

FIG. 41. Paha near St Ann's church, northeast of Long Grove.

these the Saint Ann paha (Fig. 41), north of Long Grove, is an example. Again, the dolphin-backed eminences may be more distinctly individuated and form separated hills, of which several may be strung along a common axis. An illustration of this form is offered in the paha of Allen Grove township, section 23, (Fig. 42.) Associated with a change of composition from loess to sand occurs a third variety, a narrow range of short, more or less detached, hummocky hills, with steeper slopes and rounded or somewhat peaked summits. Paha in section 19, Butler township, will serve as illustrations of this type. A fourth variety is found in the high and massive ridge of sand and loess which stretches for nearly four miles along the Wapsipinicon flood plain, in Princeton township. The ridge is crested with dune-like hummocks

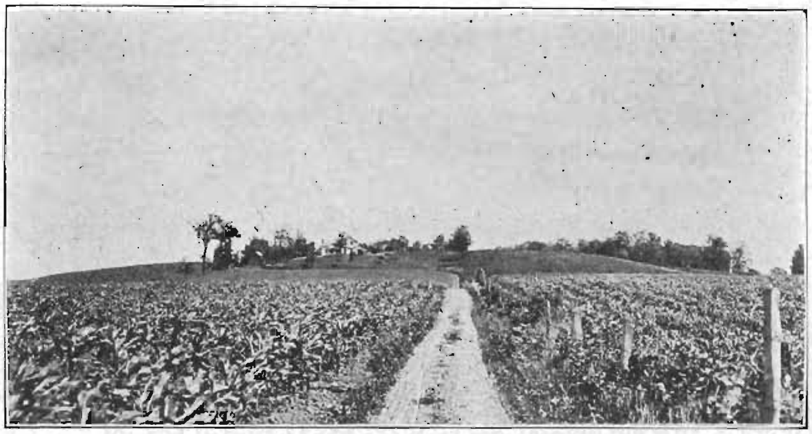


FIG. 42. Paha north of Allen Grove.

(Fig. 43), grassed or forest-covered, but with barren patches here and there of wind-blown sands. Between these hummocks, or between the ridge and the Illinoian upland, several shallow ponds occur, a few acres in extent, fed through springs by the storm water which falls on the surface of the adjacent hills. Much as this ridge resembles a region of dunes, its position, its alignment, its composition, and its structure refer it to the class of the paha.

Within the area of the Iowan drift, and well down into the Wapsipinicon flood plain, there occur in Winfield and Butler townships, as in section 18 of Butler, long, narrow, parallel

FIG. 43. Sand hills on Iowan frontier, Princeton township.

sandbars with pahoid trend which, perhaps, belong in the same category.

All these constructional forms so far described belong to the region which has been associated with the invasion of the Iowan ice. But they occur far to the south of the Iowan area. In the southwestern part of the county near Durant, in sections 32 and 33 Cleona township, low rounded hills separated by broad swales are found, which have every appearance of paha. Their structure is probably the same as that of an isolated hill, just across the line in Muscatine county, transected by the C., R. I. & P. Ry., in which a nucleus of till is covered with water-laid deposits — gravel, sand and loess.

Illinoian and Kansan Drift Plains.—Beyond the Iowan frontier the topography of Scott county may be described as that of nearly level upland plains more or less dissected by erosion. All the valleys and hills in these plains have been carved by weather and water; but their initial flat surfaces were surfaces of construction, and these in places remain but little changed. In structure they consist of glacial till covered with loess. Thickening toward the Iowan frontier and toward the Mississippi river, the loess forms a mantle of fairly uniform thickness over the remainder of the area. Since it wraps about the hills and descends into the flood plains of the valleys, the initial features of these plains cannot be attributed to it but to the glacial till beneath. This argument is supported by the fairly uniform and slight thickness of the loess over areas as yet undissected. We may then conceive of the country south of the Iowan drift sheet as once covered by approximately level constructional plains of glacial till, which have been since deeply eroded in places and still later covered with the loess mantle.

The slopes of these plains may easily be restored. In the northwestern part of the county lies a now maturely dissected upland which extends south to within a mile of New Liberty and to within about the same distance of Round Grove, thus occupying the greater portion of Liberty township. While no flat topped areas remain on the divides, the rounded summits of the ridges fall into a plane lying from 800 to 820 feet above sea level. This we may designate as the Kansan upland, since it is carved in the Kansan drift sheet and its loess mantle. The upland extends north to Yankee run in Cedar county, and slopes gently toward the southeast from an elevation of about 880 A. T., which it reaches southwest of Lowden. In Cedar county the Kansan upland merges by imperceptible degrees of lessening erosion into a plain, which stretches south of Bennett and crosses the west line of Scott county from New Liberty southward. In Scott county the division is marked, the maturely dissected upland overlooking the plain from an elevation of about twenty feet. In the neighborhood of New Liberty the plain stands at a height of about 800 feet A. T., and here one or two sections remain uninvaded by drainage channels. Going south, however, channels multiply and deepen, until within two or three miles from New Liberty tabular divides of any extent have disappeared and the district has practically been reduced to slope. The level tops of the remaining ridges still indicate the initial surface, which thus is seen to decline southward to about 740 A. T., where it overlooks Mud creek.

Across the valley of Mud creek lies a loess-mantled drift-plain, which extends thence south and west to the Mississippi river, occupying thus about three-fourths of the area of the county. This we may call the Illinoian drift plain, since it is supposed to represent the drift deposited by a lobe of glacial ice here moving westward from the region of Illinois. Over much of the area the plain remains flat and featureless. Even its edges along the Mississippi river are tabular areas representing old plain surfaces. Thus the slope of the plain may readily be reconstructed, after allowing for the varation in the original thickness of the loess cover. The present surface stands highest at the north, about Eldridge at about 800 A. T., and at the south, on the high prairie about Blue Grass, at nearly the same elevation. Between Blue Grass and Eldridge runs a central sag at 740 A. T., west of Mount Joy; and level tracts at this elevation extend to Davenport, to Le Claire and to Maysville. The Illinoian plain, as it approaches the Mississippi in Buffalo township, dips toward the river with a slope perceptible to the eye. Toward the Wapsipinicon there is also a short northern slope best seen where, in a few places, the Iowan paha are absent. McGee* has noted the slopes which, on either side of Duck creek, dip toward that central axis. All these slopes are constructional and are not due to the erosion of the present streams.

At one point the Illinoian topography crosses the broad channel of Mud creek. In the southwest corner of Cleona township, extending into Allen Grove, lies a broad shelf at from 720 to 740 A. T., about forty feet above the Mud creek flood plain and as much below the adjoining hills of the Kansan upland. Upon this lies a low loess ridge parallel to the channel of the creek, suggesting an embankment upon a current-cut terrace. This shelf overlies, it may be noted also, the deep preglacial channel of "Cleona river."

Fluvial Plains of Aggradation.—Constructional relief forms built up by deposits of rivers are of marked extent in the county. The flood plain in the ancient channel now occupied by Elkhorn and Mud creeks, and the far larger flood plains of the Wapsipinicon are examples which may be more conveniently described under the drainage of the county.

EROSIONAL RELIEFS.

Causes and Conditions.—The Iowan frontier separates, as we have seen, two essentially different topographies. To the north the land is modeled, to the south it is carved. To the north the hills are heaped and moulded, to the south they are hills of circumdenudation, remnant hills left by the removal of material by the wash of rains and the cutting of streams. Carved out thus by running water, the summits conform everywhere to the divides, and have no more definite alignment or

*11th Ann. Rept. U. S. Geol. Surv., p. 405.

orientation than that imposed by the initial slopes of the drift plain and the consequent courses of the streams. Outside the Iowan drift the diversity of aspect of different sections of the county depends, then, on the degree of erosion which any section has suffered. This is under the control of several causes, the most important of which are age, material, nearness to local base levels of erosion and initial height above them.

Since erosion is a constant process, since creeks and rivers are unceasingly cutting down their beds and conveying the wash of the hillsides to the sea, the longer the time since they began their work upon any district, the more will they have accomplished, the more severe will be the erosion of the district, and the further advanced will it be in the cycle through which topographic forms flow under the agencies of destruction. Conversely, the younger any district is, *i. e.*, the shorter the time since it received its initial form, the less must it have suffered from erosion. In the earliest stages of the cycle of destruction, an originally level or nearly level tract will have but few streams, and these will have barely incised their channels into the land surface. Their branches will be few and short. Large areas will remain undrained, and here and there storm water will gather in original inequalities of the surface, forming lakes, ponds, marshes and swamps. No district in Scott county south of the Iowan frontier presents these characteristics of the first stage in the sculpture of the land. With the lapse of time and the unceasing work of running water, the chiseling of the land is carried forward to another stage with different and equally defined characteristics. Lakes and marshes have now been filled and drained. Streams have cut their channels deeper and now run, at least in their lower courses, in steep-sided, V-shaped valleys. Their affluents are more numerous and have pushed their head waters by retrocessive erosion back far into the areas originally undrained. Flat-topped remnants of the original plain are still left on the divides. Hills are wider still than valleys, and more of the land mass remains than has been cut and carried away. An advanced stage may be seen when the work of erosion has gone so far that the original land mass is thoroughly dissected, when the divides have narrowed into ridges, and of these perhaps only those at greatest distance from the master streams still touch the initial plane. The whole county has been reduced to slope. Later stages than this need not be mentioned, since they find no illustration within our area.

With this brief word indicating the changes which time brings about on the face of the land as it advances from infancy to youth and to maturity, we may scarcely more than enumerate the other factors which have wrought out the physiognomy of the county. Of these elevation is a factor of prime importance. The work of the stream depends upon its energy—the energy of molar motion which is dependent on gravity. The higher the fall, the greater the power. The more elevated the district, the swifter will be its streams, the more energetic their corrasion, and the sooner therefore will the district reach any given stage in the erosional process. High uplands may therefore be maturely dissected, while low initial plains as old in years linger still in their topographic infancy.

Relative hardness of material and distance from local base-level are concomitant causes, accelerating or retarding the normal processes of erosion. The softer the terrane, the more easily it is carved and the more rapidly does it pass through the stages in the cycle of destruction; while the harder the terrane, the longer will it linger in each successive stage of the process. Other things being equal, horizontal nearness to base levels implies in the earlier stages of the erosional cycle streams of relatively steep gradient, swift and of great corrading energy, while distance from base levels implies slight gradient and slow streams of little eroding power.

Illustrations of these laws of earth sculpture are everywhere at hand in Scott county. The scenery of every creek teaches the topographic effect of nearness or distance from the base level of the master stream. Take, for example, the Black Hawk. South of Davenport the stream debouches upon the flood plain of the Mississippi between bluffs about 150 feet high. Their sides are complexly lobate, furrowed deeply with ravines, and are often too steep for profitable agriculture. Naked scarps of yellow till and loess show where the creek swings against the side of the bluff and saps it. Roads are diverted here from rectilinear courses to secure easier gradients. But with each mile of distance from the base level of the Mississippi, the height and steepness of the hills along the Black Hawk diminish, until in about five miles, the traveler on the B., C. R. & N. Ry. finds himself on a plain flat as a floor and scarcely scored by drainage channels. Now, in age, in elevation, and in hardness of the strata the high prairie at Blue Grass is practically the same as the rugged country of the lower Black Hawk. It differs simply in distance from the base level of the Mississippi and in the exemption from erosion which that distance has so far insured. Thus also the traveler going north from Davenport on the C., M. & St. P. Ry., in about five miles leaves behind the deep and complex pinnate valleys along the Mississippi and reaches the level tracts around Mount Joy. The same change is accomplished in still less distance in going west from the dissected margin of the upland at Le Claire, and also south from the Wapsipinicon in the eastern part of Butler township.

The influence of the relative hardness or softness of terranes is illustrated in the soft loess-silt; the yellow loam which everywhere covers Scott county except within the Iowan frontier and on the river bottoms. Loose textured as is the loess, the fact of its presence is proof of the recency of its deposition. So easily is it eroded that, were it of any considerable age, geologically speaking, it must long since have been washed away to the sea. Indeed, most of the valleys of the county were cut before the loess was laid down, as may be seen from the fact that it descends the hillsides well down to the creek bottoms. Where the loess is of considerable thickness, and especially where it was deposited on country already deeply eroded, there obtains a most intricately dissected relief, which is best seen on the Kansan upland about Big Rock. Here the channels of the permanent streams and their primary and secondary ravines are cut in older and heavier deposits, but the ultimate branches, the twigs of the erosion system, are cut largely or wholly in the loess. These are often so close that it may be said that no room exists for another. In form they are often spatulate, the broad and comparatively shallow bowl of the spoon lying well up toward the crest of the upland. The ravine constricts, however, as it descends, and opens into the ravine to which it is tributary by a narrow gateway. Sometimes the bowl has deepened and forms a little cirque, in which occasionally a tiny grove is growing. The spatulate form is normally developed wherever a layer of softer material overlies one of greater resistance. The stream, whether a permanent one or merely the occasional course of the water of rains, cuts through the weaker bed and reaches the lower, harder bed first, in its middle or lower track. Here, its down cutting is delayed by the greater resistance it meets. The grade of the stream above is thus lowered, since it cannot be cut below the point of passage over the harder stratum. Erosion spends itself, therefore, above this point, in widening the valley or the gully. Spatulate ravines in process of formation show a ravine bifurcating, rarely trifurcating, toward the crest. These upper branches widen and at last cut into the neighboring branches, while the stem ravine is deepening its bed. Loess gullies usually begin where the slope of the hillside is steepest, and this, on convex slopes, is in the central portion. Here, down cutting is most active, while above this portion, where the slope is more gentle and less water is at work, the effect of rain wash is more toward sheet erosion. On long slopes, less steep, there are developed ravines of corresponding length, separated by narrow, lingulate lobes. These tongue-like divides descend with a gentle and fairly uniform grade to near the floor of the trunk valley, where their slope becomes more steep. The obtuse angle thus formed may express a change from a weaker stratum above to a more resistant stratum below, as from loess to till, or from till to rock. Or it may express simply the more active erosion, the more rapid down cutting, going on in the trunk valley.

On well kept farms the extreme twigs of loess erosion stems are not allowed to develop, but so soft is the silt and so rapidly is it cut down by rain wash, that eternal vigilance is the price of ungullied hillsides. When constant watch has not been kept the lobes of the hills are most closely ribbed, or, if the disaster is recent, they are disfigured by close parallel gashes (Fig. 44). The beginnings of trouble may be

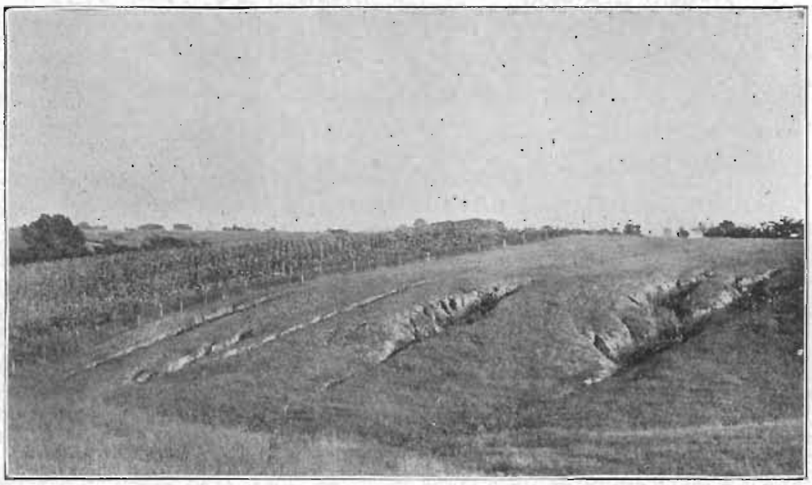


FIG. 44. Characteristic loess-gullies, and even sky line of Illinoian plain; Princeton township.

seen on hillsides in pasture, where, in a season of drought, the grass has here and there been trodden out. In such spots the loose loam, now unprotected by its mattress of grass, is blown away by the wind or washed out by an occasional rain, so that slight pittings of the surface are the immediate result. The heavy rains of fall and spring deepen these depressions into gulches where the grade of the hills is greatest, *i. e.*, on the central portion of the slope. This may coincide with a loess-mantled shoulder of till, so that a system of loess gulches is often seen to start on a line with the summit of Kansan till exposed in the roadway.

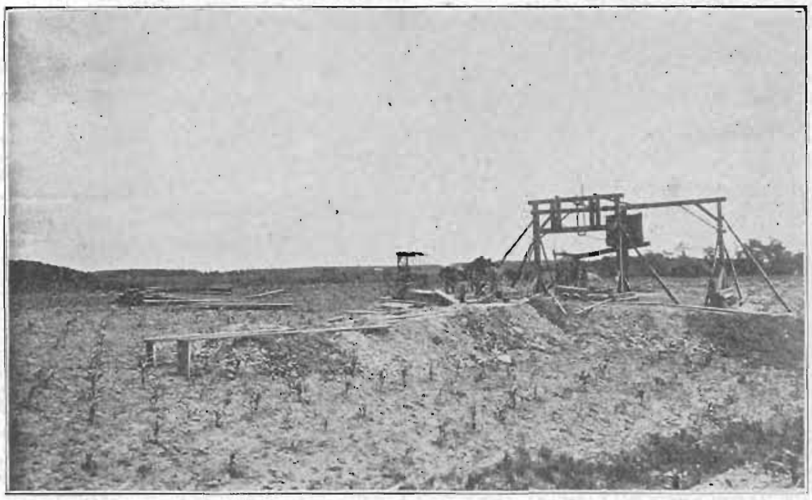
The ready corrasion of the loess is best seen on the steeper hillside roads. Here a wagon rut soon cuts to a miniature canyon a few inches perhaps in width but several feet deep, and in two or three seasons an unmended road becomes impassable.

Elevation as a factor in topographic form is better illustrated by comparing Scott county with outside areas, than by comparison of different districts within its limits.

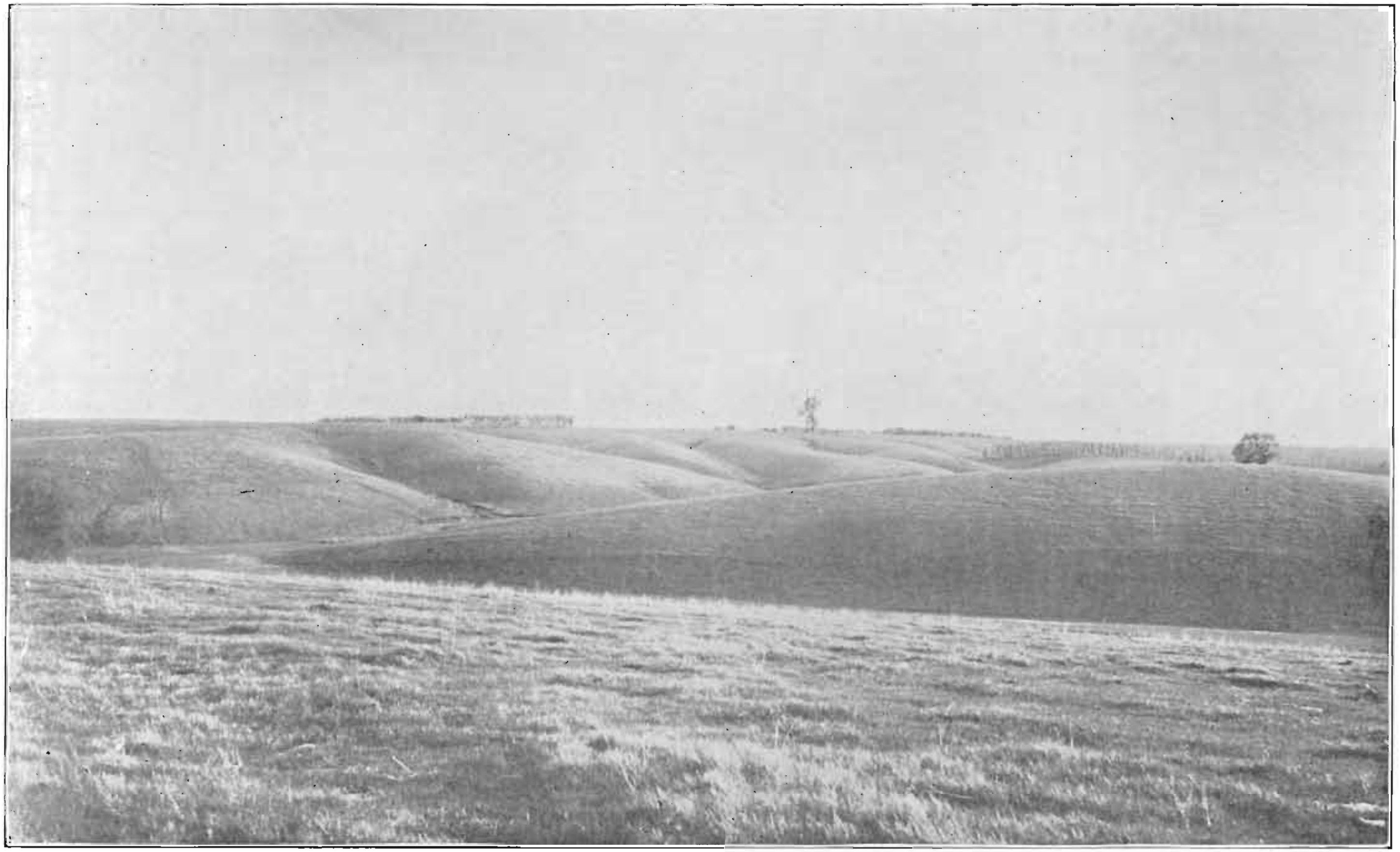
Recent as are the superficial deposits of the county, in which its relief is for the most part worked out, the youthful expression of the face of the country is due largely to its low altitude above the local base levels of the master streams. The Illinoian plain descends to within about 150 feet of the Mississippi at the south, and to within 100 feet of the Wapsipinicon flood plain at the north. The higher levels of the Kansan plains and uplands lie about 150 feet above the latter datum. So slight are the local differences that we have not succeeded in disentangling any special topographic features due to these rather than to other causes. But by comparison with other regions it may be seen that, with equal age, had any considerable elevation been given the county, its streams, instead of moving sluggishly over muddy bottoms in shallow valleys, would rush and cascade over the rocks into which they had deeply cut their gorges, and there would have resulted a rugged region, more picturesque indeed than the present, but far less suited to the needs of man.

We have seen that, other things being equal, the topography of any region varies with its age. Using, therefore, this delicate test, there have been discriminated in Scott county three topographic areas of different age, the Iowan area, the Illinoian plain, the Kansan upland. The narrow belt south of the Wapsipinicon bottoms, designated as the Iowan area, is one of extreme youth. Erosion has had time to make few changes in it as yet, and it remains substantially as laid down by the Iowan ice and its attendant waters.

The Illinoian.--The Illinoian plain is evidently older than the Iowan. Its surface is, at its margin, deeply carved. Even in the interior, about Blue Grass, Walcott, Mount Joy and Eldridge, rainwash and storm water have swept out broad shallow depressions which have drained any ponds which once may have existed. No sedgy Iowan sloughs are here found. But the Illinoian plain still is young. Erosion has, for the most part, only nibbled at its edges. Even to its margins, overlooking the two master rivers, remnants of the original plain surface are left. The mesa-like tops of these outermost salients are well seen in the level streets of that portion of Davenport built on the bluffs, and unfortunately for the builder and the taxpayer illustrations are not wanting in the same district of the sharp, steep bevels chiseled by stream and rainwash. Deep as are these complex, pinnate valleys along the margin of the Illinoian plain, everywhere the eye crosses the valley to find on the other side the flat-topped divide at the



F G. 45. Illinoian plain near Buffalo, showing wide tabular divides: sinking a coal shaft.



TYPICAL TOPOGRAPHY OF LOESS-MANTLED KANSAN UPLAND, LIBERTY TOWNSHIP.

same level. If imagination refills the valleys with the material washed out from them, the initial plain is at once restored. Somewhat back from the river the divides are so wide that stations may be taken from which the valleys are invisible, and the original plain becomes a matter of vision. Even the valley of the Mississippi thus sinks out of sight, the bluffs in Illinois ranging their flat-toped summits in the same plane with those of Iowa. This phenomenon is sometimes startlingly distinct. The northern Illinois asylum for the insane at Watertown, perched on the high bluffs overlooking the Mississippi, forms an imposing landmark far up and down the great river. But from view points on the Iowa side north of Davenport, the castellated towers of the asylum apparently rise in the far distance from a level plain, which seems to stretch unbroken to the observer. The youth of the Illinoian is seen also in the wide area of the interior scarcely as yet scored by erosion channels. The region stretching from Blue Grass to Mount Joy, Eldridge and Porter's Corners, exhibits nearly the initial form of the upland plain out of which all the reliefs of the Illinoian area have been carved. To the eye much of it lies as level as the flood plain of a great river. The horizon line is as even as that of the ocean. Indeed, riding over this prairie on a summer afternoon, one seems to be voyaging over a sea of verdure. Level fields of corn and grain stretch away to the limit of vision. The distance lies hazy and blue, while here and there rise islands of darker green, the planted groves of the farmsteads. The tabular area on which Blue Grass is situated is more than five miles long and from one to four miles wide, and within these limits the maximum relief is less than twenty feet according to the topographic maps of the United States Geological survey. From Green Tree Tavern one may travel north and west to Walcott for fourteen miles, and according to the same authority he will not have changed his elevation above sea level more than twenty feet in the distance.

The Kansan.—The Kansan upland of Liberty township is much more completely dissected, and, therefore, may be held to be of greater age than the Illinoian plain. Valleys and ravines have invaded the entire area, covering it with arborescent lines of drainage. Divides once tabular have been worn back into convex typical ridges. The crest of at least the axial ridges retain the horizontality of the original plain out of which they have been carved. (Plate VIII.) The skyline is therefore for the most part even, but the heavy deposits of loess cause here and there slight sinuosities. With the lapse of time these crests will be broken down into cols and rounded summits, but that stage is far in the future, according to our common standards of measure. Roads generally maintain their rectilinear courses over this rough country, the county commissioners making the best of the situation by cuts and fills. In several instances roads are laid out along the ridges and up the valleys. Railroads make use of the creeks as natural highways, the Burlington, Cedar Rapids & Northern railway using the south branch of Walnut creek, and the Chicago, Milwaukee & St. Paul railway the north branch. Another evidence of the age of this region is found in the well opened valleys of its creeks and their broad flood plains. These will be considered in detail under the topic of drainage.

The Kansan plain immediately about New Liberty retains its original constructional features for the most part. Still no water stands upon it; slight depressions, water worn, everywhere leading away to the creeks. But south toward Mud creek it conforms in its erosion to that which Kansan plains elsewhere have suffered under similar circumstances of altitude and distance from base level.

DRAINAGE.

Scott county occupies an angular space between the Mississippi and its affluent, the Wapsipinicon, the latter river constituting most of its northern boundary, and the former bounding it to the east and south. No part of the county is more than eleven miles from one or the other of these master streams. Disregarding its many meanders the course of the Wapsipinicon along the northern border is about twenty-seven miles, while the frontage on the Mississippi is about thirty-six miles in length. Yet something more than one-half of the county drains to the shorter course of the smaller river. The basin of the Wapsipinicon, which in Jones county is markedly narrow, widens in Scott and Clinton counties to twenty-five miles.

The Wapsipinicon River.—The different portions of the valley of the Wapsipinicon in Scott county show two distinct types. As it enters the county near Big Rock it leaves a flat-bottomed valley, three miles wide, whose rock floor has been filled to a depth of 300 feet, and enters a gorge some forty rods wide, within which the river swiftly runs over a rocky bottom, washing on either side the bases of precipices thirty feet high, and hills which rise 100 feet above the river. This gorge—one of the picturesque spots of the county—is less than a mile in length, and probably marks the position to which the river was once pushed over to the southwest, from its older track, by the Iowan ice. Beyond the gorge the river again enters the open, level valley-plain, three miles wide, silt-filled to an unknown depth. Down this plain it sluggishly wanders with many meanders to the Mississippi, which it enters through several distributaries. From the terraces which mark the limits of floods of the present river, the alluvial plain gradually rises some fifty feet to where it meets the boundary hills. Near the Mississippi, northwest of Princeton, these are high and steep, and descend to the plain by low ledges of rock on which talus slopes are as yet but little developed. Further to the west, in Winfield township, the line of demarkation is fainter, the Iowan drift plain merging into the Wapsipinicon bottom. With some sandy tracts and some lagoon ponds these bottoms comprise much fine and fertile alluvium, unsurpassed as corn and grass lands in the county.

Down this flood plain, evidently fashioned by another and much larger stream, the Wapsipinicon swings in easy curves whose inner radii are from fifty to seventy rods. Here and there are cut-offs and bayous. In Allen Grove township, in especial, the earlier meanders along which the county line was originally drawn have been mostly cut off, so that patches of Clinton county now lie on the south side of the river, while Scott extends its jurisdiction over tracts which once lay within the horseshoe bends to the north, but which are now cut off from the rest of the county by the present channel. Some of these old channels are not yet filled, and even in mid-summer droughts they convey perhaps one-fifth of the water of the river. According to the county maps these cut-offs have been so numerous as to imply a distinct change in the regimen of the river since the settlement of the county. An elevation of the region would lead the stream to thus shorten its course, as would any cause which increased its erosive and transporting power. Of the possible causes the probable one, though it has not been tested by any local investigation, is that change produced by the plow and the axe which has affected all our streams, and which greatly increases their volume and energy in times of flood.

In Liberty township the flood plain lies about seven feet above ordinary stages of the river while the highest floods overflow a terrace twelve feet above the same datum. In the same township, below the gorge already described, an isolated rocky hill stands on the flood plain, cut off from the hills of the banks by a wide and ancient channel now in cultivated fields. The affluents of the Wapsipinicon cross its wide flood plain in courses more or less diverted down stream. Thus Mud creek approaches its master stream to within a mile at a normal angle and then runs along it at this distance for some five miles, until the Wapsipinicon swings in to the right bank and picks it up. The lower courses of Jones creek, Lost creek, Martin creek and Glynn branch have been rectified, and cross all or part of the flood plain in public or private ditches.

Rock and Walnut Creeks.—The valley of Rock creek forms a natural frontier along part of the northern county line, the hills of the right bank rising from Liberty township. Rock outcrops at various points along the stream, as the name suggests, and especially near the village of Big Rock. The valley is wide and open above the village, with flood plains occasionally one-half a mile wide. Rock creek is about fourteen miles in length and maintains an unusually uniform flow. It is the only creek in the county utilized for water power, and at Big Rock twelve feet of head is estimated to furnish fifty-two horse power for a flour and feed mill just across the county line.

Parallel to the valley of Rock creek lies that of Walnut creek, the next affluent of the Wapsipinicon toward the south. The headwaters of its southern branch are gathered on the Kansan plain about New Liberty, at about 800 A. T. Entering the Kansan upland and descending rapidly, it cuts through the drift and discloses the country rock at many places near the stream level, at about 700 A. T. In its lower course its valley widens to a flood plain as wide as that of Rock creek, and here it receives its northern branch which comes to meet it over a rich bottom land of still greater extent. At Dixon the valley narrows, and the stream has cut a scarp of forty feet in till and loess. Here the trench of the stream is about a rod wide and about twelve feet deep. A mile east of the village it enters the flood plain of the Wapsipinicon.

