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# GEOLOGY

OF

## CHEROKEE AND BUENA VISTA COUNTIES

With Notes on the Limits of the Wisconsin Drift as Seen in Northwestern Iowa.

BY

THOMAS H. MACBRIDE.

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## INTRODUCTION.

### LOCATION AND AREA.

The two counties especially the subject of inquiry in this report lie in the northwestern portion of the state of Iowa. They constitute the very center of the great northwestern prairie recently

come to distinction as the most fortunate, fertile and prosperous section of a famous state.

These two counties have on the north O'Brien and Clay, counties already described in this series of reports;\* on the west Plymouth county, fully discussed in Volume VIII;† on the south they are bounded by Woodbury, Ida and Sac, and on the east by Pocahontas. Each county is exactly square and contains sixteen congressional townships. For purposes of present description the two counties are here associated; but as a matter of fact, they are in many particulars, as the sequel will show, quite as unlike as two prairie counties well could be. Present unlikeness in the present instance, of course, bespeaks different history, and our story is marked by contrasts everywhere and not by comparisons. Cherokee county is more like Plymouth and Sioux; Buena Vista resembles part of O'Brien and Clay and especially the counties farther north. Buena Vista, true to the meaning of its name, has its own peculiar charm; Cherokee presents a landscape so varied and yet withal so moderate as to be without a rival in all that looks to agricultural beauty and easy, fortunate husbandry.

#### PREVIOUS GEOLOGICAL WORK.

These two counties have never hitherto been studied by the naturalist. Dr. White seems to have crossed them and to them devotes something more than a page;‡ but satisfactory study and thorough description were at that time prohibited alike by the state of geological knowledge and by the limits under which Dr. White's survey was made. The part taken by Owen and Nicollet in the discovery and description of this northwest portion of the state has been already sufficiently set forth in these reports.§

#### PHYSIOGRAPHY.

##### TOPOGRAPHY.

To an ordinary observer it might seem idle to attempt to find, much less to describe anything of interest in the so-called mo-

\* Iowa Geol. Surv., vol. XI, pp. 461, 5c8.

† Iowa Geol. Surv., vol. VIII, pp. 318-366.

‡ Geol. Surv. of Iowa by Charles A. White, vol. II, pp. 225-6, 1870.

§ Iowa Geol. Surv., vol. X, p. 191, and vol. XI, p. 405.

notonous prairie of our northwestern counties. At first sight to most people one prairie is exactly like another, and a "rolling" landscape in one locality is simply the counterpart of "broken" country twenty-five or fifty miles away. But let the attentive observer once traverse the prairie with the special intent of study or comparison and his views of monotony and of prairie topography in general will undergo remarkable change. Especially will this be the case if the path of his investigation chance to cross the two counties now the theme of description and discussion.

Let our traveler, for instance, enter Cherokee county from the west, near the middle of its western boundary and pursue a course directly east across Cherokee and Buena Vista counties; at first he will encounter a comparatively level plain; "gently rolling," he would say. But as he proceeds the hollows deepen and he presently encounters the broad fine valley of the Little Sioux, west fork, stretching southward. Again he ascends. The country once more becomes nearly level only to break again into the succeeding south-extended valleys of Willow and Rock creeks; until at length it reached the deep trough of the Little Sioux itself, a great eroded channel, with high, boulder-strewn bluff-like banks, much too large indeed for the present diminished stream. Crossing this the western topography is repeated. The several branches of the Maple succeed, each showing an erosion valley leading south, perfectly draining the meadows and separated by long low ridges, sometimes of such width as to make the lifted meadows and fields almost perfectly flat, a plain and yet a water-shed. Such or similar topography carries us a little distance across the eastern boundaries of the county. We enter Buena Vista. For several miles the traveler notes little difference; but as he pursues his journey eastward suddenly the scene is entirely changed. He passes over the last broad clay-covered ridge and looking southward may behold the town of Alta, beautifully located and perfectly named, a crest, a summit of older than historic interest. Still trending eastward the traveler presently finds himself confronted by an unexpected swamp, a marsh of unusual extent, sufficient perhaps to deflect the unopened section highway. Beyond the swamp, safely crossed or

turned by some detour, rises a singular ridge which proves to be made of sand or gravel and is entirely unlike the crests of Cherokee county, as different, in fact, as different can be, precipitous, narrow, soon crossed, landing the traveler by perhaps irregular, abrupt descent upon a plain again, which curiously enough shows no erosion, or only the slightest, has no valleys and no streams, no ridges with their sloping sides as water-sheds, but instead a confusion of irregular mounds, some perhaps worthy the name of hills, others simply swells or low, abrupt, causeless elevations, a few feet in height, on which perchance the farmer has pitched his farmstead, as if to keep out of the general wet. Some of the hills are so large and mound-like as to have attracted everybody's attention; they are real knolls, almost dunes, with a trend southeast, northwest.

As the traveler proceeds great marshes again obstruct his course, affecting not sections only, but sometimes a township entire; there are no bridges, only here and there a culvert through which the road-makers have coaxed part of the slough water from one side of the road to the other, it matters little in which direction. To the south are the beginnings of the Raccoon river, small creeks which wind about through lands much better drained. To the north the mounds and ridges are again the features of the landscape, stretching off about the town of Marathon, becoming more and more prominent as we approach again the county line.

The topography of the country is an inscription written in large letters, it is true, and occasionally somewhat obscured and blurred, since it often overlies similar earlier inscriptions—becomes a palimpsest in most real sense—but an inscription it still remains, legible enough once we find the key and take the pains to decipher line after line.

These topographical differences between two adjoining sections of the country are accordingly no accident. We should find very similar contrasts if we drive from Sac to Calhoun, or from Crawford into Carroll county. We have before us two distinct topographic plans or types, each bringing with it a history of its own. The topography of Cherokee county is erosional; that of Buena Vista county, morainic. The first represents the gen-

eral effect of long continued weathering, the washing of storm-waters down a broad and gentle slope; the second shows the scattered piles of drift material and detritus deposited by some great glacier or ice-sheet, once dominant so far south and west, its debris as yet little affected by the rains and snows of the centuries that have since elapsed.

In our present problem erosion finds extremest illustration in the deep-cut valley of the Little Sioux; the drift, or morainic topography is emphasized when the swamps and marshes deepen into lakes, as in the counties immediately to the north of us, or when the hills and kames rise to ridges or knobs of considerable height, as at Ruthven or in the vicinity of Ocheyedan; in our present limited district there are really no morainic lakes, though plenty of swamps, and the morainic elevations are generally low and insignificant.

Of course, we have not overlooked Storm lake. Here is a body of water fine enough and large enough to deserve not mention only, but a more or less complete description. From what has been said and from accounts heretofore given of Spirit lake and Okoboji\* it is evident that Storm lake belongs in some way at least to that great series or chain of fresh water glacial pools that extends from far northwest in Minnesota and South Dakota all the way to Wall lake in Iowa and the pools of Green and Dallas counties farther south and east.

One of the largest of our glacial lakes, Storm lake, is strangely enough one of the most shallow. Its extreme length is about three and one-half miles; its greatest breadth about two miles. The shores are low and generally even with several sandy beaches. Boulders formerly decorated the whole margin, but especially the northern and eastern rim, as with an ornate wall, but these have mostly been long since hauled away by enterprising builders. The bottom of the lake is, however, reported to be paved with stone in many places, and here and there along the shore an erratic block of unusual size may yet be seen. The greatest depth of the lake from all accounts does not exceed fifteen feet; the outlet, once a marshy slough, has long since been closed; the incoming streams are few and of minor importance. The

\* Iowa Geol. Surv., vol. X, pp. 202-212.

fact is the lake has been slowly filling, probably for a long time, and chiefly by vegetable detritus. Once the lake seems to have stretched away in shallow expanse much farther to the north and west as evidenced by the present reedy, marshy swamp, undrained, extending half way to Alta.

To one accustomed to Spirit lake and Okoboji it is a matter of surprise to see no high hills or mounds about Storm lake. The surroundings are remarkably low, almost flat in fact, with no hills worthy of the name approaching the lake on either side. But the truth is the history of Storm lake is entirely different from that of either of the lakes named. Those are far within the moraine of the Wisconsin drift. Storm lake, on the other hand, is at the very limit of the same drift-sheet. It would seem to be the remnant of some preglacial valley, part of the drainage system of this country before the Wisconsin ice came on; or it may represent part of the drainage channel that at one time lay along the glacier's front, choked up at length by the extension of the ice below, that is, toward the southeast. The drainage, never very vigorous here, since, as we shall see, most of it went north by way of Brooke's creek, was easily checked and Storm lake with its accompanying swamp was the result. That the stream was thus checked is evident from the circumstance that the lake's outlet when all glacial topographic change had ceased was into the Coon river, an intra-morainic stream, and not by way of the glacier's margin. The ice was possibly not very thick here and the morainic materials are proportionately scant. Nevertheless, Storm lake is a beautiful feature of this prairie landscape. Its bright waters attracted the pioneer; nor are they less charming to the thousands of people who now find happy homes about its curving shores. Its unprotected surface and its shallowness expose the waters of the lake to the full violence of the wind. These are stirred to the very bottom, producing the wildest effects in both waves and color; hence the name.

The Little Sioux valley, the topographic feature of opposite type, is interesting for several reasons. It is a great channel cut through drift, and although recent as the story of Iowa goes, is yet far older than Storm lake or any of the morainic topography of Buena Vista county. When the glacier lay on all the plains to

the east and north, the valley of the Little Sioux, as it appears in Cherokee county today, broad and deep, did its part in carrying away the waters from the glacier's front, the constantly melting margin. Indeed the valley seems to have been more than once nearly choked by deposits of Wisconsin gravel and perhaps in the upper parts of its course with ice. Especially north of Cherokee the banks of the river valley are everywhere marked by gravel terraces far above the flood-plain of the present stream, sometimes as much as a hundred feet above it. Such deposits are not the effect of ordinary erosive process. There is every evidence that the channel of the river had been fully excavated long before these deposits came to place. Sometimes they hang as a simple residue far up on the side of the sloping bluff, as in section one of Cherokee township; again they form great masses and parapets choking up half the valley as in Spring township; sometimes two or three succeeding terraces may be traced, as in section one of Cherokee township. The main part of the city of Cherokee rests upon one of these benches; the Illinois Central railway follows another north of the city. South of Cherokee the deposits are still abundantly traceable but they are as a rule much lower; nevertheless, they affect the configuration of the valley entirely across the county.

The presence of these gravel-trains, for so such deposits are named, affects the topography in yet another way; the gravel has not only in many places filled up and obliterated older erosion features, but it has itself been subject all the while to the processes of erosion. This often brings about a superposition of a newer topography directly against or upon one a great deal older. We encounter evidence of recent change, of newness and youth, where we should naturally expect the reverse. The walls of the river valley to the north everywhere show this. Old tributary streams have been choked across, and new channels later excavated, sometimes, generally indeed, in the direction of the older valley; not always. The banks of Mill creek show all along these same erosion peculiarities; high terraces of gravel cut by recent steep and short erosion channels. The same thing may be observed in the valley of Brooke's creek, especially in Brooke township, Buena Vista county. These gravel banks often give

rise to springs, as in section fifteen in Cherokee township. These are to be explained by the topographic or structural peculiarities just described. Storm waters of the older, generally higher terrace are caught, filtered and allowed to emerge slowly at the last, often far above the level of the present streams. Sometimes the gathering ground is not extensive enough to form a spring of constant flowing stream, and we have simply a hillside seep or bog. Everywhere the gravel along the principal stream has filled the mouths of incoming valleys and then been again cut out, so that the mouth of any tributary valley is apt to be the narrowest part of it.

