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OBSERVATIONS ON GLACIAL GEOLOGY MADE ON TRIPS THROUGH
IOWA AND NORTHWESTERN WISCONSIN

by

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OBSERVATIONS ON GLACIAL GEOLOGY MADE ON TRIPS THROUGH
IOWA AND NORTHWESTERN WISCONSIN.

F. T. THWAITES, Jan., 1921.

(Revised Dec., 1921.)

NOTE: This report is confidential, for it contains criticisms of unpublished work by Weidman.

In connection with the work on the pre-Wisconsin terraces and the upland gravels of the Driftless Area I made one excursion into Iowa in September, 1919, and ^{another} in August 1920. In the latter month I made a trip through Weidman's "second area". Observations on glacial geology made on these trips are here set forth. They by no means reach final conclusions but merely present certain ideas that I gained at the time.

Areas seen. The 1919 trip to Iowa extended from Dubuque to Dyersville, thence north through Garneville and Monona to Waukon, thence via Postville and Monona to McGregor. The principal object was to study the Rockville conglomerate of McGee and the Waukon iron ore, the results of which investigation are presented in the paper on the Windrow formation.¹

¹ Thwaites, F. T. and Twenhofel, W. H., Windrow formation; an upland gravel formation of the Driftless and adjacent areas of the Upper Mississippi valley: Geol. Soc. America, Bull., Vol. 32, pp. 293-314, 1921.

Examination of the drift was limited to stopping at cuts in the leached Kansan till along the Hawkeye Trail and a few

exposures of the sandy drift south of Dyersville. It was my impression that McGee greatly exaggerated the fact that some streams flow through the hills and not through adjacent broad valleys. This phenomenon is readily explained by Kansan stream diversions on an irregular bed rock surface. In the course of post-Kansan erosion narrow rock gorges were formed in the diverted sections which contrast sharply with the parts of the valleys which have been cut in drift. The so-called Iowan strip near Dyersville appeared to me to be alluvial deposits and low slopes adjacent to large valleys.

North from Dyersville to Waukon, and east to the Mississippi, the loess is so thick that a hurried trip shows little of the drift. At no point have I seen or heard of bowlders large enough to prove glaciation. So far as I know, there is still considerable doubt on this matter for the presence of scattered glacial pebbles does not have any significance.

I also examined the peneplain question and found that the same cuesta topography as in Wisconsin is present in Iowa. Near Waukon, however, there does^{look}/like some evidence of the two plains suggested by Trowbridge (1) but I was unable to

(1) Trowbridge, A. C., The erosional history of the Driftless Area; University of Iowa Studies, Studies in Natural History, Vol. 9, No. 3, 1921.

decide to what extent the phenomena might be explained by (a) effect of local disturbance of strata at Waukon, and (b) effect of the Decorah shale which is thicker there than in Wisconsin.

This shale is an important spring horizon and therefore must have a considerable effect on the topography. It seems to me that these things should be considered in more detail than is apparent in Trowbridge's report.

The journey through the "Weidman area" extended from Mondovi through Durand, Ellsworth, River Falls, Roberts, Hudson, Somerset, Osceola, St. Croix Falls, Barron, Menomonie, Eau Claire, and thence to point of beginning. Data was sought as to (a) amount of post-glacial erosion, (b) age of older drifts, (c) position of border of Wisconsin drift, (d) age of St. Croix Dalles, (e) separation of moraines and pitted outwash plains, (f) age of valley terraces and their relation to the pre-Wisconsin terraces, and (g) upland gravels and their relation to the drift border. The results of the Iowa trip are also incorporated under these headings. This excursion extended from McGregor west on the North Iowa Pike to Algoma, thence south through Ft. Dodge to Guthrie Center, east through Des Moines and Iowa City to Muscatine, north via Clinton and Maquoketa to Dubuque.

(a) If a region of fair relief is heavily covered by glacial drift the streams will in many places be diverted from their former courses. During subsequent erosion/^{rock}gorges will be developed which will be in sharp contrast to the parts of the valleys excavated in the less resistant drift. The question was: to what extent are such diversions present in northwestern Wisconsin? This could not be answered from the extremely unsatisfactory notes of Weidman and Hall. The trip

from Durand to River Falls is through a region of mature erosion topography where such diversions are very scarce, if present at all. Does this mean that the valleys were never greatly filled by drift or does it signify that the valleys are in large part younger than the drift? Very few valleys contain undistributed drift. The sides are as sharp as those of the Driftless Area clear up to north of River Falls. A particularly striking feature that was investigated with some care is "The Monument", a crag of St. Peter sandstone in SE SE 9, 28-18W. It is about 40' high and is so soft that it could not have been present when the country was first left by the pre-Wisconsin ice. It certainly looks like an instance of "recraging" as was urged by Weidman. Such post-early-glacial crags are described by Alden (1). I do not think,

(1) Alden, W. C., Quaternary Geology of Southeastern Wisconsin; U. S. Geol. Survey, Prof. Paper 106, p. 141, plates XI B, XVI A, 1918.

however, that it casts any serious doubt on Martin's conclusion that the Neillsville mounds are nunatacks. They are isolated on a drift-covered plain whereas little if any till is left around the base of the Monument. (2). Similar conclusions were

(2) Martin, Lawrence, The Physical Geography of Wisconsin, Wisconsin Geol. & Nat. Hist. Survey, Bull. 36, pp. 314, 315, plate XXVIII, 1916.

reached from a study of northeastern Iowa where, as stated by Trowbridge in conversation, there are no glacial stream diversions.