Mud Creek.—The next tributary of the Wapsipinicon, Mud creek, has the largest area of supply of any of the county creeks. It is itself an insignificant stream, occupying near its mouth a trench four or five rods wide and six or seven feet deep. But it has a magnificent valley — first noted by Leverett, large enough for the Mississippi—*i. e.*, a broad flood plain from half a mile to more than a mile in width, marshy in places and with here and there a shallow pond. From either side the hills come down into the valley with gentle slopes, loess covered, and loess also is found on the flood plain. No distinct banks are seen except where the creek now swings against the hills. Furthermore, the valley neither constricts nor ends at the head of the creek. It continues broad and spacious past Durant and Wilton to the great bend of the Cedar. From Durant southward it is occupied by a southward flowing tributary of the Cedar, called Elkhorn creek.

The divide between the two creeks, three miles north of Durant, consists of an imperceptible rise in the flat bottom of the flood plain, and on it lie several small ponds (Fig. 46). Above Durant the valley divides, and the town is situated

FIG. 46. Ancient channel of Mississippi river at the divide between Mud and Elkhorn creeks.

on a long low ridge, an island in the ancient river which cone filled these waterways. In this region of inosculating channels, this river must have occupied a space from two to three miles across. Connecting with the great valleys of the Cedar to the south and the Wapsipinicon to the north, and through them into the Mississippi, connecting also through a short reach of the Wapsipinicon with a similar abandoned channel extending up Brophy's creek, past Goose lake, to the Mississippi at the mouth of the Maquoketa, this ancient river which flows by Durant cannot have failed to have received its share of the floods of waters which slowly moved southward in Pleistocene times within the Mississippi valley and in parallel channels. Certainly this great waterway was not fashioned by its present creeks.

Each tributary of Mud creek traverses in its lower course a broad re-entrant of the ancient flood plain. Thus that of the little creek that comes down past Maysville is a mile and one-half long and half a mile and more wide. It is believed that these broad flood plains were filled from the main channel rather than aggraded by their own creeks.

Other Affluents of Wapsipinicon River.—East of Mud creek a number of short streams, Jones creek, Martin creek, Glynn branch, Mason creek and Contention branch, flow north into the Wapsipinicon over the Illinoian plain and through the Iowan area. In the latter their northern courses are not sensibly diverted. Lost creek also rises on the Illinoian plain and flows eastward on the slope toward the Mississippi, until within hailing distance of the headwaters of Bud creek which continues its general direction eastward, it turns north, is diverted northwest by the massive paha ridge in sections 28 and 29, Princeton township, and then issues forth upon the Wapsipinicon flood plain. The situation suggests the capture by Lost creek of the headwaters of Bud creek, but the unscored Illinoian plain along the divide does not bear this out. These creeks all flow in narrow valleys overlooked by the unworn tabular divides of the Illinoian plain.

The Affluents of the Mississippi are of similar nature, creeks of steep gradient rising back on the prairie and flowing at first in shallow sags, in which crops are cultivated to the immediate streamway, gradually deepening their channels until they flow out on the flood plain of the Mississippi between walls of rock surmounted by steep and high bluffs of till and loess. Of these Spencer and Crow creeks are the largest north of Duck creek, their courses being about ten miles in length. Duck creek rises near the Muscatine county line, on the level prairie between Walcott and Blue Grass, and follows an apparently initial depression in the Illinoian plain, or in its loess cover, nearly due east to near its mouth, thus running parallel, but in the opposite direction, to the Mississippi for about seven miles. Most of this distance would be saved should a short, little creek west of Davenport, down whose valley run the tracks of the Chicago, Rock Island & Pacific railway, sometime cut through the col, less than twenty feet in height according to the United States topographical maps, which now separates their valleys. To north of Davenport the valley of Duck creek is shallow and open, cut in loess and in till, but near its mouth it has cut its narrow way in rock whose precipices rise in places thirty feet in height.

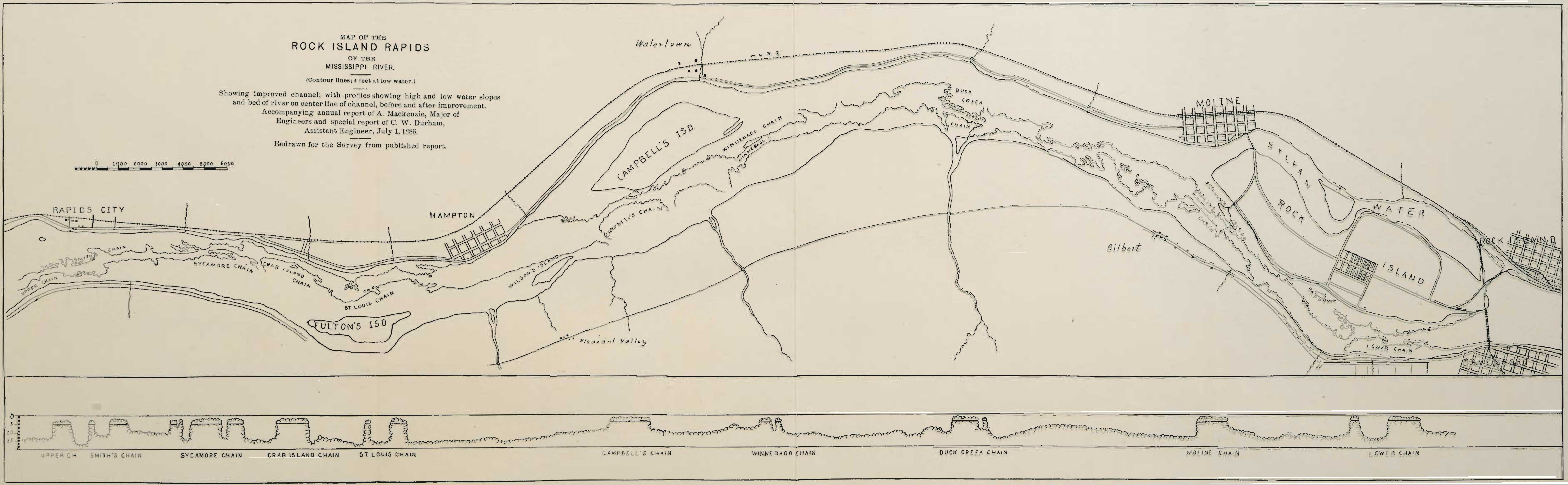
Black Hawk creek runs parallel to Duck creek, but falls into the Mississippi at the bend below Davenport. Owing to a local depression in the rock surface the lower valley is cut only in loess and till, although in places Carboniferous shales are seen near water level. The valley is utilized by the Burlington, Cedar Rapids & Northern railway as its gateway to Davenport, and the railway profile shows a descent for the little stream of 100 feet in somewhat less than three miles. Midsummer droughts leave water only in pools, while storms may make it a destructive torrent, washing away embankments and bridges. On reaching the Mississippi flood plain it turns southwest, hugging the river bluffs, and then, within about 160 rods of the river, turns northeast and continues this course for about a mile until it discharges at Fisherton.

Buffalo, the southern township of the county, is drained by seven parallel creeks, from one to five or six miles long, which resemble Black Hawk creek in their courses to the flood plain of the Mississippi, except that for a mile and more back they flow over rocky bottoms and have made many vertical cuttings in the Devonian limestone of the region.

The Mississippi.—For the first four miles of its course along the east front of Scott county the Mississippi traverses the wide alluvial flood plain of an ancient river now occupied on the Iowa side by the Wapsipinicon. At the mouth of the latter river the Mississippi divides its waters, sending a part through the bayous with which the distributaries of the Wapsipinicon inosculate, the main channel being diverted to the east by the sediment of the affluent. On this wide plain, to the eye as level as the sea, no rock is anywhere in view. But at Princeton the Mississippi enters a rock-cut valley scarcely wider than the river itself. On either side the bluffs descend abruptly to a flood plain so narrow that room is given only for road and railway, and a street or so of the villages which are located along this portion of the river course. Ledges of limestone outcrop in the hills and extend to the water's edge, and beneath, harassing the river in rapids. At Smith's island this gorge widens a little with the outcrop of weak Carboniferous shales. Below the island it constricts again with the reappearance of hard Silurian limestone. From Valley City to below the mouth of Duck creek the valley is more open, being nearly two miles wide at Watertown. On the right bank lies a beautiful and fertile flood plain, more than a mile wide, consisting of alluvial silt with some stretches of sand spread over a current-cut terrace of rock. Midway this wider track there enters on the left bank the ancient river valley now occupied in part by Rock river. At Davenport the Mississippi swings well in against the western bluffs, leaving Rock Island as a detached portion of this terrace flood plain separated from both the Iowa and the Illinois shores. On the same fluvial floor of rock, lying about twenty feet above the river and formed by lateral cutting and covered with a thin veneer of alluvium, stand the lower portions of Davenport. Below this city the bluffs retreat from the stream, leaving a flood plain a mile wide, but again sweep round to the river at Horse island above Buffalo, narrowing the plain to about a quarter of a mile in width from this point to the county line.

Terraces.—With the exception of this flood plain terrace the terraces of the Mississippi in Scott county are by no means conspicuous. In Davenport a narrow bench, about fifty feet above low water, is utilized by the Chicago, Rock Island & Pacific railway tracks. At Crow creek an indistinct terrace lies thirty feet above the flood plain, or about the same height as the bench at Davenport. Between Le Claire and Princeton an ill-defined platform on the hillside occurs at about fifty feet above water level and in section 14 S. W. qr., Le Claire township, a broader terrace of buff sand reaches thirty-seven feet above the same datum, which may be referred to the Wisconsin sub-stage of the Pleistocene.

Rock Island Rapids.—A topographical feature of special economic interest is the series of rapids extending from Le Claire to Davenport and known as the Rock Island rapids. For more than seventy years these rapids have been a notorious obstacle to the navigation of the river, and for nearly as long a time their improvement has received the attention of the government. The brief sketch appended is founded on reports of government surveys, especially those of Lieut. Robert E. Lee, 1837, Lieut. G. K. Warren, 1854, and Major Mackenzie, 1886. Rock Island rapids occupy a stretch of the river fourteen miles in length and have a fall of 20.4 feet at low water. Over the entire distance the bed of the river consists of rock deeply worn in pools and rising in ledges known as "chains," which stretch across the stream from bank to bank, leaving originally a depth in places of only thirty inches, even in the channel, in midsummer droughts. The portion obstructed by "chains" aggregates about three miles, leaving eleven miles of unimpeded navigation between the head and foot of the rapids. Over certain chains the difficulty was not so much the depth of the water as the narrow and tortuous channel and the swiftness of the current. The greatest measured velocity over any chain has been 8.36 feet


MAP OF THE
ROCK ISLAND RAPIDS
OF THE
MISSISSIPPI RIVER.
(Contour lines; 4 feet at low water.)
Showing improved channel; with profiles showing high and low water slopes and bed of river on center line of channel, before and after improvement. Accompanying annual report of A. Mackenzie, Major of Engineers and special report of C. W. Durham, Assistant Engineer, July 1, 1886.
Redrawn for the Survey from published report.
1000 2000 3000 4000 5000 6000
RAPIDS CITY
HAMPTON
Watertown
W. U. R. R.
CAMPBELL'S ISD
WINNEBAGO CHAIN
DUCK CREEK CHAIN
MOLINE
SYLVAN
ROCK
WATER
ISLAND
ROCK ISLAND
DAVENPORT
Gilbert
Pleasant Valley
FULTON'S ISD
ST. LOUIS CHAIN
CRAB ISLAND CHAIN
SYCAMORE CHAIN
SMITH'S CHAIN
UPPER CHAIN
WILSON'S ISLAND
CAMPBELL'S CHAIN
MOLINE CHAIN
LOWER CHAIN
UPPER CH
SMITH'S CHAIN
SYCAMORE CHAIN
CRAB ISLAND CHAIN
ST LOUIS CHAIN
CAMPBELL'S CHAIN
WINNEBAGO CHAIN
DUCK CREEK CHAIN
MOLINE CHAIN
LOWER CHAIN

per second. The location of the chains is shown on the accompanying map. The geological formations to which they are assigned are as follows:

Upper chain	Le Claire limestone
Smith's chain	Le Claire limestone
Sycamore chain	Le Claire limestone
Crab Island chain	Le Claire limestone
St. Louis chain	?
Campbell's chain	Otis beds
Winnebago chain	Otis beds
Duck Creek chain	Lower Davenport beds
Moline chain	Lower Davenport beds
Lower chain	Lower Davenport beds

Up to 1886 there had been removed from these claims in deepening, widening and straightening the channel 87,926 cubic yards of material, at a cost of $1,166,650. About $350,000 has since been spent in the prosecution of the work, which is still in progress.*

History of the Drainage.—The history of the rivers of this region is a long and complicated one, and no single county, perhaps no one state, supplies sufficient data for its exposition. Nothing further will here be attempted than to suggest the local problems involved, and their solution will be left to the results of a much more complete research.

Scott county lies immediately to the south of the driftless area, and is separated from it by a narrow tongue of Iowan drift. In glacial times that area was bounded on both sides by the fronts of the lobes of great continental glaciers. It is possible that at one or more stages of the glacial epoch these lobes met to the south of the driftless area and thus inclosed, behind an ice dam, a sheet of water whose drainage would be over the confluent ice in the region of Scott county. Streams thus cutting their way through the ice would be let down upon the land beneath regardless of its relief. There is a body of evidence going to prove that while the ice streams flowed from either side toward the central axis of the Mississippi, they did not reach it concurrently in certain stages of glacial

*Letter of Capt. O. D. Townsend, Upper Miss. Impr. Com.

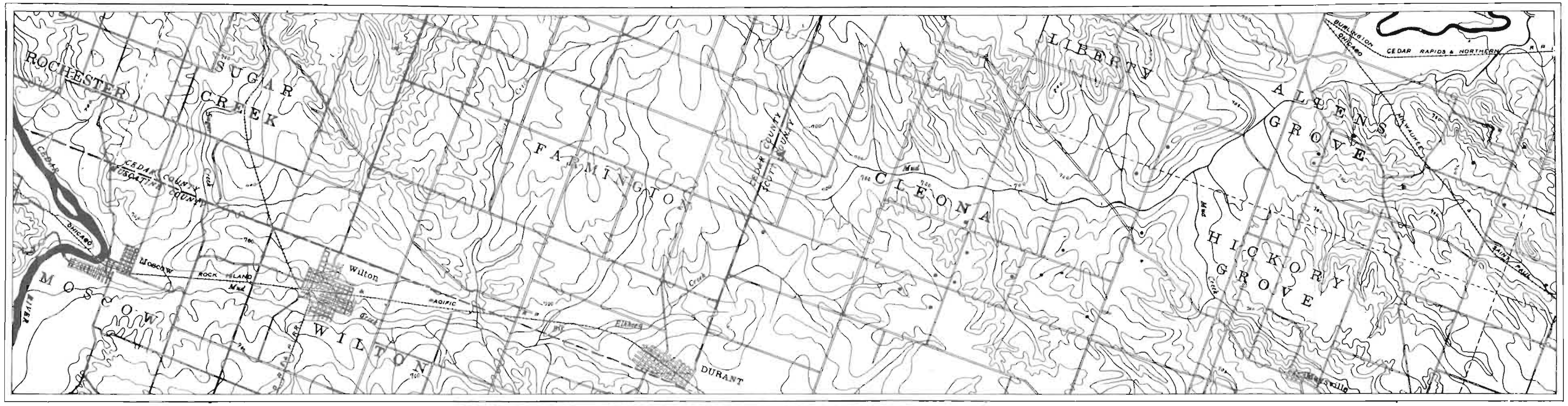
history. At one stage the Illinoian ice crossed the Mississippi channel and invaded Iowa; at another the Iowan glacier carried the wave into Illinois. The effect of the migration of the fronts of these great glaciers must have been to push the river draining the driftless area sometimes to the west into Iowa and sometimes to the east into Illinois.

Elevation and deformation are also factors of which account must be taken. Deep river channels lying 130 feet below the present local base level of the Mississippi can be accounted for only by a previous elevation of the region. Local evidences of deformation, such as warped terraces, may be looked for, closing some old channels and opening others. On the accepted theories of Pleistocene history we should expect to find in this region a complicated series of southward drainage channels, some deep and some shallow, some open and some closed, some rock-cut and some lying wholly in the drift.

Some seven channels have been investigated more or less fully which confirm this expectation. Of these the channel now occupied by the Mississippi from Sabula to Clinton is one of the oldest. It measures from four to seven miles across from bluff to bluff, and the artesian well at Sabula found the fluvial floor of rock only at 163 feet below the level of the fluvial floor of the flood plain; *i. e.*, at 419 A. T. Certainly a channel with so aged a physiognomy may be considered preglacial.

It probably connects through the deep, wide, silt-filled valley of the lower Wapsipinicon with Cleona channel. This is known to reach a depth of 400 A. T., and is at least between two and three miles in width. It is now completely filled. Hills stand above the old waterway, and its existence would not be suspected were it not for the deep wells of the region. These show the presence of several distinct tills in the old valley, and its date may safely be considered as preglacial.

Goose lake channel and the channel which passes by Durant resemble each other closely. Each is now drained by small creeks, one flowing north and one south, separated



ANCIENT CHANNEL OF THE MISSISSIPPI RIVER, NOW OCCUPIED BY MUD AND ELKHORN CREEKS.
Redrawn from Davenport, Wilton Junction and Durant sheets of the U. S. Geological Survey. The black dots locate deep wells in drift.

by a low, swampy divide. In each loess is deposited in places, and their age may be reckoned as pre-Iowan. Each would accommodate the volume of the Mississippi, but, while Goose lake channel would be filled by a rise of the great river of about seventy feet, a rise of 140 feet would be required to flood the other, according to the atlas sheets of the United States Geological Survey. This would even now be effected were the Mississippi blocked with glacial ice at Le Claire, together with the Marais D'Ogee channel. Durant channel follows closely the western edge of the Illinoian drift sheet, as has been shown by Leverett, its discoverer, who has traced its course southward to where it re-enters the Mississippi near Fort Madison. It is, therefore, reasonable to suppose that the line of the southern drainage of the region was held in this channel by the incursion of the Illinoian ice.

A low, open, alluvial waterway extends from Fulton, Ill., southeastward along the valley of Cat-tail creek and connects with the broad flood plains of the Rock river. With the same flood plain connect the still broader bottoms, known as the Marais D'Ogee, which continue into Illinois the great valley of the Wapsipinicon. So recent is the occupancy of the Marais D'Ogee by the Mississippi, if not its original excavation, that the great river still sends a portion of its waters at highest flood around by that eastern route, and a slight deformation would suffice to divert to it the entire river.

The present channel of the Mississippi from Princeton southward has already been described. Any extended discussion of its age would be premature. The narrowness of the rock-cut channel, the absence of flood plains, the relatively steep gradient, the long stretches of rapids, all are features of topographic youth, and point to an age much less remote than that of the deep and wide, silt-filled channel above Princeton. It is evident that there has been a local rejuvenescence of the river from Princeton southward, and

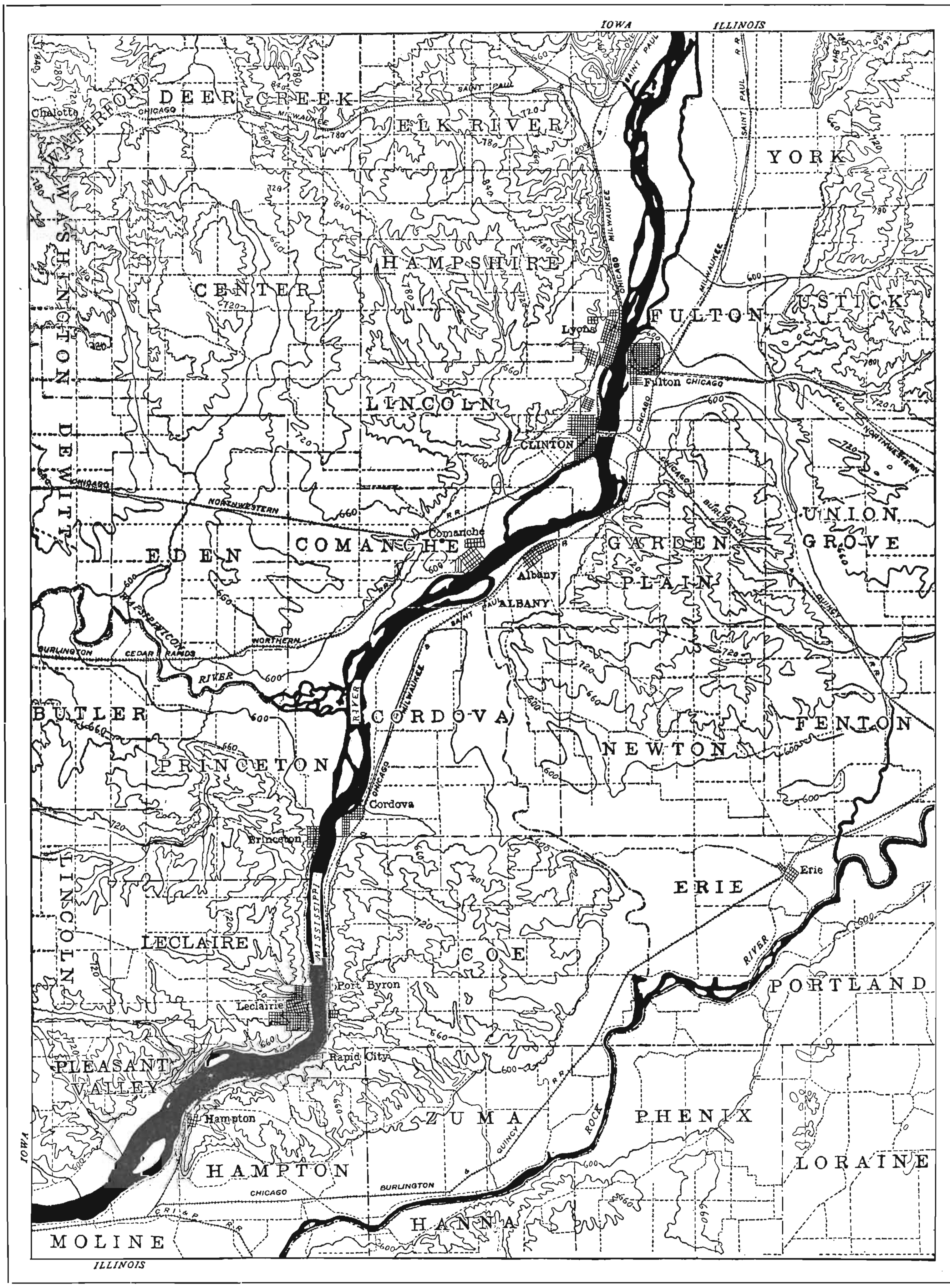
Cleona channel supplies a more ancient path from which the river may have been diverted.

STRATIGRAPHY.

Taxonomic Relations.

The subjoined table affords a conspectus of the geological formations of the county. The last column is subject to revision in the sub-stages of the Cedar valley and Gower. Those under the Cedar valley stage are not all very clearly made out; and those under the Gower are only retained as sub-stages provisionally, until it is seen whether work in other counties confirms the conclusion pretty surely indicated in Scott, that they are but lithological phases of contemporaneous deposition.

GROUP.	SYSTEM.	SERIES.	STAGE.	SUB-STAGE.
		Recent.	Alluvial.	
Cenozoic.	Pleistocene.	Glacial.	Iowan. *Sangamon.* Illinoian. *Yarmouth.* Kansan. *Aftonian.* Pre-Kansan.	
			Residual Clays. *Geest.*	
	Carboniferous.	Upper Carboniferous	Des Moines.	
			Cedar valley.	Dielasma beds. Spirifer Parryanus beds.
Paleozoic.	Devonian.	Middle Devonian.		
			Wapsipinicon.	Upper Davenport. Lower Davenport. Independence. Otis.
	Silurian.	Niagara.	Gower.	Anamosa. Le Claire.



Map of Mississippi river and its ancient channels in northeastern Scott county and adjacent portions of Iowa and Illinois.
Redrawn from Clinton sheet, U. S. Geological Survey.

Geological Formations.

SILURIAN.

GOWER STAGE.

The entire body of the Silurian rocks in Scott county belongs to the Niagara series. The lowest stage of the Niagara, the Delaware stage of Calvin, has not been recognized in the county, and all the Silurian limestones are referred to the upper stage, here termed the Gower. These limestones form the country rock over the northern and larger part of Scott county, their southern limit trending slightly northwest from Valley City to about five miles north of Durant. Exposures of the Gower occur in all the townships north of this line, except in Sheridan and Lincoln, where it lies buried deeply beneath the drift.

There are two distinct lithological types of the Gower limestone. The pure, hard, crystalline dolomite free from chert and especially adapted to the manufacture of lime, known as the Le Claire limestone from its occurrence at the village of that name. The light-buff, granular dolomite, evenly bedded and extensively used for building stone, has been named by Calvin by the term long used in commerce, the Anamosa stone. These subdivisions have been ranked hitherto as distinct stages, but the evidence at hand does not seem to warrant any chronological separation. The terms Le Claire and Anamosa will therefore be used merely as convenient designations of different lithological varieties of rocks of the same stage. Regarding both building stone and lime rock as practically contemporaneous, a name for the stage of their deposition becomes needful. None so appropriate suggests itself as Gower, the name of the township in Cedar county in which occurs many outcrops of both the Le Claire and the Anamosa stone, and in which are situated the famous Bealer quarries at Cedar Valley.

The Le Claire Stone.—The Le Claire limestone is a practically pure dolomite, a double carbonate of lime and magnesia represented by the chemical formula of (Ca. Mg.) CO_3. The normal ratio in pure dolomite is, calcium carbonate 54.33 per cent, magnesium carbonate 45.65 per cent. The following analysis of the lime rock at Le Claire by Dr. C. F. Chandler* shows not only a close approximation to this ratio, but also the remarkable freedom of the rock from siliceous, ferrous and argillaceous impurities:

Insoluble silicates or sand	0.42
Oxides of iron and alumina	0.53
Carbonate of lime	57.54
Carbonate of magnesium (by loss)	41.51

No nodules of chert occur, and although cavities are plentiful, in none is found quartz either in crystals or in chalcedony. The color of the rock is normally a light bluish-gray, varying to darker shades as well as to almost white. Weathered cavities and cracks are often stained buff. The rock is fine, close and crystalline in grain, brittle, with irregular or subconchoidal fracture. Cavities, largely due to the removal of fossils, abound and give to the rock a porous or vesicular appearance and a trachytic harshness. Useless for building stone, it forms a rock unsurpassed in perhaps the whole geological series for the manufacture of lime. A distinguishing characteristic of the Le Claire rocks is the absence or abnormal disposition of its bedding planes. Like the Racine limestone of Wisconsin, it often forms huge mounds in which scarcely a trace of stratification is visible.

These mounds are often fossiliferous, and in them occur irregular masses of breccia and conglomerate difficult to delimit, since the matrix is identical with the fragments in color and texture. Especially towards the sides and summits obscure stratification lines occur, merging into the mound proximally, and distally dipping outward and downward at considerable angles. An excellent example occurs at Schmidt's lime quarry southwest of Dixon. Others are to be seen about Le Claire, forming the centers of apparent anticlines.

Hall, Geology of Iowa, vol I., pt. 1, p. 368.

Outcrops of Le Claire stone are usually traversed by parallel planes, commonly about a foot or less apart. These affect masses of limestone more than twenty feet in vertical thickness and with a dip usually from 12 to 25 degrees, but occasionally rising as high as 40 degrees. Along these planes,

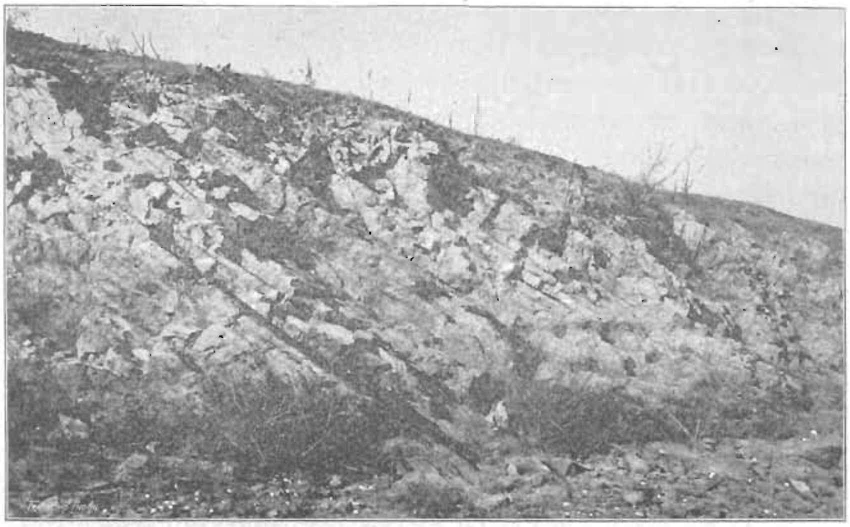


FIG. 47. Le Claire limestone showing oblique bedding. Beds dip to the northeast; (one-half mile south of Le Claire, Iowa.)

tilted as high as 32 degrees and 36 degrees, frequently lie layers of fossils, and the colonial aspect of the fauna of different layers, here crinoid stems, here Rhynchonellas and there spire-bearing brachiopods, or Pentameri, strongly suggests that the fossils have not been washed to their present resting place, but remain in the place of their growth. Nowhere do these planes transect fossil belts, and as pointed out by Calvin,* they therefore cannot be placed in the category of slaty cleavage. The inconstancy of the dips is notable. Within short horizontal distances they vary in degree and direction. For example, in the most southern exposure below Le Claire, along the Mississippi (S. E. qr. Sec. 4, Le Claire Tp.),

*Proc. Iowa Acad. Sci., vol III, 1896, p. 56.

the dip is 30 degrees east southeast; at the schoolhouse, 15 rods east, the rocks lie in a nearly horizontal plane; while a quarter of a mile up stream the dip is 15 degrees north.

In the same township, Sec. 14, Nw. qr., Se. ¼, the Le Claire stone is exposed on a low platform near the edge of the Mississippi river. It is here thinly bedded. On the south the layers dip from 35 to 48 degrees northeast. Toward the north, for fifty feet succeeding, the bedding is obscure, and this gives place to limestone of the same facies dipping 4 degrees southwest. Layers are often seen to interbed and merge with breccia and the structureless rocks of the mounds.

The interpretations which have been given to these abnormal planes are diverse. At an early date Hall believed them due to the flexures of strata once horizontal*. White† and McGee‡ concurred with Hall in regarding them as due to deformation. Worthen§ had earlier suggested false bedding or slaty cleavage as explanations.

Hall afterwards revised his earlier opinion and suggested that these dips might be due to oblique lamination.‖ Norton¶ showed that the assumption of the deformation gives a thickness to the beds at Le Claire far in excess of anything which can be conceded. Later measurements confirm this statement. For a distance of 3,300 feet below the village the uninterrupted dip averages some 20 degrees. If the bedding planes represent tilted strata, the original thickness of the tilted block must have been more than 1,000 feet.