The effect of this upon the landscape is sometimes very peculiar, often very beautiful. From the hill-top in Morey's field in Spring township of Cherokee county, the view is one of the finest in northwestern Iowa; one of the finest in the whole prairie country. To the north is the far-stretching terrene of O'Brien county; below and close at hand the level meadows of the flood plain of the Sioux, here very wide; east and south great gravel terraces close in the view with sculpture of the most varied, but withal most softened and pleasing contour.

Between the Little Sioux and Mill creek is a wide gravel tongue carved on both sides by recent erosion and presenting everywhere evidence of the newness of its topography. We have already had occasion to mention the topographic differences between Cherokee and Buena Vista counties; but even in Cherokee county the difference in form, in relief, between the steep bowlder-strewn slopes in Cherokee and Cedar townships and the fair and long-sloping, loess-covered hillsides of Rock and Tilden townships is not only patent, but seems sufficiently striking to awaken the intelligent interest of every student, not to say every intelligent farmer.

Everywhere, especially to the northeast, the topography of Cherokee county has been profoundly modified by close association with a topography of an entirely different character as will appear in what is here to follow. The topography indeed seems to be all erosional; but the typical and pure sculpture of the erosion model does not appear north and east of Mill creek valley.

## DRAINAGE.

The drainage of the two counties is correlated, of course, with the topography, affects it or is affected by it. The drainage of Cherokee county belongs to three distinct systems. Buena Vista county has in large part no natural drainage. Its prairies, however, lie on the great divide of Iowa, and the streams that do serve fall now east, now west, and so enter in one direction the tributaries of the Mississippi, in the other those of the Missouri river. In Cherokee county, except a few localities to the north, the drainage is practically perfect; the general slope is to the southwest deepening and widening channels in the same direction. slowly deepening and widening channels in the same direction. Of these the principal is the Little Sioux river which traverses the county almost diagonally from northeast to southwest. Its valley is wide south of Cherokee city; its banks are generally high and in many places covered with native forest. Where the channel is narrower it is so on account of the vast deposits of gravel already described. Nevertheless, even at its entrance into the county where gravel abounds, the flood plain of the river is still wide enough to afford room for fine meadows and far-extending farms sheltered by high, precipitous, bluff-like banks. The waters of the river are unfailing, but the present rate of erosion, though constant, is small. Only in times of freshet does it appear that there is any cutting at all and then chiefly through the shifting of the current from side to side as is customary along all our prairie streams. Even this erosion is more than made good by the deposit of material brought in constantly from the adjoining cultivated fields. But the impressive feature of the entire course of the stream is everywhere the gravel, omnipresent, hanging along the banks. South of the city of Cherokee the accumulations are for the first four miles found almost wholly on the east side of the stream and are piled against the older banks to a height of forty or fifty feet; below Pilot Rock the situation is reversed. Pilot Rock church stands upon a gravel plain a mile or more in width and possibly thirty or forty feet above the present level of the stream, all west of the river. At Quimby, a few miles farther southwest, the river is wholly west of

the gravel plain, and so on; the stream shifting back and forth to the southern boundaries of the county.

Immediately north of Cherokee city the Little Sioux receives one of its principal tributaries, Mill creek. This is a fine perennial stream which enters the county near the middle of its northern boundary and brings with it the drainage of nearly the whole of O'Brien county. Mill creek has also suffered immensely by deposits of gravel. From section 1 in Liberty township south and east the creek has simply made its way through great piles and banks of glacial detritus that become more and more pronounced as we approach the Sioux.

A high table-land of drift, skirted, west of Cherokee, by the Illinois Central railway, separates the entire drainage area of Mill creek from that of the southern slope of the county. Here, that is, west of the Little Sioux, a series of smaller streams, Fiddle creek, West fork, Rock creek and others, flow in long straight valleys almost directly south, affording ample drainage and in ordinary years a constant supply of water. East of the Sioux the Maple river with its tributaries exhibits a typical prairie erosion-drainage-system. The stream channels seem to reach every part of the terrene, dividing and subdividing, in the most natural fashion, nowhere choked by deposits from without, nor bordered anywhere by gravel trains save those which may be accounted for by causes purely local. The flood plain of the Maple is generally a rich black alluvium of indefinite depth, exposed here and there by an erosion that has followed the cultivation of the valley.

The drainage of Buena Vista county, such as there is, is in almost every way wholly different from that just described. The Little Sioux skirts the county along the north and receives as tributary Brooke's creek and one or two minor streams; the Coon river becomes efficient in some of the southeastern townships; but the entire central and eastern portion of Buena Vista county is without any natural drainage at all. Instead, we have here simply wide marshes and low sand-hills as already described. The valley of the Little Sioux is wide and deeply eroded; probably a valley of erosion in large part, although, as stated in our discussion of Clay and O'Brien counties, that part of the valley

before Linn Grove seems of different history and may be in part constructional. The banks of the river in Buena Vista county are generally precipitous, breaking down suddenly from the common level with short, precipitous, narrow, tributary ravines.

The Raccoon river, or North Coon river, as it stands on the local maps, appears as a considerable stream in Providence township. It is for many miles of its tortuous course perennial, fed by seeping springs and long crooked prairie sloughs, now generally either tiled or at least in process of artificial drainage of some sort. The former, southern, outlet of Storm lake is one of the tributaries of the Coon; another branch takes rise about half a mile north of the lake shore but is cut off from the lake by a low plateau of sand and gravel upon which stands the city.

The most interesting stream in Buena Vista county is Brooke's creek. This stream also takes rise in marshy ground about a mile and a half north of the lake and flows almost directly north to the Little Sioux. Flows, did we say? Flows is a term too strong by far. For the greater part of its course Brooke's creek consists simply of a succession of marshes by nature imperfectly

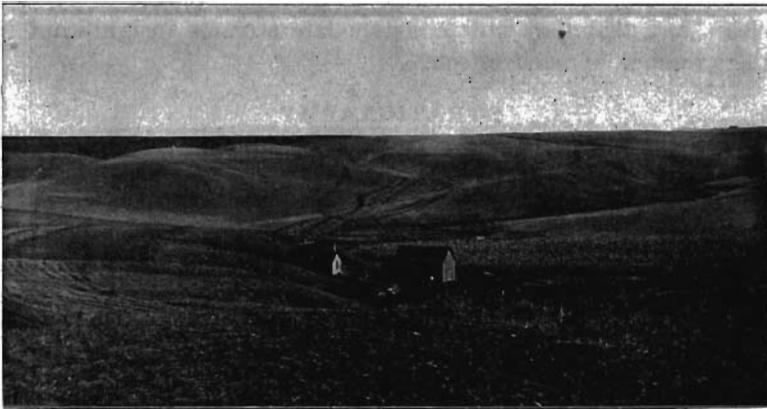


FIG. 56. View at the mouth of Brooke's creek, looking east toward the valley of the Little Sioux river, Buena Vista county, Iowa.

united, and originally hardly to be recognized as a creek at all. Northward we have a more definite stream and channel; until as we approach the Sioux the usual erosion features succeed with

steep, bluffy, banks, gravel beaches and short impassable tributary ravines. (Fig. 56.)

The southwest townships of the county are well drained by the several branches of Maple creek, Maple river in Cherokee county. In all parts of Buena Vista county where natural drainage has been less efficient, artificial channels have been constructed, their course dictated by the art of the civil engineer. Some of these form far-extended systems and drain whole townships at a time.

In general, in comparing the streams of the two counties here discussed it may be said that Mill creek, the Little Sioux, Brooke's creek and the several branches of the Coon river are all that they are largely by virtue of their relation to the Wisconsin drift; all the other drainage channels here mentioned are simple erosion valleys, ramifying into what was once a nearly level plain, the conduits of storm-water and this alone, in all their history. The first named channels are plainly different. Only casual observation suffices to show that they have been at some time flooded to the brim, that they have been again and again choked up with gravel, as often largely eroded and swept clean, and that they now accommodate streams insignificant in the presence of such effects.

#### STRATIGRAPHY.

The geological formations recognizable in Cherokee and Buena Vista counties are wholly of recent age. That is, they have been laid down in times recent and new as things geologic go. They consist in Iowa of sands, gravels, clays, or of a mixture of all three; often mingled together in any given locality, nevertheless not without a certain definite and easily ascertainable order when taken in wider and more comprehensive view.

These superficial strata are called collectively the Cenozoic, and those with which we have here to do are the latest of the Cenozoic. The following table shows the relation of these deposits to each other as these occur in northwestern Iowa.

TABLE OF FORMATIONS IN BUENA VISTA AND CHEROKEE COUNTIES.

GROUP.	SYSTEM.	SERIES.	STAGE.
Cenozoic.	Pleistocene.	Recent.	Alluvial.
		Glacial.	Wisconsin clays.
			Wisconsin gravels.
			Loess.
			Kansan.
		Pre-Kansan.	

**Pleistocene Deposits.**

**THE KANSAN DRIFT.**

The Kansan drift as frequently defined in these reports is everywhere identified by the presence of a horizon of blue clay which appears to underlie all sorts of surface deposits, of whatever age, over almost the state entire. These blue clay deposits, when long exposed to the weather or to oxidation due to proximity to the present surface, become very much changed in appearance. They lose the blue tinge entirely and become brown or yellowish and where free from sand and gravel often show a peculiar jointed structure, as of crystalline origin, often with further decoloration or oxidation marking the seams. In this condition beds of Kansan clay may somewhat resemble loess, but are easily distinguished by lack of homogeneity, by the presence of drift pebbles, bowlders of various shapes and sizes distributed through the clay.

Now in the two counties here studied, as in all northwestern Iowa, there is no doubt of the universal presence of this Kansan till. Whatever the surface formation, whether drift, alluvial deposit, gravel, whatever it may be, the uniform report of those who dig wells, the country over, tells of the blue clay. The depth

at which the stratum occurs varies continually, but it is encountered invariably and everywhere if the drilling proceed to any considerable depth. In many places the depth, if we may trust reports, is not very great. At Storm lake, for instance, the bottom is said to be blue clay. South and west of the lake well reports give twenty to fifty feet as the usual horizon. In Brooke township, Buena Vista county, the brownish beds of joint clay are everywhere exposed by erosion along the short, steep-walled ravines. At Marcus in Cherokee county the blue clay is reported as at the surface, but only four miles north it was not encountered nearer than eighty feet from the black surface soil.

Immediately overlying the blue clay, constituting the commonly exposed drift of all Cherokee county and the western edge of Buena Vista, is a yellow but strongly calcareous till whose age and origin is still a matter of conjecture. The deposit is perhaps Kansan; it is certainly older than the Wisconsin, although at first sight closely resembling in appearance deposits elsewhere so described. It contains many of the elements of the Wisconsin; it is richly calcareous and contains limestone boulders and pebbles in abundance. As ordinarily exposed it shows few signs of age, such as weathering or decomposition. In some localities, however, as along the south bank of the Little Sioux, it seems to be overlain by older material. It contains greenstone pebbles not a few, but carries also abundant fresh-looking granite boulders, of small size as a rule, but of very varied composition. These, of course, are more plentifully displayed along the channels which have been more recently eroded. The whole body of this drift is of somewhat darker color than is the typical Wisconsin, and contains sand-boulders here and there, and occasionally, low down, alternating beds of water-laid sand. South of Peterson the more coherent boulder clay caps a bed of sand forty feet or more in thickness, and it appears elsewhere to overlie considerable beds of sand and silt as far south, at least, as Cherokee.\* In the vicinity of Peterson and particularly northward from that point, up to the time of the drainage of the Wisconsin ice, the surface seems to have undergone only the slightest erosion. We have here a portion of the

\* Iowa Geol. Surv., vol. XI, p 487.

flat prairie watershed left by the older drift. To this the regular processes of drainage which have so beautifully served the country to the south had not yet approached. At least the topography in this neighborhood is of the most recent type. Relying upon indications suggested by the topography chiefly, these deposits were mapped as Wisconsin in the report on Clay and O'Brien counties of two years ago. They may prove to be what has been described as earlier Wisconsin; they may be older. The same difficulty was encountered in Plymouth county, and for a more thorough presentation of the problem the reader is referred to the report on that county.\* The problem will be referred to a little later on in the present report. Not until the whole drift of western Iowa from south to north is consecutively and continuously studied may we hope to see the stratigraphy of this part of Iowa definitely made out and accurately entered upon our maps.