Trowbridge has concluded that the main part of the valleys are post-Nebraskan in age (1). I am not ready to agree with

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- (1) Trowbridge, A. C., Preliminary report on geological work in northeastern Iowa; Iowa Academy of Science, Proc., vol. 21, pp. 205-209, 1914; Physiographic studies in the Driftless Area; Geol. Soc. America, Bull., vol. 26, p. 76, 1915; The erosional history of the Driftless Area; University of Iowa Studies, Studies in Natural History, vol. 9, No. 3, 1921.
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this conclusion for the following reasons: (a) it is not proved that much of the upland drift of eastern Iowa is of glacial origin, (b) the age of the drift of the Central Plain of Wisconsin is not known and this plain and the valleys draining it antedate that drift, (c) the observed phenomena could have been brought about by erosion of a glaciated topography like that east of Prairie du Sac where the drift was never thick enough to cause stream diversions, and (d) the time necessary to make the huge rock valleys even in part is so vast compared with the time since the last glaciation, even if we allow for possible changes in stream gradient and climate, that it requires an immensely longer Pleistocene period than is currently accepted. It would seem that further detailed work is needed before a final conclusion can be reached on this interesting point.

I examined the amount of erosion in the Kansan areas of Iowa with some care where we saw the Kansan from Guthrie Center to Maquoketa. The topography is in the stage of advanced youth to sub-maturity. Considerable remnants of the old drift plain are still found. Locally the streams are

cutting in rock but there I saw no conspicuous rock gorges as in northeastern Iowa. It hardly seems credible that the Nebraskan is so much older in terms of erosion than the Kansan that the main valleys of the Driftless Area were made in Aftonian time.

The post-Wisconsin valley of the Des Moines River is well marked (1). Most of the Iowa reports do not seem to

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- (1) Lees, J. H., Physical features and geological history of Des Moines valley; Iowa Geol. Survey, Vol. 25, pp. 423-615, 1916.
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consider the effects of the water from the melting ice. Many of the county maps do not show outwash or stream terraces. Some writers seem to have confused pre-glacial and post-glacial erosion. How much of the rock gorges of the vicinity of West Union and Mitchell were made by post-glacial erosion and how much by water from the Wisconsin ice is hard to tell from the available literature. It did not seem to me that Alden and Leighton (2) gave enough weight to the effect of the

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- (2) Alden, W. C. and Leighton, M. M. The Iowan drift, a review of the evidences of the Iowan stage of glaciation: Iowa Geological Survey, vol. XXVI, p. 72, 1915.
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limestone sills in regarding erosion and fixing a local base level. It is true they considered that hypothesis but did they correctly evaluate it?

(b) The Iowa Survey ascribes the rolling topography of parts of the northeastern portion of that state to a post-Kansan

and pre-Wisconsin glaciation which mantled the weathered and eroded surface of the older Kansan and Nebraskan. I saw this area through Fayette, Chickasaw, Floyd, and Mitchell Counties. The so-called Iowan topography may be described as long gentle slopes, boulder-strewn where undisturbed by man, nearly free from loess, marshy at many places before the extensive tile drainage, but at all points an erosion and not a glacial topography. It has no sags as does the Wisconsin drift plain farther west. Does it seem credible that ice could go over a country as rough as the Kansan area now is and not leave somewhere a sag or a swell of glacial topography? In their careful study of the leaching of this area it hardly seems that Alden and Leighton could have quantitatively considered the effect of either the high water table or the fact that the drift of a limestone area originally contained more ground limestone than did the drift on the Coal Measures to the west. It is certainly a strange thing that the Iowan drift should be almost entirely confined to the upland formed by the Silurian and Devonian limestones.

I examined some exposures of the so-called Buchanan gravels. At but one point (near west 1/4 post, 22, 97-16W) is there any suggestion of till above the rusty gravel. I was by no means sure that it is not a mixture of boulders, loess, and weathered gravel. The same error in mistaking a thin surface layer for till has been made so many times in the past that I am now very cautious in describing anything as till unless seen in a good, deep exposure.

I did not stop to search for any of the areas where fresh till is described as overlying weathered till ("gumbotil"). These were for the most part found only by boring so that it was not possible for me to verify them. This line of evidence was considered the strongest one by Alden and Leighton, although there is also a pre-Kansan "gumbotil".