Calvin** has recently given the entire subject a more thorough investigation, and holds that the phenomena in question are neither due to folding nor to lateral compression, as in slaty cleavage; but are examples, on a scale perhaps hitherto unknown, of false bedding or oblique lamination, such as is to

* Rept. Geol. Surv. Iowa, Hall and Whitney, 1858. p. 73 seq.
† Geology of Iowa, White, vol. I, p. 131. 1870.
‡ Pleistocene Hist. of Ne. Iowa, p. 340. 1891.
§ Geol. Surv. of Ill. vol. I, p. 130. 1835.
‖ Twentieth Annual Report, Regents N. Y. p. 307.
¶ Iowa Geol. Surv., vol. IV, p. 134.
**Proc. Iowa Acad. Sci., vol. III, pp. 52-53.

be seen wherever in sea, lake or river, a current is extending a bar by dumping sand or silt over its edge, thus adding layer after layer lying at angles more or less inclined. "The phenomena suggest that during the deposition of the Le Claire limestone the sea covered only the southern part of the Niagara area; that at times the waters were comparatively shallow, and that strong currents, acting sometimes in one direction and sometimes in another, swept the calcareous mud back and forth, piling it up in the eddies in lenticular heaps, or building it up in obliquely bedded masses over areas of considerable extent * * *. In the town of Le Claire, on the west side of main street, there is evidence of the erosion of the sea bottom by currents, and subsequent filling of the resulting channels with material of the same kind as formed the original beds. In eroding the observed channel some of the previously formed layers were cut off abruptly, and in refilling the space that had been scooped out the new layers conformed to the concave surface and lapped obliquely over the eroded edges of the old ones."* The entire thickness of the Le Claire stone is nowhere displayed in Scott county, and no section reaches the maximum thickness of the beds, some ninety feet, observed in Linn county, near Mount Vernon.

The Anamosa Stone.—Intimately associated with the crystalline lime rock known as the Le Claire are beds of a soft, granular building stone, lying in even and horizontal or slightly undulating layers. They are best seen in the quarries about the village of Le Claire, where the stone differs from that of the typical quarries near Anamosa in little except in a slightly stronger tint of buff and a less frequent lamination.

Chemically the Anamosa stone is a dolomite, differing in its constituents from the Le Claire in the larger per cent of the insoluble ingredients. While in the Le Claire there is less than one per cent of insoluble ingredients, in the Anamosa they have been found to form six times as large a proportion. In Scott county, as elsewhere, the Anamosa stone runs in

*Calvin. Op. cit., pp. 54-57.

even, parallel courses, whose thickness depends in part upon weathering, but in which layers from eight inches to a foot are most common. To these dimensions quarry layers of several feet in apparent thickness can usually be split readily. Bedding planes are smooth surfaced, and are not separated by intercalary seams of clay. Joints are distant, allowing the quarrying of stone of any desired horizontal dimensions. The fracture of the rock is even and smooth, affording the utmost advantage to the sledge and chisel of the workman.

The weathered zone of the Anamosa, which may reach ten feet in depth, consists of spalls and calcareous plates from a fraction of an inch thick up to three or four inches in thickness. Two distinct lines of lithological variation occur. One is a transition from a granular to a crystalline condition, a trend toward the Le Claire. The other is a change to a harder rock of finer and more compact grain, with subconchoidal fracture, weathering more or less readily into rhombic chipstone. Layers of this nature are termed "flint" by quarrymen, on account of their fracture and relative hardness, although wholly destitute of silica. This variation trends toward the Devonian lithological types.

The trend toward the Le Claire is exhibited in many quarries throughout the county from Big Rock to Princeton, and as far south as Valley City. The rock lies in heavy layers, commonly two feet thick, traversed by few or no lines of lamination and, like the typical Anamosa, disposed in gentle undulations as if laid down on an uneven surface. In texture, the stone is more or less vesicular, sometimes so finely so as to suggest the texture of pumice, and is also distinctly more crystalline than the pure Anamosa type. It is more earthy than the Le Claire and can never be used for the manufacture of lime. It is darker and more ocherous in its colors than the Le Claire and resembles in many respects beds of the Delaware stage, from which it is distinguished by its most intimate associations with other beds of the Gower. It still more resembles the Coggon beds which in Linn county* were found immediately to underlie the Devonian series. The characteristic Coggon fossils have not been found in these beds in Scott county, and they can not be definitely assigned to the Coggon horizon.

Relation of the Le Claire and the Anamosa Beds.—From his studies at Le Claire, Hall reached the conclusion that the Anamosa beds there exposed, rested in synclinal axes of the Le Claire and belonged not only to a later stage, but even to a distinct epoch. While he placed the Le Claire in the Silurian, as co-ordinate with the Niagara, he assigned the Anamosa to the Onondaga Salt group. Worthen and Meek, White and McGee referred all the strata of the Silurian in Iowa to the Niagara, refusing to draw any lines of subdivision within the formation. Calvin and Norton, however, have distinguished the Le Claire from the lower beds of the Niagara, to which Calvin has given the name of Delaware, and have also separated to a greater or less extent the Anamosa and the Le Claire limestones. In the geology of Linn county† Norton states that the theory of simultaneous deposition of the two limestones under different conditions, the "lime rock" of the Le Claire, representing the irregular aggregation of reefs, and the granular limestones of the Anamosa the remoter deposits of calcareous sediments derived largely from the reefs, seems best to explain all the phenomena of the beds in question observed in Linn county. The close paleontological relations of the two beds, the lithological gradations between them, and the occurrence of crystalline lime rock in places upon the granular limestone of the Anamosa beds are mentioned. At the same time the great thickness of the Anamosa, its wide distribution, the appearance in it of post-Niagara species, are taken to indicate that it represents a somewhat later stage of Silurian sedimentation. Since the publication of the report just cited, quarries have been opened on the Cedar

* Norton: Geology of Linn Co., Iowa Geol. Surv. vol. IV, p. 138. 1894.

†Iowa Geol. Surv., vol. IV., pp. 130-134. 1894.

river west of Mount Vernon, which show clearly the most intimate relation between the Le Claire and Anamosa types. The highly inclined lime rock of the former is seen to pass directly by lateral gradation into slightly inclined beds of building stone of the latter type.

In Scott county alternations along the same horizons between the Le Claire and the Anamosa are frequent; the intermediate lithologic forms between them are numerous. The Le Claire lime rock is moreover interbedded with the Anamosa, or superior to it, so that it becomes impracticable to maintain a formational distinction corresponding to the lithological one. At Steffen's the crystalline lime rock passes laterally into granular building stone within the limits of a small quarry. At Becker's quarry, Le Claire, the former overlies the latter.

TYPICAL SECTIONS OF THE LOWER LE CLAIRE TYPE.

I. SCHMIDT'S QUARRY, LIBERTY TP., SEC. 14, SW. QR., SW. ¼.

Dolomite, white, crystalline, brittle, vesicular, massive, with some obscure and variant lines of bedding. A similar mound some 30 feet thick is exposed by the roadside an half mile southwest (Liberty Tp. Sec. 22, N. ½).

II. LEDGE OUTCROPPING ON ROCK CREEK, LIBERTY TP., SEC. 6, SE. QR., NW. ¼.

Dolomite crystalline, gray, weathering to highly pitted surfaces, in layers up to 4 feet thick, dipping from 23 degrees to 32 degrees east northeast; thickness, 15 feet.

III. ANKEN'S QUARRY, LIBERTY TP., SEC. 13, NE. QR., NE. ¼.

Some 12 feet are here exposed of even bedded, crystalline dolomite in layers up to 1 foot in thickness, the lower 2 feet of the section being in thin layers a few inches thick. The rock forms a slight syncline whose greatest slope in the eastern part of the quarry is some 4 degrees west. Some small Rhynchonellas were observed, and on the dump fragments were found of softer, granular, vesicular limestone which was not seen in place. Adjacent ledges show the Le Claire limestone of the usual type dipping 40 degrees north.

IV. MEEVES' QUARRIES, LIBERTY TP., SEC. 18, W. ½.

Several small quarries have been opened for local uses on the farms of George and of Henry Meeves. Some have been filled up, and those examined showed a rough, crystalline limestone. A close-grained and laminated flagstone, which approaches the Anamosa type, is said to have been taken from another.

V. STEFFEN'S QUARRY, CLEONA TP., SEC. 5, SW. ¼.

This quarry includes several outcrops opened at different times along both banks of a small tributary of Mud creek. The opening now worked on the left bank of the stream has a quarry face of 14 feet, and excavations have been made for 9 feet below the present floor.

		FEET.
3.	Loess	3
2.	Till, Kansan, brown, non-calcareous, with a number of small bowlders, separated from loess by a distinct pebble line	2-10
1.	Limestone, upper surface deeply pitted by weathering. The cavities, descending nearly to the quarry floor, are lined with brown, unctuous residuary clay and are filled with till, and across them the pebble line on upper surface of till passes without downward deflection. Rock, highly inclined in even layers, varying in dip from 20 to 30 degrees southeast. To within nine feet of the surface layers are thin, rarely reaching six inches, and layers up to a foot readily split up. Below, the layers run from six inches to a foot in thickness, and some beneath the present floor are said to reach three feet, and to readily cleave to desirable thickness. Above, the layers are hard, blue, crystalline lime rock; but below, this passes into a granular, light buff building stone, of the Anamosa type. Some layers are covered with short, flexuous, rod-like fossils, which have not been described, but which are often seen in quarries of the Anamosa stone. Joints are distant, and stone 10 feet square can be taken out	14

Ten rods below this section, on the same bank of the stream, occurs an outcrop of even and horizontally-bedded crystalline limestone, and twenty rods distant a mound of lime rock, with southward dipping strata on its south flank.

VI.

Fifteen rods below the above section, on the right bank of the creek, eight feet of hard, bluish-gray Le Claire rock occurs, with the bedding planes dipping 15 degrees northwest, and the layers running from four inches to eighteen inches thick. Within three rods to the north this dip becomes horizontal in the following section:

	FEET.
3. Limestone, granular, in spalls up to four inches thick..	5
2. Limestone, in two and three layers, irregularly bedded, semi-crystalline..........	4
1. Limestone, hard, of close grain, laminated, but not readily cleaved, to quarry floor....................	6

VII. BUD CREEK.

South of the town of Princeton Bud creek cuts a gorge in the Le Claire some eighty feet in depth. The dolomite here is buff or gray, hard, crystalline, vesicular, and lies in regular layers, dipping 3 degrees and less toward the west. The rough surface layers are, for the most part, a foot or less in thickness, although layers occur four feet and even six feet thick. Silica is wholly absent, and fossils are rare, a few moulds of Le Claire corals alone being seen. Some of the heavy layers are intermediate in texture, approaching nearly to the Anamosa type.

VIII.

In Princeton, opposite an old warehouse, a mound of Le Claire is shown in a slight excavation. The Le Claire occurs also in Allen Grove Tp., Sec. 7, Ne. ¼, where it has been burned for lime for fifty years. Half a mile north, Sec. 6, Se. ¼, lies an old quarry, showing ten feet of semi-crystalline limestone in horizontal layers up to fourteen inches. The upper half of the ledge is more evenly bedded, and resembles the rougher and more porous stone of the Anamosa beds. The lower portion is harder and more crystalline. At Big Rock the Le Claire outcrops at a number of places near the village. It is seen associated with the Anamosa in many outcrops along the bluffs bordering the Wapsipinicon in Princeton township, usually nearly horizontal, but occasionally dipping as high as 15 degrees, and along the Mississippi river from Princeton nearly to Island City its outcrops are quite too numerous to mention. For nearly two miles southwest of Le Claire the ledge along the river is practically continuous.

THE ANAMOSA TYPE.

VELIE & NASON'S QUARRY, LE CLAIRE.

	FEET.
7. Loess, weathered jointed, indurated, brown and reddish-brown, becoming more clayey toward the base, where it passes into No. 6..........................	4

6.	Clay, pebbly, dark red, non-calcareous, sandy or highly stony in places	3
5.	Till, gray, not accessible	25
4.	Limestone, soft, granular, weathered into spalls and thin calcareous plates, some as thin as a mm. Upper rock surface but slightly pitted. Limestone buff and dark buff, often finely laminated with darker brownish lines	12
3.	Limestone, buff, lustre earthy, granular, in layers about 6, 8 and 12 inches thick. Bedding planes continuous, even, parallel; joints distant	31
2.	Limestone, more irregular in bedding and texture. In one place it constitutes a single massive layer of hard, gray lime rock, graduating into layered buff, granular building stone which thickens and thins, forming lenticles about 20 feet in length	8
1.	Limestone, buff, granular, in even courses	4

The floor of the quarry is composed of thin irregular layers of finely laminated rock, buff and gray, of finer grain and more brittle than the rock above, and worthless for either building stone or lime. This is said to extend at least 17 feet below the quarry floor. At the west end of the quarry the dip is not more than 3 degrees. This increases toward the east until it reaches 12 degrees west, 20 degrees south.

H. BEEKER'S QUARRY, LE CLAIRE.

The rock of this quarry is in part of the Anamosa type, but is less regularly bedded. The layers are about one foot in thickness and dip 10 degrees north northeast.

		FEET.
4.	Limestone, granular, buff, slightly more compact than Anamosa type, in layers 6 inches and upward in thickness	5
3.	Limestone, crystalline, gray, largely fragmental, the fragments being small	4
2.	Limestone, gray, crystalline, compact; in two or three layers, with moulds of long Amplexus-like corals	4
1.	Limestone, resembling Anamosa type in color and granular condition, but closer textured, harder and with less even fracture	10

A. LANCASTER'S QUARRY, PRINCETON.

		FEET.
3.	Limestone, gray, crystalline, pure, vesicular and cavernous, stratified, used for lime	10
2.	Limestone, intermediate in character between Nos. 3 and 1, in heavy layers, weathering in places into rhombic chipstone	10
1.	Limestone, buff, granular, fine of grain, somewhat coarser textured than the Anamosa type, non-laminated, in heavy layers ranging from 24 to 28 inches in thickness, even and regularly bedded and over most of the quarry approximately horizontal; an excellent building stone	8

F. H. THEILMAN'S QUARRY, LE CLAIRE.

This quarry, which lies across a small creek and to the north of Velie and Nason's, displays some 18 feet of the same excellent building stone. From below, the thickness of the layers is as follows: 12 inches, 16 inches, 10 inches, 6 inches, 6 inches, 24 inches; above which are layers from 6 inches to 12 inches. The quarry has been worked some 8 feet deeper than its present floor. On the east face the dip is 5 degrees west northwest; on the west face the dip is 2 degrees northwest. The upper rock surface, as in the quarry across the creek, forms a low hill fairly smooth of surface and unbroken by pits.

On the same side of the creek lies a small quarry, with a face of 17 feet, belonging to G. H. Davis. The stone, as in the quarries just described, is of pure Anamosa type. It lies in layers up to 18 inches thick, dipping slightly toward the west.

GAMBLE'S QUARRY, LE CLAIRE.

This quarry is situated in the heart of the village and has not been worked for a number of years. The stone is of the best and was extensively used in the buildings of the Rock Island arsenal. The quarry face is about 30 feet. The stone runs in even, parallel courses, with a slight dip, not over 3 degrees toward the west. The lower 14 feet are a light buff, granular, homogeneous limestone, with smooth even fracture, in layers from 6 to 14 inches thick, traversed by vertical distant joints running 10 degrees north of west and 30 degrees west of south. Above these layers lie 3 or 4 feet of rough vesicular and cavernous limestone weathering to a most irregular face, of no value except for riprap. The remainder of the quarry lies in the zone of weathering and shows layers from 2 inches to 6 inches thick. The extremely thin weathered plates and spalls, often seen in quarries of this rock, do not here appear.

FIG. 48. Overturn fold in Anamosa limestone (retouched). Pinneo's quarry, Princeton township.

C. W. PINNEO'S QUARRY, PRINCETON TP., SEC. 35, SW. QR.

		FEET.
2.	Limestone, buff, weathered into thin layers from a fraction of an inch to 4 inches thick. Horizontal at west end of quarry; at east end flexed into a strong overturn fold 8 feet high, with overturn toward the east. Upper surface weathered into pits, two of which are filled with white plastic, gritless clay (Carboniferous ?) with white saccharoidal sandstone at bottom	10
1.	Limestone, light buff, in even layers from 6 inches to 10 inches thick, fine grained, undisturbed from their horizontal position except under the anticline of the upper layers, where they form a slight monocline with a fall of 9 inches in 7 feet	10

RICH'S QUARRY, PRINCETON TP., SEC. 34, NE. QR., NW. $\frac{1}{4}$.

Like the two quarries just described, this has been opened in the ledges of limestone which form the bases of the high hills which front the Wapsipinicon flood plain in this township, and its floor is approximately level with the plain.

		FEET.
5.	Superficial deposits resting on unpitted rock surface..	2
4.	Limestone in thin layers, mostly from 2 to 4 inches thick, a few reaching 8 inches, and some consisting of thin calcareous plates............................	12
3.	Limestone, close, granular, slightly harder and more brittle than typical Anamosa stone, in even, horizontal courses from 6 to 20 and 24 inches in thickness, buff in color, with few cavities and smooth surfaced, including a foot or so of thinly laminated "flinty" limestone.....................	14
2.	Limestone in layers from 2 inches to 18 inches, semi-crystalline..	7
1.	Limestone in thin, gray, crystalline, calcareous plates............	5

INTERMEDIATE TYPES.

The following sections represent beds of the Gower stage which resemble the Anamosa in their even and regular and slightly undulating courses, and in their buff color. They differ from the type in their heavier bedding, in absence of lamination, and in a more vesicular texture in their semi-crystalline facies. They are intermediate between the Anamosa and Le Claire types:

JAMES MOHR'S QUARRY, LIBERTY TP.

		FEET.
4.	Loess...........	2
3.	Geest, dark brown, unctuous, residual clay resting on a rock surface pitted to depth of about 1 foot.......	$\frac{1}{6}$–$\frac{1}{2}$
2.	Limestone, crystalline, hard, in layers up to 8 inches in thickness. On upper surface decayed to a depth of from 4 to 8 inches, to limestone meal or flour....	3
1.	Limestone in layers up to 18 inches in thickness, rising from approximately horizontal at west end of quarry to a southwest dip of 7 degrees at the east end, rock buff, semi-earthy, vesicular; near base earthy and finely mottled with drab.....	15

Across the creek substantially the same rock outcrops at the same level, but here it dips 15 degrees east and 20 degrees south. A quarter of a mile to the west lies the mound of Le Claire stone already described under Schmidt's quarry. A few rods west of this, an old quarry at the same level shows 12 feet of reddish-buff limestone in layers about 2 feet thick, not laminated, very finely vesicular, and partially crystalline, dipping 6 degrees northeast.

D. SNYDER'S LEDGES, LIBERTY TP., SEC. 1, NE. QR., NE. ¼.

This natural section, in ledges from 20 to 30 feet in height, along the gorge of the Wapsipinicon river, exhibits admirably the characteristics of these beds. They have been quarried in places for local uses. The rock is for the most part, a soft, earthy dolomite, dark buff or ocherous yellow in tinge, and finely vesicular. The layers are heavy, many being 2 feet in thickness and some upwards of 3 feet. No lamination planes appear. Here and there the rock takes on a more crystalline and harder facies. The bedding planes are not so smooth as in the typical Anamosa stone. Infrequent cavities are seen up to 4 inches in diameter, and a low cave about 10 feet above the river is said to have been penetrated to a distance of 80 feet. The rock stands in smooth surfaced walls without chipstone, and the only talus is formed of huge blocks detached by frost and the roots of trees.

COWLE'S QUARRY, BIG ROCK.

At this quarry, and outcrops adjacent, a soft, buff, highly and coarsely vesicular dolomite is exposed, moderately even in its courses, which run about horizontal, and mostly from one to two feet in thickness. The vesicles in the rock are largely due to the moulds of fossils, and these, or their corresponding casts, are occasionally well enough preserved for identification. The following species were noted: *Atrypa reticularis*, *Leptœna rhomboidalis*, *Spirifer radiatus*, *S. eudora*, *Rhyncho-*

treta cuneata americana, *Siphonocrinus nobilis*, *Eucalyptocrinus cornutus* (?).

At D. Rasch's quarry, in the same village, twenty-five feet of much the same rock is exposed as at Cowle's quarry.

GLEGG'S QUARRY, BUTLER TP., SEC. 17, NW. QR., NW. ¼.

		FEET.
4.	Limestone, spalls, hard	5
3.	Limestone, buff, granular, crystalline, in two layers	1½
2.	Limestone, rough, cavernous, without lamination, massive	4
1.	Limestone, buff, fossiliferous, in horizontal layers from 3 to 6 inches	5

The same beds outcrop on the south side of the region of outcrop of the Le Claire and Anamosa types at Le Claire, abutting on the northern Devonian frontier. The following sections are taken from this district:

LE GRANDE'S QUARRY, TWO AND ONE-HALF MILES BELOW LE CLAIRE, ON THE MISSISSIPPI RIVER.

		FEET.
1.	Limestone, brownish-buff, vesicular, earthy, crystalline, to level of water in Mississippi river	12

The upper two or three feet constitute a level and uniform layer. Below this lies a massive dome, in which bedding planes are obscure or absent, on each side of which the rock lies in outward dipping layers. To the south the dip is 10 degrees south southwest. On the north side the dip is more gentle. The rock, in texture, is intermediate between the Anamosa and Le Claire, while its attitude is wholly that of the latter.

H. HANNA'S QUARRY, PLEASANT VALLEY TP., SEC. 12, SE. QR., SW. ¼.

This quarry has a face of some thirty feet, and has been excavated along a ledge of a branch of Pigeon creek, the quarry floor lying eight feet above water level. The rock is heavily bedded, vesicular, and in certain layers running from one to five feet in thickness, pitted with cavities one to three inches in diameter, which may be confluent. The strata have a scarcely perceptible dip toward the west. The stone is a coarse, more or less crystalline, brownish-buff dolomite, some more compact and crystalline layers being lighter in color, and the more porous beds the more deeply stained by the oxidizing agents.

J. DODD'S QUARRY, PLEASANT VALLEY TP., SEC. 12, SE. QR., SW. $\frac{1}{4}$.

This little section is of special interest since it is found within 40 rods of the lowest beds of the Devonian, the Otis limestone, and must therefore lie near the summit of the Silurian column.

	FEET.
3. Limestone, magnesian, vesicular, buff, in layers 1 foot in thickness or less; more or less decayed..........	8
2. Limestone, magnesian, buff, with cavities up to 3 inches in diameter; evenly-bedded layers from 1 to 2 feet in thickness, dipping some 5 degrees east southeast..	7
1. Concealed to water of creek..........................	6

DYER'S QUARRY, PLEASANT VALLEY TP., SEC. 10, SE. QR., SE. $\frac{1}{4}$.

This quarry has been worked along ledges on Crow creek and well exhibits the rapid lithologic and structural alternations which obtain at this horizon. The ledge quarried farther up stream shows 23 feet of buff, granular, laminated, magnesian limestone, slightly more compact than the pure Anamosa type. For 10 feet from the top, this is weathered to characteristic spalls from a fraction of an inch to 2 or 3 inches thick, which graduate into the heavier layers of the main body of rock, which runs in even, smooth-surfaced courses up to 18 inches thick, dipping from 9 degrees to 22 degrees northeast, across the creek; 15 rods southwest of this exposure there outcrops crystalline lime rock. In thinness and evenness of layers, and in the dip which here amounts to 27 degrees northeast, this body of Le Claire stone corresponds with the granular Anamosa stone exposed so short a distance away at about the same level. Six rods further down stream the lime rock continues unaltered in texture, but now lies in layers 4 or 5 feet thick or more, and approximately horizontal.

The following section belongs to the Niagara limestone but may represent higher beds than those described:

QUARRY OF WM. RHEIMS, CLEONA TP., SEC. 7, NW. ¼.

		FEET.
4.	Limestone, magnesian, horizontally bedded, brown, semi-crystalline, weathering into small chipstone, with one or two 6-inch layers more resistant.......	9
3.	Limestone, magnesian, light gray, laminated, earthy, in places vesicular, more thinly bedded than above, passing in places into thin beds. This includes a distinct layer of buff magnesian limestone 1 foot thick...	6
2.	Limestone, magnesian, gray, irregularly bedded, thin layered, weathering to small, sharp angled chipstones..........	6
1.	Limestone, magnesian, brown, earthy, ocherous, in thicker beds than above, partly concealed.........	3

DEVONIAN.

The water front of Scott county along the Mississippi river exhibits a complete natural section of the Devonian strata of Iowa with the exception of their highest members, the Lime Creek shales and the State Quarry beds. As the strata dip gently toward the south and west, the lowest beds of the series lie farthest toward the north and east, appearing above the Niagara, first about one mile below Valley City, on the south fork of Pigeon creek. The highest beds in the section are disclosed in the southern townships, in numerous sections, from the vicinity of Buffalo to the south county line.

WAPSIPINICON.

Otis Limestone.—The outcrops of this limestone are so few and slight, that, with its associated beds, the Independence shales, it has escaped notice in the county until the present survey. In all respects the rocks referred to in this sub-stage are identical with the limestone first noted in Linn county, and named after Otis, a small station five miles east of Cedar of impalpable calcareous silt, affording a very fair quality of lithographic limestone. It is hard, brittle, breaking with a conchoidal or sub-conchoidal fracture. In color it varies from light to dark drab and brown, and weathers toward white. Often thinly bedded, these thin layers merge into massive beds, four or five feet thick, unevenly laid and sur-Rapids, where its full thickness is seen. So constant is its facies that, were their labels removed, specimens from widely separated outcrops, from the ledges of the Mississippi, the Cedar and the Wapsipinicon, could not be told apart. Lithologically, the Otis is a non-magnesian limestone, thus standing in strong contrast with the dolomites of the Gower stage, which it overlies. It is dense, of the finest grain, compacted faced. These are often finely fragmental, the matrix of the same color and texture as the fragments, and slight in amount. Sometimes the layers are simply crackled. A determinative characteristic of the Otis, and one which fortunately is seldom wanting south of central Linn county, is the presence of a little gregarious brachiopod, *Spirifer subumbonus* Hall. For the time represented by the Otis sub-stage, the Devonian sea bottom in this region in Iowa swarmed with this little animal, other species being strangely absent or unrepresented in the record of the rocks.* From what region *Spirifer subumbonus* migrated hither is an unsolved problem. In the New York area it abounded in Hamilton and Tully times. In Iowa, the day of this earliest visitant of the Devonian fauna soon closed. The end of the Otis sub-stage witnessed a slight elevation of the sea bottom, an approach of the shore line, and a distribution of clay silts where lime deposits had before prevailed. With this change of depth and bottom, with the passing of the Otis, and the incoming of the Independence, the little spirifer either became extinct or withdrew from the region, or possibly survived a little longer during the Independence, with such changes of form as to be no longer

*Since the above was written we learn that Prof. J. A. Udden has found on Pigeon creek, below Valley City, a minute coral.

recognized as the same variety. On the basis of this extremely restricted fauna, consisting of a single species not found elsewhere below the Hamilton, the Otis cannot rank lower than the Middle Devonian of the New York series.

In Scott county no clear contact of the Otis with an inferior limestone is found, although the Niagara occurs within about forty rods of the most northern outcrops. In Pleasant Valley township, Sec. 13, Se. qr. Nw. ¼, the Otis appears in the road opposite the house of W. E. Haskins, in conjunction with a vesicular magnesian limestone upon which it may rest. In Linn county several excellent contacts between the Devonian and the Silurian occur, where the Otis is seen to pass downward through transitional layers into a buff, heavily-bedded magnesian limestone, called the Coggon, and supposed to be the uppermost member of the Silurian series in the region. The Otis outcrops only along a narrow zone between the mouth of Duck creek and Valley City.

Independence Shale.—In its typical exposure in a miner's shaft, near Independence, was found a fine, fissile and highly fossiliferous shale, varying in color from light gray to black. In Linn county the Independence is represented by a heavy and persistent bed of buff shales and argillaceous limestone, called the Kenwood, which occupies the same horizon beneath the brecciated beds of the Lower Davenport sub-stage, as the Independence. At one locality, near Linn Junction, this has been found to include shales of the same facies as that at Independence, and carrying the same fossils. In Scott county the fossiliferous shale has not been found, but the Kenwood type of the Independence is seen at two outcrops on Crow creek resting directly, as in Linn county, upon the Otis limestone. The greatest observed thickness of these beds in Pleasant Valley township is seven feet, and the total thickness of the formation may not greatly exceed this measure. Lithologically it is a rough, brown, earthy, ferruginous limestone, in layers from two to four inches thick, and carrying lenticular nodules of flint.

Lower Davenport Beds.—Immediately south of the area of outcrop of the Otis and Independence, in the east half of section 27, Pleasant Valley township, occurs a Devonian terrane which has been designated the lower Davenport.* It is in these beds that Duck creek has cut the steep and narrow gorge near its mouth. Devil's glen, as the spot is called, is one of the most picturesque places in the county, and its beauty, together with its nearness to Davenport, suggests its appropriation as a permanent park. The lower Davenport is quarried for lime at Gilbert and for building stone and ballast at several quarries along the Mississippi near Camp McClellan. It fronts the river in low ledges above Davenport and along Rock Island, and extends as far west as the quarries of West Davenport, where it is overlain by the upper Davenport beds. But one fossil, a cyathophylloid coral, has been found in them.† The lower Davenport limestones are unfossiliferous. They contain too small a percentage of magnesium carbonate to prevent their rapid effervescence in cold dilute hydrochloric acid. The prevailing color of the stone is drab, weathering to light gray. For the most part the limestone is hard, compact, and fine grained, with earthy lustre, and smooth subconchoidal, conchoidal, or splintery fracture. Near the base one or two layers are partially crystalline, and a distinct bed in the quarries near Camp McClellan is a finely mottled gray, with a texture and weathering corresponding to that indicated by the alternation in color. Near the base certain layers of an earthy, ferruginous, brown or buff limestone occur. These are seen beneath low arches in the strata along the Mississippi ledges, and here in one place the same lithological variety is seen to fill unconformably a long, low depression in the gray limestone of the normal type. In places white and saccharoidal layers occur. The lower beds are massive and moderately heavy; but the upper layers are

*Norton: Proc. Iowa Acad. Sci., vol. I, pt. IV, pp. 22-24. 1893.
†Udden, Journal Cinn. Soc. Nat. His., vol. XIX, p. 93.

commonly finely laminated, weathering to thin and even calcareous plates.

With all these variations the lower Davenport has a distinct lithological facies wholly different from that of any other terrane of the Devonian except the Otis, and from this it is clearly separated by the Independence. The facies of the lower Davenport is not confined to a limited area It characterizes a continuous and constant horizon of the Devonian from Davenport at least as far north as Fayette, and is lithologically identical in all its outcrops, whether on the Mississippi, the Cedar, the Wapsipinicon or the Volga. In Linn county its brecciated fragments rest upon the Independence, and in several localities it is seen to underlie the upper Davenport beds. The maximum thickness is perhaps forty feet.