As to pre-Kansan drift, we are also here not without abundant evidence. Reports of wells in various parts of both counties suggest, indicate assuredly, a forest-bed beneath the all-pervading blue clay. Not infrequently the well-digger encounters under the blue clay a "black muck" which gives up water indeed, but "stinking" water, unpotable of man or beast. The surprise of the ordinary land-owner under such circumstances is hardly to be wondered at. In some localities, as for instance southwest of Storm lake, a stratum of such decaying organic stuff several feet in thickness is reported, and the more shallow wells all over this section were rendered useless in this way. Fortunately, in most cases good water is obtainable by going deeper and casing out the waters of the muck horizon.

In no case is a solid or rocky horizon reported. However shallow or deep the well, the report of those who dig or bore is always the same; clay, gravel, sand, clay, "nigger-heads." All the drift below the muck beds, all below the blue clay must be reckoned pre-Kansan. How many successive drift formations this term pre-Kansan may include who may now declare? From the nature of the case less is known of their character and extent, although they have been reported from different places in western

\* Iowa Geol. Surv., vol. VIII, pp. 335-351.

Iowa and in some places at least are easily accessible for investigation.

All that we know of the pre-Kansan in northwestern Iowa indicates its surprising depth. In the report made last year concerning O'Brien county reference was made to two very deep wells, wholly in the drift, one in Omega and one in Caledonia township. The latter is reported as more than one thousand feet deep. We have now confirmation for the depth at the latter point. At Marcus, immediately to the south of the Caledonia well and at no great distance, seven or eight miles, the Illinois Central railway undertook recently the drilling of a well. By the courtesy of Mr. W. J. Harnahan we have the record of the boring made:

"From the surface to thirty feet in depth, blue clay.

From thirty to 560 feet, yellow clay mixed with bowlders.

From 560 to 680 feet in depth, red clay containing numerous bowlders.

At the latter depth the well was abandoned. No solid rock was encountered, but the numerous lot of large bowlders and "nigger-heads" made it almost impossible to get the hole down."

Here we have the pre-Kansan for 530 feet and below that easily identifiable, by color at least, another stratum 120 feet in thickness and still no rock in place! The thinness of the Kansan is surprising. It would seem as if all the oxidized upper portions of that old formation had been in this locality swept away, perhaps by the erosion of the Wisconsin times. A little farther to the north, however, the blue clay is covered by the usual deposits of loess, yellow drift, gravel and sand very much as in the southern parts of Cherokee county. Evidently any coal that may exist beneath Marcus is pretty deep down.

There seems to be plainly enough a vast body of ancient drift extending from northwest to southeast across several counties here. This drift formed a watershed in Kansan times, forms a watershed still, despite all the erosion that has succeeded its deposit, despite the fact that since its deposit another glacial epoch has come and gone.

#### THE LOESS.

The peculiar fine yellow clay known as loess is a characteristic surface deposit over the larger part of Cherokee county and over

most of the western townships of Buena Vista county. In Cherokee county all the country south and west of Mill creek is loess-covered. North and east of this stream, loess is doubtless to be found, but everything is obscured by the more or less abundant and extensive deposits of overwash Wisconsin gravel. The transition from one surface to the other is often abrupt. Thus if the traveler going south crosses the bridge near schoolhouse No. 5, Cherokee township, there is no loess north of the bridge, but on the south side of the creek the loess appears abundantly along the highway and so on west from the schoolhouse named to Cleghorn. West from Cleghorn there is no trace of the later drift. Marcus is in sight on the high table-land or divide already mentioned, but the drainage is everywhere good; there are no swamps and bowlders. Immediately south of schoolhouse No. 1 in Anthony township, and one mile south of the Cleghorn road, there may be seen a fine exposure of typical loess, six or eight feet in thickness. It appears to rest immediately upon a bed of gravel. Over all this part of the country there is scarce a bowlder to be found; not one in sight as the traveler passes along the highway. A few small granite blocks are said to occur, but none attract attention on hill or in valley. Those used by the farmers for foundation stones are hauled from the valley of Mill creek. We are beyond all trace of the influence of the Wisconsin drift in this direction. At and around Marcus the subsoil is everywhere loess, though often rather thin, but thickening to the north. Wells often do not reach the blue clay but show abundant water at from ten to thirty feet. North of Marcus a cistern in process of excavation showed loess six feet, sand, five; no gravel. The excavator and the owner agreed that twenty feet of sand often lay above the blue clay. This will account for the success of the shallow wells above referred to. There are evidences of loess in O'Brien county as far north as Paulina, but in O'Brien county the formation occurs in patches; it nowhere forms a mantle covering the whole country as in southern and western Cherokee county.

## THE WISCONSIN GRAVELS.

These deposits as usual occupy the valleys, especially the valleys of all streams leading away from the margin of the Wisconsin drift. They are not conspicuous in Buena Vista county, but in Cherokee county, along the Little Sioux and in the valley of Mill creek they are everywhere in evidence. Indeed, nearly all the northeastern part of Cherokee county is heavily charged with gravel deposits. Mill creek, from a point nearly north of Meriden to its union with the Little Sioux, presents the appearance of having been at one time nearly if not altogether choked with gravel. This stream in this respect is in singular contrast with the streams on the western side of Cherokee county. All the tributaries of Mill creek, and these are generally from the north, appear like Alpine channels; they are literally paved with bowlders. In section 4 of Cherokee township on the level of the floodplain of the creek there is a curious gravel mound, probably a residuum of post-glacial erosion. Brooke's creek shows some evidence of this same overwash gravel but nothing like as much as might have been expected. There seems never to have been very much current northward in that part of the stream now named Brooke's creek. At the same time, the channels leading into Brooke's creek and Fox creek are paved with bowlders much as in the vicinity of Mill creek. Most of these, however, seem to have come from the eroded drift of the locality.

There is a very heavy deposit of drift at Sioux Rapids, high above the course of the present stream; but more remarkable still, there is a moderately large, well defined gravel mound, not stratified, so far as could be ascertained, just north of Larrabee, its materials used now constantly for the improvement of the streets of that village. The Sioux Rapids gravel may be esteemed part of the overwash of the great Wisconsin ice margin which lay in the upper part of the town; but the Larrabee mound may mean something more. It is not isolated, but forms part of a continuous series of such deposits extending from Sibley south and east, including the gravel pit at Sheldon and similar deposits about Calumet. All these taken together and studied in connection with the peculiar topography of eastern O'Brien county may indicate that the Wisconsin ice did after all, transiently at least,

go over the great divide in this particular region. However, these gravel deposits form only one of the many indications that all this part of the country has been profoundly modified by the Wisconsin drift sheet, even if it be finally concluded that the ice itself never passed over it. This phase of the subject will be considered later on. It remains only here to say that these extralimital gravels, if so they may now be termed, possess some peculiarities not commonly noted in connection with mounds that are plainly intra-morainic. The Sheldon gravel, for instance, is plainly covered by a deposit that may be fairly denominated loess, whatever its source. The gravel contains a goodly number of rotten boulders and, as heretofore described, the lower layers have become silicified, or rather solidified, by percolations from above. Similar peculiarities are noticeable in all the localities specified. Even south of Larrabee, in section 1 of Cherokee township, identically the same solidified layer may be found near the bottom of a deposit of gravel, showing identity of composition and history. It is possible, as above suggested, that all this is but an overwash dating from the ultimate retirement of the Wisconsin ice, but the situation suggests the need of more exhaustive inquiry.

However all this may be, there are to be found, stretching entirely across Buena Vista county from north to south, and almost across it from east to west, mounds of gravel of no uncertain meaning. These mark well for us the westward limits of the latest drift. They are morainic; they form here the Altamont or marginal deposit of the Wisconsin ice. Many of these mounds or hillocks are merely capped with gravel, some show at the surface little or none; most are gravel and sand throughout. In this county they are generally low, often hardly noticeable to the untrained eye and are in general, save for their geologic interest, wholly insignificant.

#### THE WISCONSIN CLAYS.

Typical Wisconsin drift is exposed only here and there in central and eastern Buena Vista county. For the most part the surface is so very level that erosional or other cuttings are few. Along the banks of the Little Sioux river, as near Sioux Rapids,

are beautiful drift exposures afforded by railway cuts and recent erosion; but as has been already indicated this body of drift is certainly older than the ordinary Wisconsin till, older than the drift contained within the Altamont moraine. Nevertheless, there is no doubt but that a thin sheet of typical Wisconsin clay-drift underlies as subsoil nearly all of the eastern half of Buena Vista county. Opportunities for observation are not many, owing to the level topography, wells being almost the only recourse. Cuts made in draining or shaping the highways often show nothing but a deep black soil, or, where a mound or morainic ridge must needs be cleft, the exposure shows little but gravel. Contact between the older and later drift, except where the latter was represented by sand or gravel, was nowhere observed.

#### ALLUVIAL DEPOSITS.

Alluvial deposits in Buena Vista county are limited almost entirely to the immediate borders of the Little Sioux. At Sioux Rapids and thence west to and including the mouth of Brooke's creek, there are found splendid alluvial bottom lands with deep warm soil, the most fertile in the county. The valleys of the several divisions of Maple river show similar beautiful alluvial meadows, sometimes a mile and more in width. Similar soils, though nothing like so deep, cover more or less completely the widespread gravel trains that stretch southward and westward from Cherokee, along the banks of the Little Sioux. Such soil conditions are to be especially noted in the vicinity of Quinby. The Little Sioux alluvium is, however, a very different thing from that of the Maple system of streams. The latter is the result of slow erosion with gradual accumulation from the rich surface of the surrounding slopes. In consequence the erosion of the present stream exposes a black soil, many feet in thickness, with only here and there a trace of sand and gravel. Along the Sioux on the contrary, on account of the entirely different history already sketched, the present erosion makes havoc of the comparatively thin veneer of rich soil and exposes the subsoil of the gravel train or sweeps it down to hamper the meadows and lower-lying fields.

## THE MARGIN OF THE WISCONSIN DRIFT.

In all the study of these northwestern counties of Iowa one object of the Survey, kept continually in mind, has been the determination in this direction of the western limits of what has all along been designated as the Wisconsin drift. The fact of the identity of this deposit within its own limits, is almost everywhere easily discoverable; but when we come to define the deposit at its margin and in respect to other and older formations, not as it might appear in some clean vertical section, but as it comes to view spread out upon the surface of the ground, we are confronted by difficulties not a few.

In the first place, the drift itself near its margin is not always typical in constitution or character. The till which it overlies may perchance contain many of the same elements, derived by an earlier ice-flood from identical sources, and so, except as modified by time, present much the same appearance. Now the time modifications, weathering, oxidation, etc., are always in the older drift shown at their best, of course, nearest to the surface. But by the very conditions of the problem the surface is just that part of the older drift most likely to be altered or even entirely removed, especially at a glacial margin at the time of recession, when everything is more or less completely swept by marginal drainage floods. A clean section of undisturbed, indisputable superposition is at the very margin of an overlying sheet scarcely to be expected. We should the rather be prepared, as far as the constitution of exposed material is concerned, to find a commingling of elements old and new, or the deposit of the latter drift upon beds also fresh in appearance, because in large measure deprived, by the very on-coming of the later drift, of those superficial characteristics, time-developed and distinctive. Of course, in numberless instances the old surface is yet perfectly identifiable, but such instances are to be looked for well within the margin of the later sheet.