In the quarries of West Davenport the lower Davenport retains its hardness, brittleness, and fineness of grain. It is more irregularly bedded, and massive and even, thin laminæ are uncommon. Barris* early noted the decided change which here, as elsewhere, occurs in passing downward into the lower Davenport beds. "There succeeds a rough rock, concretionary in appearance, closely approaching the character of chert. In Cook's quarry (and I suppose the same might hold true in reference to Smith's) the workmen only blast down until they come to what they call the 'flint rock.' Mr. Cook told the writer that he could at once recognize the presence of this rock by the peculiar ring it gave back to the stroke of the iron bar, even though its surface was covered up by water." Nowhere are the "flint-like" characteristics just described more noticeable than in these quarries. They consist of the comparative hardness of the rock and its smooth conchoidal or splintery fracture; yet, with the exception of rare siliceous nodules, no flint or silica in any form is contained in it.

Brecciation of the Lower Davenport.—For the most part the Lower Davenport beds in Scott county retain the attitude in

*Proc. Davenport Acad. Sci., vol. II, pp 263-264. 1878.

which they were laid as sediments on the sea floor. In Johnson, in Linn and in Buchanan counties these beds are so highly disturbed, so completely brecciated, that the evidences of the cause and nature of the process have been largely destroyed, and the origin of the breccia has remained one of the riddles of Iowa geology. But in Scott county the disturbing forces were much less intense. They affected here but one terrane and that so slightly that much of it remained undisturbed, and the brecciated portion retains structures which offer valuable clues to the nature of the stresses to which it has been subjected. The earliest stage in the process is seen where the thin calcareous plates of the formation have been slightly flexed. The stress here was sufficient only to crackle the brittle rock at right angles to its planes of lamination, and the layers are now penetrated by a network of calcite veins of infiltration from the narrowest visible to 2 or 3 mm. in diameter.

An advanced step is frequent where, under a somewhat stronger stress, the rock has been broken into small angular fragments. These retain for the most part the plane of the layer to which they originally belonged, but by the disarrangement of the fragments the upper and lower surfaces of the layers are made more or less uneven. That the rock is a true crush breccia and not one formed either out of scree or by the deposition in water of angular detritus, is proven by the sharp and unworn edges and corners of the fragments and in especial by the fact that often their sides are matched and lie in juxtaposition. The matrix here is very small in amount and often difficult to define. Many of the cracks are filled with calcite, and where the interspaces are considerable between the larger fragments, they are filled with small particles of the rock and a calcareous silt of a slightly different color.

An interesting phase is where the thin laminæ so characteristic of the formation have been separated and slightly broken and now lie in a matrix of different color and texture, still retaining largely their original parallelism. Such, certainly, are not formed by the cementation of beach shingle. No other theory for their formation is tenable than that of crush under lateral pressure.

In the quarries in West Davenport illustrations are found here and there of an advanced stage in the process where, under a severe stress, the fragments are wholly disarranged. They retain the flint-like sharpness of their edges, and their interstices may be filled with a fine greenish clay resembling that of the coal measure pockets which abound in the same quarries.

On Rock Island the ledges of lower Davenport limestone show but slight disturbance. Low anticlines and synclines are not infrequent, and in several restricted areas, seldom more than a rod or so wide, the strata have yielded to horizontal thrust and are flexed, crumpled or completely shattered. An example of a layer bent beyond its limit of elasticity and fractured, is given in figure 49.

FIG. 49. Lower Davenport beds, partially brecciated, showing large imbedded fragment, with characteristic lamination, flexed and broken.

On the Iowa side, opposite Rock Island, the same phenomena may be seen, but not so clearly, since the ledges have in large measure been concealed or destroyed by the growth of the city of Davenport. Here the strata are occasionally seen to lie in low arches from 20 to 100 feet long, under which, at water's edge, a brownish, softer limestone sometimes appears. This, in its position and appearance, resembles the Independence, and in the fact that it contains a few small angular fragments of the Lower Davenport type, as in the brecciated zone in Linn county. It also reappears in fragments of breccia. It seems best correlated, however, not with the Independence, but with a brown, ferruginous limestone, carrying similar drab fragments of Lower Davenport type found near the summit of the Lower Davenport beds at Duck Creek. In the hollows of some of the synclines the Lower Davenport is locally brecciated as on Rock Island. In this region, as at Fayette, Linn Junction, and other classic localities of this brecciated horizon, it contains occasional siliceous, elliptical nodules with curiously carious surfaces, and reaching 6 inches and more in diameter. These however, are not characteristic of the Lower Davenport, being found more numerous in the Independence.

Upper Davenport Beds.—In the quarries in the vicinity of Davenport there rests upon the Lower Davenport beds a limestone of distinct lithological facies and carrying an abundant and characteristic fauna. The extension of this limestone in Linn county has been described and named the Upper Davenport.* The most eastern outcrop of which the writer is aware was in Fulton's old quarry, now filled up, in the Sixth ward, on Fourth avenue, Davenport. It extends at least as far west as to the quarries of West Davenport, and an exposure on the bank of the Mississippi river, opposite the foot of Offerman's island (Rockingham Tp., Sec. 9., Nw. ¼), resembles it in texture, although no fossils were found to complete the identification. The Upper Davenport is a tough, hard, gray, semi-crystalline, granular limestone, lying in irregular and rough-surfaced layers varying in thickness up to 2 feet, which break unevenly under the sledge. Blocks often show slicken-

*Norton: Proc. Iowa Acad. Sci., 1893, vol. I, pt. IV., pp. 22-24, and Iowa Geol. Surv., vol. IV., 1894, p. 160.

sides on vertical surfaces, and occasionally a small angular imbedded fragment is seen of the Lower Davenport limestone. The rock is highly fossiliferous as a rule, and certain layers are formed of a coquina of brachiopod shells; but so firmly are they cemented, so tough and hard is the rock, and so resistant to decay, that fossils are disengaged with difficulty, and perfect forms are rarely obtained; 15 feet is probably a sufficient allowance for the entire thickness of the beds. The Upper Davenport limestone has been recognized by nearly all workers in the field as a distinct stratum. In 1877 Barris* emphasized the demarkation of these beds from the Cedar Valley shales above, and the Lower Davenport below, in the statement that "this series of beds seems to be well defined in both its upward and downward limits, the Hamilton above and this flint rock below." Tiffany† also speaks of "upper fossiliferous strata" as distinct from the lower unfossiliferous beds, and like Barris assigns them to a lower geological formation than the beds above. In 1891 Calvin‡ defined the Gyroceras beds of Buchanan county (the equivalent of the beds in question), as "a rather hard, compact limestone, a few feet in thickness and containing numerous specimens of a large Gyroceras, with which are associated robust forms of *Pentamerus comis* Owen." In 1893 Norton§ recognized the same beds in Linn county, and identifying them with the fossiliferous "Corniferous" of Barris at Davenport, suggested the designation of Upper Davenport. In 1897 Barris‖ describes more fully "the lowest fossil-bearing rocks found in the vicinity as the Phragmoceras beds." In the same year Udden¶ classifies the Devonian rocks below the Cedar valley in this locality in two beds, the upper of which is the equivalent of the Upper Davenport of the writer, "consisting of three or four ledges of a strong, somewhat granular, thick-bedded limestone, with large cepha-

*Loc. Geol. of Davenport and vicinity; Proc. Davenport Acad. Sci., vol. II., pp. 262-264.
†Geology of Scott county, etc., Davenport, 1885, p. 13.
‡Am. Geol. vol. VIII., p. 142.
§Proc. Iowa Acad. Sci., pp. 23-24. 1893.
‖Proc. Davenport, Acad. Nat. Sci., vol. VII., p. 1.
¶Journal Cincinnati Soc. Nat. Hist., vol. XIX, p. 93.

lopods, numerous corals and brachiopods and other fossils."

While there has thus been a general agreement as to the delimitation of these beds, there has been a wide difference of opinion as to the rank which should be assigned to them. Hall* classified both Davenport limestones as Upper Helderberg, making no special distinction between them. Worthen refers them to the Hamilton, as does White,† who says, "all the Devonian strata of Iowa evidently belong to a single epoch, undoubtedly referable to the Hamilton period," and with some modifying statements confines them still more strictly within the limits of the Hamilton shales. For paleontological reasons Barris‡ assigned these beds to the Corniferous, stating "that they contain a series of fossils entirely different from any in the Hamilton group. Their general affinities seem to be with the fossils of the Corniferous and Upper Helderberg." McGee§ rechristened the entire series of calcareous Devonian sediments with a term originally proposed by Owen, the Cedar Valley limestone, and this classification Barris‖ has recently accepted. The director of the present Survey and his assistants have considered it unwise to attempt any correlation with the divisions found to obtain in New York. The classifications suggested have been made for local convenience in such parts of the field as the members of the corps have occupied. And wherever the lower strata of the Devonian have been studied in Iowa, some subdivisions have seemed necessary. Thus, with the discovery of the Otis limestone, the more or less calcareous outcrops of the Independence, and the distinct fauna and lithological facies of the Upper and Lower Davenport beds, it seemed best not only to distinguish them from from one another, but grouping them together as the Wapsipinicon stage, to thereby separate them from the Cedar Valley limestone of McGee. Such a separation has been found convenient in Buchanan, in Linn,

*Geol. Iowa, 1858, vol. I, pt. I, pp. 81-84.
†Geol. Iowa, 1870, vol. I, p. 187.
‡Proc Davenport Acad. Nat Sci., vol. II, p. 269. 1878.
§11th Ann. Rep. U. S. Geol. Surv., p. 319.
‖Our Local Geology. Proc. Davenport Acad. Sci., vol VI, p. 1, seq.

in Johnson and in Scott counties. And with the discovery that the Otis and Independence underlie the Upper Davenport, it became impossible to refer the latter to the Corniferous. The Upper Davenport beds were made the highest member of the Wapsipinicon stage because in Linn county a sufficient faunal break seemed to occur between these beds and the shales of the Cedar Valley above. This was seen in the relative predominance of different species above and below this line, in the presence of different species, and in changes in the varietal forms of the same species, as, for example, in the presence of the variety *Orthis macfarlanei* in the Upper Davenport, and of *Orthis iowensis* in the Cedar Valley. In Scott county the reasons seem equally cogent for drawing the line between the two stages at this horizon. The lithological break is as distinct and the change in fauna as abrupt as in Linn county. A list of twenty-four species is given by Barris,* which are restricted to the Phragmoceras (Upper Davenport) beds, and only eight are named which pass upward into the beds next higher. If it appears that the difference in fauna has been exaggerated, the upper limit of the Wapsipincon may well be redrawn.

Fauna of the Upper Davenport.—The fossils of these beds have been collected with great pains for many years, and have been carefully studied by members of the Davenport Academy of Natural Sciences. In its publications are recorded lists of fossils and descriptions of new species, for which science is indebted chiefly to the indefatigable labors of Barris. The following comprises the Molluscan, Crustacean and Crinoidan fauna so far as now known:

*Proc. Davenport Acad. Nat. Sci., vol VII, p. 5. 1897.

Proetus clarus Hall.‡
Proetus crassimarginatus Hall. ?‡
Proetus prouti Shumard.*‡
Proetus rowi Hall.‡
Phacops rana Green.*
Calceocrinus barrisi Worthen.*
Megistocrinus nodosus Barris.*
Stereocrinus triangulatus Barris.*
Gyroceras pratti Barris.*
Phragmoceras walshi M and W.*
Actinopteria decussata Hall.*
Conocardium cuneus Conrad.*
Paracyclas elliptica Hall.*‡
Paracyclas lirata Conrad.*
Capulus echinatum Hall.‡
Capulus erectum Hall.†‡
Platystoma lineatum Conrad.*
Straparollus lativolvis Calvin.*
Athyris vittata Hall (abnormal form).†
Atrypa reticularis Linn.*†‡
Newberria johannis Hall.*†‡
Orthis macfarlanei Meek.‡
Pentamerus comis Owen.*‡
Pentamerella arata Hall.*
Pentamerella dubia Hall.‡
Pentamerella micula Hall.*
Productella spinulicosta Hall.* ‡
Rhynchonella venustula Hall (*intermedia* Barris).*‡
Spirifer bimesialis Hall.†
Spirifer asper Hall.‡
Spirifer subundiferus M. and W.*
Spirifer fimbriatus Conrad.*

Teeth and plates of several species of fish occur in the Upper Davenport, of which only *Ptyctodus calceolus* N. & W.

*On authority of Barris.
†On authority of Calvin.
‡On authority of Norton.

has been identified. An interesting assemblage of corals is found, including *Acervularia profunda* Hall, *Phillipsastrea billingsi* Calvin, which is found six feet from summit of beds, and a form assigned with some question by Calvin to *Favosites placenta* Rom.*

Sections of the Wapsipinicon Stage.—The width of the belt of known outcrops of the Otis and Independence beds does not exceed two miles. The most southern outcrop is in Pleasant Valley Tp., Sec. 23, Se. qr., Ne. ¼, at the crossing of Crow creek. The stream has here cut through the thin alluvium veneer which covers the flood plain of the Mississippi and discloses a ledge, three feet high, of two layers dipping 3 degrees southwest. The rock is a dove-colored, compact limestone, with *Spirifer subumbonus.* A few rods east a shallow quarry has been opened in the same limestone.

A half mile north of the preceding station, where the Davenport road crosses Crow creek, in Sec. 23, Ne. qr., Ne. ¼, the same rock is exposed, and from this point up the creek, on Sec. 14, Se. ¼, it recurs in the stream beds and in several ledges, one twelve feet high. Here the beds are seldom less than a foot thick and are somewhat lenticular. In places they are crackled and fragmental, making the surface and fracture highly irregular. At the farthest point up stream at which the rocks are exposed they lie in thin beds, and here also are more or less fragmental. The Otis recurs near Pigeon creek, by the roadside in Pleasant Valley Tp., Sec. 13, Ne. qr., Sw. ¼. The total thickness of the Otis may reach twenty feet. In all these outcrops the Otis remains the same non-magnesian, dense, hard, brittle, fine-grained, drab limestone already described.

The Independence, of the Kenwood type, is seen in the county only in Pleasant Valley Tp., Sec. 14, Se. ¼, along Crow creek. Here it rests directly upon the Otis, and consists of a brown, ferruginous, earthy limestone, seven feet in thickness,

*In the reports on Buchanan and Johnson counties Calvin draws the upper limit of the Wapsipinicon stage just below the Phillipsastrea horizon.

in thin layers, with nodular masses of chert, and weathering to a stiff clay. Its upper limit has not been seen.

THE LOWER DAVENPORT.

DEVIL'S GLEN, DUCK CREEK, PLEASANT VALLEY TP., SEC. 27, NW. ¼.

FEET.

11. Breccia; fragments many, small, mostly under 2 inches in size, of Lower Davenport limestone; matrix of nearly same color, bedding planes partially preserved 8
10. Limestone, crystalline, purplish-brown, irregularly bedded, containing a few angular fragments of Lower Davenport limestone.............................. 1
9. Limestone, drab, weathering to light gray, hard, compact, fine-grained, in layers 3 to 4 inches thick. Finely laminated, as shown by bands 2 mm. to 6 mm. in width, of distinct alternations in shade of color... 4½
8. Limestone, as above, laminæ picked out by weathering, in places flexed, broken and even brecciated, the layer as a whole retaining its even bedding......... 1⅔
7. Limestone, of color and texture as No. 9.............. ⅓
6. Shale, highly calcareous, brittle, finely laminated, reddish-brown, ferruginous......................... .. ½
5. Limestone, dove-colored, hard, brittle, finely laminated Nos. 5, 6 and 7 have weathered back from face of cliff, and from the distinct line that passes midway across it... ⅓
4. Limestone, of lithographic fineness of texture, light gray... 1⅓
3. Limestone, coarser in texture, coherent laminæ picked out by weathering........ .... 4½
2. Limestone, brittle, drab, weathering to white, compact, semi-crystalline, in two layers, breaking in places into thin, irregular chipstone...................... 5¼
1. Limestone, finely crystalline, white or light gray, weathering into thin, calcareous plates; passing downward, and in places laterally, into mottled, vesicular, darker gray limestone, which merges into a basal, light yellowish gray, massive, finely crystalline limestone, briskly effervescent in cold, dilute hydrochloric acid................. 8

GILBERT LIME QUARRIES.

		FEET.
2.	Limestone, evenly and horizontally bedded, fine-grained, dense, white or light gray, weathering to detached laminæ from $\frac{1}{8}$ of an inch to 1 inch in thickness, passing gradually into No. 1	5
1.	Limestone, darker gray, in layers, less regular in texture and bedding, rough surfaced, to water in Mississippi river	7

GILBERT, BOLAND AND ANDRE'S QUARRIES.

		FEET.
2.	Limestone, as No. 2, in above section	8
1.	Limestone, mottled gray, in even layers, up to 10 inches, slightly vesicular	6

CAMP M'CLELLAN, L. GOEMEL'S QUARRIES.

		FEET.
3.	Limestone, white and gray, layers from $\frac{1}{2}$ inch to 4 inches in thickness, brittle, subconchoidal fracture, laminæ often curved from deposition over convex or concave surfaces, and in places brecciated	3
2.	Limestone, gray, mottled, in irregular layers from 6 to 12 inches in thickness	7
1.	Concealed to water in Mississippi	3

These quarries are deeply penetrated by pockets and chimneys filled with fine, gray Carboniferous sandstone and shale. There are examples where the cavernous openings so filled have no visible channel connecting them with the surface, and where the shale is intercalated for a distance between separated laminæ. Here the shales and sandstone might at first glance be supposed to belong to the Lower Davenport. Indeed, while Hall,* in his description of these outcrops, refers in a footnote to the coal measures, his statements might easily lend themselves to an erroneous impression. "There beds are separated by shaly partings and there is often much shale or clay in the interstices. Large spheroidal masses of greenish clay often interrupt the continuity of the beds, and sometimes these masses are connected with the fissures that reach the surface. The large amount of shaly

*Geology of Iowa, vol. I, pt I, pp. 82-84.

matter, either mingling with the material of the rock or occurring as shaly seams between the beds, would appear to have rendered the conditions of the ancient ocean in a great degree unfit for the development of animal life." So far as the writer has observed the shaly matter of these beds is wholly confined to the shales of the coal measures. The limestone of the Lower Davenport beds is unusually free from argillaceous admixture, and that the absence of fossils is not due to clay silts which are supposed to have rendered the ancient ocean unfit for animal life, is obvious from the fact that the highly argillaceous shales of the Cedar Valley beds, which occur but a few feet above in the geological section, are crowded with the remains of the animal life of the time.

SECTION OF THE UPPER DAVENPORT BEDS.

QUARRY OF MRS D. MEUMENN, DAVENPORT, FIRST WARD. ON FLOOD PLAIN OF THE MISSISSIPPI.

FEET.

3. Soil, black, sandy, with sparse gravel, passing into joint clay of same color containing sand and gravel...... 2
2. Limestone (Upper Davenport), gray, granular, crystalline, close textured, tough, hard, in rough-surfaced, irregular layers varying in thickness from 14 inches at base to 4 to 6 inches above. Blocks often show slickensides. Most abundant fossils *Phillipsastrea billingsi* and *Pentamerus comis*. Rarely a small angular fragment of the Lower Davenport type is seen imbedded. Rock is penetrated by numerous cavities filled with clay (Carboniferous), often containing bowlderets of Upper Davenport type with rounded surfaces, together with sandstone and rolled pebbles, of quartz and jasper 6
1. Limestone (Lower Davenport beds), brownish-drab, of finest texture, hard, brittle, in irregular layers 9 inches and less in thickness, unfossiliferous, also penetrated as No. 2 by pockets of clay which in places becomes a conglomerate of worn limestone pebbles in a clay matrix............................ 5

QUARRY OF HENRY SCHMIDT, DAVENPORT, FIRST WARD. ON FLOOD PLAIN OF MISSISSIPPI RIVER.

		FEET.
5.	Soil, black, passing into No. 4	1
4.	Joint clay, drab, slightly sandy and containing a few pebbles, lower foot stained and mottled by ferric oxide	3¾
3.	Shale (Cedar Valley), calcareous, yellow, highly fossiliferous	1½
2.	Limestone (Upper Davenport beds), of color and texture described in above section, layers 6 to 10 inches thick, joints oblique, stylolated; fracture irregular, upper surface in places a coquina of detached valves of a Newberria with other brachiopods and corals	12
1.	Limestone (Lower Davenport). Upper surface extremely uneven, due to irregularities of deposition. Contact with No. 2, in some places marked by a thin band, not exceeding 2 inches thick, of greenish clay. At eastern end of quarry these beds rise and pinch the Upper Davenport to a thickness of about 5 feet. Lithologically a light, brownish-gray or medium dark drab, fine-grained limestone of conchoidal fracture, containing small and very rare crystals of sphalerite; more or less brecciated, fragments small, retaining their sharpest flint-like edges intact, edges of fragments often match although slightly detached. Matrix always slight, sometimes of calcite crystals, occasionally of clay, and often of limestone slightly more earthy and lighter in color than the fragments	8

Numerous cavities reach to the bottom of the quarry. Joint seams have been widened in places to about 5 feet, and pipes and chimneys occur filled with light bluish-gray or greenish, finely laminated clay, or with a scree of such clay and pebbles and fragments of Cedar Valley shale and Upper Davenport limestones. A selvage one or more inches wide, of brownish, acicular, matted, transverse crystals of calcite sometimes separate the filling from the smooth and decaying walls of the cavities. These cavities have been fully described by Barris.*

*Proc. Davenport Academy of Nat. Sci., vol. II, pp. 234-235.

CEDAR VALLEY STAGE.

The limestones and shales of this stage of the Iowa Devonian extend from the south line of the county as far to the northeast as Davenport. In the quarries in this city the lowest beds of the Cedar Valley consist of a soft, friable calareous shale crowded with fossils and separated from the hard limestone of the Upper Davenport by a sharp line of demarkation. The bedding planes in each of the two stages are everywhere parallel, and no trace of unconformity is to be seen. Instances of supposed unconformity which have been cited are perhaps due to the filling of cavities in the Upper Davenport with scree from higher beds.

Southwest of Davenport no Devonian limestone is seen along the river bluffs until the creeks are reached which traverse the southwest quarter of section 13, Buffalo township. Thence south to the county line every water course discloses the strata of the Cedar Valley limestone, and several large quarries afford artificial sections. So fossiliferous are the strata that the region about Buffalo has long been classic ground to the paleontologist. Large collections have been made from these beds, including the type specimens of a number of species. The time allotted to the present investigator precluded any thorough collection, with systematic classification by closely discriminated horizons. Such horizons would scarcely be expected to extend far beyond the limits of the locality, and their delimitation may well be left to that careful investigation of resident geologists whose work has already been so fruitful.

A fairly well defined basal bed, some 30 feet in thickness, consists of limestones more or less argillaceous, and calcareous shales normally blue in color but deeply weathered to buff and brown. Although in part barren, they are as a whole, highly fossiliferous. They lie in even and nearly horizontal layers, thin, or of moderate thickness, traversed by rather frequent oblique joint planes, and nowhere shattered orbrecciated as in Linn county.

All observers have noted the prevalence of encrinal layers largely made up of fragments of crinoid stems. A characteristic species of these beds is Spirifer pennatus. The fossils associated with it are much more numerous than the following list of the commoner forms:

*Atrypa reticularis.** †
*Atrypa aspera.** †
Chonetes scitula.†
Crania hamiltoniæ Hall.*
*Orthis iowensis.**
*Orthis vanuxemi.**
*Pentamerus comis.**
*Pentamerella dubia.** †
*Pholidostrophia nacrea.** †
*Stropheodonta demissa.**
*Stropheodonta perplana.**
*Spirifer asper.** †
*Spirifer subvaricosus.** †
*Tentaculites hoyti.**
*Aulopora cornuta.**
*Favosites alpenensis.**
*Monticulipora monticula.**

SPIRIFER PARRYANUS BEDS.

There rests on the beds just described a layer of white limestone, about 1 foot thick, with flinty fracture, weathering into conchoidal chipstone, and containing many masses of darker gray color, roughly columnar in shape, with radiating plates which afford a somewhat cruciform transverse section. This horizon is fairly constant throughout the region. At John Saur's old quarry, Sw. ¼, Sec. 13, Buffalo Tp., its most eastern outcrop, it lies 47 feet above low water in the river. At Clark's quarry, about one-half mile west of Buffalo, three

*On the authority of Calvin.
†On the authority of Norton.

miles west and three-quarters of a mile south of Saur's, the same stratum is found about 20 feet above the same datum. This is the closest approximation made to the dip of the limestone of the region.

Above the layer just described lies a hard, light gray, crystalline limestone, with a system of joint planes different from the argillaceous beds beneath, and on the whole a distinct assemblage of fossils. *Spirifer pennatus* has now disappeared and *Spirifer parryanus*, which occurs sometimes with *S. pennatus* a few feet below the white stratum, has become a characteristic and one of the most abundant species. Associated with it are many corals which in places are so abundant as to constitute a reef. Of these *Acervularia davidsoni* E. and H., *Cladopora iowensis* Owen, were noted, the former being especially common. *Atrypa reticularis* occurs in a robust form with *Newberria johannis*, *Capulus erectum* and a Dielasma. This bed is 3 feet thick at John Saur's quarry, and 7 feet thick in Dutcher's, and its total thickness cannot much exceed the latter figure.

Passing up the creeks of section 14 and the sections west, there is seen to succeed a stratum of shale and argillaceous limestone, 6 or 7 feet thick, weathering to a greenish clay, and abounding in *Athyris vittata*. *Spirifer parryanus* continues through this bed, and with it are *Sprifer asper*, *Atrypa reticularis*, the small, fine ribbed type of the Lime Creek shales, *Cyrtina umbonata*, *Orthis iowensis*, *Stropheodonta demissa*, normal type, as well as a small, finely striated variety.

Upon this shale there rests heavily-bedded layers of gray and buff dolomite, weathering to darker shades, in places soft, earthy, ocherous, in others hard and crystalline, forming superficial sparkling crusts simulating sandstone. In the lower layers occurs a horizon in which *Stropheodonta demissa*, in several varieties, weathers from the soft limestone in great numbers. Associated with it are *Spirifer subvaricosus*, *Orthis iowensis* and *Atrypa reticularis*, the latter in a robust and coarse-ribbed form; 2 or 3 feet above are found casts of

Spirifer capax, which Calvin has shown are identical with *S. parryanus*, together with *Stropheodonta demissa*, and several species of coral, among them *Ptychophyllum versiforme*. Layers, probably a little higher, are characterized by giant forms of the commoner Devonian brachiopods. *Atrypa reticularis* is found measuring 44 mm. in width, and a flaring *Orthis iowensis* reaching 50 mm. *Stropheodonta demissa* continues common and assumes a transverse form reaching some 50 mm. wide by 30 mm. long. These dolomitic beds are apparently equivalents of the so-called Montpelier sandstone.

DIELASMA BEDS.

On Dodge's ravine, south half of section 15, Buffalo township, the beds just described are overlain with a thin gray limestone containing many terebratuloid shells and lamellar stromatoporoids. *Dielasma iowensis* Calvin, is here common, and a small species is associated which may be allied to *D. romingeri*, *Athyris vittata*, *Rhynchonella venustula*, a small form of *Atrypa reticularis*, and a small, strongly plicated variety of *Stropheodonta demissa* were collected from the same bed. These layers are provisionally separated from the *Spirifer parryanus* beds, as no trace was found of that shell.

SECTIONS OF THE CEDAR VALLEY STAGE.

L. E. DUTCHER'S QUARRY OF BUFFALO TP., SEC. 13, SW. QR., SW. ¼.

		FEET.
2.	Limestone, hard, gray, crystalline, fossiliferous, *Spirifer parryanus* abundant, in horizontal layers, 4 to 9 inches thick. Rare and small pits filled with coal measure clays indent the upper surface	7
1.	Limestone, argillaceous, blue, weathering to buff, upper 9 feet highly encrinal. Main joints run north 35 degrees east and do not continue into No. 2.....	14

OLD QUARRY, SAUR'S RAVINE, ¼ MILE WEST OF DUTCHER'S QUARRY.

		FEET.
4.	Limestone, gray, crystalline as No. 2 in preceding section	6

		Feet.
3.	Limestone, white, of finest grain, weathering to conchoidal chipstone, with many irregular columnar masses of darker limestone	½–1
2.	Limestone and shale, blue and buff, highly fossiliferous, weathering to thin lamellar chipstone; including harder, less shaly beds above of encrinal limestone largely composed in places of columns of crinoids, maximum thickness of any layer, 8 inches	16
1.	Limestone in bed of creek, gray, argillaceous, no fossils noticed	

WALKER'S QUARRY, BUFFALO TP., SEC. 22, NW. ¼, LEFT BANK OF DODGE CREEK.

		Feet.
4.	Limestone, Spirifer parryanus beds, light gray, crystalline, with abundant stromatoporoid corals and *Acervularia davidsoni*	2½
3.	Limestone, grayish white, with columnar masses and septaria-like partings	¾
2.	Limestone, encrinal in part	6½
1.	Limestone, argillaceous to quarry floor, fossiliferous, Nos. 1 and 2, originally blue in color, are now deeply oxidized along all partings, retaining only blue cores	6

In an older quarry, a few rods up stream, the same beds are seen. Below No. 3 of the preceding section lies a brownish, argillaceous limestone, highly fossiliferous, some two feet thick, resting upon encrinal layers, with shales and limestones interbedded, aggregating nine feet in thickness. Beneath this there lie at the base of the quarry three feet of heavy, dark bluish-drab limestone, breaking into irregular masses with subconchoidal fracture, pyritiferous, very sparingly fossiliferous. Further up the creek, in section 22, the following sequence of beds was observed:

		Feet.
6.	Soft, buff, earthy limestone, with numerous casts of *Spirifer parryanus* and large corals, among them *Ptychophyllum versiforme*	11
5.	Weathered, buff, argillaceous limestone, *Stropheodonta demissa* very abundant, with *Spirifer subvaricosus* and other brachiopods	3

4.	Soft, buff, earthy, massive limestone, with a few individuals of *Stropheodonta demissa* and *Stictopora crassa?*	4
3.	Soft, drab, argillaceous limestone, unfossiliferous	2
2.	Yellow, argillaceous, limestone or calcareous shale, crowded with *Athyris vittata* and other small brachiopods	3
1.	Gray, crystalline limestone, with many corals, with *Spirifer parryanus;* forming bed of creek	

Still higher up the same creek the following section is seen in section 15, Buffalo township, Sw. qr., Ne. ¼:

		FEET.
6.	Shale of coal measures, greenish, fissile	2
5.	Limestone, ocherous, rough, varying locally in hardness, layers heavy and cavernous, upper half unfossiliferous, lower half contains many lamellar stromatoporoids	6
4.	Limestone similar to the above crowded with Dielasma of several species, including *D. iowensis*, Stromatoporoids abundant	½-¾
3.	Limestone, ocherous, containing many Stromatoporoids	1
2.	Limestone, varying in hardness, with moulds of fossils and casts of a giant flaring *Orthis iowensis* and other brachiopods, deeply stained with iron and manganese	4
1.	Limestone, argillaceous, bluish-drab, weathering to buff, in three layers	2½

In Fridley's ravine, Buffalo township, Sec. 20, Ne. ¼, the beds immediately above the Athyris shale are more firm and crystalline. A small quarry on the hillside, fifteen feet above the creek, shows:

	FEET.
Limestone, magnesian, buff, hard, with sparkling surfaces, resembling sandstone, contains large transverse forms of *Stropheodonta demissa*	

A few rods down stream this recurs at five feet above the creek and rests upon soft, buff, argillaceous limestone, three feet thick, crowded with *Athyris vittata* and other brachiopods. This passes into harder blue limestone containing the same fossils, exposed for two feet above water level.