Furthermore, the marginal material, well washed by the waters of the melting ice, is apt to consist largely of sand and gravel, spread sometimes far beyond the limit of actual ice action and as such often hardly distinguishable from other gravel deposits having a different origin and a different history.

As far as composition is concerned, we are required in the present problem to distinguish between the Wisconsin and an older body of drift or till. The Wisconsin and Kansan have already been contrasted in an earlier volume of the present series.\* At the drift margin, as suggested, all these distinctions are apt to be very much obscured.

In the second place in our effort to delimit a glacial sheet such as the Wisconsin we must always be guided to a very considerable extent by purely surface indications, by the character of the surface soil, the presence or absence of surface boulders, and above all by the configuration of the surface as expressed in general topography. In Iowa, almost without exception, the older drift sheets are covered by a mantle of well defined loess; the Wisconsin is so far supposed to be without loess.\* It is generally conceded that where other indications are lacking the presence of a deposit of loess may be taken as a mark of the older drift. Unfortunately the test is not infallible. Near the borders of the Wisconsin the loess seems to have been sometimes entirely swept away or at least so confused with outward material as to render its identification less positive. Thus the loess is plainly in evidence in Buena Vista county, close up to the borders of the later drift, but in the ultra-morainic portions of Clay and O'Brien counties, far out from the definitely marked drift margin, no loess was discovered.

Again the surface of the older drift is practically destitute of boulders; not that there are not plenty of Kansan boulders, but that these are not commonly found at or on the surface. In boring wells they are encountered all too often, and are brought to light everywhere along the water courses by the ordinary processes of present erosion. The famous Pilot Rock in Cherokee county is a magnificent Sioux quartzite boulder, (Fig. 57.) exposed by the erosion that has gone on before it and around it especially since the days of the Wisconsin drift and probably long before. All the valleys leading into the Little Sioux near its exit from Buena Vista county are crowded with boulders, probably most of them released by recent rapid erosion, although

\* Iowa Geol. Surv., vol. VI, p. 439.

† Iowa Geol. Surv., vol. VI, pp. 347, 439; vol. VIII, p. 444.

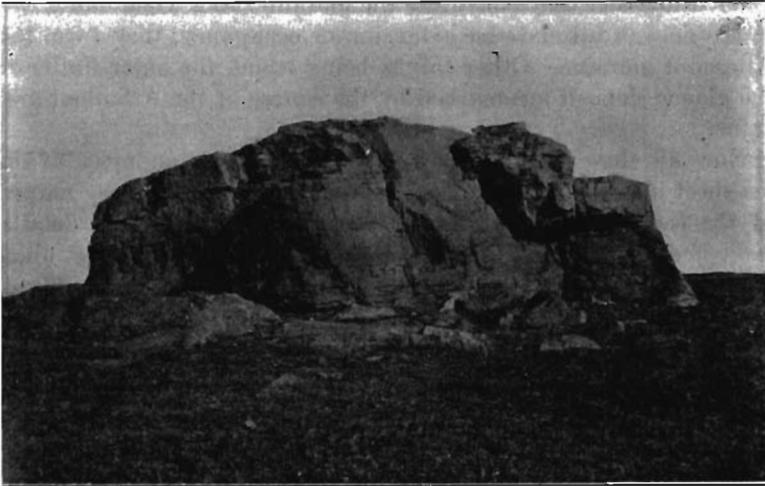


FIG. 57. Pilot rock, a Sloux quartzite boulder, four miles south of Cherokee, Iowa.

some of them may be of Wisconsin origin and owe their present position to blocks of drifting Wisconsin ice.

But the most patent distinction between earlier and later glacial deposits is found in the topography of the deposits themselves. This has often been pointed out and is referred to here only because necessary to the elucidation of some peculiar features in the present problem. For instance, in attempting to delimit anywhere the Wisconsin lobe by the topography we may generally consider that we have passed the border when we leave evidence of recent erosion and come out upon that which is plainly ancient and exhibits the results of long subjection to the ordinary destructive influences of the weather. Imperfect drainage and erosion resulting in short deep ravines indicate, in so far, newness and generally in northwestern Iowa are marks of the Wisconsin drift.

Again the cessation of the ice advance in the path of any glacier is marked by the deposition which always takes place in the most definite and characteristic, though often irregular fashion. Piles of sand and gravel occur as mounds and hillocks, anywhere and everywhere. These as we know are called morainic hills;

taken altogether they constitute the moraine, and, when laid down in the field of ultimate ice-extension or occupancy, they form the Altamont moraine. Other things being equal, the outer limits of the glacial deposit are marked by the course of the Altamont moraine.

Now all these characteristics by which the boundaries of an ice sheet may usually be discerned are subject in the very nature of the case to modifications affecting every one of the details indicated. Some of these possibilities have been touched upon already in the pages immediately preceding. For instance, in the matter of surface deposits; if the landscape reached by the invading ice, should, notwithstanding age, have remained after all flat or poorly drained, it may be covered on the glacial retreat by all sorts of new material in the form of overwash, or it may remain level and be cut in every direction by new drainage channels and so simulate in all respects a typical youthful topography.

Again the effect of the presence of the glacier on streams and valleys accurrent is most pronounced. The tendency may be easily imagined; all streams and valleys accurrent will be more or less completely dammed up, their channels partly filled or converted into marshes, lakes and swamps: so that such a valley ceases entirely to form part of the drainage system of the country, or even cuts a new channel parallel to the glacier's front, and finally persists as a new stream, losing for the student almost all diagnostic value, though demanding explanation.

On abcurrent channels the effect is of course quite the reverse. Such conduits will be called upon suddenly to carry far more than the usual quota of waters. They will become widely and deeply eroded; new channels, even here also, may be cut through where there were none before and all old drift material and alluvium be re-sorted and mingled with the new: as the current slackens in volume and speed the wide new-washed channel may be in part filled up, only again to suffer erosion with the subsequent action of the persistent stream whether large or small, and, as before, all the most vivid peculiarities of recent erosion may be found associated with drift far older than the topography would at first imply.

All these conditions are abundantly illustrated by the concrete example before us. We may see them all as we attempt to trace the Altamont moraine from the point where it emerges from the northern townships of Carroll county.\* The accompanying map shows an irregular border trending north and west to the northern line of the state.

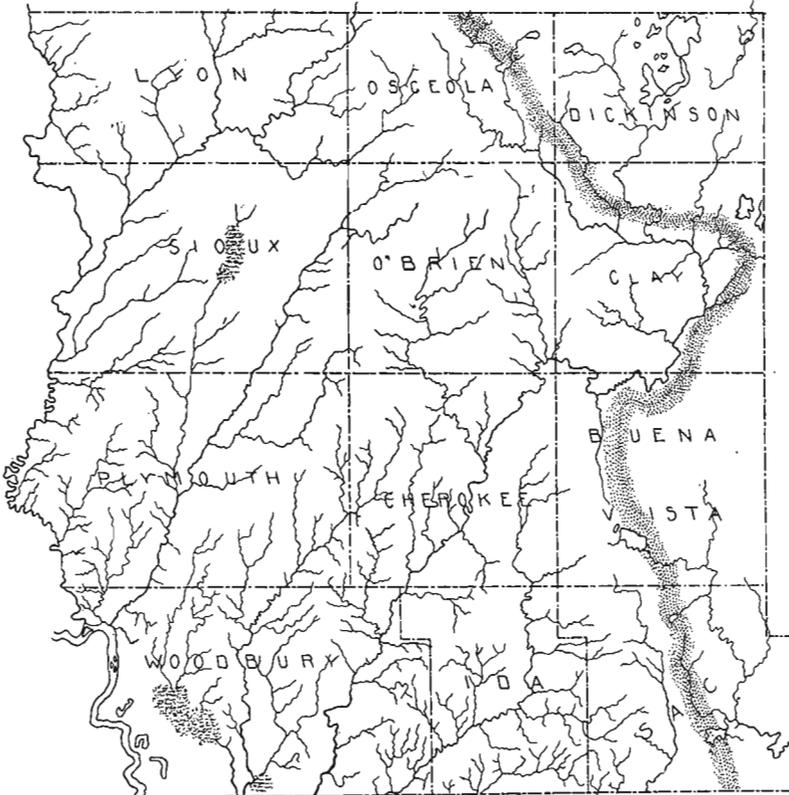


FIG. 58. Map showing approximately the location of the Wisconsin Altamont moraine in Northwestern Iowa, in the light of present knowledge.

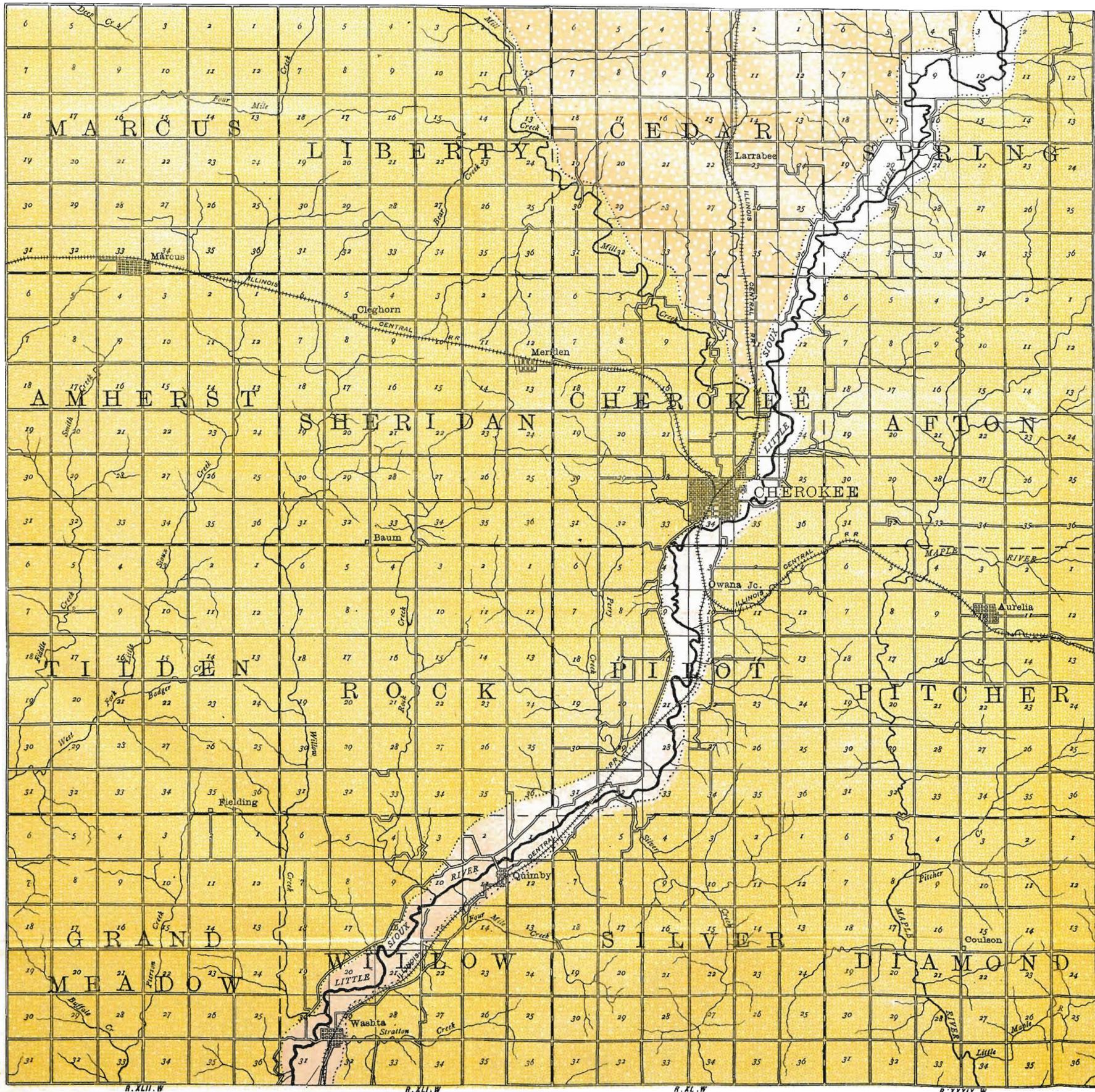
—By T. H. Macbride.

The array of hillocks thus indicated is often very much broken, sometimes fails for a few miles altogether, but may generally be kept in easy vision all the way by the student who attempts to follow along the highways the course of the moraine.

\* Iowa Geol. Surv., vol. IX., pp. 57-60.  
22 G Rep

It has not been found practicable to show on the map the width of the conformation since the range of mounds and kames in this region is nowhere simple; rather is the Altamont here bound back to very numerous secondary or recessional moraines marking various and repeated oscillations incident upon the close of the period. However the moraine is sometimes very narrow indeed, not more than a mile or two in width; then again it may effect more or less completely a township, a county, or more. The map then indicates the outer or distal limits only; for further details the reader is referred to the particular maps of the several counties forming part in the general problem.

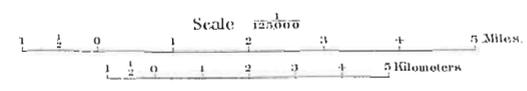
Leaving Carroll county at a point nearly south of Carnarvon, the Altamont may be traced through Carnarvon to Lake View. Wall lake lies in the very margin of the morainic wall, but terminates southwesterly in wide deposits of gravel, which have to a large extent filled up an ancient river channel, apparently a part of that which is now the Boyer, probably the principal stream of an ancient Boyer system. The entire upper portion of this stream with all its eastern tributaries was obliterated by the Wisconsin ice. During the life of the glacial sheet a new Boyer was formed, namely, the present stream, above the point near where the Northwestern railway crosses the river west of the town of Wall Lake. It will be noticed that the present river here debouches into the old valley. The present river was in large part, at least, the marginal drainage channel, while that part of the original Boyer channel which lies between the present Wall lake and the point of debouchment specified was practically abandoned, if not wholly so. With the approach of the ice from the north the old river seems to have continued for some time efficient; its old channel in the abandoned portion being filled with gravel as of a gradually failing stream, like the Platte, for instance; but at the final retreat no permanent stream remained, however small, to open up a new channel and so occupy in this particular place the old river bed. Wall lake lay as a pool in the part nearest the moraine, just in the moraine, in fact, prevented by the accumulated gravel, and by nothing more substantial, from contributing even so much as its overflow to the current of the Boyer river; while Indian creek and Coon river,



IOWA GEOLOGICAL SURVEY

MAP OF THE  
SUPERFICIAL DEPOSITS  
OF  
**CHEROKEE**  
COUNTY,  
IOWA.

BY  
T.H. MACBRIDE  
1902.



- LEGEND  
GEOLOGICAL FORMATIONS
- ALLUVIAL DEPOSITS
  - WISCONSIN OVERWASH GRAVEL ETC
  - LOESS OVERLYING OLDER DRIFT (MANSAN)

just inside the same moraine, effected the drainage as well as might be of that particular region which had in pre-Wisconsin times been the gathering ground of probably the main stream of what is called the Boyer. These last named streams still continue in their own crooked ways, while the divide that separates Wall lake and its marshes from the present valley of the Boyer cannot be more than a dozen feet, possibly not half so much; it is not perceptible to one passing over the ground.

From Wall lake the Altamont bends northwest and crosses the township line road at a point about six miles north of the village of Wall Lake; it then continues almost due north at a distance of from one-half a mile to one mile west of the township line road just mentioned, quite or almost to the southern limits of Delaware township. Here the border bends west to include Round lake, thence almost due north to the village of Northam on the line of the Chicago, Milwaukee and Saint Paul railway which here follows for some distance the outer margin of the moraine. Northam is in a notch in the moraine. From Northam the hills trend north and then west. The ice sheet appears to have obliterated entirely on the east the drainage channel of which Storm lake and its accompanying marsh appear to be a residual part. Indeed it is not impossible that Storm lake and its accompanying marshes may even form part of the same old-time drainage system as that represented by Wall lake farther south. At any rate Storm lake and its northwestward extension, though offering typical Wisconsin topography, probably occupy a pre-Wisconsin valley and lie outside the Altamont moraine. The ice margin would appear to have reached the lake on the east and northeast but not on the west. Here is, however, a problem for closer investigation than was possible in the present course of the survey. Some local student will find this a fruitful field for further inquiry.

North of Storm lake the moraine trends northwest by west. It is encountered by anyone who drives northward along the highway passing through the center of Washington township. It is first met at the corner of sections 21 and 27. Thence the moraine follows the general course of Brooke's creek. For a couple of miles the newer drift here also acted as a dam and we have a series

of marshes extending half way to Alta. These marshes continue for several miles through Washington township and for some distance in Elk, indicating the stoppage of the original drainage here. They are all now tributary to Brooke's creek, though still much in need of assistance in the way of tiling and ditching. From Elk township north Brooke's creek is well defined, seems to have formed for a short distance, and comparatively short time, the drainage channel for the margin of the ice; and the limits of the moraine, here trending north and south, are determined by Brooke's valley, though less perfectly indicated by the hills themselves everywhere much affected by erosion. Indeed the morainic hills of the northern part of Buena Vista county extend in low billowy ranges in the general direction of east and west, and the Altamont moraine often fades out into a mere deposit of sand or gravel modifying the surface soil. This is plainly the case immediately south of Linn Grove. The moraine is within a few rods of the village but so spread out as to be hardly discernable, and yet identifiable in the topography and by the constitution of the surface soil.

From Linn Grove east the moraine follows the general course of the Little Sioux. The ice probably reached the present course of the stream in many localities but the evidence of this approach has been largely swept away by erosion; thus Soldier creek, at one time in its turn part of the marginal drainage system, has greatly affected the original form of the country along the south bank of the river. Nevertheless, all the way from Linn Grove to Sioux Rapids there are curious indications of the obliteration of an older topography. Thus in the southeast quarter of section 10 in Barnes township, within half a mile of the river, we have a marsh that can be explained on no other hypothesis. At the point where the Minneapolis railway is crossed by a high bridge, northeast quarter of section 14, there is evidence of the filling up of an earlier drainage channel, not very large, it is true, but patent. In many localities the drainage of the surface is yet *away from the river*, in fact in the original direction as will be explained later.

At Sioux Rapids the morainic deposits occupy the upper portion of the city. Here is to be referred the deposits and gravel

at the schoolhouse and at the city water tower, but not those before mentioned as overwash, and now used by the city as a gravel pit. From Sioux Rapids the margin of the morainic deposits may be traced eastward toward Marathon and again north at a little distance generally from the river but once more forming its southern bank through the northern half of Herdland township in Clay county, and especially at and about Gillett's Grove. From this point the moraine bends off to the northeast again, toward the center of Logan township, thence northward, a little east of the center of the township, then north again and finally west and northwest through the town of Dickens, thence almost west to a point north of Everly. From this point the border follows almost exactly the course of the Ocheyedan river, emerging from Osceola county and leaving Iowa at a point just east of the station Biglow in Minnesota. The details for Dickinson and Osceola counties have been already somewhat discussed in these reports\* and may be more accurately presented in a special map hereafter.

The Little Sioux river, with the Ocheyedan as its western tributary, will thus appear to have been determined in its course from the state line almost to Peterson by the margin of the Wisconsin ice. Indeed, there is no doubt that the stream between the limits named acted as drainage channel probably for a long time, as long as the ice lay in the vicinity. A glance at the map is all that is needed to show to any observer that in some way the course of the drainage in this part of Iowa has been strangely changed. The high plateau followed by the Chicago, Rock Island and Pacific railway from Webb to Sibley, seems to have been without doubt a pre-Wisconsin divide, the very crown of the ancient drift and yet undrained, or at least but little eroded by the drainage channels which led off east and west, perhaps chiefly east. It may be, for instance, that the Little Ocheyedan represents in part at least one of these older streams, but the remarkable out-thrust of a lobe of ice westward nearly across Buena Vista county changed the whole face of the country. A study of the topography of O'Brien county led the present writer to believe that the larger part of that county had been covered by the Wisconsin ice, though irregularly and by a sheet that left

\* Iowa Geol. Surv., vol. X, pp. 189-239.

deposits of very moderate thickness and was soon withdrawn.\*

We are now in position to sketch the history of present topography of all the northwest portion of our state. The invasion of the Wisconsin ice was from the north with a distinct trend toward the southeast. This was probably occasioned by the existing configuration of the country. There existed a well-perfected drainage system tributary to the Mississippi river, probably by way of the Des Moines valley much as now. As the ice reached our northern frontier north of the counties we have been studying, it at first made use of the existing stream channels, both west and east. The outwash from the glacier's front went over the Rock river system of streams. This is abundantly evidenced by the omnipresent deposits of Wisconsin gravels all the way down the Rock river and even yet discoverable far above the level of the present flood plain, as in the vicinity of Rock Valley in Sioux county. The streams on the east side of the divide were obliterated as the ice progressed and the entire drainage thrown more and more westward against the divide as against a wall. This resulted in the present Ocheyedan river with its high erosion wall on the western or southwestern bank and the deposits of gravel at high levels and far out of the course of present floods as at Allendorf, for instance. The upper course of the Little Sioux seems to have been used for a while but eventually cut off below or southwardly by some westward thrust of the ice across its course. When the ice front rested but little north of Spencer, or possibly at Spencer, the Ocheyedan still conveyed away its waters, passing the present site of the town of Dickens and so on eastward probably to what was then the Des Moines. From a point about half-way between Dickens and Ruthven the ice began to move directly south and then a few miles to the west, throwing the river by a sharp flexure first to the west and then south. This movement cut the river off entirely from its old eastern conjunction with the Des Moines and shunted it southward, perhaps into a channel at that time continuous with what we now recognize as the Boyer, from the town of Wall Lake south; so that the Ocheyedan for a while actually drained into the Missouri instead of the Mississippi and by the way of the

\* Compare vol. XI, p. 486. The entire report on O'Brien county was left uncertain and tentative for lack of information as to what lay south. See vol. XI, p. 482.

Boyer. As we shall see, it never got into the Mississippi again. At this time the river occupied as part of its channel in Clay county the great valley in Logan township of Clay county now called Elk valley and occupied by the insignificant Elk creek. Later by a westward thrust of the ice this channel was also cut off, the glacier approaching Gillets Grove. The damming of the water by this move seems to have thrown the river over a portion of the divide hitherto untouched, namely that part immediately south of Dickens, so that the river here assumed its present channel. From Gillets Grove the drainage seems to have still passed for some time on south, past Webb and Marathon, until at length the ice moved west once more, this time to Brooke's creek, obliterating its own drainage channel southward and sending the waters of the river over the divide by way of Sioux Rapids and Linn Grove into what was probably already Brooke's creek, pouring into the Waterman just beyond Peterson and so occupying the channel of that stream south through Cherokee county.