CARBONIFEROUS.

SURFACE DISTRIBUTION.

The Carboniferous strata of Scott county are separated from the great coal field of Illinois only by the narrow and late cut trench of the Mississippi. It is to this field that they belong genetically, since they were laid down at the same time, along the shore of the same sea, with the once continuous deposits across the river.

The largest and richest Carboniferous area in the county lies in Buffalo township. Le Claire township includes a valuable outlier whose shales are worked at Island City, and another lies deeply buried beneath the drift in the northwestern part of the township. Carboniferous deposits are reported in well records near Eldridge. They outcrop near the western and northern limits of the county, in Cleona and Liberty townships. About Davenport there are no quarries which do not show pockets of Carboniferous sandstone or shale. So many are these outliers that it is not difficult to believe that well nigh the entire county once lay beneath the Carboniferous sea, and was covered with a continuous veneer of its offshore silts.

The surface upon which the Carboniferous muds and sands were laid is an exceedingly uneven one. The outlier at Island City, for example, occupies a channel cut in the Niagara limestone, a little more than a mile wide where it is transected by the trench of the Mississippi, and more than 200 feet deep. In Buffalo township the valleys of the creeks show many sections of pre-Carboniferous channels, with vertical walls, filled with coal measure clays. About Davenport the Devonian was deeply dissected before the deposition of Carboniferous strata. This was in part by open waterways, but often also by subterranean stream courses in caverns. On Rock Island an eroded basin filled with coal measure shale was found in constructing the shops of the arsenal. This was explored for more than 1,000 feet. Its width was 900 feet and its depth was seventy feet and more. In building the Rock Island bridge coal shales were found in places at pier No. 5, to a depth of twenty-five feet below low water, or fifty feet below the ledges of Devonian limestone on the island adjacent.*

In the quarries of Davenport these shales occur as the fillings of crevices. Barris notes one in Cook's quarry 20 or 30 yards in length and 3 feet wide, extending nearly or quite down to the Lower Davenport beds.† More frequently they are seen to occupy pits and irregular cavities and caverns whose connection with the surface is not always to be found. Above Camp McClellan an exposure of these clays may be seen filling a cavern whose roof of Devonian limestone is still partially in place. In Fulton's quarry there was noted, some years since, a cavity 30 feet wide filled with most thinly laminated, non-calcareous, fissile, greenish shale extending nearly to the quarry floor. In the same quarry was a vertical crevice filled with a conglomerate of rolled pebbles of quartz, many of which were 3 inches in diameter. About Davenport there occurs also a fine, white, laminated sandstone associated with the greenish clay, and without doubt of the same age. In places this has infiltrated into the finest seams of the limestone, and here and there the fine clay parts the calcareous plates of the Lower Davenport beds into laminæ as thin as paper. In the larger cavities the limestone forming the sides exhibits a weathered surface and occasionally is parted from the clay by a selvage of brown calcite in fine, transverse, acicular crystals. Often the clays contain fragments of the adjacent limestone. The attitude, composition and stratigraphy of these deposits point directly to their age as Carboniferous. Still more conclusive are the fossils which have been found in them, the impression of a large Euomphalus "very similar to a Carboniferous form,"‡ and a fossil plant identified by Barris§ as one

*A. S. Tiffany, Geology of Scott Co., etc., Davenport, 1885, pp. 14-15.
†Proc. Davenport Acad. Nat. Sci., vol. I., p. 261.
‡Hall: Geology of Iowa, vol. I., pt. 1, p. 130.
§Proc. Davenport Academy of Nat. Sci., vol. III, pp. 163-168.

belonging to the coal measures. At Black Hawk the cuttings of the Chicago, Burlington & Quincy railway disclosed a Carboniferous outlier beneath the drift, with 18 inches of coal.

Carboniferous outliers occur in the immediate valley of the Mississippi at water level and below, from Muscatine county as far north as the city of Clinton. Furthermore, the intricate dissection of the pre-Carboniferous country rock just described, the filling of the finest seams and crevices, and the numerous small cavernous channels, preclude the hypothesis that there has here been any deep denudation of the pre-Carboniferous country rock since Carboniferous times. For in all probability the seams and cavities thus filled with sea silts were near the rock surface at the time of their filling. Yet it would be unsafe to conclude that the present valley of the upper Mississippi antedates the Carboniferous. The present rock-cut valley of the river is a shallow one, and the greater elevation of the country rock, and of the outliers in the western part of the county, may be largely due to post-Carboniferous deformation. Since the coal measure outliers in the northern part of the county rest immediately and unconformably on Silurian strata, we may infer that the rocks of that area had formed a land area during Devonian times and had been sculptured by running water, with a maximum relief of about 200 feet. With the coming in of the Des Moines stage of the Carboniferous a progressive depression of the land from the south northward brought in the Carboniferous sea, at least into the deeper valleys, if not over the entire surface. The elevation above tide of the bottoms of the various outliers, so far as known, is about as follows:

	FEET A. T.
Buffalo Tp.	560
Davenport Tp.	500
Island City	488
Eldridge	580
Le Claire Tp., Porter's corners	465
Cleona Tp., Sec. 4	614
Cleona Tp., Sec. 7	725
Lincoln Tp., Sec. 2	620
Liberty Tp., Sec. 22	735

The lithological characteristics of the Carboniferous deposits of the county are given under the detailed sections, and it will there be seen that, like the strata of the Des Moines stage to which they belong, they consist chiefly of shales with some sandstone, fire clay and ironstone, argillaceous, bituminous limestones, and discontinuous seams of coal.

SECTIONS OF THE CARBONIFEROUS, BUFFALO TOWNSHIP.

J. JAMES & SON, SEC. 3, SW. CORNER. COAL SHAFT RECORD.

		THICKNESS.	DEPTH.
9.	Yellow clay, Pleistocene	22	22
8.	Forest bed ("black dirt, like barnyard, with wood")	$\frac{1}{2}$-4	26
7.	Blue clay, Pleistocene	11	37
6.	Soapstone, Carboniferous	17	54
5.	Sandstone, light yellow	30	84
4.	Black, slaty shale	2	86
3.	Blue rock, hard, argillaceous and ferruginous limestone	11	97
2.	Coal	$2\frac{1}{6}$	99
1.	Fire clay	16	115

RECORD OF J. ANDERSON'S COAL SHAFT, ROBT. WILLIAMS' FARM, SEC. 11, NW. ¼.

		THICKNESS.	DEPTH.
7.	Glacial clays	48	48
6.	Soapstone	4	52
5.	Sandstone, white	2	54
4.	Shale, blue	$5\frac{1}{2}$	$59\frac{1}{2}$
3.	Sandstone and shale	$41\frac{1}{2}$	101
2.	Slaty shale	1	102
1.	Coal	3	105

CLAY PIT OF DAVENPORT BRICK AND PAVING COMPANY, BUFFALO.

		THICKNESS.	DEPTH.
8.	Loess, middle and upper phases	7	7
7.	Till, red, brownish-yellow, clayey, pebbles plentiful but small, few exceeding 2 inches, and only one seen reaching 5 inches	5	12
6.	Shale, weathered, gray and ocherous yellow, readily disintegrating, joints and seams and spaces between laminæ filled with ocherous accumulations	5	17

		THICKNESS.	DEPTH.
5.	Shale, black, finely laminated	12	29
4.	Shale, gray	3	32
3.	Shale, dark drab and black, brittle, fine-grained, containing ferruginous nodules and nodular layers	42	74
2.	Shale, gray, disclosed in shaft below bottom of pit	26	100
1.	Rock very hard (limestone?) dip of shale 4° W., 20° N at		100

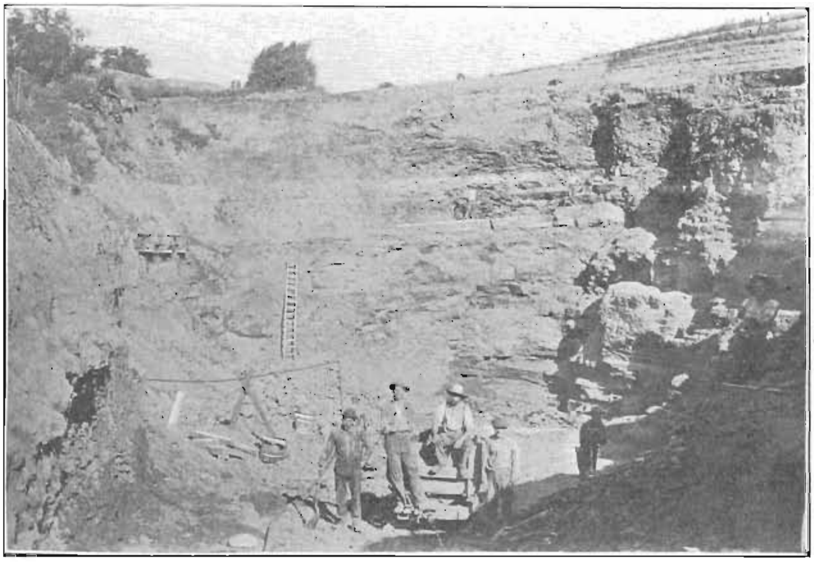


FIG. 50. Clay pit of the Davenport Brick and Paving company, Buffalo, Iowa.

C. ROWAN, SEC. 10, SW. QR , NE. ¼. RECORD OF COAL SHAFT.

		THICKNESS.	DEPTH.
7.	Yellow clays	35	35
6.	Blue clays	30	65
5.	Potters' clay, Carboniferous	4	69
4.	Sandstone	5	74
3.	Slaty shale	3	77
2.	Hard, black rock	3	80
1.	Coal	3	83

RECORD OF WELL, BUFFALO TP., SEC 16, SE. QR., SE. ¼.

		THICKNESS.	DEPTH.
9.	Yellow clay	20	20
8.	Soapstone	25	45

		THICKNESS.	DEPTH.
7.	Slate	2½	47½
6.	Coal	½	48
5.	Fire clay	2	50
4.	Shale	20	70
3.	Coal	2½	72½
2.	Fire clay	1	73½
1.	Limestone, Devonian	66½	140

RECORD OF WELL OF M. SARGENT, LE CLAIRE TP., SEC. 5, SE. ¼, CURB 700 A. T.

		THICKNESS.	DEPTH
9.	Soil	7	7
8.	Blue shale	67	74
7.	Gray sandstone	10	84
6.	Darker shale	10	94
5.	Dark caprock	3	97
4.	Coal	5	102
3.	Fire clay	12	114
2.	Shale	105	219
1.	Limestone at		219

CLAY PIT OF LE CLAIRE BRICK AND TILE CO., ISLAND CITY, LE CLAIRE TP.

		THICKNESS.	DEPTH.
7.	Loess and till, unmeasured.		
6.	Cannel coal	2	2
5.	Potters' clay	4	6
4.	Coal	1	7
3.	Fire clay	4	11
2.	Shale, gray	2	13
1.	Shale, black, to bottom pit	20	33

WELL RECORD OF LE CLAIRE BRICK AND TILE CO , ISLAND CITY.

		THICKNESS.	DEPTH.
6.	Shale, dark	90	90
5.	Sandstone, fine, white, hard	6	96
4.	Shale, blue	70	166
3.	Sandstone, as No. 5	9	175
2.	Shale, blue	25	200
1.	Limestone, with water vein beneath shale under sufficient pressure to rise within four feet of surface	26½	226½

CLEONA TOWNSHIP, SEC. 7, SW. ¼.

A small outcrop of fine yellow sandstone, unfossiliferous, rests on Niagara limestone on the shoulder of a hill 36 feet above the level of the creek below. No ledge was found at this height on the hillside. Fragments and disintegration bowlders occur for a few rods, and a small pit marks the site of a long disused quarry.

CLEONA TOWNSHIP, SEC. 4, SW. ¼.

WELL RECORD, FARM OF WM. RHEIMS.

		THICKNESS.	DEPTH.
4	Pleistocene deposits	144	144
3.	Slate	1	145
2.	Coal	1	146
1.	Limestone at		146

ELDRIDGE, RECORD OF CREAMERY WELL.

		THICKNESS.	DEPTH.
2.	Pleistocene deposits	180	180
1.	Shale, gray, fine grained	20	200

LINCOLN TOWNSHIP, SEC. 2, SW. ¼.

RECORD OF WELL ON FARM OF DETLER ARP.

		THICKNESS.	DEPTH.
3.	Pleistocene deposits	113	113
2	Shale	7	120
1.	Limestone	10	130

LIBERTY TOWNSHIP, SEC. 22, NE. QR., SW. ¼.

Here a road cutting on the side of the hill descending to Walnut creek, exposes some 30 feet of Le Claire limestone of the massive Le Claire type. Midway up the hill occurs a large cavity, 3 feet deep, broadly open above, with extensions into the rock on either side filled with greenish, plastic, gritless clay, entirely similar to that at Davenport, Clinton and many other localities in this region of the state.

GEEST.

The indurated rocks of the Silurian, Devonian and Carboniferous systems record that inconceivably long lapse of time during which the area now occupied by Scott county was covered with the waters of the Paleozoic ocean. At last the sea retired wholly from the area, and for countless ages a land surface was exposed to the disintegrating and dissolving action of the weather. The rock surface was thus everywhere roughened. Wherever the root pried apart the layers of limestone, or where by any cause a way was made for the downward passage of water, there the ground water charged with humic acids and carbon dioxide took up the rock into solution and opened pipes and chimneys and pits and cavities of various shapes and dimensions. Slight though it may be, there is yet in all limestones an insoluble residue of fine quartzose, argillaceous and ferruginous matter. Left behind after the carbonates of lime and magnesia were dissolved and carried away to the sea, these insoluble ingredients remain as fine, plastic, unctuous, gritless clays. The ferric oxides which were able to color the bulk of limestone to which they originally belonged only a faint tint of buff, when concentrated in the thin residue of clay give it the deepest shades of red and brown. These products of rock decay, known as geest, have in places been wholly removed by glacial scour, but for the most part the rock surface and the geest upon it remain much as they were at the beginning of the invasion of the ice. Deeply and firmly frozen, they resisted the slight erosive action of the glaciers whose chief function in these regions seems to have been the deposition of material excavated elsewhere.

In Liberty and Cleona townships the preglacial decay of rocks is especially well marked. Pits of weathering descend as much as 12 feet from the rock surface. These are lined with geest, but are usually filled with glacial clays. The section given of Steffen's quarry p. 431, exhibits the common condition of the rock surface under the Kansan drift. A typical exposure of geest is also seen in a road cutting in the north half of section 22, Liberty township, on the side of a hill descending to Walnut creek. The rock surface slants with the slope of the hill, showing the valley here to be preglacial. On this surface lies from 1 to 2 feet of geest, a dark, reddish-brown, jointed clay, graduating upward by reassortment into a lighter loam, which in turn passes into 2 feet of true loess. In the geest are found sparse pebbles of glacial drift even to its base, showing a slight rehandling of the geest by the over-riding ice. Along the Mississippi river, in the region covered with Illinoian drift, the rock surface is less deeply weathered and pitted.

PLEISTOCENE.

TAXONOMIC RELATIONS.

In the diversity and interest of its deposits of glacial drift, Scott county is hardly surpassed by any area of equal size in the United States. Lost pages of Pleistocene history are here recoverable, and evidence is at hand which may help to solve questions of long dispute in glacial geology. The drift deposits of the county will be described under the categories now in use by the Iowa Geological Survey, which recognizes the following sequence of events in Iowa during the age of the Great Ice:

First.—An invasion by glacial ice from the north, perhaps an extension of the Kewatin ice sheet, whose center of dispersion lay west of Hudson bay. Little is known of the till deposited by this invasion and it is termed for the present the pre-Kansan drift sheet.

Second.—A stage of deglaciation, the Aftonian, during which the glaciers retreated, probably beyond the limits of the state.

Third.—A second and more formidable invasion by the Kewatin glacier, which pushed the ice front south to the Missouri river. This stage and the drift sheet then deposited are known as the Kansan.

Fourth.—A second stage of deglaciation, the Yarmouth, during which the land left bare by the retreat of the ice far to the south, weathered into rich soils of prairie and forest.

Fifth.—A third ice invasion, the Illinoian, entering Iowa from the east, and occupying a narrow strip of country along the Mississippi extending from the Wapsipinicon south nearly to the Des Moines.

Sixth.—A third stage of deglaciation, the Sangamon, during which the drift sheet left by the retreat of the Illinoian ice weathered into soil, and was covered with peat swamps, savannas and forests.

Seventh.—A fourth ice invasion, the Iowan, coming from the north and extending on its eastern margin as far south as Scott county. Southward from the front of the Iowan ice was laid down in some manner, at present undetermined, a silt called the Iowan loess.

Eighth.—A fourth stage of deglaciation and soil formation, the Peorian.

Ninth.—A fifth ice invasion, the Wisconsin, confined in Iowa to the central portions of the state, and extending as far south as Des Moines. Of the nine stages just enumerated records of all are believed to exist in Scott county with the exception of the last two, the Wisconsin and the Peorian.

CONSPECTUS.

STAGES OF GLACIATION.	STAGES OF DEGLACIATION.
9. Wisconsin.	
7. Iowan.	8. Peorian.
5. Illinoian.	6. Sangamon.
3. Kansan.	4. Yarmouth.
1. Pre-Kansan.	2. Aftonian.

PRE-KANSAN.

No exposure of this drift has so far been discovered in Scott county. As described in its typical outcrops in the southern part of the state by Bain, its discoverer in Iowa, it is physically a dense, flaky, bluish-black till. It can be recognized with certainty only where it is separated from the overlying Kansan till by a weathered zone, an ancient soil, or a forest bed. The pre-Kansan appears in evidence in the following records of the wells of the county, and these present little except its attitude, color and local thickness.

CLEONA TP., SEC. 4, SW. ¼, FARM OF WM. RHEIMS.

		THICKNESS.	DEPTH.
3.	Clay, blue, hard, pebbly, Kansan	50	50
2.	Ancient soil, "smelling like ground," emitting gas, making it difficult for diggers to stay in the well more than half an hour at a time, containing wood, of which the largest piece was about one inch thick, Aftonian	1	51
1.	Clay, blue, hard, pebbly, pre-Kansan, penetrated to depth of	19	70

No water was found, and a well was drilled near by and on the same level. In this no record is at hand of the ancient soil, but the number 1 was found to continue to a depth of 146 feet, giving the pre-Kansan here a thickness of 95 feet. The well is situated in the area of Kansan unreached by the Illinoian or Iowan.

CLEONA TP., SEC. 19, NW. ¼, HEINRICH GOETTSCH.

		THICKNESS.	DEPTH.
5. 4.	Clay, yellow Clay, blue	102	102
3.	Clay, black, ill smelling, Aftonian	45	147
2.	Clay, blue, hard, pre-Kansan	50	197
1.	Quicksand, mostly fine	134	331

This well penetrates the bed of a preglacial river which passed northeast through Cleona township, and which we may refer to conveniently as Cleona river. It is in such deep valleys, where glaciers must deposit and where they can least erode, that ancient tills may be expected to be best preserved.

ALLEN GROVE TP., SEC. 26, NE. ¼, HENRY ROH.

		THICKNESS.	DEPTH.
6.	Clay, yellow above and blue below	100	100
5.	Quicksand	25	125
4.	Clay, blue, stony.		
3.	River sand	70	
2.	Clay, blue, stony.		
1.	Gravel	25	300

There are apparently three distinct tills here penetrated, the combined thickness of the two lower being eighty feet.

The lowest of these we may refer to the pre-Kansan. Still less conclusive is the evidence of the next section, which seems to lie in a tributary to Cleona river.

HICKORY GROVE TP., SEC. 19, NW. QR., NW. ¼, JOHN FRAUEN.

		THICKNESS.	DEPTH.
7.	Clay, yellow. Loess ?	20	20
6.	Sand, yellow	10	30
5.	Clay, yellow	120	150
4.	Clay, blue	10	160
3.	Sand	20	180
2.	Clay, blue	50	230
1.	Gravel	3	233

This well, like the preceding, is situated in the area of Illinoian drift, and it is hardly safe to say more than that the No. 2 may represent the pre-Kansan drift sheet.

AFTONIAN.

As has been seen from the above sections, the pre-Kansan till is sometimes separated from the overlying Kansan by an old soil or forest bed. At the typical localities in Afton county, it is separated by heavy layers of gravel and sand. Such have not been found in Scott county except in the channels of Cleona river and its branches. Deposits of muck and peat, soils mingled with vegetal detritus, and old forest beds are of much more consequence as evidence of interglacial stages, since they imply a freedom from ice for times sufficiently long for the accumulation of the deposits in question. Of the flora and climate of the Aftonian, nothing is known from the evidence at hand in Scott county. Indeed, so far as the county alone is concerned, the scanty data at hand upon which the Aftonian and pre-Kansan are based, could as readily be explained by local and temporary advances and retreats of a single ice sheet. But meager as are the data, they agree with a large body of evidence from other counties which consistently witnesses the hypothesis here used.

KANSAN.

In the northeastern areas of the county designated as the Kansan upland and the Kansan plain, the Kansan till lies immediately beneath the superficial water-laid clays; but many exposures occur in other parts of the county in areas marked as Illinoian and Iowan. Like any till, it is an unstratified mixture of bowlders, cobbles, pebbles, sand, rock meal and clay. Of these the finest grindings of the glacial mills, rock meal and clay largely predominate. Bowlders are neither plentiful nor large, and cobbles are comparatively rare. As in other glacial tills the larger stones are generally granitoids. Of erratics one foot and over in diameter counted in the Kansan drift exposed in the cut of the Burlington, Cedar Rapids & Northern railway west of Davenport, 51 per cent were granitoids, 37 per cent Carboniferous sandstone and limestone, 10 per cent greenstones and 2 per cent quartzites. In other exposures quartz porphyry is not rare. Four bowlderets of this rock were noted in the ravines on the farm of Mr. D. Snyder, section 1, Liberty township. On an adjoining farm two nuggets of copper have been found, whose home was probably the Lake Superior region. A group of bowlders from this till lie by the roadside in Liberty Tp., Sec. 6, Se. qr., Nw. ¼. They are from two to four feet in diameter; four of them are granites, one a diorite. Three bowlders of coarse, pinkish granite are found in a slough in Cleona Tp., Sec. 7, Sw qr., Ne. ¼, which measure each more than three feet in diameter. In Reim's quarry, Cleona Tp., Sec. 7, Nw. ¼, eight bowlders were noticed, of which three were granites, three Carboniferous sandstones, and one a quartzite.

Of the smallest stones and pebbles to about half an inch in diameter, greenstones prevail over granites, and still more numerous is local material—cherts of the Niagara, limestones of the Devonian, and shales and sandstones of the coal measures. The following list was made of 186 pebbles taken at random in the lower five feet of unaltered Kansan till, in the Burlington, Cedar Rapids & Northern railway cut west of Davenport:

	PER CENT
Greenstone	24
Granite	15
Jasper	6
Quartz and quartzite	5
Miscellaneous	1
Limestone	29
Cherts	6
Sandstone	5
Shale	2
Coal and coaly shale	7
Limonite	½

Several tallies of pebbles were made, with like results, from Kansan till in various parts of the county, and a classification of more than 500 pebbles from unaltered Kansan near Mt. Vernon, Linn county, gave about the same general ratios; greenstone, 33⅓ per cent; granite, 16½ per cent; limestone, 26⅓ per cent; chert, 6 per cent; but naturally showed a less number of coal measure shales and sandstones.

Thus it appears that while granites prevail over greenstones among the bowlders, the reverse is true among the smaller stones. This is readily explained by the structure and weathering of the two classes of rocks. Granite weathers normally into immense bowlders of disintegration and these are not readily ruptured into smaller masses. But when granite is once broken into small fragments these soon crumble into sand by the decomposition of feldspar and mica. On the other hand several of the rocks popularly known as greenstones readily break up into angular chipstones. But their small fragments are exceeding obdurate. Their large numbers in the Kansan are an example of the survival of the hardest.

Bowlders, sometimes, are beveled and faceted, and scored pebbles are common, especially greenstones and limestones. Even pebbles less than an inch through have been thus set in the ice and cut in the glacial lathe. The Kansan till is therefore a ground moraine, accumulated beneath the Kansan ice sheet, largely derived from its erosion of the geest and rocks of the state, and compacted into a dense tough mass by the pressure of the ice.

That the Kansan is largely derived from the rocks of the state, ground fine in the glacial mill, is shown by the quantity of undecomposed flour of limestone which it carries in its clay. The unaltered Kansan till never fails to effervesce briskly when touched with a drop of strong acid.

In color the Kansan is normally a bluish-drab. In texture it is exceedingly hard and compact. It is often seen to be traversed by vertical reticulating joints which part it into polygonal blocks up to 3 feet in diameter. These cracks are often filled with thin, ocherous crusts, and on either side the till is stained brown up to 1 or 2 inches. Such are the effects of percolating waters on the deeper Kansan. Near the surface it is universally weathered, and exposures of normal Kansan, as it has been described, are very rare. To a depth which varies, reaching sometimes 12 and 15 feet, it has been so profoundly altered that the weathered zone has been supposed to be genetically distinct from the unweathered till, a product of a later ice invasion, or deposited in a different manner. The lime has been leached out, so that the clay no longer responds to a test with acid. In places the lime has gathered into hollow concretions. The texture has been loosened by frost and decay, so that the till crumbles readily into small particles near the surface, while further down its jointed structure appears in larger and larger rhombic blocks.

Still more striking is the change in color. From a fraction of a foot to 2 feet or more from the surface the Kansan is rusted to a reddish-brown, a terra cotta red, or a deep purplish-red, by the oxidation of its iron compounds and by the accumulation of iron salts brought down by percolating waters from the soils above. This zone has been designated by Bain, the *ferretto*, a verbal short cut whose superiority to the well worn phrase of "zone of ferruginous accumulation" is obvious. The ferretto changes downward to a lighter and less reddish-brown, to brownish-yellow, and to a yellow distinctly brighter than the buff of the loess. So deep have these changes extended that seldom is one privileged to see the yellow merge into mottled gray and at last into the unaltered blue of the Kansan till. Where the Kansan is overlain by the Illinoian the ferretto may be placed in the Yarmouth inter-glacial stage.

YARMOUTH.

The lobe of ice from the great Kewatin glacier, beneath which the Kansan drift sheet was moulded, at last retreated from Iowa. In counties farther to the north it is supposed that at this time of rapid melting of the ice, heavy deposits of gravels were laid down in swift, glacial streams, and these have been termed by Calvin the Buchanan gravels. These gravels are not known to exist in Scott county; they are found in force a few miles north of the county line, near DeWitt, and it is from pits in the paha-like hills which they there form that the gravel is obtained which is being largely used for road making in Scott county. A sand and gravel at Dixon, beneath the loess and deeply stained, may perhaps belong to this formation. Just south of the county line the Durant cut of the Chicago, Rock Island & Pacific railway discloses a gravel, almost wholly made up of local materials, overlying Kansan till and covered with a ferretto; and similar gravels no doubt exist in the adjacent hills across the line. With these possible exceptions, the retreating Kansan glacier left behind it no gravel trains in Scott county, but only the barren, clayey waste of its ground moraine, the blue till. Barren and blue it could not long remain; gradually it became clothed with vegetation; forests and savannas of grasses, we may conceive, grew upon its level plain. Meanwhile its surface became deeply weathered, leached of its lime, comminuted into finer clay, and reddened with accumulations of iron. Where local conditions favored, it is believed that deep soils rich in humus were formed on prairie and in peat bog. These soils and the interglacial time of their making have recently been termed the Yarmouth by Leverett. Such buried soils have been noted in Scott county by several glaciologists. Thus McGee* describes a subsoil bed in the bluff at the corner of Harrison and Sixth streets, Davenport, intercalated between a blue till (the Kansan) some thirty feet thick, and fifteen feet of till (the Illinoian), upon which rests the loess. This ancient soil, which is not now visible, is described as "jet-black in color, weathering brownish, light, friable, of peaty appearance, with a maximum thickness of two feet." At a ravine in Crow creek, Pleasant Valley Tp., Sec. 14, Se. qr., Se. ¼, a stiff, gray, gumbo-like clay, two feet thick, with many bullet-shaped, calcareous nodules, underlies a till supposed to be Illinoian, and may be referred to the Yarmouth, although it is water-laid.

In exposures in Davenport an ashen, gummy clay, with black streaks apparently of humus, is taken to be of Yarmouth age by Leverett, since it rests upon the Kansan and is overlain by the Illinoian. Forest beds appear in a number of the well records of the county; and although these records are seldom complete enough for certitude, in several instances there is a fair presumption that the forest horizon is the Yarmouth. About Eldridge, it is reported by two drillers that quite generally a forest bed is struck at from twenty to forty feet beneath yellow clay, which may include Illinoian with the loess, and above blue clay, which may be Kansan. Another driller reports that wood is often struck at about twenty-five feet in the vicinity of the adjacent station of Mount Joy. The following is perhaps a typical section of the Pleistocene in this region:

SHERIDAN TP., SEC. 4, SW. QR., SE. ¼. WELL OF CHAS. MEIER.

	THICKNESS.	DEPTH.
4. Soil, black	5	5
3. Clay, yellow, loess and Illinoian (?)	20	25
2. Forest bed, Yarmouth (?)	10	35
1. Clay, blue, stony, Kansan, to rock	65	100

* Pleistocene History Northeastern Iowa, 11th Ann. Rep., U. S. Geol. Surv., p. 493.

BUFFALO TP., SEC. 3., SW. ¼. WELL OF S. JAMES & SON.

		THICKNESS.	DEPTH.
3.	Yellow clay, loess, and Illinoian (?).........	22	22
2.	Ancient soil, with wood, Yarmouth (?)......	4	26
1.	Blue clay (Kansan) to rock	11	37

ILLINOIAN.

It has been recently discovered that Iowa was invaded by glacial ice from the east, in a narrow belt stretching along the Mississippi from the Wapsipinicon to Ft. Madison. To Leverett belongs the honor of working out the cumulative and concordant evidences which attest the hypothesis. Some of the proofs found in other counties are not seen in Scott, such as westward bearing striæ and the presence of bowlders of jasper conglomerate, whose parent ledges lie northeast of Lake Huron. But here, as elsewhere, the evidence of the Illinoian invasion has been left in a topography differing alike from the Iowan and the Kansan, and in a till of somewhat different physical characteristics. The Illinoian drift is intermediate in its leaching and weathering between the Iowan and the Kansan, from which it is sometimes separated by horizons of weathering and ferric and humic accumulations. It contains a large number of pebbles of local derivation. It is thin in the county, wherever it has been seen, and over much of the Illinoian area the drift encountered in natural sections is either Kansan, or at least has not been discriminated from it. The topography and limits of the Illinoian have been described. We append a few typical sections.

DAVENPORT, EIGHTH AND MARKET STREETS.

		FEET
6.	Humus layer..	½
5.	Clay, brown, jointed, sandy..........................	2
4.	Till, bluish-gray, mottled with reddish-brown, clayey, jointed, with many small calcareous concretions, pebbles small (Illinoian)...........................	3
3.	Clay, stiff, whitish pebbly, non-calcareous...........	3

2. Till, clayey, calcareous, brownish-yellow mottled with gray; jointed, breaking in rhombic blocks about 1 inch in diameter, weathers on outside to thin crust of yellow clay which crumbles under fingers to small particles and dust. Clay grows finer and more plastic above and less pebbly. Kansan...... 14
1. Till blue, or slate colored, pebbly, with gravel largely of limestone and chert and less than an inch in diameter, jointed, with reticulating cracks from a few inches to 3 feet apart, filled with fine yellow sand and with limonite crusts. On each side of these cracks, till is oxidized to brown for 2 or 3 inches, a few larger pebbles, up to 6 inches noted, all of limestone, fresh and scored. Near base and outer edge of hill veins up to 7 inches thick occur of coarse sand and gravel, discontinuous, dipping outward 13

SIXTH AND HARRISON STREETS.

		FEET.
8.	Loess, light buff, pulverulent, fossiliferous, with small loess-kindchen, superficially indurated	8
7.	Loess, ashen, pulverulent, calcareous, horizontally laminated	2
6.	"Soil black, Sangamon."*...........................	1
5.	Till, reddish, leached for 2½ feet from its surface, with calcareous concretions for 4 feet from surface, "with traces of horizontal bedding at bottom, but with few vertical fissures or seams, a characteristic Illinoian till"*	7
4.	Till, yellow, calcareous, limestone and chert pebbles abundant, jointed, oxidized (Kansan), passing into No. 3..	9
3.	Till, mottled, blue and buff, transitional in color and texture between Nos. 2 and 4......................	2
2.	Till, bluish-gray, tough, hard, compact, jointed; pebbles small, few bowlders; calcareous; about 20 feet from base occurs a horizontal zone about 3 feet wide in which occur several thin seams of fine sand and of fine silt; these seams are highly oxidized and in places cemented by ferric oxides, Kansan.........	33
1.	Sand fine, gray and yellow, passing upward into yellow silt, stratification horizontal and undisturbed. Fragments of this silt occur in the till immediately above	5

*From notes of Mr. Frank Leverett.

The two following sections are kindly furnished by Mr. Leverett:

DAVENPORT, EIGHTH STREET, BETWEEN MYRTLE AND VINE.

		FEET.
5.	Iowan loess	30
4.	Reddish-brown surface of Illinoian till sheet, leached and stained during Sangamon interglacial stage	2½–3
3.	Brown, calcareous till, crumbling readily, a characteristic Illinoian	15
2.	Ash colored, gummy clay, with black streaks apparently of humus, representing the Yarmouth interglacial stage	2–3
1.	Brown till, calcareous, fracturing in cubical blocks, color changing to bluish-gray at 12–15 feet. Characteristic Kansan till	25

One to two miles south of Blue Grass the ravines expose the following beds:

		FEET.
4.	Loess	15
3.	Yellow till (Illinoian)	8–10
2.	Gummy, gray clay	3–6
1.	Brown, sandy till (Kansan), exposed a few feet	

Similar sections are found in the ravines about one and one-half miles northwest of Blue Grass.

SANGAMON.

This interglacial stage is recorded in the weathered surface and the ferrettos of the Illinoian drift, and the old soils and forest beds formed upon it. These are overlain by Iowan loess. Several examples of Sangamon deposits have already been cited. It is probable that the widely published section of W. H. Pratt of a cutting near Davenport* discloses, in its ancient soil and peat, the same formation. A number of well sections in eastern Scott county include beds of peat and old soils which may be Sangamon in age. The exact position of these beds is difficult to find out, the yellow clay of the drillers' record including not only the loess but also all weathered and oxidized tills beneath. But where quicksand

*Proc. Davenport Acad. Sci., vol. I, p. 96. Geology of Iowa, White, vol. I, p. 119. 1870.

is given beneath yellow clay of not more than the usual local thickness of the loess, it may be assumed that the yellow clay is wholly the loess.

About Porter corners, west of Le Claire, it is reported that yellow clay twenty or thirty feet thick is underlain by quicksand, and that beneath this is sometimes found an old forest bed, several feet thick.

LINCOLN TP., SEC. 23, E. ½, WELL OF MRS. MARY JONES.

		THICKNESS.	DEPTH.
6.	Yellow clay	30	30
5.	Quicksand	12	42
4.	Forest bed (Sangamon)	6	48
3.	Clay, bluish	20	68
2.	Clay, yellow, pebbly	40	108
1.	Clay, blue, pebbly, to rock	12	120

A generalized section of the Pleistocene in Le Claire township is given by Mr. Clark, well driller at Le Claire, as follows:

		FEET.
6.	Yellow clay	25
5.	Quicksand, fine, bluish	6-20
4.	"Rotton wood."	
3.	Clay, thin, hard, smooth, without pebbles.	
2.	Yellow clay, stony.	
1.	Blue clay, stony sometimes, with bowlders near bottom.	

IOWAN.

The last glacial invasion of Scott county hardly more than crossed its northern boundary. Its track is found only east of the great elbow of the Wapsipinicon, and not more than 2 to 3 miles south of its flood plain; and yet within these narrow limits are found perhaps all of the characteristics by which Calvin has proved its existence as a separate drift sheet of a distinct ice invasion. The peculiar topography of the Iowan in Scott county has already been noted. The drift, compared with the Kansan, is more sandy and contains more large pebbles, cobbles and bowlders. While the latter do not strew the fields with the profusion seen in Delaware and

Buchanan counties,* yet they are sufficiently common to form a distinct contrast with the loess-covered areas to the south. Pinkish granites are especially noticeable, and of the rarer rocks, quartz porphyry may be named. Deep cuttings are uncommon in the Iowan area, and none was found which reached through the unleached till. The deep red ferrettos of the Kansan are lacking, oxidized surfaces having a brownish tint. The Iowan area as here mapped includes the loess moraine of pahoid hills, even though these may in part rest on earlier drift.

Iowan Loess.—With the exception of the Iowan drift plain and the alluvial bottom lands, all of Scott county is covered with a mantle of fine silico-argillaceous silt known as the Iowan loess. It presents three phases due largely to alteration since it was laid down. Lowest of these lies the ashen loess. This is a bluish-gray silt, sometimes laminated obscurely, usually more pervious than the loess above, and retaining its original calcareous constituents. These may be uniformly distributed, but near the edges of outcrops they are segregated into calcareous nodules known as loess kindchen, loess puppen and loess manchen. These are the "clay dogs" of the brick maker, to whom they are an unmitigated nuisance, burning into quick lime within the bricks in the kiln, and bursting them by the expansion of the lime when hydrated by the absorption of water.

In this zone there is also a concentration of ferruginous constituents forming brown ocherous pipes and tubes sometimes 3 feet long, and concentric nodules of the same material. These "bulls eyes" occasionally reach a diameter of 6 inches, and, although soft while remaining in place, rapidly harden when exposed to the weather on the surface of a bank. Limonite crusts also occur, following lines of lamination and water movement. Occasionally such a crust, or a band of ocherous stain, divides the ashen loess from the main body of loess above. This ferretto is not taken to indicate an old

*Calvin: Iowa Geol. Surv., vol VIII., pp. 172-173, 244-245.

weathered surface, but merely the place of deposit of iron salts by the movement of ground water in the entire mass of the loess. Often it is impossible to draw any line of separation between the two lower phases, the one grading inperceptibly into the other.

The main body of the loess is a light buff loam, often mottled or streaked with gray where it has either escaped oxidation or has been deoxidized by the penetration of water containing organic matter in solution. Vertical cleavage is a notable characteristic. Lime occurs in minute, branching tubules, in kindchen and in small fossils, but the two latter are much less numerous than in the ashen loess below. Oxidation has often affected the entire mass of the loess, so that the lower phase is absent.

The loess weathers superficially into a brown clay to a depth of from zero to four or five feet, according to the activity of agents of erosion. This phase differs from the main body in its higher oxidation, seen in its deeper color and the still darker narrow bands of ferruginous stain which often traverse it parallel with its upper surface, in its general induration, in its fineness of particles due presumably to disintegration, in its complete leaching, in the absence of fossils, and in its tendency to break down into a slope of crumbling fragments.

Other differences in the loess are due to circumstances of deposition. On the Iowan frontier loess graduates vertically and laterally into sand, while a few miles distant to the south sand is for the most part absent. Over the drift plains of the interior of the county, the thin mantle of loess forms a somewhat finer and more plastic loam. This is due in part to the deposition of the coarser material within short distance of the periphery of the Iowan ice, and in part to the alteration of the material by prolonged weathering. The latter cause is conceived as specially effective on level tracts where erosional agents are comparatively inoperative, where a heavy humus layer continually generates acids which effect disintegration, and where the level of ground-water stands high.

The loess rests here and there on unmodified till, the line of demarkation being of necessity sharp between the deposits of ice and of water. More often it passes into clays intermediate in texture and color, as in the Kansan area, or as within the limits of the Iowan by interlamination into stratified sands.

Red Loam.—Outside the Iowan area hillside gullies which cut through the loess, often show beneath it a reddish, loess-like loam, often laminated, sometimes jointed, more clayey than the loess, and yet like it readily friable even when dry. No distinct line separates the red loam from the loess, and, beneath, it merges into a more plastic clay which in a few inches becomes pebbly and passes into the red ferretto of the till. So seldom is a section found on the summits of the hills and uplands that little can be said as to its occurrence at high levels. It is seen on the bluff at Division street, Davenport, four feet thick, and in places it here is black with humus. It is near the bottom of hill slopes that it usually is disclosed by gullies, and in the Mississippi valley, where it often outcrops between Le Claire and Princeton, it descends to within ten feet of the water of the river. Here it is more deeply stained with ferric oxides and reaches the greatest measured thickness—some nine feet—which is three or four times what seems to be its average thickness elsewhere.

At Theilman's quarry, Le Claire, the red loam is seen to rise along the slope of the rock from about the level of the flood plain of the river, till here being practically absent, and thinning as it rises to merge into the loess. On the river bank, a few rods distant, the red loam is nine feet thick, is slightly laminated, but not so distinctly as is usual in lake clays. Physically it resembles a loess composed of a somewhat wider range of particles, the siliceous particles being larger than in normal ashen loess. Toward the base it becomes slightly gravelly.

SECTIONS OF THE RED LOAM.

LE CLAIRE TP., SEC. 26, SW. ¼, ON BANK OF MISSISSIPPI.

		FEET.
3.	Humus	½
2.	Yellow loam	¾
1.	Red loam, non-calcareous above, jointed, weathering into fragments a fraction of an inch in diameter; below more friable. Near upper surface rare pebbles occur up to 2 inches in diameter, to road	5

LE CLAIRE TP., SEC 14, NW. ¼, ON BANK OF MISSISSIPPI RIVER.

		FEET.
2.	Red loam, with rare pebbles	4
1.	White clays, with horizontal, interbedded sand and gravel, to high water beach of river	4

LINCOLN TP., SEC. 1, EAST ½, HILL SLOPE.

		FEET.
4.	Loess to hill summit	30
3.	Loess, lower phase, slightly reddened, separated from buff loess above by slight ferretto and ocherous stain 2 inches wide	4
2.	Loam, reddish, laminated, non-calcareous, siliceous, particles indistinguishable in size under the microscope from those of ashen loess at Davenport, readily friable beneath fingers	3½
1.	Kansan till, ferretto	2½

BLUFF, DIVISION STREET, DAVENPORT,

		FEET.
5.	Loess, upper and middle type. This grades into ashen loess below, but in places a ferretto of 3 inches separates them. This ferretto is also seen in places below the upper surface of the ashen type	10
4.	Loess, ashen, fossiliferous, with calcareous tubules and kindchen. Limonite casts, more or less spherical, occur up to 2½ feet in diameter, which, on a horizontal section, simulate contorted laminæ	11
3.	Red loam, transitional, laminated, calcareous; mottled here and there with dark humus which in one place becomes a black humus layer	4
2.	Ferretto of till, leached free of lime, darkened	3
1.	Till, calcareous to within a foot of the ferretto, a stiff, stony, yellow clay without cobbles or bowlders, but with many small pebbles, of which limestones and cherts predominate; exposed	8

Numbers 1 and 2 slope back into the hill and toward Duck creek. To the south, down the hill, the till is broken by two depressions, each some two and a half rods wide, extending below the cutting, separated by a steep-sided mound of till six feet wide, and filled with fossiliferous loess crowded with limonite tubules, bull's eyes and crusts obscurely laminated, dipping downward with the hill.

DIXON, BANK OF WALNUT CREEK.

		FEET.
6.	Loess, light buff, pulverulent	22
5.	Loess, mottled, gray and buff, with rare and small kindchen, passing by interlamination into No 4	8
4.	Loess, light brownish-buff, of much the same texture as above, but slightly more clayey, with rare and small kindchen, readily friable	1
3.	Loam, light reddish-brown, obscurely laminated, with some sand, more plastic than above, grading into No 2	$\frac{3}{4}$
2.	Sand, clayey, with an occasional pebble, bright terra-cotta red	$2\frac{1}{2}$
1.	Till (?), purplish-red, predominantly sandy, with numerous pebbles, all small, no stratification lines seen; pebbles mostly cherts and greenstones. Till dips with slopes of hill in both directions	8

The intimate association of the red loam with the loess, the gradation between them, and the loessial texture of the loam indicate that the two silts were laid down in the same waters. The color of the loam and the wider range in size of its constituent particles, associate it with the ferretto of the tills on which it rests and show that, in part, it is derived by wash therefrom.

Loess Sands.—The absence of sand and gravel over the larger part of Scott county is a striking fact, and one in strong contrast with the abundance of these coarser deposits of running water in the counties a little north and northwest, where the Iowan ice had full play. Beyond a short distance south of the Iowan frontier, even in the immediate vicinity of the channel of the Mississippi river, there were no currents in Pleistocene times, so far as the superficial deposits show, capable of carrying heavier sediment than the fine silt of the loess. North of that frontier sand is plenty, and its relations to the Iowan loess are so close that it seems best described in connection with it.

In the great ridge of hills in Princeton township, which overlook the flood plain of the Wapsipinicon, heavy beds of sands are superior and peripheral to the loess. In many road cuts in this district typical loess is seen to pass outward into sands by gradations which show that the two deposits were contemporaneous. The loess is often seen also to pass downward into beds of sand by intercalation in tortuous, irregular, discontinuous layers, showing conclusively the genetic identity of the two deposits.

A few typical sections are appended.

BUTLER TP., SEC. 20, EAST $\frac{1}{2}$.

		FEET.
2.	Sand, stratified	3
1.	Loess, buff, fossiliferous, graduating outward into fine yellow sand, and toward the margin overlying stratified sand of same color	6

BUTLER TP., SEC. 19, SECTION OF EAST END OF PAHA.

		FEET.
3.	Soil, passing into loess	2
2.	Loess, buff, fine	3
1.	Sand, fine, stratified, yellow, passing upward into true loess by interstratification	5

On the margin the loess passes under reddish, clayey sand, with purer sand from 1 to 3 feet thick.

WINFIELD TP., BETWEEN SECS. 14 AND 20.

		FEET.
2.	Soil	$\frac{3}{4}$
1.	Loess, upper and middle phase, graduating downward into fine stratified sand which, on the north side of the hill, dips outward and downward	5

These sections transect the margins of paha, and it is probable that, as in some more thoroughly studied paha in Linn county, a complete section would show the sand to thin from the margin invaded, and to be absent in the central portions of the hills.

The following sections indicate something of the structure of the massive sand hills northwest of Princeton. It must be remembered that these sections are not vertical, but are descriptions of exposures along the slope of the hills. Thus the lower members which appear to underlie the upper may only abut upon their flanks.

NORTH SIDE OF HILLS ON ROAD IN SEC. 29, PRINCETON TP.

		Feet.
3.	Unexposed or with small outcrops of yellow sand	62
2.	Loess, typical light buff, floury in fineness, interstratified with very thin and distant, parallel, and fairly continuous veins of finest sand dipping 6 degrees with slope of hill	28
1.	Sand, light gray, merging inward into sandy clay and loam and buff loess, to base of hill	20

The section on the south side of the same hill is more complete.

		Feet.
10.	Grass-covered, sandy slopes, with an occasional bed of somewhat clayey sand	25
9.	At 85 feet from base, fine yellow sand, dipping with the hill, south 4 degrees, graduating downward by intercalation of bands of maximum thickness of 2 inches, into typical loess.	
8.	At 73 feet, typical loess.	
7.	At 68 feet, typical loess, fossiliferous.	
6.	At 63 feet, loess, fine.	
5.	At 58 feet, loam, loess-like, a fine clayey sand with many kindchen, thickening down hill and merging downward and laterally inward into loess 7 feet thick.	
4.	At 46 feet, loess, typical, light yellow-gray, with kindchen and fossils, 5 feet thick.	
3.	At 43 feet, sand, yellow and somewhat clayey.	
2.	From 25–38 loam, brownish buff, fine, sandy.	
1.	From 1–25 concealed, probably sandy.	

A deep gully on the same range of hills, section 23, Princeton Tp., shows clearly the same relations of the loess and the sand, the latter overlying the former and spread along its sides. This gully, the largest in the county, some 75 feet deep and several hundred feet wide, has been cut out in the last 15 years. Before that time the hillside could be driven across at any point. At the head of the gully, at the height of about 10 feet, black soil passes down into brownish, slightly sandy loam, and this into light buff, pulverulent loess.

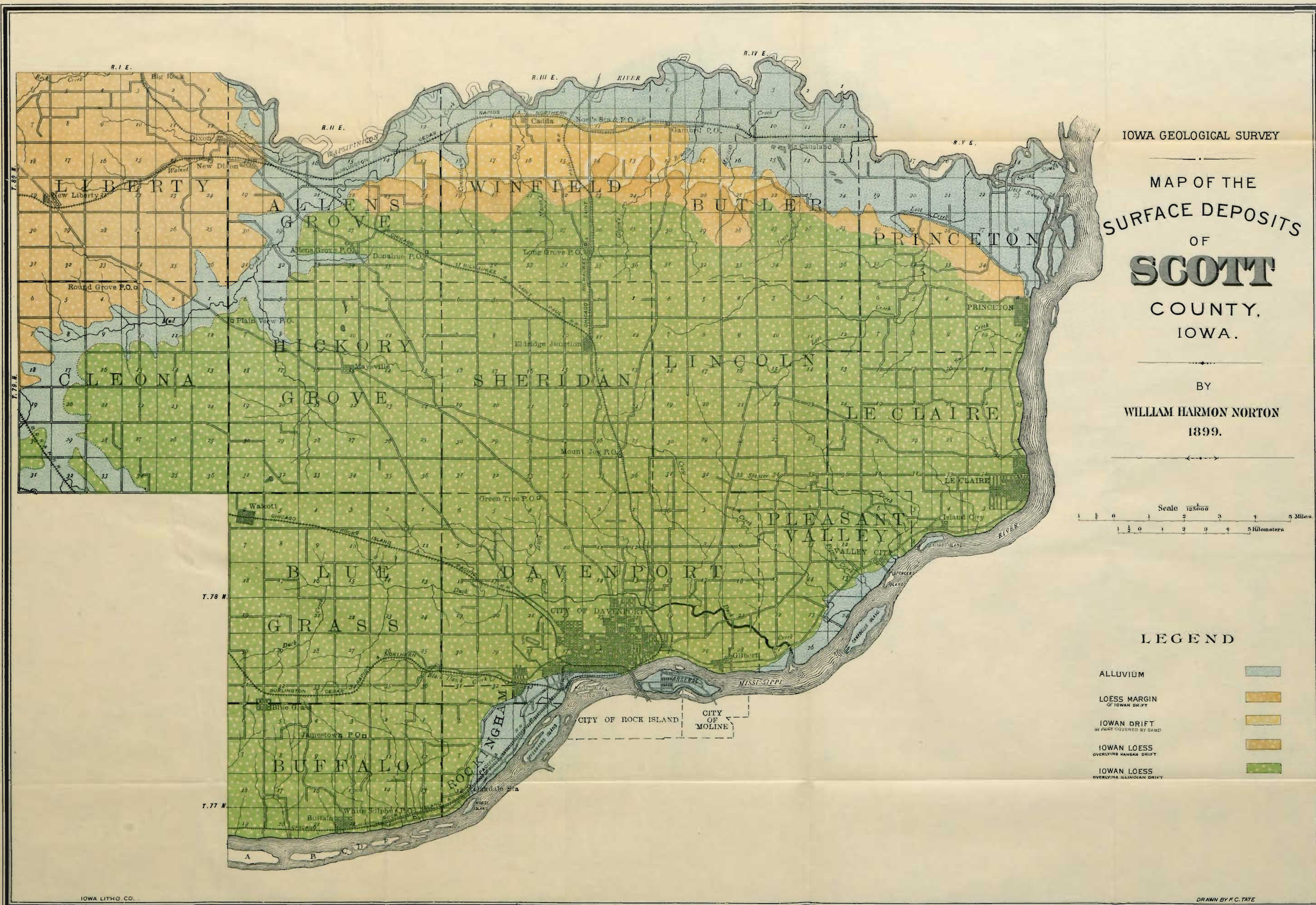
Within a few rods from its head the ravine has cut well down toward the base of the hill, and here, within 5 feet from the bottom of the gully, stratified reddish-yellow sands, dipping 4 degrees south, pass downward by interbedding into loess. The transition is effected in about 2 feet, within which measure the sand grows finer and its laminæ more narrow from top to bottom, with a corresponding increase in the width of the interbedded loess. At the same level, a few feet distant to the south, the loess is succeeded outward by fine, and finely laminated, horizontally bedded, light yellow sand, including thin, darker bands of clayey sand and grading upward into coarser and redder sand. The relation between the loess and the fine sand cannot be seen; but they probably grade into one another as they are known to do elsewhere in the Wapsipinicon valley. The aspect of such gradations strongly suggest that the deposit of loess was here made in currents retarded by hills of glacial till, while sand was being laid down in the more rapid currents along the open channel of the river valley.

It is difficult to estimate the thickness of the loess with any degree of accuracy. Road cuttings seldom give a measure of the thickness, since it folds down over pre-existing hills like a blanket. Well records do not discriminate between this and yellow glacial clays. All the evidence at hand goes to show a considerable thickening of the loess in the vicinity of the Iowan margin, where it may attain the measure of 40 or 50 feet. Along the Mississippi the loess reaches 25 or 30 feet at Davenport, but is considerably thinner than this in Buffalo township. Over the interior of the county the yellow loess can hardly be conceded more than 15 or 20 feet.

The loess we have described is that intimately associated with the invasion of the Iowan ice and laid down as a result of conditions, at present not well known, in the glacial waters attending its melting.

Preglacial Surface.—A very slight investigation suffices to show that the preglacial topography was widely different from that which meets the eye to-day. Rivers ran hundreds of feet below the present surface. Hills relatively high stood where the level prairie now stretches to the horizon. Were the cover of drift removed from the underlying rocks, their surface would be found rugged and hilly, deeply scored with manifold ravines, and trenched by river valleys deeper than that of the Mississippi, and as wide. But it is scarcely practicable to draw the details of that ancient surface. For the most part we must rely on the records of the wells which have been sunk in the past few years. It is a familiar fact that the well driller finds the distance to rock far from equal even from the same level. In one section, the drill grinds on the native rock within fifty feet from the surface; a mile or so away, rock is only found within 300 feet from about an equal elevation. These deep depressions, now plastered over with glacial mud, were cut by running water. They are not local discontinuous pits. They join and form continuous valleys, cut out by ancient rivers. Accordingly, the deepest drift wells are not found in clusters but in lines.

The best defined of the old channels thus marked out, lies parallel, for the most part, with the valley of Mud creek, from which it is nowhere more than two miles distant. In Cleona township the course begins in section 14, not in the immediate valley of Mud creek, but across the crest of a low swell on the left bank. Udden, the discoverer of this ancient river valley, has traced it southward from here into Muscatine county, and its course therein is described in his report upon that county in the present volume. In section 21, the



IOWA GEOLOGICAL SURVEY
MAP OF THE
SURFACE DEPOSITS
OF
SCOTT
COUNTY,
IOWA.
BY
WILLIAM HARMON NORTON
1899.
Scale 1/125000
5 Miles
5 Kilometers
LEGEND
ALLUVIUM
LOESS MARGIN OF IOWAN DRIFT
IOWAN DRIFT IN PART COVERED BY SAND
IOWAN LOESS OVERLYING KANSAN DRIFT
IOWAN LOESS OVERLYING ILLINOIAN DRIFT
LIBERTY
ALLENS GROVE
WINFIELD
BUTLER
PRINCETON
CLEONA
HICKORY GROVE
SHERIDAN
LINCOLN
LE CLAIRE
PLEASANT VALLEY
BLUE GRASS
DAVENPORT
BUFFALO
ROCKINGHAM
CITY OF DAVENPORT
CITY OF ROCK ISLAND
CITY OF MOLINE
MISSISSIPPI
RIVER
WAPSIPINICON
Dixon
New Dixon
New Liberty
Round Grove P.O.
Plain View P.O.
Allens Grove P.O.
Donahue P.O.
Long Grove P.O.
Eldridge Junction
Maysville
Mount Joy P.O.
Green Tree P.O.
Walcott
Blue Grass
Jamestown P.O.
Buffalo
Gilbert
Le Claire
Princeton
Island City
Valley City
Cadda
Gambril P.O.
McCausland
R. I E.
R. II E.
R. III E.
R. IV E.
R. V E.
T. 80 N.
T. 79 N.
T. 78 N.
T. 77 N.
IOWA LITHO. CO.
DRAWN BY F. C. TATE

old valley lies two miles south of the creek, along the main divide of the region. Thence it bends northward, and in section 15 of Cleona township, reaches within a mile of Mud creek; the hills here which overlie the old channel still being some fifty feet above the present valley. Trending northwest, it crosses Mud creek at Plain View, and recrossing, bends again northeast to Allen Grove and north by Donahue to the Wapsipinicon.

Several well sections have been given showing the nature of the deposits which have filled this old valley, which we may conveniently designate the Cleona channel.

Another buried channel, not so plainly marked, is traced by deep wells from the northeast corner of Blue Grass township, north along the east line of Hickory Grove township. It either runs north to join Cleona channel, or turns eastward along the north line of Sheridan township, and thence to Long Grove and the Wapsipinicon valley.

North of Davenport, in Tp. 78 N., R. III W., Sec. 12, are several deep wells whose apparent isolation is due to the incompleteness of our data. In some instances of deep wells, investigation shows that the apparent great depth to rock was due to the fact that heavy Carboniferous shales were reckoned as "blue clay" instead of as rock. Such wells also indicate buried channels, but of such vast antiquity that they were filled with the silts of the Des Moines stage of the Carboniferous.

The list of wells which is appended to the report, exhibits data gathered mostly from the well drillers of the county. In several instances it was made from written records, in others, from the memory of the driller. No high degree of accuracy attaches to the records of the materials through which the drill passed; though they no doubt represent at least a composite of mental impressions derived from long experience in the region. The distance to rock is believed to be, in most instances, reliable.

ECONOMIC PRODUCTS.

Coal.

In several of the Carboniferous outliers of the county, as at Black Hawk and Island City, there occur thin seams of coal, but the only seams thick enough for profitable working are found in the large Carboniferous area of Buffalo township. Here mining operations have been carried on for nearly half a century; and along Stillwater creek, and about Jamestown, their record is left in the numerous heaps of refuse which mark the places of prospect shafts and abandoned workings. In 1897 three mines were reported in active operation, all near Jamestown. The Williams company mine, leased by T. E. Anderson, reports the number of days worked at 225, and an output of 4,500 tons. The mine of James & Son reports 130 days' work, and an output of 2,572 tons. From the Clipper mine Mr. S. Long took a few hundred tons, and some was mined from a "bank" on the farm of Mr. E. Pahl. The small output is in part due to the discouragement of a slack market and low price. The coal was sold in 1897 at the "banks" for $1.50 per ton. Several prospect shafts were being sunk at the time of the survey about Jamestown, Buffalo and Stillwater.

The seam worked by the Jamestown mines lies in a trough about two miles long and 200 yards wide, trending from northwest to southeast, and reached at a depth of about ninety or 100 feet from the surface. In the center of this "swamp," as it is termed, the coal has a thickness of from four to six feet, but it thins as it rises to either side of the trough, where it lies some ten feet higher than in the center. In the James mine it is worked on each side for 100 yards from the central axis, and at this distance it is reduced to a thickness of two and a half feet. The trough rises from each end gently toward the center. Thus, at the James mine, the dip is toward the northwest at the rate of eight feet in 300 yards. Slight faults, rolls and pinch-outs occur on each side of the axis, with the down throw on the swamp side, but nowhere do these seriously interfere with mining. The farthest point toward the northwest to which this seam has been traced is Blue Grass Tp., Sec. 33, Se. ¼, where coal two feet thick is said to have been found, but to be unworkable because no roof overlies it. At the Williams mine, which has been worked for thirty years, the swamp is reached at a depth of 102 feet, and coal has been worked to 150 yards to each side. The swamp here sinks to the southeast. Detailed sections of these mines are given elsewhere in this report.

South of Jamestown there is an area where the coal is said to lie in a comparatively flat and uniform seam. It has been mined on the farm of Mr. Charles Rowan, Buffalo Tp., Sec. 10, W. ½, about eighty feet from the surface. Several seams, two and three inches thick, occur above the one mined. Wells show that coal is underlain with fire clay sometimes to a depth, as is reported, of twenty-five or thirty feet, and at from 175 to 200 feet from the surface the drill passes into Devonian limestone. Toward the northwest coal is reported one and one-half miles south of Blue Grass, Buffalo Tp., Sec. 8, Nw. ¼, where a well record gives it a thickness of twenty-one inches at a depth of 114 feet from the surface.

In the Stillwater district, west of Buffalo, no mines were found in operation. Here the coal is said to lie in "swamps" with a maximum thickness of four feet, and to be reached by shafts at a depth of about fifty feet below the creek bottoms. A full description is given by Keyes* of these mines as he found them in operation in 1893.

Mining in Buffalo township is carried on with little difficulty or expense. Coal is found within easy reach of the surface, and in workable seams, well roofed with hard carbonaceous and argillaceous limestone or firm gray shale. No serious dislocations occur and all engineering problems are at their simplest. While the main swamps may be worked out in the near future, there are apparently large amounts of coal in

*Iowa Geol. Surv., vol. II, pp. 472-473.

thinner seams, which will much longer yield a moderate return to the industry of the miner.

All coal of the region is of the ordinary bituminous type, and, in its comparative freedom from injurious impurities and small per cent of ash, it compares well with the leading coal mines of the state, as is shown in the following chemical analysis* of a typical seam:

FRIEDLY & HOYT, BUFFALO.	Moisture.	Total combustibles.	Ash.	Volatile combustibles.	Fixed carbon.	Coke—fixed carbon plus ash.	SULPHUR. In sulphides	In sulphates	Total.
Top of seam.......	3.48	89.79	6.73	41.32	48.47	55.20	4.99	.54	5.53
Middle of seam....	3.66	87.46	8.88	41.44	46.02	54.90	3.72	.15	3.87
Bottom of seam....	2.89	82.03	15.08	38.09	43.94	59.02	7.80	.38	8.18

Building Stone.

Superior building stone is well distributed throughout the county. *The Silurian* in the Anamosa type of the Gower, furnishes cut stone unsurpassed in quality in the state, and, in its heavier layers of coarser grain, a stone practically indestructible for bridge piers, culverts and heavy masonry generally.