Such a history as this accounts for a great many of the peculiar features of the region described; perhaps for nearly or quite all of them. It will be noted that the ice in accomplishing this singular deflection of the river, now called the Little Sioux, but which is really more exactly as we see the Ochevedan, occupied continually strategic points. It does not always by its moraine touch the channel of the present stream, but meets it only at those points essential to throw it in the direction it has finally assumed. Thus the moraine reaches the river at Ochevedan, at Spencer, at Gillets Grove, and again from Sioux Rapids to Linn Grove, and so accomplishes the whole movement. If it be objected that the terrene about Marathon and east of the river generally is lower than the table-land about Peterson, we have only to reflect that the change in the course of the river was not effected by the terrene but by the ice-front itself, and that the channel was cut to its present depth, or deeper, while the ice was still the dominant factor in the topography. The lowlands about Webb and south and the present course of the intra-morainic Coon river indicate the probable course of the drainage before the westward out-push, and are low for that very reason. Under some such hypothesis as that herein set forth we may reasonably

explain the peculiar topographic and other surface features of western Clay and southern O'Brien counties. In the successive damming up of the river, first in the vicinity of Ruthven, and then further south at Gillet's Grove and at Sioux Rapids, there must have been overflow in every direction. This may perhaps account for the gravel deposits along the course of Mill creek, especially near its mouth, for the deposits of sand and gravel in out of the way places, as at Sibley, Sheldon and in the region about Larrabee and north. We have also in our present hypothesis at least a partial clearing up of some of the peculiar drainage features that have been a mystery as we have heretofore attempted to account for the present topography of O'Brien and Clay counties. We may reflect that the erosion operations that had been begun toward the east were by the advent and residence of the Wisconsin ice all for a long time almost entirely suspended; in some cases, at least, never resumed; hence the marshes and lakes or undrained flats such as have characterized southern Osceola county and northern O'Brien. Southwestern Clay county shows something of the same topography.

In view of our present light we may now also better understand the wonderful erosion features of Waterman creek already discussed in the report of O'Brien county. Attention is there called to the remarkable newness of the erosion processes especially as noted in Grant and Waterman townships. It was also suggested that the Little Sioux is a tributary of Waterman creek rather than the reverse. This idea is strongly confirmed. Until the Wisconsin ice pushed across Buena Vista county, Waterman creek was a simple prairie stream, not unlike the upper part of the Floyd, though probably not quite so deeply eroded, flowing southward in the present channel—all uneroded, of course,—of the Sioux river south through Cherokee. Presently, however, Brooke's creek, from the neighborhood of Linn Grove on, began to play the part of drainage outlet for a melting glacier. How rapidly the little creek and the channel of the lower part of the Waterman now became eroded, we may easily imagine. A great ditch was cut in the soft old drift from the present mouth of Brooke's creek to the bluffs of the Missouri, and the upper part

of the Waterman was left to cut back its channel by the use of storm water probably at first by a succession of falls, certainly by an erosion of most precipitous character. The erosion of Waterman creek is accordingly the most recent in the whole country; in fact, it is even now in progress. It has no great gravel trains for the reason that it never drained the ice, at least, not to any considerable extent; its walls are falling in with each recurring spring, almost with every heavy rain, and it is gradually cutting back into the general terrene, much as a ditch sometimes cuts back in a prairie field when the sod is broken.

The remains of once used river channels are not the least interesting and instructive features of the landscape, confirmatory in the highest degree of our present argument. The abandoned channel of the Boyer at Wall Lake has been already mentioned. There are other bits of this old channel, all unfilled, still further north, in Jackson, Delaware and Eden townships of Sac county, and to some extent in Providence township of Buena Vista county. Then we have the great pit in Logan township of Clay county, referred to in an earlier report as a valley of construction; possibly so in part but more likely as we now see a fragment of an old-time river channel. It is probable that other curious misplaced valleys in other northwestern counties adjacent to the border of the drift may have had a similar history, but time has not allowed more exact investigation.

For the industrious Buena Vista county farmer who may perchance read these lines in his quiet home, it will seem a thing hard to believe much less to realize, that in times, even as history reads, not so long gone by, all the landscape about Peterson and Linn Grove and their hills was girt by a wall of ice, to the north, to the east, to the south, a wall probably scores of feet in height, gray and somber, from whose crumbling foot and base streamed persistent fountains flooding the whole country with their turbid waters and even choking up the affluent streams with unheard of loads of sand and gravel. And yet such seems to be the undoubted history of all this prairie region. On no other theory divivable so far, may its peculiarities be understood, much less explained. Of course, such a theory asks credence on other grounds than the mere fact that it fits the situation. Evidence

of changing alternations of climate, moving up and down the meridians of the continent, is abundant. But the facts corroborative of the so-called glacial theory are easily accessible to any who choose to enter farther upon the subject and need therefore not further occupy us here.

#### ECONOMIC PRODUCTS.

The natural resources of the limited district herein described are quickly listed. There is no coal, no limestone, no sandstone, no first-class brick clay, at least none at present in use. What is known of the geology of the state, taken in connection with what has been ascertained elsewhere relative to the occurrence of oil or natural gas, does not lend encouragement to the view sometimes expressed that these substances naturally belong as part of the original wealth of northwest Iowa. Coal occurs a little farther south and east, but it is not likely that the coal-bearing rocks of Webster county extend under the drift so far west as our present region. Cretaceous coal might be thought a possibility since the sandstones of that system crop out in the county west along the Sioux river. But even if such Cretaceous coal were possible the depth of the overlying drift in all places so far explored, would seem to make the mineral almost, if not quite, inaccessible. All evidence at hand at present would indicate that there are no indurated rocks anywhere in the counties now considered within less than several hundred feet of the surface.

#### Soils.

The soils of northwest Iowa are its wealth, a richness immediately accessible and if properly used, unlimited in future productiveness. Oft recurring glaciers have prepared and pulverized this garden; nature through centuries has covered it with rank vegetation for the enrichment of its humus; all atmospheric agencies have done well their work until now, as far as regards natural fertility, there are nowhere better soils. Nevertheless, these soils are not all just alike. In Buena Vista and Cherokee counties there are at least three distinct types: soil with Wisconsin subsoil; soil with loess subsoil; and soil that is the imme-

diate result of water transportation, the alluvium. From what has been said the limits of the several types are already patent. The first affects nearly the whole of Buena Vista county; the second occupies all the prairies of Cherokee county; the third, the lowlands of the wider river valleys, as of the Maple and the Little Sioux. True alluvial soil is much the same everywhere. It generally rests upon a sub-stratum of sand and gravel and is of easy tillage and excellent crop-producing quality. The loess soils have been often described in other volumes of these reports. They make up the productive fields of probably by far the greater part of Iowa; certainly of nearly all the river eastern counties. Long ago McGee, the first thorough student of the soils of Iowa, described the loess of the northeastern part of the state and dwelt with admiration upon the agricultural possibilities of all those counties especially affected by the loess.\* Mr. McGee in the same work presents certain views in regard to the correlation between the distribution of the loess and the distribution of the forests of the portion of Iowa he has studied. To these views also we may refer later on, but the forms of Cherokee county bear abundant evidence to the accuracy of Mr. McGee's judgment when he associated the loess-covered country with all forms of agricultural wealth. The Wisconsin soils are of entirely different character but apparently of equal excellence. No farms withstood better the unparalleled drought and heat of the summer of 1901 than did those of Buena Vista county, and other counties within the Wisconsin moraine. The surface soil is here very fine, very black and very rich; the subsoil either a fine calcareous clay, overlying gravel, or a more porous mixture of lime gravel and sand. At any rate, the subsoils of Buena Vista county seemed to yield up to the growing crops in unusual measure the moisture needed at a time when other subsoils seemed to fail entirely. It is a problem what effect the wholesale tile-draining of northwest Iowa is likely to have upon the region and upon the state at large in the matter of local precipitation. In the days when vast areas were yet undrained but lay as pool and marsh and lake over hundreds of square miles, northwestern Iowa acted as a water storage reservoir for the remainder of the state. All summer long the waters sucked up, day by day, by the summer sun were passed on in

\* Eleventh Ann. Rep. U. S. Geol. Surv., pt. I, p. 189.

clouds to descend as showers all up and down the eastern counties. But with the progress of our agriculture these surface waters have almost entirely disappeared, hurried away by our finer systems of drainage to the rivers and to the sea, and the immediate source of local showers for Iowa has disappeared as well. We are probably too near this situation yet, rightly to understand it or to reckon accurately the change we have effected; but the case will certainly bear investigation and all the most exact observation of those in position to observe will be needed to enable us wisely to use the resources of this great state and to prevent our civilization from self-injury, if not self destruction.

The Wisconsin lands are in some places not a little incumbered with bowlders; but these have proved of great value everywhere as building stone where no other rock was at all accessible. West of the moraine and its immediate vicinage there are bowlders only where these have been exposed and accumulated by the later processes of erosion, as along the banks, ravines, of the Little Sioux and of Mill creek. The scarcity of such rock south and west of the latter stream is remarkable and even notorious. The famous Pilot Rock south of Cherokee is a remarkable example of a bowlder of the older drift, long buried but now, probably since Wisconsin times, uncovered by erosion. This rock has been quarried again and again, and is likely to be finally utterly destroyed and carried away. It is in more senses than one a historic landmark and surely deserves a better fate. The bowlders that strew the hillsides above the city of Cherokee are probably all set free by similar erosional agencies, although some of them may be of Wisconsin time, brought down, as already suggested, in floating ice. The bowlders about Sioux Rapids are apparently of Wisconsin age; one massive limestone block near the upper railway station can hardly belong to the older drift.

But in general the soils of the counties here discussed, whatever their nature, whatever their foundations, are of the finest quality, and yield to husbandry, year after year, with undiminished vigor, the varied crops which belong to this latitude in the great Mississippi valley.

**Brick and Tile.**

Brick and tile are both extensively manufactured in both counties, more attention being paid to tile, for which in Buena Vista county there has been a great demand. At Sioux Rapids Mr. J. F. Cooley manufactured in the year 1900 some 500,000 bricks and 60,000 tiles. The brick is rather soft, but answers every purpose for inside work. The tiles are said to be of the first grade. The material is derived from a fine alluvial deposit close by the river, apparently a bed of silt, which possibly reaches the Kansan blue clay. At Linn Grove, a little farther down the river, a similar deposit affords material for the manufacture of considerable quantities of both brick and tile. At both points coal is the fuel employed and it must be brought from a distance, even coming, some of it, as reported, from southern Iowa. At Storm Lake a similar bed of what seemed to be silt is worked profitably in the manufacture of soft brick and tiling of various sizes but fair quality, all rapidly taken up by the local demand.

At Cherokee Mr. J. W. Townsend manufactures some two and one-half million brick per year and 100,000 tiles. Coal is, of course, the fuel employed; said to come from the Webster county mines. The clay, rather sandy, is brought from an adjacent hill to the kilns on the west bank of the river. The exposure has been brought about by recent erosion but belongs to pre-Wisconsin drift. It forms a part of the general body of the local drift and is capped by loess though of impure character. Beneath is a distinct stratum of sand which in turn rests upon what is probably the omnipresent blue clay. The lower layers were not well exposed at the time of our visit, but the section as it then appeared was approximately as follows:

	FEET.
4. Dark orange colored loess.....	6
3. Fine, silt-like, sandy clay, not unlike the loess of the Missouri hills.....	20
2. Sand .....	1
1. Blue clay.....	3

No. 3 where exposed on the face of the bluff by natural erosion shows abundant loess-kindchen.

The brick manufactured by Mr. Townsend are when well

burned hard, of a dark yellowish brown color, and suitable for all sorts of construction. It is a curious fact worth noting, perhaps, that many years ago an attempt was made near Marcus to burn brick, using the wild hay of the prairies as fuel. The experiment seems to have been only partially successful. But there ought to be found good brick clay at Marcus, particularly to the south of that village. Just at the town the loess deposits are somewhat scanty, but the material is abundant in various places in the township south, and is also not lacking three or four miles north of the corporation.

#### Gravels.

In both the counties here discussed there are unlimited supplies of gravel suitable for the preparation of highways. When once the era of good roads actually arrives these gravel deposits will assume more nearly their real value, that is, they will be better appreciated than now. Nevertheless, in the towns of Cherokee county, and in both city and country in Buena Vista county, gravel is today the road material. An organized effort for the use of this material, extending the paved or graveled road year by year, would soon make the country roads of all northwestern Iowa the very best in the state.