The quarries about Le Claire are the best developed of any using the Anamosa stone. Detailed sections of the quarries of F. H. Thielman and of Velie and Nason have been given together with several others of less economic importance. In all these quarries the light buff dolomite runs in even courses about 1 foot in thickness, traversed by vertical joints so distant that stone can be taken out in dimensions far in excess of any possible demand. No channelers are used, but the stone is uniform of texture and can be broken with fairly even fracture along the lines desired. The color is slightly warmer than obtains in the Anamosa quarries. The rock can be easily dressed or sawed when green, and it contains no

*Keyes: Iowa Geol. Surv., vol. II. 1894, p. 508

injurious constituents, such as quartz or pyrite. At the Rock Island arsenal it has been laid in dressed stone, but rock-faced ashlar will usually be found the most pleasing cut. The overlying stripping of glacial clays is rather heavy and seriously increases the cost of working some of the quarries at present. But if railroad facilities were offered, encouraging the development of the industry, all this stripping could be handled at slight expense by hydraulic machinery. The localities where the Anamosa stone occurs are without railways, and for this reason the quarry industry is but little developed. In no quarries has modern machinery been introduced. The strippings are moved with spade and barrow, and the rock is quarried by means of the jump drill, the wedge and the crowbar.

The strength of the stone is more than adequate to any strains it is likely to bear. Sample blocks from F. H. Thielman's quarry tested by Prof. A. Marston,* Iowa Agricultural college, withstood 1,200 pounds per square inch, proving it a stronger stone than such well-known stones as the Berea sandstone and the Bedford oolite.

The heavier, coarser grades of the same type are nowhere found near enough to railways to warrant any working of the quarries beyond the supply of local needs. Much of this stone lies in layers about 2 feet thick, with moderately smooth surfaces, and, while highly vesicular, its cavities do not injure the stone for purposes of heavy masonry. As a dolomite it is more resistant to the chemical attacks of the weather than is ordinary limestone, and it endures frost, as many stones of finer grain cannot do. The quarries of this group are described in the preceding pages.

The Devonian furnishes some very good building stone, the most durable being that from the Upper Davenport beds. This stone is rough and hard and not easily brought to desired shapes and sizes. On the other hand it is exceedingly tough and durable, of a beautiful color, and where properly dressed

*Iowa Geol. Surv., vol. VIII, p. 402.

and set, rock-faced ashlar is most pleasing; it leaves little to be desired. Trinity church, Davenport, is an example of the architectural capacities of the stone. The geological section of the Davenport quarries supplying this stone, which is used to a considerable extent about the city, has already been given. The only quarry reported is that of Mr. H. G. Schmidt, whose output was for 1897, some 3,000 perch, quarried chiefly for rough and rubble and road work.

The Lower Davenport beds, in their lower layers as exposed between Davenport and Gilbert, afford a very fair and durable building stone. It is of this stone that the cathedral of the Protestant Episcopal church was built. Most of these beds are of no value for masonry, soon breaking up into thin calcareous plates and chipstone, on exposure to the weather. The chief quarries are Louis Gomel's and Boland Andre's near Camp McClellan, which supply a large amount of excellent crushed stone for roads and streets.

The Cedar Valley limestones are for the most part too argillaceous to afford building stone of good quality. Several layers of the lower beds constitute a fair stone, and large quarries are now worked in them near Buffalo, chiefly, however, for rough and rubble and road work. The sections of the largest of these are given elsewhere. L. E. Dutcher's quarry, about two miles east of Buffalo, worked when visited about thirty men, besides teamsters. The rock is easily handled. Scarcely any stripping is necessary. The stone is blasted out of the ledges, broken up with the sledge, and carried on wagons a few rods to the bank of the Mississippi, where it is loaded on barges for government use in rip rap and on dams. Some also is used for road material in adjacent townships.

At A. C. Walker's quarry, one-half mile east of Buffalo, the same kind of rock is quarried and for the same purposes. About thirty-six men and fourteen teams are employed. In 1897, 25,876 cubic yards were quarried, valued at $13,782.

Lime.

The Le Claire beds of the Gower stage offer an inexhaustible supply of a stone unsurpassed in the United States for the manufacture of lime, but the industry remains almost wholly undeveloped and largely for want of facilities for transportation. Thus the lime quarries of Le Claire are unworked, while across the Mississippi lime burned from the same rock has made the name of Port Byron a familiar term to architects and builders.

Mr. H. Schmidt has supplied local needs, for a number of years, from a very pure lime rock quarried near Dixon. At Gilbert, Mr. H. Kuehle & Son burn the Lower Davenport beds, whose freedom from clay, quartz and iron insure a lime of great purity. As a non-magnesian limestone it produces a hot, quick lime admirably adapted for many manufacturing purposes. Several paper and straw mills have been supplied with it in the three adjacent cities. A new draw kiln is now building. In the pot kilns in use in 1897, $675 worth of lime was burned.

Clays.

CARBONIFEROUS.

The shale clays of the Carboniferous strata of the county form a source of wealth which has only begun to be drawn upon. At two points, Buffalo and Island City, these clays are utilized for the manufacture of brick. Both sites are well chosen, since the shale at each place is deep, with little refuse, and can be worked in open pits. The Island City plant is somewhat handicapped for want of railway transportation for its product. Both plants have the great advantage of wharfage on the Mississippi.

The Davenport Brick and Paving company operates an extensive plant at Buffalo, consisting of eight down draft kilns, capacity 440,000; an auger brick machine for end or side cut paving brick, capacity 35,000 per day; large drying sheds; an iron clad steam drier, capacity 25,000 per day; an 80 H. P.

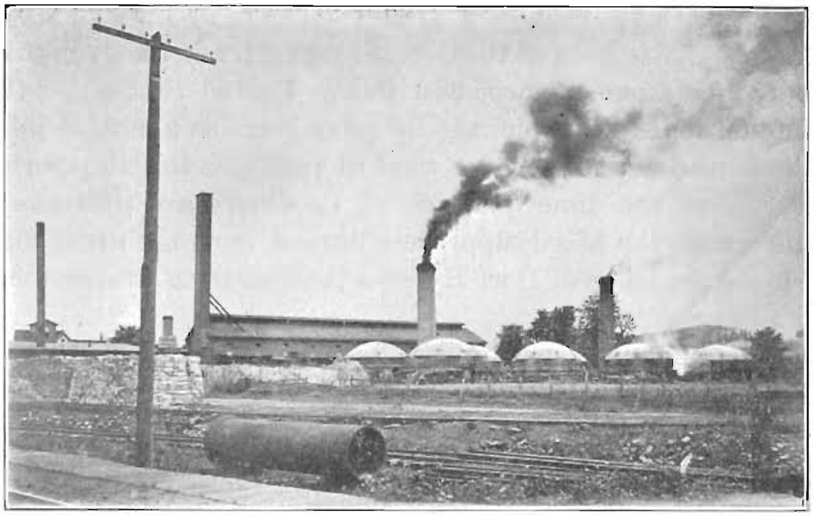


FIG. 51. Plant of Davenport Brick and Paving Company, Buffalo.

engine; an Eagle clay crusher and the usual pit machinery. Fire brick for the kilns are made from the lower 26 feet of the pit. Sidewalk brick are burned chiefly from the glacial clays. For pavers the shale is used mingled with a certain amount of the loess. Fuel is obtained at the coal mines at Jamestown three miles distant. The excellent quality of the pavers is shown by the following tests made by E. P. Boynton, C. E., Cedar Rapids:*

Paving brick, common. Abrasion and impact, per cent of loss, average	14.85
Porosity, absorption, per cent of gain	.93
Transverse strength, modulus of rupture, average	2,056.00
Comparative rating by formula	61.88

Draintile and sewer pipe are manufactured to a limited extent. The output for 1897 is reported as follows:

Common building brick	10,000
Paving brick	2,153,000
Draintile	3,000

The large plant of the Le Claire Brick and Tile company is situated three miles below the town, on the banks of the Mis-

*Iowa Geol. Surv., vol. VII, p. 379.

sissippi. It consists of a Chambers stiff-mud machine, capacity 50,000 per day; a Brewer tile machine, capacity 15,000 per day; a Chicago steam drier, double tunnel, capacity 50,000 brick per day; two round down draft kilns, capacity 70,000; and a sixteen furnace, Eudaly patent, down draft kiln, capacity 250,000. Common building brick and drain and sidewalk tile are manufactured. The pit is conveniently situated just back of the works, and its whole face is used. Fire brick are made for the kilns from the fire clay found on the ground. The building brick are of excellent quality, hard, tough, ringing and of even texture. Like the stone and lime quarries at Le Claire, the industry is seriously handicapped for want of a railroad. The brick sell chiefly to the cities along the Mississippi river, in Scott and adjacent counties.

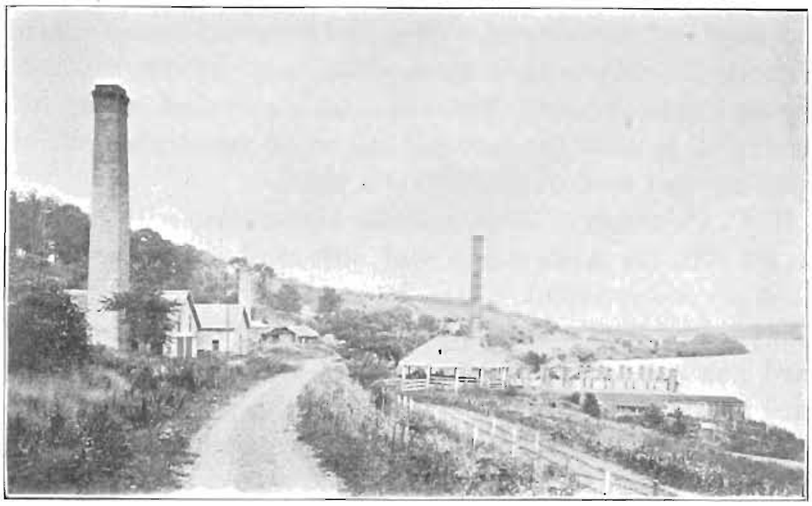


FIG. 52. Plant of Le Claire Brick and Tile company, Island City.

LOESS.

The loess supplies a good and abundant brick clay, easily manipulated and distributed well over the entire county. It is naturally manufactured most largely at Davenport, where there are four large yards in and adjacent to the city. The clay banks of the different plants are geologically identical, consisting of the three phases of the loess; the stiff joint clay of the weathered loess above the middle buff, and the lower and more sandy ashen loess. The whole face of the banks is worked, but the whole thickness of the ashen loess is not always used, since it gives too large a proportion of sand. Either on account of some hidden quality in the Davenport loess, or on account of skill in its manipulation, the brick from these yards are distinctly better than the average of loess brick. At all the yards brick for outside walls are moulded with a fine ocherous sand, found beneath the loess near Black Hawk. The iron, in which the sand is rich, oxidizes in the kiln and gives the surfaces of the brick a pleasing deep cherry-red color. The average weight of the brick is about 4,800 pounds per M.

The Black Hawk Brick company's plant is situated west of the city and consists of a new Anderson soft mud machine, capacity 25,000 per hour; three kilns, capacity 600,000, and ten drying sheds, capacity 250,000. All sand used is dug in the yard; coal is used for burning and wood for drying off. The sales amount to about 2,000,000 a year.

H. P. Pohlman & Bros. operate three kilns with a capacity of 480,000, an Anderson Chief soft-mud machine, capacity 2,500 per hour, and adequate drying sheds. The output from this yard in 1897 was 900,000. The Otter & Pohlman brick yard has substantially the same plant and output, and the yard of Mr. J. Ruch, similarly equipped, produced in 1897 a somewhat smaller quantity. The three yards last mentioned are situated on the bluffs in the northwestern part of the city.

The only plant that remains to be mentioned is one recently built for the manufacture of pressed brick at Long Grove. This place was selected for the reason that it is the first station coming north from Davenport on the Chicago, Milwaukee & St. Paul railway where the sub-loessial sands appear, being near the Iowan margin. Both sand and clay are taken from the same pit in the yards, conveniently situated adjoining the railway tracks. The plant consists of a U. S. dry press, capacity 20,000 per day, an Alsip up and down draft kiln, capacity 106,000, and the necessary engines, sheds, etc. At the time of inspection the first kiln of bricks was not through burning.

Road Material.

The supervisors have recently shown an exemplary enterprise in the making of good roads throughout the county. In the Kansan upland steep grades are being reduced by cuts and fills, and in every township road metal is being laid down where roads are difficult in wet weather. Most of the material is brought from a pahoid kame of the Buchanan gravels south of De Witt. Some is taken from the Devonian quarries of the Cedar Valley stage near Buffalo, and a better quality from the quarries of the Wapsipinicon stage at Davenport. The still harder Le Claire stone will no doubt be utilized in the future, and the Carboniferous shales and other clays offer inexhaustible mines of clay ballast wherever it is deemed expedient to burn it for this purpose.

Soils.

The soils of the county are of several distinct kinds. Those developed upon the Iowan drift are very limited in extent, since the Iowan area is small and much of it covered with aqueous deposits. The soils developed on the loess, wherever the land is level or gently undulating, are exceedingly fertile, and from them the larger part of the enormous agricultural wealth of the county has been drawn. But where the hillsides are steep, as on the Kansan upland, humus is rapidly removed, and the soil soon depleted of its nitrogenous constituents. Such hillsides, with their deep, porous loess mantle, are admirably adapted for forest culture, for orchards and vineyards, and are largely used for fruit raising about Davenport. The soils of the sandy hills of the Iowan frontier are light and poor, while those on the silts of the broad bottom lands of the Wapsipinicon and Mississippi are among the most fertile in the county.

Water Supply.

From almost any point of view in the county the wind engine is a conspicuous figure in the landscape, and its presence not only attests the prosperity of the farming community, but it suggests the significant fact that the ground water of the region has lowered since the settlement of the county. The earlier shallow wells are mostly dried up, and of recent years the well driller has been busy mining for that most valuable of minerals — water. The shallow veins just beneath the loess still occasionally afford a domestic supply. Water is found near the surface on the alluvial bottoms and sandy terraces. On the Wapsipinicon flood plain drive wells are commonly used, but generally the driller has been compelled to go for permanent and adequate supply through the heavy mantle of drift to the country rock. Here a well-defined water horizon is often found in sand and gravel, but not infrequently the rock itself must be penetrated until a vein is found in the strata. In the districts where the coal measures form the country rock, the water problem becomes particularly serious, since these shales and sandstones are either wholly dry or contain a little water of undesirable quality. The driller is compelled, therefore, to go through these shales to the limestone beneath, and wells sometimes more than 300 feet in depth are necessary.

The sands and silts interbedded with tills in the buried channel of Cleona river, contain water in large quantities. So fine are these sediments that they pass through the driller's sieves, and it is only with great care and skill that he can sink his well to coarser sand and gravels, often 250 or 300 feet beneath the surface.

Coming from considerable distance below the surface, and protected by heavy sheets of dense glacial clays, the water supply of the county at large may be assumed to be free from any bacterial contamination. The few small towns on alluvial bottoms should exercise constant care to prevent the pollution of their shallow wells and the ravages of disease which inevitably ensue. Wells in rocks are usually safe wells in this region, but it must be pointed out that where the strata dip more or less steeply, their bedded planes furnish open waterways from the surface downward, and ready access of superficial contaminations of any kind to the deeper veins. If we mention the town of Le Claire as occupying such a site it is not from any evidence or ground of suspicion of any impairment of the purity of its present water supply, but only because the high dip of the strata on which the town is built makes such an impairment possible at any time. An artesian well would insure an abundance of pure and wholesome water, and could be drilled at small expense.

ARTESIAN WELLS.*

Few local artesian basins of the United States have been so thoroughly studied as has the district of Davenport, Moline and Rock Island, by Prof. J. A. Udden, of the latter town. Before Professor Udden's paper appeared in the seventeenth annual report of the United States Geological Survey, he very generously placed in our hands the notes upon which his manuscript was based. We are also indebted to the owners of several wells for information, and to Mr. A. S. Tiffany, who loaned his set of drillings from the Kimball house and the city park wells.

In number of artesian wells Davenport slightly outranks any other town in the state. The exploitation of the field is comparatively recent. Nine of the fourteen wells were drilled during the present decade. This extension of the use of artesian water has taken place in the face of the fact that the city water supply, drawn from the Mississippi river, passes through one of the largest mechanical or rapid filtering plants in the United States. The preference for artesian water on the part of large consumers is probably due in part,

*Norton: Iowa Geol. Surv., vol. VI, p. 272, et seq.

in the majority of instances, to its relative cheapness. In one instance a well was put down simply "to bring the water company to terms."

TABLE OF ARTESIAN WELLS AT DAVENPORT.

OWNER.	Depth.	Diameter in inches	Elevation of curbs A.T.	Original head A. T.	Present head A. T.	Original discharge.*	Present discharge.*	Water horizons A. T.	Temper'tre.	Date of completion.	Driller.†
Witts' Bottling Works	780	....	575	657	634	300	....	....	.....	1891	...
Woolen Mills	1053	3½	564	651	....	......	....	479 ft.; -136 ft.; n.bo'm	.....	1890	2
Crystal Ice Co	1067	6-4	590	605	602	250	240	-10 ft. and St. Peter.	60° F	1893	2
Malt and Grain Co	1076	5	592	627 631	602 607	....	.....	-108 ft; -464 to -474.	.....	1892	2
Kimball House	1100§	8-4	579	637	599	......	.....	-131 ft. and St. Peter.	.....	....	2
Tri-City Packing & Provision Co.	1100	8-5	564	610	610	250	250	-236 to bottom.	....	1893	1
Gas company, two wells	1200	5-4	564	612	612	.....	....	....	.....	1891	2
Schmidt building	1200	4	576	600 606	....	45 28	.....	....	.....	1892	2
City park	1797	....	704	682	670	‡125	.....	....	....	1888	1
Glucose Manufacturing Co.	1500	5	562	.....	620	......	230	....	60° F	1880?	...
Glucose Manufacturing Co.	2101 2105 2107	5	562	.....	643	....	380 400 400	....	60° F	.... 1889 1892	1

*In gallons per minute. † 1, J. P. Miller & Co.; 2, A. K. Wallen. ‡By pumping. §Approximately.

The first flow of the wells of this district rises from about 479 feet A. T., near the base of the Devonian. This may represent the natural springs which rise from the Independence shale in other counties, and indeed the shale near this level of the Kimball house record, preserved by the Davenport Academy of Science, may be the Independence rather than a cavern filling as held by Udden. The water is corrosive in quality and insignificant in quantity. A second flow is obtained in the Galena limestone, at depths from -108 A. T. to -242 A. T. This is the so-called "upper water," and is impregnated with sulphureted hydrogen. To enjoy the characteristic taste and odor of the gas, the water must be taken immediately from the well. Aeration and relief from pressure permit an escape of the gas so rapid and so complete that chemists rarely find traces of its presence in samples sent to their laboratories for analysis. The water is usually separated by tubing from the lower flows. The yield is generous, amounting in the Witts' well to 300 gallons a minute, and at Carbon Cliff, Ill., to 400 gallons. At Davenport the head is reported somewhat lower (less than ten feet) than that of the water from the Saint Peter. At Carbon Cliff the reported pressure equals a head of 684 feet A. T.

The third water horizon lies in the Saint Peter sandstone, whose depth is variously reported in different wells at from -376 feet A. T. for the summit to -577 feet A. T. for the base. This flow has furnished so far most of the discharge of the Davenport basin. Other flows unspecified in the extant records, occur in the Oneota and the sandstones of the Saint Croix, and under greater pressure and with heavier discharge if we may judge from the wells at the city park and the glucose factory.

ANALYSES.

The following analyses indicate the qualities of the waters from their different horizons, excepting that from near the base of the Devonian. The first of the Witts' well is from the Galena. The second, of the Crystal Ice Co.'s, is from the Saint Peter only, all upper waters being shut off by tubing 1,067 feet in depth. The analyses from the glucose factory well probably represent admixtures with the deeper waters below the Saint Peter.

WITTS' BOTTLING WORKS.

	GRAINS PER U. S. GALLON.	PARTS PER MILLION.
Calcium carbonate	2.1480	36.80
Magnesium carbonate	1.6034	27.47
Iron carbonate	.4488	7.69
Sodium carbonate	16.4457	281.75
Sodium sulphate	23.4069	401.01
Sodium chloride	26.1753	448.40
Silica	.4377	7.50
Total	70.6658	1212.50

Analyst, E. T. Burghausen, chemical works, Cincinnati. Authority, J. A. Udden.

CRYSTAL ICE AND COLD STORAGE CO.

	GRAINS PER U. S. GALLON.	PARTS PER MILLION.
Silica ($Si O_2$)	.497	8.571
Alumina ($Al_2 O_3$) Ferric oxide ($Fe_2 O_3$)	.182	3.143
Lime (Ca O)	1 624	28.000
Magnesia (Mg O)	.530	9.143
Potash ($K_2 O$)	......	....
Soda ($Na_2 O$)	31.834	548.857
Chlorine (Cl)	15.859	273.429
Sulphur trioxide ($S O_3$)	13 282	229.000
Carbon dioxide ($C O_2$)	9.139	157.571
Water in combination ($H_2 O$)	.829	14 286
Free (CO_2)	[1.110]	[19.143]

UNITED AS FOLLOWS.

	GRAINS PER U. S. GALLON.	PARTS PER MILLION.
Calcium bicarbonate ($Ca H_2 (CO_3)_2$)	4.690	80 857
Magnesium bicarbonate ($Mg H_2 (CO_3)_2$)	1.922	33.143
Ferrous bicarbonate ($Fe H_2 (CO_3)_2$)	.406	7.000
Sodium carbonate ($Na CO_3$)	12.667	218.571
Sodium sulphate ($Na_2 SO_4$)	23.705	408.714
Potassium chloride (K Cl)	......	....
Sodium chloride (Na Cl)	26.266	452.857
Alumina ($Al_2 O_3$)	Trace.	Trace.
Silica ($Si O_2$)	.497	8.571
Oxygen replaced by chlorine (O)	3 613	62.287
Solids	73.776	1272 000

Analyst, Dr. J. B. Weems, May 27, 1896.

The waters of the Wagner brewery well at Rock Island, Ill., the paper mill well at Moline, 1,628 feet deep, and of the East Moline well, 1,340 feet deep, are similar in chemical composition to those of the Witts' well and the Crystal Ice Co.'s. If the "upper water" is not mixed with the lower in all these wells (excepting, of course, Witts'), this marked similarity, closely approaching in some instances practical identity, strongly suggests that the upper water from the crevices of the Galena really rises from the horizon of the Saint Peter or even from still lower veins, and this assumption is reinforced by the volume and head of the Galena water. On the other hand, the presence of sulphureted hydrogen in the upper water supports the assumption that it is native to the Galena.

GLUCOSE FACTORY (WELL UNKNOWN).

COMPOUNDS.	GRAINS IN U. S. GALLON.
Calcium bicarbonate	5 132
Magnesium bicarbonate	4.770
Calcium sulphate	5.540
Sodium sulphate	16.096
Sodium chloride	28.080
Alumina	0.361
Silica and unsoluble residue	0.216
Total	60.195

Analyst, Chemist of Co. (?). Authority, D. W. Mead, Hydrogeology of Illinois, Table X.

GLUCOSE FACTORY (WELL UNKNOWN).

COMPOUNDS.	PARTS PER MILLION.
Calcium carbonate	202 0
Magnesium carbonate	110.0
Sodium carbonate	7.0
Sodium sulphate	364.0
Sodium chloride	833.0
Insoluble	226.0
Total	1,742.0

Analyst, E. Guteman, Davenport. Authority, J. A. Udden.

PERMANENCE OF THE PRESENT SUPPLY.

The original head of the earlier wells, from 1,000 to 1,200 feet deep, is exemplified in that of the Kimball House and of the Woolen Mills wells—a head of from 637 to 651 feet A. T. The wells drilled in 1891 and 1892 show no original head higher than 631 feet, and in two wells the head was only 600 and 612 feet A. T. From 1893 to 1895 the water rose in new wells of this depth to from 606 to 615 feet A. T. In old wells it is impossible to state how much of the loss of pressure is due to leakage from various causes. The well at the woolen mill, for example, lost 62 feet of head in the first three years after it was drilled. About 300 feet of casing was then taken out, much corroded and in places perforated. When new tubing to that depth was adjusted, the water rose to a tank 10 feet higher than the head before repairs were made. How much higher it would rise was not tested. That any overdraft is local, is shown by the fact that in 1894 the village well at Milan, three miles south of Rock Island, headed at 635 feet A. T. In Davenport, at least the deeper wells, from 1,800 to 2,100 feet deep, maintain nearly their original pressures.

In summation, we may say that the supply available to wells less than 1,200 feet deep is being overdrawn. All wells should be kept in thorough repair. Any considerable increase in the number of the wells in the district will probably make pumping necessary in all the wells of this depth. But the larger reservoirs below the Saint Peter show little or no signs of exhaustion, and the limit of their supply may be far from being reached.

GEOLOGICAL SECTION.

The first attempt to interpret the relations of the deeper strata at Davenport was made by Mr. A. S. Tiffany.* This was based upon samples obtained by him from the well at the city park. As an illustration of the pains sometimes needful to secure these valuable data, it may be said that the trips which Mr. Tiffany made to the well involved some 300 miles of travel. Abridged and slightly rearranged, and the elevations A. T. being added, Mr. Tiffany's section is as follows:

FORMATION.	THICKNESS.	DEPTH.	ELEVATION A. T.
Drift	100	100	604
Coal Measures	30	130	574
Corniferous	390	520	184
Lower Helderberg (Le Claire)	80	600	104
Niagara	175	775	-71
Cincinnati and Trenton	300	1,075	-371
Saint Peter, Calciferous	100	1,175	-471
Other groups, Calciferous	622	1,797	-1,093

*American Geologist, vol. III, pp. 117-118.

The samples from this well and from that at the Kimball house were kindly placed by Mr. Tiffany at the service of the writer and have been described by him in detail.* It was found impracticable to reconcile the records of the two wells, and a large part of each section was left undetermined as to the age of the strata. For example, the horizon of the Maquoketa shale, although 242 feet thick at the Kimball house well, was represented in the samples of the Park well only by several samples of non-argillaceous dolomite. The presence of interbedded layers of dolomite in the Maquoketa is not strange, but the absence of any shale, or record of shale, is singular. The following was the author's section based upon these data:

FORMATION.	THICKNESS.	ELEVATION A. T.
Pleistocene or recent	13	566
Devonian	115	451
Upper Silurian	320	131
Maquoketa	242	-111
Galena-Trenton	425	-536
Saint Peter sandstone	90	-626

Thus the great body of the strata referred by Tiffany to the Corniferous was placed with the Niagara, the base of the Devonian being lifted 267 feet.

Since the publication of the author's paper, Prof. J. A. Udden, of Rock Island, has collected and most skillfully collated a large amount of data from the three adjoining cities, including some well records and series of drillings from the Illinois towns that are specially complete and reliable. The general geological section which he has constructed from these must be a close approximation to the fact.

*Iowa Geol. Surv., vol. III, pp. 200-202.

	FORMATION.	THICKNESS.	ELEVATION A. T.
14	Devonian	55	500
13.	Niagara	340	160
12.	Maquoketa	223	-63
11.	Galena	244	-307
10.	Trenton	100	-407
9.	Shale	41	-448
8.	Sandstone	76	-524
7.	Shale	66	-590
6.	Lower magnesian	800	-1,390
5.	Sandy shale	35	-1,427
4.	Arenaceous limestone	27	-1,452
3.	Sandstone	145	-1,597
2.	Calcareous shale	75	-1,672
1.	Sandstone	97	-1,769

Nos. 1-5 are referred by Professor Udden to the Potsdam and Nos. 7-9 are included in the Saint Peter.

After a close examination of all the facts in the case, involving the conflicting records of about a dozen wells, we find few changes to suggest, and these in points of minor detail. We should incline to place the base of the Devonian at about 475 A. T., relying upon the recorded samples of the Kimball house well, and other data, and would follow these same sources of information and the records of the Davenport Academy of Science in placing the limits of the Maquoketa at 131 A. T. and 109 A. T. The records of the Saint Peter are singularly conflicting. The reported top of this sandstone varies from -376 A. T. to -485 A. T., and its base from -456 A. T. to -577 A. T. It will be noted that while we limit the Saint Peter to the sandstone, Professor Udden joins with it the shales immediately below and above, which we have allotted to the Trenton and to the Upper Oneota. Below the Saint Peter the section rests upon the records of three wells.

GLUCOSE FACTORY, DAVENPORT, 562 A. T.

STRATA.	THICKNESS.	DEPTH.	A. T.
Surface material	52	52	510
Limestone, bluish	...	410	152
Shale	...	635	- 73
Limestone	...	970	-408

STRATA.	THICKNESS.	DEPTH.	A. T
Shale	30	1,000	-438
Sandstone, Saint Peter	42	1,042	-480
Limestone, sandy	530	1,572	-1,010
No record	258	1,830	-1,268
Shale	40	1,870	-1,308
Limestone, sandy	20	1,890	-1,328
Sandy rock	160	2,050	-1,488
Shale	50	2,100	-1,538

MOLINE PAPER CO., 564 A. T.

STRATA.	THICKNESS.	DEPTH.	A. T.
Sandstone (Saint Peter)	65	1,141	-577
Red marl and limestone	316	1,457	-893
Sandstone	121	1,578	-1,014
Limestone	50	1,628	-1,064

MITCHELL & LYNDE'S BUILDING, ROCK ISLAND, 558 A. T.

STRATA.	THICKNESS.	DEPTH.	A. T.
Sandstone, Saint Peter	145	1,104	-546
Limestone	811	1,915	-1,357
Sandstone, compact	30	1,945	-1,387
Limestone	35	1,980	-1,422
Sandstone	130	2,110	-1,552
Shaly limestone and shale	75	2,185	-1,627
Sandstone	97	2,282	-1,724

According to these records, the base of the Lower Magnesian cannot well be below -1,357 feet A. T., and may more probably be placed not below -1,268 feet A. T. with the glucose factory record, which is more exact in other details than that of the Mitchell & Lynde's boring. Nor will these records allow us to extend the section below -1,724 A. T. In the absence of frequent samples showing the true nature of the different strata from the base of the Saint Peter to -1,268 A. T., in view of the character of the strata of Magnesian series, which often causes even a geologist to hesitate as to whether to call them limestones, sandstones or shales, and in view of the 121 feet of sandstone included in the record of the Moline Paper Co., it seems preferable to leave indeterminate the base of the Oneota, or Lower Magnesian, and to place the base of the entire Magnesian series, including the

Saint Lawrence, at 1,328, the base of the last limestone in the glucose factory record. The sandstone and shales below this will fall in with the Basal sandstone of the Saint Croix.

At White Sulphur Springs, a beautiful park overlooking the broad Mississippi (Buffalo Tp., Sec. 24, Nw. ¼), there still flows one of the pioneer artesians of the state. It was drilled over thirty years ago and its depth is 800 feet. The hotel, which was once one of the chief health resorts of the state, was burned in 1893, and has not been rebuilt. The water is strongly sulphurated and it retains all the qualities which have made it sought after for medicinal purposes.

ACKNOWLEDGMENTS.

The assistance is greatfully acknowledged which was rendered during the survey of this county by all to whom opportunity offered, by owners of mines and quarries, deep wells and kilns, and by the persons engaged in well drilling. Our indebtedness is especially great to the director and members of the Survey for very many suggestions; to Dr. Calvin, to Professor Udden, and to Mr. Leverett, the privilege of whose counsel was enjoyed in the field, to Dr. Barris and the Davenport Academy of Natural Sciences, to Capt. C. D. Townsend of the Upper Mississippi Improvement Commission, and to Mr. J. W. Brown, division engineer, Burlington, Cedar Rapids & Northern railway.

APPENDIX.

The record of wells mentioned on page 493 follows. As has already been stated, these records are not absolutely accurate, but are offered as the best at hand and for the purpose of preserving them for future use.

RECORD OF WELLS IN SCOTT COUNTY.

OWNER.	Section.	Quarter.	Quarter.	Depth — rock not reached.	Depth to rock.	Depth in rock.	Total depth.	Curb A. T.	Bottom A. T.	Rock surface A. T.	Authority.	
Liberty Township—												
L. Riefe	2	SE	SE	...	100	...	...	...	...	...	..	
Z. Parker	7	NE	NW	...	93	...	113	...	...	...	2	Yellow clay 18, blue clay 75.
J Stoltenberg	7	SE	......	...	60	30	90	...	...	...	..	
J. L. Andre	8	NE	NE	...	150	...	...	...	...	...	1	Yellow clay 35, yellow sand, blue and yellow clay to bottom.
Klahn	8	NW	......	...	60	58	118	...	...	...	..	
G. Parker	8	SE	SE	...	143	...	143	...	...	...	2	Yellow clay 40, sand, remainder blue clay.
J. Hickson	10	NE	NW	...	112	...	...	...	...	...	..	
Dixon City Hotel	12	SE	SE	...	23	50	73	680	...	657	1	Nearly all fine blue, silty quicksand.
J. Holt	13	SE	SE	...	60	...	108	...	...	...	1	Yellow clay 25, black muck 35.
J. Flinker	15	NW	......	...	60	75	135	...	...	...	1	
J. Killian	16	SW	......	...	60	...	...	...	...	...	..	
P. Mohr	17	NE	NW	...	60	...	...	800	...	740	..	
......	18	SE	SE	...	81	...	...	...	...	...	..	
A. Paustian	9	NW	NE	...	18	...	...	800	...	782	..	
Town of NewLiberty	20	SW	......	...	90	...	...	...	...	...	..	
Town of NewLiberty	20	SW	......	...	108	...	...	800	...	692	1	Yellow clay 16, yellow sand 3, blue clay 89.
Town of NewLiberty	20	SW	......	...	50	...	...	...	...	...	..	
A. Weise	20	NW	NE	...	100	...	...	...	...	...	1	Yellow clay 16, quicksand 10, blue clay 74.
W. M. Lensch	20	SE	SW	...	90	...	...	...	...	...	..	Yellow clay 20, sand 3, blue clay 67.
W. M. Lensch	20	SE	SW	...	60	30	90	...	...	...	1	Little blue clay.
H. Schmidt	22	SW	SE	...	50	65	115	...	...	...	1	Yellow clay 25, red clay 25, boulders on rock.
M. Smallfield	24	SW	NW	...	105	...	165	...	...	...	13	
J. Flinker	24	SE	......	...	140	...	...	...	...	...	..	
H. Quistorf	25	SE	SW	42	...	...	...	...	...	...	1	Hard, blue clay from 12 to 40, stopped in sand.
E. Moeller	32	SW	SW	...	60	...	72	...	...	...	..	Yellow clay 20, sand 2, blue clay 38.
H. Arp	33	SW	SW	...	...	...	150	...	...	...	..	
T. Ketelson	35	NE	NW	...	128	22	150	810	...	672	..	
T. Killian	16	SE	SE	...	8	...	64	...	...	...	2	
J. Killian	16	......	......	...	120	...	125	...	...	...	2	
T. Ketelson	26	SE	NE	...	70	...	74	...	...	...	13	Thick, yellow clay throughout.
Cleona Township—												
D. Boll	1	NE	NE	222	...	...	...	730	500	...	..	
C. Gimm	4	NW	NE	...	42	...	72	...	...	...	..	
W. Rheims	4	SW	......	...	162	...	163	...	...	...	2	
W. Rheims	7	NW	NW	...	121	...	...	...	...	...	..	
J. Schroeder	7	SW	SE	...	80	...	108	...	...	...	..	
H. Kroeger	9	SW	SW	...	45	...	113	740	...	595	4	All yellow clay.
H. Hein	10	SW	SE	265	...	...	...	...	...	...	..	
F. Kardel	11	NE	SW	...	...	...	...	...	...	...	..	
J. Rathjen	12	SW	SW	242	...	...	...	...	...	...	4	Yellow clay 35, blue clay 205, sand 2.
H. Speth	13	NW	......	275	...	...	...	...	...	...	4	Yellow clay 10, blue clay 116, quicksand 150, ends in gravel.
A. Franz	13	SE	NE	...	193	...	...	...	...	...	..	
H. Hein	14	NW	SE	282	...	...	...	750	468	...	..	
G. Paustian	14	NE	NE	280	...	...	...	740	460	...	4	Yellow clay 10, blue clay 268, sand and gravel 2.
Juergen Mumm	14	NE	SW	280	...	...	...	...	...	...	..	
M. Hoersch	15	SE	SW	167	...	...	...	...	...	...	..	
Johann Mumm	15	SW	......	188	...	...	...	...	...	...	4	Yellow clay 15, blue clay, stony, 171, gravel 2.
P. Paulson	16	NE	NW	...	58	...	122	...	...	...	3	
P. Paulson	16	NW	SW	...	111	...	137	...	...	...	3	
H. Goettsch	19	NW	NE	331	...	...	331	730	399	...	3	
Lena Mumm	21	NE	NE	278	...	...	...	740	462	...	4	Yellow clay 12, blue clay 236, sand and gravel 30.

RECORD OF WELLS IN SCOTT COUNTY—CONTINUED.

OWNER.	Section.	Quarter.	Quarter.	Depth—rock not reached.	Depth to rock.	Depth in rock.	Total depth	Curb A. T.	Bottom A. T.	Rock surface A. T.	Authority.	
H. Mumm	22	NW	SE	306	...	...	...	760	454	...	..	
J. Theil	22	NE	NE	146	...	...	...	...	...	...	4	Yellow clay 15, blue clay 129, saod and gravel 2.
H. Wessel	23	NW	SE	133	...	...	...	...	...	...	5	Yellow clay 20, sand 10, blue clay 100, gravel 3.
J. Reimer	30	SW	SW	32	...	...	...	...	...	...	..	
W. Rhelms	4	SW	......	....	146	...	161	...	...	...	..	
J. Tesrow	24	NW	......	144	...	...	...	...	...	...	5	Yellow clay 7, red sand 7, sand 21, gravel 25.
Durant	..	......	......	....	...	...	...	...	...	...	3	Yellow clay 25, sand 5, blue clay 109.
Near Durant, on cr'k	...	....	......	....	..	...	...	...	...	...	9	To rock, 100-150 feet.
Allen Grove Township—												
E. Snyder	7	NW	NW	....	50	...	..2	...	...	...	..	
C. Rohwer	13	......	......	137	...	...	...	...	...	...	13	Ends in 25 feet of sand.
D. Yale	29	NW	SW	...	99	...	111	...	...	...	1	Yellow clay 20 feet, blue clay stony 70, hard pan 9.
E Gallegher	20	NW	SE	....	155	...	...	...	...	...	..	
M. King	20	SE	NW	75	...	...	75	...	...	...	1	Yellow clay 20, blue clay 50, hard pan dry 5, no water.
E. Richardson	20	SE	SE	....	100	...	118	...	...	...	..	Blue clay 70, sand 30.
* * * ...	24	NW	......	300	...	...	...	...	...	...	..	
O. H. Walton	24	......	......	320	...	...	..	750	430	...	13	Yellow clay, blue sticky clay, quicksand, stopped in 50 feet of river sand.
Wm Blythe	25	SE	NW	....	246	...	...	...	...	...	1	
H. Rohwer	26	NE	NE	300	...	...	...	740	440	...	7	Stopped in gravel.
Gilmore	27	SE	SE	..	228	...	...	700	...	472	L	
J. Hasenmiller	28	NW	SE	165	...	...	...	...	...	...	..	Stops in sand.
E. O'Neil	28	SE	NE	....	312	...	323	760	...	448	..	Yellow clay 50, 50 feet of sand, mostly blue clay, coarse gravel.
J. Carter	28	SW	SE	300	...	...	...	720	420	...	..	
H. Ketelson	30	NE	SE	46	...	...	...	...	...	...	..	
C. H. Brockmann	31	SW	NW	275	...	...	...	740	465	...	..	
H. Schultz	33	SW	SE	....	113	...	..	...	...	...	..	Yellow clay 16, quicksand, blue stony clay to 50, sand and gravel 2, blue clay 61.
H. Stahft	33	NE	SW	....	240	...	250	680	...	440	11	Mostly quicksand, 100 feet of sand in one bed.
H. Latrode	33	NW	NE	....	212	...	...	720	...	508	..	
R. O. Curtis	34	SE	SE	....	...	...	...	80	...	...	..	Struck rock.
H. Weise	35	NE		113	...	...	...	...	...	...	..	
Town of Donahue	36	NE	.....	....	100	...	...	...	...	...	10	
Town of Donahue	36	NE	.....	...	157	3	160	...	...	...	..	Yellow clay, blue clay, quicksand 15.
Chas. Middlemass	24	NW	SW	300	...	...	...	730	430	...	7	Mostly fine sand.
Hickory Grove Township	—											
H. Klindt	2	SE	NW	....	71	...	81	...	...	...	13	
C. Rock	4	NE	SW	..	72	...	...	...	...	...	..	
F. Rock	4	SE	NW	....	150	6	150	...	...	...	13	
P. Burmeister	4	NW	NE	....	70	...	74	...	...	...	10	
M. Spelletich	5	SE	SE	....	69	...	77	...	...	...	6	
D. Wunder	5	SW	SE	180	...	...	...	...	...	...	..	
Joseph Vort	6	?	?	....	215	...	...	...	...	...	..	
Plainview	7	NW	NW	225	...	...	...	730	475	...	4	
Plainview	7	NW	NW	....	232	...	...	...	...	...	4	
M. Spelletich	7	NW	SE	293	...	...	...	740	447	...	4	
M. Spelletich	7	SE	NW	....	245	...	...	...	...	...	4	
M. Spelletich	7	SE	SE	....	55	...	...	720	...	665	4	
J. Soutter	8	NE	SE	....	30	47	77	...	...	...	6	
P. Burmeister	9	NW	NW	....	70	75	...	...	...	...	10	
P. Burmeister	9	SW	NE	....	80	85	...	...	...	...	10	
H. Arp	9	SE	SW	....	50	53	...	...	...	...	13	
J. Kerker	9	SE	SE	....	40	64	...	...	...	...	12	
P Meyer	10	NW	SE	....	80	95	...	...	...	...	13	
C. Meyer	11	SW	SE	....	67	...	81	...	...	...	12	
B. Painter	12	NE	......	....	215	...	...	740	...	525	U	

RECORD OF WELLS IN SCOTT COUNTY—CONTINUED.

OWNER.	Section.	Quarter.	Quarter.	Depth — rock not reached	Depth to rock.	Depth in rock.	Total depth.	Curb A. T.	Bottom A. T.	Rock surface A. T.	Authority.	
Ira Burch	12	SW	SE	....	190	...	191	740	...	550	12	Yellow clay 40, blue till 150.
Hans Joens	13	SE	NW	....	155	...	157	...	...	...	13	Water on rock.
J. Steenbock	13	SW	SE	....	208	...	212	710	...	502	13	
Maysville	15	......	......	....	78	...	...	...	...	...	..	
Maysville	15	......	......	....	120	...	130	...	...	...	9	
W. Koberg	15	NE	SW	....	105	...	...	...	...	...	..	
A. Lage	16	NW	SW	....	85	...	91	...	...	...	13	All yellow clay.
H. Klindt	16	SW	SW	....	...	...	74	...	...	...	10	Ends in rock.
G Golinghast	17	SE	......	....	50	...	78	...	...	...	4	
M. Spelletich	18	SW	SE	....	270	...	...	780	...	510	..	
J. Frauen	19	NW	NW	233	...	...	...	...	...	..1	5	Ends in gravel.
J. Paustian	19	SE	NE	137	...	...	...	...	...	...	5	Yellow clay 20, sand 5, blue clay 105, gravel 7.
J. Hamann	20	NE	NW	....	110	...	...	...	...	...	..	
Th. Karbel	21	SE	NE	88	...	...	...	...	...	...	..	
M. Gries	22	SW	SW	....	165	...	170	720	...	555	13	From 100 feet down all quicksand and sticky clay.
J Plambeck	23	NE	SE	280	...	...	...	720	440	...	13	Mostly blue clay.
W. Fry	24	NE	SE	....	206	...	208	740	...	534	9	Yellow clay 17, blue clay hard 60, sand 138.
Schoolhouse	26	SE	SE	....	215	...	250	740	...	525	9	Ends in gravel.
E. Sindt	27	NW	NE	88	...	...	...	...	...	...	13	Yellow clay 15, blue clay 15, quicksand, ends in gravel.
C. Haller	29	NE	SE	116	...	...	...	...	...	...	4	
P. Riessen	29	NW	NW	126	...	...	...	...	...	...	..	
C. Paustian	30	NE	NW	...	130	...	143	...	...	...	5	Yellow clay 20, sand 5, blue clay 105
Geo. Dietz	31	SW	SE	55	...	...	...	...	...	...	5	Yellow clay 15, quicksand 5, blue clay 30, gravel 5.
Schoolhouse	32	NW	NW	115	...	...	...	...	...	...	5	Ends in gravel.
A. H. Lamp	33	NW	NW	86	...	...	...	...	...	...	5	Yellow clay 20, sand 6, blue clay 58. gravel 2.
Maysville creamery.	15	NW	SE	....	90	...	90	740	...	650	1	Yellow clay 16, quicksand 10, greenish clay 64.
Geo. Dietz	31	SW	SE	70	...	...	...	...	...	...	5	Yellow clay 16, sand 5, blue clay with bowlders, gravel.
J. Plambeck	36	SE	....	....	230	...	240	740	...	510	9	Quicksand 60 feet, on rock.
J. Soutter	8	NE	......	....	80	...	90	...	...	...	13	Yellow clay 40. blue clay to rock.
Blue Grass Township—												
S. R. Miller	1	NW	.....	117	...	...	...	...	...	...	..	
S. R. Miller	1	SW	SW	275	...	...	...	760	485	...	12	Yellow clay 35, blue, hard clay to bottom, did not cave, no
S. R. Miller	1	SE	NE	113	...	...	...	...	...	...	14	Ends in gravel
S. R. Miller.	2	NE	NW	102	...	...	...	...	...	...	14	Ends in gravel.
S R. Miller	2	SE	SW	117	...	...	...	...	...	...	..	
W. Arp	3	SW	SW	....	100	...	...	760	...	660	..	
G Muhl	5	SW	......	....	40	64	104	...	...	...	5	Soft, white limestone.
H. F Strohbeen	5	SW	SW	....	47	43	90	...	...	...	5	
Walcott	6	......	......	...	50	...	...	...	...	...	5	Yellow clay 14, sand 5, blue pebbly clay 31.
T. Giese	7	SW	NE	....	26	...	...	...	...	...	..	
J. Franz	8	NE	NW	...	86	...	89	...	...	...	..	
H. Goering	10	NW		....	91	...	101	...	...	...	14	
H. Goering	10	SW	SW	....	90	...	118	...	...	...	14	
H. Meyer	12	NW	NE	....	235	...	253	740	...	504	..	
Eggert Puck	12	SE	NE	..	204	...	210	740	...	536	14	
A. LeBuhn	16	NE	NE	90	...	...	...	...	...	...	5	Yellow clay 20, sand 5, blue clay 50, gravel 5.
H. Wiese	19	NW	SW	....	78	...	...	...	...	...	..	
H. Schlichting	23	SE	NE	....	110	...	120	...	...	...	14	
Schoolhouse No. 3	19	NW	......	....	78	122	200	...	...	...	5	Yellow clay 20, sand 10, blue clay 48, white limestone 122.
Buffalo Township—												
E. James	3	SW	......	....	35	..	316	...	...	...	12	Limestone 160.
L. Daurer	8	NW	NW	....	50	...	270	...	...	...	..	
C. Rowan	10	SW	......	....	60	...	...	...	...	...	..	
Barnwick	16	SE	SE	....	20	..	144	...	...	...	..	

RECORD OF WELLS IN SCOTT COUNTY—CONTINUED.

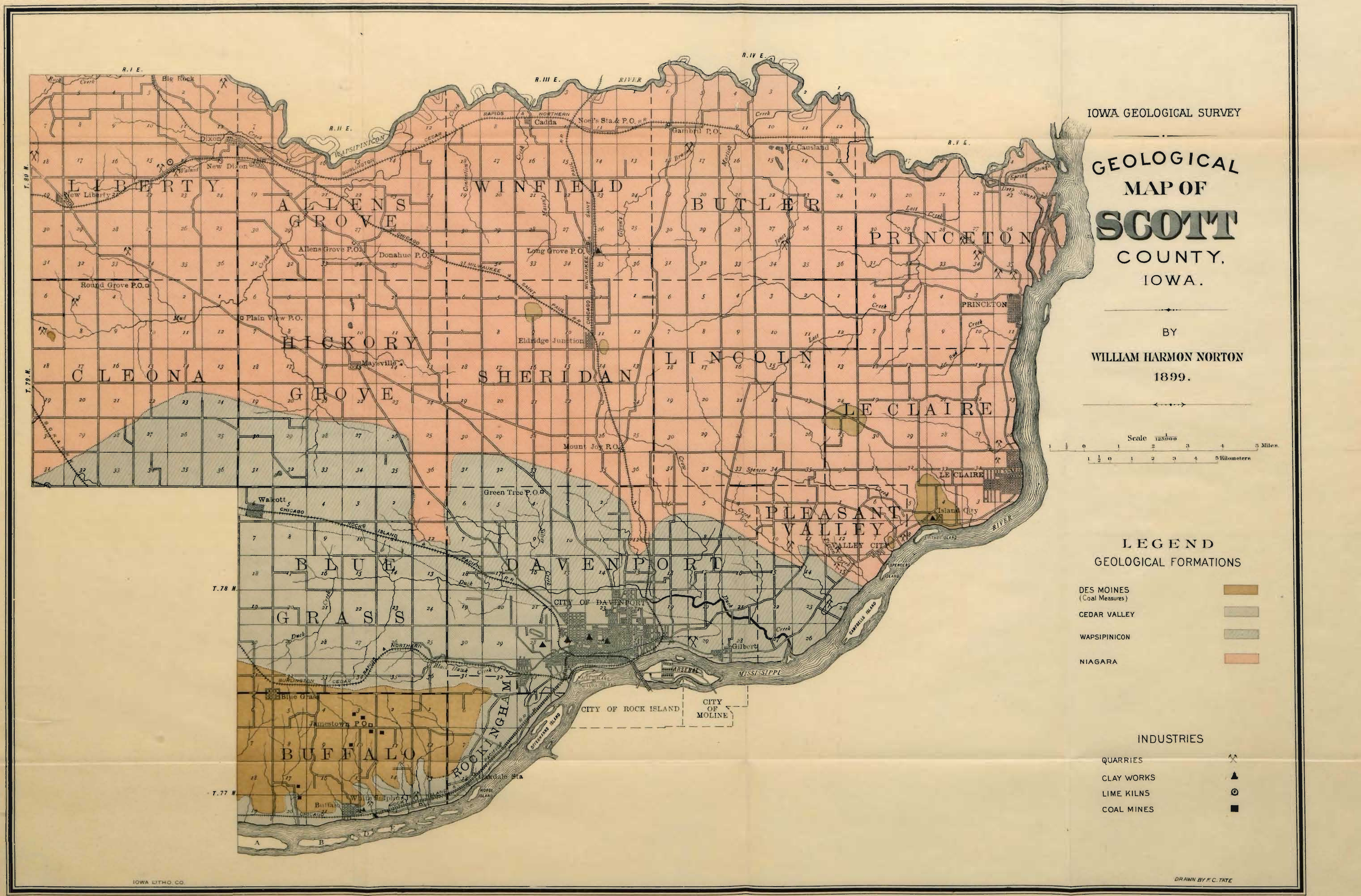
OWNER.	Section.	Quarter.	Quarter.	Depth — rock not reached.	Depth to rock.	Depth in rock.	Total depth.	Curb A. T.	Bottom A. T.	Rock surface A. T.	Authority.	
F. Bell	18	NE			80		261				12	Limestone 161 feet.
J. Murray	10	NW			35		305				12	No coal, limestone 160.
Winfield Township—												
J. Ennis	11	SW	SW	70								All sand.
C. Gillian	7	SE	SE	150							8	Sand 20, hard, blue, pebbly clay 120, sand 5, gravel 5.
School No. 4	14	NW			125							
St. Ann's Church	14	SE	SW		64	36	100				9	Sand 15, yellow clay 10, blue clay, a little sand.
P. Jones	15	NW	NW		190			720		530		
School No. 3	16	NW	NW	94							8	Sand 70, blue clay 20, gravel 4.
N. Schallmeier	18	SW	SE	200							8	
N. Denklau	19	SW	NW		153		173				13	
A. Brownlee	26	NW	SE		220			725		505		
J. Robertson	27	NE	NE		120		121				8	Yellow clay 50, hard, blue, stony clay 70, sand and gravel thin.
J. Grill	30	SE	SE	115								
C. Preston	31	NE	SE		180							
J. Neil	35	SW	SW		225			780		555		
Hotel Long Grove	35	NW		54							8	Ends in gravel.
Sheridan Township—												
C. Clapp	2	SW	NE		122		128				9	
J. Lensch	2	SE	SE		114		118				8	
C. Meier	4	SW	SE		100		199				8	Yellow clay 25, old soil 10, blue clay 65, coal 2, shale 97.
J. Baustian	5	NE	SW		200		237	760		560	13	Shale 37 feet.
J. T. Cooper	5	SW	SW		140		145				12	Yellow and blue clay, gravel on rock.
S. Burmeister	6	NW	SE		120							
E. Rohwer	6	NE	SW		140							
L. Husted	7	SE	SW		166							
Eldridge	11	SW			127		135	7			6	Yellow clay less than 20, mostly blue clay, ends in limestone.
Eld. Creamery	14	NW	NE		180		201	780		600	1	
Chas. Erhsam	20	NW	NE		72			730		658		
J. L. Seaman	27	NW	SW		90						L	
H. Stoltenberg	28	NW	SE		100						L	
W. Hughes	33	NW	SE		170		180				14	
Claus Lamp	19	SW	SW		270		285	740		470	6	Mostly hard, blue clay.
Davenport Township— (Range 3, E.)												
Chas. Murray	1	SE	NE		105							
W. Untiedt	7	NE	SW	120							14	Ends in gravel.
School No. 2	7	NE		122							5	Yellow clay 30, sand 10, blue clay 80, gravel 2.
Capt. Stahr	7	NW	NW		160							
J. Carlin	10	SW	SE		115		140				14	
G. Conklin	11	SW	NW		90		106					
E. Daugherty	12	SW		212				700	488		14	
R. Clay	12	NE	SW	230				680	449			
M. Boyle	13	NW	SW		85		94				14	
*J. Armel					202		245				9	
*Dr. G. P. Maxwell					100		130				9	
†Schuetzen Park					160		240				14	
J. Hever	21	SE	SE		155		200				14	
Thos. Sindt	7	NW	NW		160		167				14	
Davenport Township— (Range 4, E.)												
I. Barr	4	SE	NW		100		150				13	
C. Van Evera	4	SW			90		115				14	
R. Schaefer	4	SW	SW		80		85				14	
J. Barnholdt	5	NW			88		98				14	
H. Wiese	6	NE			79		94				14	
J. Barr	7	NE	SW		142		157				13	
F. Thomas	9	NW	SW		150		163				14	
C. Carstens	17	SE	SW		120		138				14	
H. Woodford	18	NE	NW		176							
A. J. Partridge	18	NE	NE		90		106				14	

RECORD OF WELLS IN SCOTT COUNTY—CONTINUED.

OWNER.	Section.	Quarter.	Quarter.	Depth — rock not reached.	Depth to rock.	Depth in rock.	Total depth.	Curb A. T.	Bottom A. T.	Rock surface A. T.	Authority.	
I. Barr	18	NW	......	....	70	...	90	...	...	...	14	
J. Barr	18	SE	NE	....	58	...	65	...	...	...	14	
Wm. C. Schaefer	19	NE	SW	....	80	...	93	...	...	...	14	
J L. McCullough	20	SW	......	....	90	...	160	...	...	...	14	
E. S. Kellog	18	NW	SE	...	90	...	105	...	...	...	14	
Butler Township—												
J. Henry	22	NE	SW	....	100	...	...	...	...	...	U	
J. Henry	22	NE	SE	....	62	...	...	...	...	...	U	
J. McCausland	23	NE	......	67	...	...	...	...	...	...	U	
	25	......	......	....	65	...	...	...	...	...	U	Sandstone at 65.
D. Holst	26	SE	NE	175	...	...	...	740	765	...	U	
E. Mueller	35	NW	NW	....	60	...	...	...	...	...	6	
Lincoln Township—												
D. Arp	2	SW	NW	....	120	...	130	...	...	...	6	Ends in limestone.
C. Schneckloth	7	SE	SE	....	140	...	...	...	...	...	..	
I. Barr	7	NE	NE	...	101	..	121	...	...	...	13	
J. H. Barr	22	NE	SW	....	190	...	...	740	...	550	..	
Thos. Criswell	23	NW	SW	....	160	...	...	...	...	...	13	
M. Jones	23	SE	......	....	120	...	150	...	...	...	15	
M. Thompson	27	NE	NE	...	175	...	182	...	...	...	14	
H. Schroeder	33	SW	SW	....	55	...	75	720	...	665	14	
M. Barr	26	SW	SW	....	86	...	116	...	...	...	14	
Benj. Criswell	23	NW	......	....	190	...	...	...	...	...	15	
Princeton Township—												
J. Carroll	30	NW	NE	....	60	...	...	...	...	...	..	
C. Fulmer	4	NW	NE	....	80	...	...	...	...	...	16	
C. Like	4	NE	SE	....	100	...	...	...	...	...	16	
O. Peaslee	9	SW	SW	....	169	...	...	720	...	551	16	
W. Florence	5	SW	SW	....	70	...	82	700	...	630	..	
Le Claire Township—												
J. Brown	17	SW	NE	....	100	...	...	...	..	...	..	
J. Wilson	21	SE	NW	....	100	...	...	...	...	...	..	
G. Leamer	25	NW	NE	....	210	...	381	740	...	530	14	Shale from 210-375, ends in limestone.
J. C. McGinnis	30	SE	NW	....	170	...	250	...	...	...	15	
W. H. McGinnis	30	SE	NE	....	120	...	150	...	...	...	15	
J. Stafford	36	SE	NW	....	150	...	246	...	...	...	..	
H. Stafford	36	NE	SW	....	100	...	121	...	...	...	..	
H. Whitson	25	SE	NE	....	120	...	15	...	...	...	15	
M. Miller	31	SW	NE	....	150	...	...	...	...	...	15	
M. Wilson	32	NE	......	....	60	...	150	...	...	...	15	
T. Taylor	32	NE	......	....	55	...	75	...	...	...	14	
H. Stone	32	SW	......	....	31	...	...	...	...	...	15	
J. Suiter	33	NW	SE	....	35	...	...	...	...	...	15	
J. McCaffry	4	NW	......	....	40	...	...	...	...	...	15	
A. Schurr	4	NW	......	....	50	...	78	...	...	...	12	Yellow clay 25, blue clay to rock, shale.
G. Hyde	36	SW	NW	....	80	...	100	...	...	...	15	Lime rock 20 feet.
Porter's Corners	35	NE	NE	....	175	...	305	...	...	...	15	Yellow clay 30, quicksand, blue till, 100 feet of shale, 30 feet of limestone.
(Rockingham)												
F. J. Shaeffer	5	NW	......	....	40	...	216	...	...	...	14	Shale from 40 to 206 feet.
Walnut Hill school	5	NE	NW	....	40	...	225	...	...	...	14	Shale from 40 to 206 feet.
J. A. Punt	5	NW	NE	...	30	...	186	...	...	...	14	Shale to 10 feet of bottom.
Fairview school	7	NE	SE	....	...	...	110	...	...	...	14	Shale and blue clay in alternate layers.

*City of Davenport, Gaines St.
*City of Davenport.
U Prof J. A. Udden, Rock Island.
L Mr. Frank Leverett, United States Geology Survey.
1 M. Crownwick, Dixon.
2 S Spitler. Bennett.
3 H. Voss, Durant.
4 J. P Buhrmeister, Plainview.
5 J. Strueben, Walcott.
6 C. Cook, Mt. Joy.
7 E. M. Buhrmeister, Eldridge.
8 H. Meyer, with Tieple Bros., Wilton.
9 Tieple Bros., Wilton.
10 M Burmeister, Donahue.
11 J. W Hoover, Wheatland.
12 H. Stoltenberg, with J. C. Buck, Davenport.
13 C C. Buhrmeister, Davenport.
14 J. W. Buck, Davenport.
15 Stone & Clark, Le Claire.
16 M. L. Conrad.

Records for which no authority is named are given by the owner.


IOWA GEOLOGICAL SURVEY
GEOLOGICAL MAP OF SCOTT COUNTY, IOWA.
BY WILLIAM HARMON NORTON 1899.
Scale 1/125000
5 Miles
5 Kilometers
LEGEND
GEOLOGICAL FORMATIONS
DES MOINES (Coal Measures)
CEDAR VALLEY
WAPSIPINICON
NIAGARA
INDUSTRIES
QUARRIES
CLAY WORKS
LIME KILNS
COAL MINES
LIBERTY
ALLENS GROVE
WINFIELD
BUTLER
PRINCETON
CLEONA
HICKORY GROVE
SHERIDAN
LINCOLN
LE CLAIRE
BLUE GRASS
DAVENPORT
PLEASANT VALLEY
BUFFALO
ROCKINGHAM
CITY OF DAVENPORT
CITY OF ROCK ISLAND
CITY OF MOLINE
MISSISSIPPI
RIVER
WAPSIPINICON
ARSENAL
New Liberty
Dixon
New Dixon
Big Rock
Round Grove P.O.
Allens Grove P.O.
Donahue P.O.
Cadda
Noel's Sta. & P.O.
Gambril P.O.
Mc Causland
Long Grove P.O.
Plain View P.O.
Maysville
Eldridge Junction
Mount Joy P.O.
PRINCETON
LE CLAIRE
Island City
Valley City
Walcott
Green Tree P.O.
Gilbert
Blue Grass
Jamestown P.O.
Buffalo
Oakdale Sta.
R. I E.
R. II E.
R. III E.
R. IV E.
R. V E.
T. 80 N.
T. 79 N.
T. 78 N.
T. 77 N.
IOWA LITHO. CO.
DRAWN BY F. C. TATE