#### Water Supply.

Cherokee county is favored by the presence of two fine perennial streams, the Little Sioux river and Mill creek. These extend across the county in such a way as to be very convenient to hundreds of farmers and stock-raisers. The volume of water in the river is sufficient for water-power, and at Cherokee it was formerly used for milling purposes. At the present writing there is no water power in either county except the small dam at Sioux Rapids. This has recently been renewed and power sufficient for a grist-mill seems to have been easily obtained. In each county there is rather an unusual number of springs, and these are of greatest service in the localities where they occur. At the county farm in Buena Vista county spring water is conveyed to the buildings and farm houses by means of an hydraulic ram. However, in both counties the principal reliance for water is upon

wells. These vary very greatly in depth. It would seem that deep wells until very recently have not been found necessary. Reference has already been made to the effort at deep drilling made by the railway people near Marcus, and we occasionally hear of a well 300 to 500 feet deep, "to get through the blue clay"; but most of the wells in Cherokee county are very shallow, not more than fifteen feet, some of them, and scarcely any more than thirty feet. South of Quimby a short distance are two flowing wells said to be about 120 feet in depth and through the blue clay, but the information in regard to the wells was meager, as indeed with reference to nearly all the deep wells said to occur in this county. As a rule no record at all is kept of anything except depth, and once the land changes hands, or the man who paid for sinking the well disappears, it is impossible to get any accurate information. The value of the careful well-digger's data is great and they might with advantage in each county be made a matter of public record.

In Buena Vista county deep wells are also the exception and were heard of only southwest of the lake and west of Brooke's creek. However, on section 17 in Grant township there is a well 140 feet deep, in which is reported 20 feet to the blue clay, 70 feet of blue clay and then yellow clay and gravel to quicksand and water. At Newell is a well where the blue clay was reached at the depth of only 12 feet, but beyond that depth the record is not very satisfactory, although the well is reported 240 feet deep.

In general it may be said that the two counties are not only well watered in the ordinary sense of that term, but the supply from wells is if anything more than ordinarily accessible.

#### ACKNOWLEDGMENTS.

In the prosecution of the work of which these pages offer a brief report the author has enjoyed the constant encouragement and assistance of the general officers of the Survey. He would also here record his sense of obligation to Mr. W. J. Harnahan, chief engineer of the Illinois Central railway, for data in reference to the thickness of the drift in Cherokee county. The citizens of the two counties herein described have shown constant

interest in the prosecution of the work and many of them without specifying by name are entitled to the thanks of the Survey. The map of Cherokee county is based upon one loaned the Survey by Messrs. Moore and Chick of Cherokee, and to Mr. A. O. Whedon of the same city we are indebted for the negative from which has been prepared the illustration showing Pilot Rock. Thanks are also due Mr. C. E. Jacobs of Sioux Rapids for many favors.

#### FORESTRY NOTES.

By the testimony of all pioneers the original forest growth of Buena Vista was limited to that part of the valley of the Little Sioux that falls within the northern limits of the county. It is reported that in the neighborhood of Storm lake there was not a single tree, unless we might perhaps so dignify a few willow bushes discoverable near the western end. When we recall the somewhat abundant development of forest trees of large size, primeval at Okoboji we are probably at first surprised that no such vegetation found similar development here. The explanation of the situation is to be sought in the different topographic surroundings of the two lakes. The principal forest of Okoboji was almost entirely surrounded by water, and so protected from the fires of the northwest and west as they came in their perennial destruction. There is nothing at Storm lake either in the distribution of water or in the configuration of the land to offer any slightest protection to a growth of trees. There is but one lake, and the shore line is uniform, almost without any indentations or bays except to the west where it is flanked by marshes and here alone certain tree-like vegetation is reported to have been found.

But in the valley of the Little Sioux the case is different. Here an unusual number of forest species has maintained itself through past centuries, and these species are still represented by beautiful groves of thrifty, shapely young trees, the so-called second growth. The trees primeval, as seen by the pioneer, were, however, much scattered. They were generally old trees and although as remarked, representing many species, they yet formed nowhere a real forest. Today genuine forest conditions obtain in

many places. There is a beautiful native grove near Sioux Rapids; another, somewhat smaller at Linn Grove; while around the homestead of Mr. Brooke in section 14, Brooke township, is one of the finest native groves in northwest Iowa. The old trees which attracted first the attention and interest of Mr. Brooke are still standing (Fig. 59) surrounded now by hun-



FIG. 59. Where the prairie meets the forest. View taken looking west of north, on the farm of Wm. Brooke, Brooke township, Buena Vista county, Iowa.

dreds of their descendants which form the densest kind of a forest down the hillside. On the summit of the ridge above the residence the boundary between the two floras, woodland and prairie, is beautifully shown.

It is a curious fact that in all these native groves the bur oak always occupies the outmost post, forms the vanguard, the very foremost line. Where no other persisted or withstood the onset of fire and storm there stands the bur oak, gnarled and twisted, shorn and shortened, it is true, but still holding its ground until now that it has passed under the control of civilized man the species finds unexpected relief and young bur oaks are the characteristic feature of every uncultivated hillside along the Sioux.

But if forests are not part of the natural wealth of Buena Vista county, this is no reason why trees may not form a conspicuous feature of the landscape now. Some of the finest, most woodland-looking groves in the country are to be seen today around that

very Storm lake, once so bare and wind-swept. Planted groves adorn the whole country. In the city of Storm Lake may be seen most of the ornamental varieties of shrubs and trees that have place in the most favored grounds in other sections of the northern United States.

In Cherokee county very similar conditions marked the original valley and plain; that is the woodland species of plants were sparsely represented; in the deep gulches, on the steep hillsides by the Little Sioux and in protected corners there was here and there a tree or a clump of arboreous vegetation, but the wide area of the county was entirely treeless. Today the country might almost be described as well wooded. The original forest area has spread amazingly, and if not destroyed by the act of man would speedily cover all the steeper and less valuable slopes along creek and river. There is a fine body of second growth on the east side of the river near Cherokee, and patches of native trees occur all the way down, here and there, to Washta. Some of the primeval forest still stands in the neighborhood of Quimby. Some planted groves on the farms are also very beautiful and have established real forest conditions. The great trouble in the whole situation is that forestry and pasturage cannot go on together. If a farmer wishes to see his grove thrive and do him highest service he will not subject it to the injurious trampling of herds of cattle. Many fine groves in northern Iowa are now being ruined in this way. With the rapid occupancy of the more fertile portions of our country and the rapid destruction of our native supplies of lumber and forest products, the time is rapidly nearing, if not already at hand, when the timber lot will be as valuable an adjunct to the well-appointed farm as the pasture lot. But the same land cannot be used for both purposes. As well attempt to raise corn in the meadow. If the farmer desires a grove to shade and shelter him and his cattle, to furnish him a perennial supply of fuel and of wood to be used for all sorts of purposes about the farm to say nothing of the adornment of his holding, he can have it in northwestern Iowa as well as elsewhere in the state, but he must take care of it, at least to the extent of giving the trees a chance. Furthermore the scant native growth of the counties we have been studying is yet all-

sufficient to demonstrate that our farmer is by no means limited to the familiar willow and box-elder or white maple; he may plant all sorts of trees, ash, walnut, oak, basswood, besides those forms ordinarily used for ornament, such as pines and larches.

Since fire has been eliminated from the problem, the great enemies of the trees, enemies not under human control, are drought and the wind. The counties here considered have shown a remarkable endurance under the most trying conditions of drought, and it is a fact that the trees themselves, by their increasing numbers, protect each other from the winds, if they do not ameliorate these atmospheric conditions as a whole. There are those who have lived long in Iowa who think and believe that the occupancy of these prairies and the planting of them with trees in thousands upon thousands has greatly changed our climate. However this may be, there is no doubt whatever of the protection afforded locally to a homestead by a well situated, well cared for grove of trees. It is doubtful if the northwest prairie were habitable, at least by enlightened people, without the aid and assistance brought by plantations of trees.

The native woody plants of Cherokee and Buena Vista counties, so far as noted, are as follows:

*Tilia americana* Linn. Basswood or Linden.

A most valuable and hardy tree; a rapid grower, beautiful and clean. A fine shade tree nor less desirable in the grove where its habit of stooling, or branching from the base makes it valuable as a windbreak. The flowers are beautiful and odorous and famous for bees, yielding a preferred variety of limpid honey. This tree is native to the banks of the Little Sioux and even of Mill creek. Large trees are reported to have been sawed into lumber by the pioneer. The lumber is soft, strong, but straight-grained and very easy to work.

*Xanthoxylon americanum* Mill. Prickly Ash.

A very hardy, quick-growing ornamental shrub, easily transplanted, with spicy leaves and twigs, small early flowers followed in August by bright, red, berry-like fruit which presently breaks open, revealing in each fruit a pair of shining black seeds. Very common along the valley of the river in undisturbed bottom lands. Valuable only for ornament.

*Acer saccharinum* Linn. *Acer dasycarpum* Ehrhart and of the books generally. Common soft Maple or White Maple.

Everywhere planted for shelter and for groves and now probably indigenous in both counties along the river bottoms above the dam at Sioux Rapids, etc. A most valuable tree and one of the best servants and friends of the farmer and the pioneer, deserves a place in the Hall of Fame of all the valley states. It grows rapidly, endures abuse of every sort, shades and shelters the homes of men and offers convenient covert to the herds and flocks. Nor less has this tree especially been of service to our friends, the population of the air. Robins and thrushes frequent the maple groves and build their nests in regions that only recently knew them not. Nay more, the present writer saw a company of bluebirds, in this year of grace 1902, sunning themselves on the leafless branches of the maples of a farm in northern O'Brien county. People farther south and east think themselves privileged to see and hear these beautiful American birds, and the farmers of the northwest have reason to congratulate themselves that their tree planting offers an inviting summer residence to our choicest and most industrious and beneficent birds of song.

*Acer negundo* Linn. Box Elder.

This exceedingly useful and common tree is happily native to all the northwest. Planted as a windbreak and for shade this tree has done its part in making the country. It is not desirable as a street tree, but as a starter, as a nurse in the planting of other species, it is invaluable.

*Rhus glabra* Linn. Sumac.

This is the common sumac of all our northern woods. It is useful as an ornamental plant only. Its curious flowers, its bunches of deep red fruit, and above all, its glowing autumnal foliage, make it well worthy of preservation and of consideration in the planting of grove and lawn. It spreads rapidly from the roots and from a single shoot will soon cover a hillside if left to itself. The plant is not poisonous, as many people suppose. The poison sumac is quite a different thing. It is likely to be found everywhere, although no native specimens were observed; but it has been scattered by birds and other animals far and wide and

is probably found today in every county. It is native about the lakes to the north. It may easily be distinguished by the three-foliolate, three-parted, leaves and the loose clusters of whitish berry-like fruit that hangs all winter upon the leafless stem. In our part of the country poison sumac is ordinarily in form a small inconspicuous shrub; sometimes, however, it assumes the climbing habit and ascends trees, fence posts, etc. In this form it must be carefully distinguished from the Virginia creeper, an elegant native climber, not poisonous, with five leaflets and producing in autumn dark blue fruit like that of the wild grape.

*Prunus americana* Willd. Wild Plum.

A common tree forming thickets here and there by the streams. An exceptionally fine ornamental tree; nothing has handsomer or sweeter bloom. Inured to the severest climatic conditions of every sort, it is nevertheless rather easily destroyed by cattle. Makes a fine border to the grove, a thicket covert for birds and is in every way worthy of preservation, aside from the tang of its wild sharp fruit.

*Prunus virginiana* Linn. Choke Cherry.

A not infrequent little tree in the native groves up and down the Sioux. Useful only as an ornamental tree, since it gives out in spring rather showy clusters of white flowers, succeeded later on by abundance of shiny black fruit, the delight of birds.

*Prunus serotina* Ehr. Wild Cherry.

This occurs sparingly along the river in several places. It appears also not infrequently in groves, those long ago planted offering opportunity for this and all sorts of species whose seeds may be carried by birds. A valuable tree for lumber and of rather rapid growth.

*Pyrus iowensis* Wood. Crab Apple. Iowa Crab Apple.

Common along streams and growing in thickets even by the roadside everywhere. One of the most beautiful ornamental plants we have. Its disposition to spring up from the root prejudices the farmer sometimes against it, but after all it is easily controlled and with its prolific bloom in the early year it certainly makes amends for all the trouble it costs.

*Crataegus coccinea* Linn. Hawthorne, Red Haw.

This species was noted near Cherokee and doubtless occurs all

along the river and is to be commended in much the same way as the last.

*Symphoricarpus occidentalis* Link. Wolf Berry.

This is a clean little shrub growing in the shady woods and by the borders of thickets everywhere near the stream. It has very handsome and showy clusters of flowers that come in July and continue blooming for some weeks. In the fall come the snow berries, an attractive fruit hanging on the shrub often long after the leaves have fallen.

*Sambucus canadensis* Linn.

Not common. Escaped from cultivation here and there. Found in some places in gardens where the fruit is appreciated.

*Viburnum lentago* Linn. Black Haw.

Rare along the river. Reported from several points but not observed. A handsome little tree, useful for decorative purposes and in great popular esteem for its peculiar fruit.

*Fraxinus americana* Linn. White Ash.

Native to both countries and everywhere commonly planted. One of our finest forest trees; clean, hardy, making a pleasant grove and furnishing excellent timber for all sorts of uses as well as the best of fuel. It should be more extensively planted; doubtless would be were it not that it grows more slowly than some other species and wearies thus the patience of the average planter. But there is no reason why such trees should not now supplant the cheaper and less desirable varieties.

*Ulmus americana* Linn. American Elm. Common White Elm.

This is another common and hardy species. There is one typical specimen of this tree just north of Sioux Rapids that is as fine as any elm in Iowa. Most specimens noted were low and spreading; that just cited is tall and graceful and in every way one of the finest of its class. The elm is our street tree; no other comes near it for such purpose. With the progress of the years the long limbs sometimes meet above the street and offer to the fortunate passer-by a perfect Gothic arch of leafy symmetry.

*Ulmus fulva* Michaux. Slippery Elm.

Reported as occurring along the river in both counties. Said to have been at one time abundant near Quimby. A fine tree but not nearly so valuable as its kindred species. The bark is

reputed to possess medicinal properties and doubtless has its uses in domestic medicine. Its wood when dried in winter is said to be among the best for fencing, but we must have respect to the time of cutting and curing.

*Juglans nigra* Linn. Black Walnut.

This most valuable of all native trees is fortunately also native of the counties of northwestern Iowa. Specimens may be seen in the ravines north of Sioux Rapids and large trees are reported as once not rare along the bluffs throughout Cherokee county. Trees are easily reared from the seed and they grow at first with surprising rapidity in our prairie soils. They are not good, however, when placed alone; they must be in groves and planted with other trees at least for some years. These nurse trees may later on be cut out when forest conditions have been once established. It is a wonder that more attention is not given in northern Iowa to the cultivation of this tree. It is doubtless a slow crop, but is certainly sure and immensely remunerative. In twenty-five years a crop of walnut trees will pay an enormous interest. The grove of Senator Whiting at Monona and that of Mr. James Brown in Battle township of Ida county are famous.

*Carya amara* Nuttall. Pig Nut. Bitter Nut.

This is the only hickory noticed in the northwest. It occurs on the wood-covered slopes along the river not uncommonly. The tree is worthy a place in our list of trees to be cared for; its wood, though not so valuable as that of the shell-bark hickory, is yet of good quality and is one of the few hard woods here available. Useful for tool handles and for all purposes where strength and solidity is demanded.

*Corylus americana* Walt. Hazel. American Hazel.

Common wherever there is native woodland. The hazel is a natural nurse for other species. It occupies the border of the existing woods, holds the snow amid its slender twigs and so gives the seedlings of the oak and other forms protection at times critical. A pleasant little bush much appreciated by boys of sound mind and body and worthy of preservation for this reason if for no other.

*Ostrya virginiana* Willdenow. Ironwood.

A valuable little tree of slow growth and exceedingly hard texture, as the popular name implies. Not uncommon along the river and on the steep banks of Wild creek. The wood is of use in the same way as is that of the hickory.

*Populus deltoidea* Marshall. Cottonwood.

This is the universal tree of all the prairie country, east or west. This tree is certainly chief accessory before and in the fact, to all that has been done or attempted under the United States "timber claim" laws. Scarcely ever was any other species selected to meet the conditions of that law. Under the timber laws of our own state the tree also bore an important part, and many a fragmentary plantation is still in evidence to certify to the stimulating effect of all this economic legislation. The fact is the cottonwood is fine for certain uses. It grows with great rapidity, is hardy, enduring winter's cold and summer's drought and heat, but it does not make good plantations. It may be used around the outside, especially to the east or west, but does not do well in the center. There are beautiful rows of cottonwoods in all parts of both counties here described.

*Quercus macrocarpa* Michaux. Bur Oak.

This is the oak of all northwestern Iowa. It occurs in all forms and of all shapes and sizes. It is the common "scrub" of the gulches and ravines where trees a yard in height may be found in full fruit, nor less is it the famous tree of the pioneer to which he was indebted for lumber and for wood. Mr. Brooke has some fine specimens of the old trees near his home in Brooke township, Buena Vista county. Our illustration (Fig. 59) shows some of these.

*Quercus rubra* Linn. Red Oak.

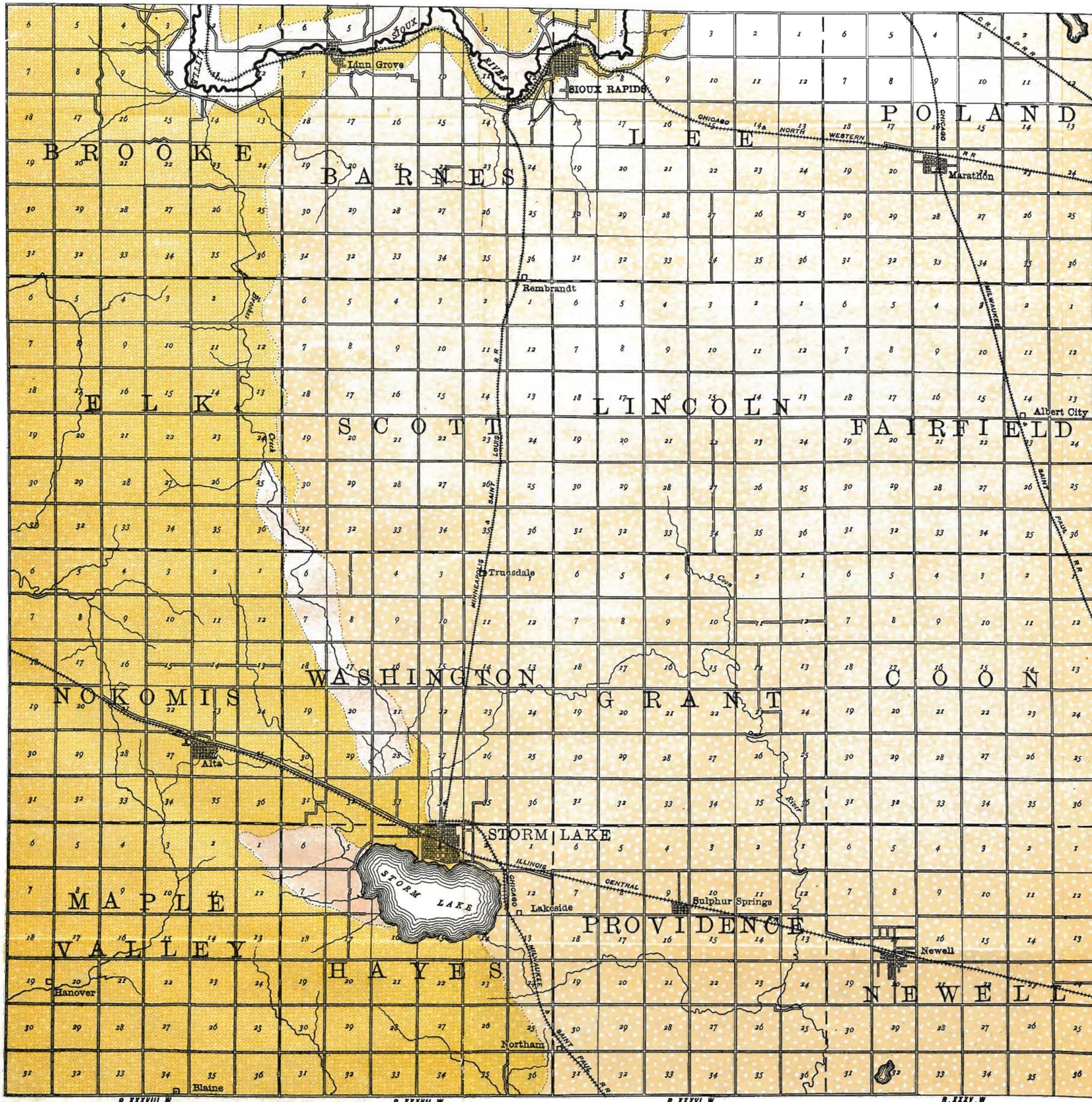
This is the only oak beside the bur oak so far noticed in this portion of the state. It is not infrequent along the banks of the river at Sioux Rapids, Linn Grove, Cherokee, etc. The specimens noted are all of small size and useful for fuel only. This species comes up well from the stump if the trees be cut in winter, and is valuable where it is desirable to keep a perpetual grove of growing forest which shall yield constant supplies of second growth wood.

*Juniperus virginiana* Linn. Red Cedar. Cedar. Juniper.

This is the only native conifer of northwestern Iowa. It is said to have been once common near Cherokee, along the bluff banks of the river, but it has certainly largely, if not entirely, disappeared. In time the tree reaches, even in this prairie country, considerable size, but its chief value lies in its desirability as an ornamental tree for the lawn or dooryard. It endures shade much better than evergreens generally and is a favorite on the farms. Makes fairly good windbreaks and can be used along the north side of the grove or plantation where the lack of light and sun in no wise incommodes it.

Besides the species here enumerated by name, there are several species of willow, some certainly native, which have not been with certainty identified. Mention has not been made either of many introduced trees planted in many parts of these counties, mulberries, poplars, fruit-trees of all sorts, which appear to thrive here as well as in some other portions of Iowa. The usual conifers also are here planted with good effect, and there seems no reason why the people of these counties may not have the advantage of the use of all or nearly all the arboreous species that are found commonly capable of enduring the somewhat trying and inhospitable climate of this state.

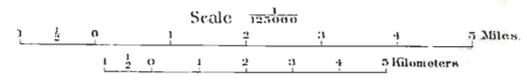




IOWA GEOLOGICAL SURVEY

MAP OF THE  
 SUPERFICIAL DEPOSITS  
 OF  
**BUENA VISTA**  
 COUNTY,  
 IOWA.

BY  
 T.H. MACBRIDE  
 1902.



**LEGEND**  
 GEOLOGICAL FORMATIONS

ALLUVIAL DEPOSITS

WISCONSIN DRIFT

LOESS   
OVERLYING OLDER DRIFT (MANSAN)

R. XXXVIII.W      R. XXXVII.W      R. XXXVI.W      R. XXXV.W

DRAWN BY F.C. TATE