The difference between the topography of the Iowan and Kansan areas is doubtless due to a combination of (a) kind of drift as affecting type of and speed of erosion, (b) underlying rock as affecting the base level, (c) grade and volume of streams which is a result largely of the above conditions, (d) presence or absence of loess, (e) position of water table which affects not only erosion but also the depth of leaching, (f) difference in age of glaciation. We must get some sort of a quantitative idea of the relative value of each of these factors before we can be sure of the last. I do not feel that this has yet been reached. Alden and Leighton ruled out several of these things as inadequate but that simply means they thought them so, for they did not present any attempt at quantitative relations. I do not like to condemn their excellent piece of work but I do feel that it does not go far enough in this line. It is still merely a matter of opinion as to the relative value of evidences, no single one of which is as they say a positive proof of the existence of the Iowan. Certain it is that the criteria used by Calvin⁽¹⁾ which gave such fantastic borders to the Iowan

(1) Calvin, Samuel. Present phase of the Pleistocene problem in Iowa; Geol. Soc. Amer. Bull. Vol. 20, pp. 133-152, 1909; The Iowan drift; Jour. Geol. vol. 19, pp. 577-602, 1911.

drift were valueless. It seems strange to me that the Iowan ice should stick so closely to a limestone upland and nowhere else go beyond the Wisconsin drift border and that it is nearly all an area of high water table. For the present then, I wish to adopt the Iowan stage of glaciation "with reservations".

Weidman's manuscript described an Iowan drift in Wisconsin which consists of gravels locally covered by till. I did not especially search for such deposits but ran onto nothing which even remotely suggested the original Iowan area. I examined some old gravels southeast of Ellsworth in NW corner 1, 25-17W. This gravel is rusty and the limestone pebbles are entirely destroyed to a depth of about 8 feet. The topography is erosional, with a few large boulders. Leverett (1)

(1) Leverett, Frank, Surface formations and agricultural conditions of the south half of Minnesota: Minnesota Geol. Survey, Bull. 14, pp. 48-49, 1919.

thinks there are two pre-Wisconsin drifts in this area, the Illinoian and the Kansan. He describes the latter as his "old gray drift" and the other as his "old red drift". The latter he describes as "generally very stony and it seldom assumes a clayey constitution. It is usually but a few feet in depth, and scarcely makes a continuous cover over the Kansan drift". In other words the "drift" is gravel which as is natural shown less weathering than the adjacent till. R. T. Chamberlin also supports the view that there are two drifts in this region by stating "*** pre-Wisconsin red drift overlies the grayish black till in many cuts along the

Northwestern Railroad between Hersey and Baldwin, Wis.

Some of these exposures show that a considerable interval of time elapsed between the retreat of the ice sheet which deposited the grayish black drift and the advance of the glacier which brought the red drift.*** Some cuts show a distinct erosion unconformity between the two drift-sheets."

(1) The evidence cited by Chamberlin does not prove, in my

(1) Chamberlin, R. T., Older drifts in the St. Croix region: Jour. Geology, vol. 18, pp. 547, 548, 1910.

judgement, that an interglacial period intervened between the two drifts. It seems most probable to me that the only drift outside the Wisconsin area is of Kansan age. There may be some Nebraskan, and possibly some Ill^oian, but it certainly has not been proved. It seems to me far more reasonable to conclude that many of the observed differences in weathering and erosion are capable of simpler explanation than by the hypothesis of multiple glaciation.

(c) The tracing of the border of the Wisconsin drift where it rests upon an area of older drift is far from being as simple as where it forms the border of the Driftless Area as near Baraboo. It is generally agreed that the Wisconsin border crosses Lake St. Croix somewhere near Hudson. Leverett's map of southern Minnesota is not clear on this point but Weidman once informed me in conversation that he "moved the Wisconsin border back five or six miles" every time he went to that region. Judging from the number of visits he made in the course of 20 years it must by now have travelled a long

April 10, 2003

NOTE: WOFR 1921-1

Observations on Glacial Geology made on trips through Iowa and Northwestern Wisconsin

Page 11 of this Open File Report is missing.

We have looked in the files in the basement and have talked with Mike Mudrey and Lee Clayton and have found no other copy of this report. It may have been missing since first filed. We have no known source to replace page 11.

This area is pitted outwash. Now it is clear that pitted outwash implies that glacial ice covered the area where it is found not so very long before the deposition of the gravels. Ice blocks could not survive an interglacial epoch. Therefore the Wisconsin ice must have crossed the Willow valley and the outwash was deposited during its retreat.

At Turtle Lake I saw no reason to change the border of the Wisconsin from the position mapped 12 years previously. I did, however, interpret the Turtle Lakes as irregularities in a glacial stream bed instead of drift blocked interglacial valleys.

(d) The age of the St. Croix Dalles is post-Wisconsin. This is evident from the sharpness of the valley sides, the unglaciated tops of the terraces, and the general lack of harmony with the adjacent area. The kettles found by me in 1908 in the bottom of the valley are probably sand dunes. The unusual amount of erosion here is doubtless due to the discharge of Glacial Lake Duluth.

(e) The separation of pitted outwash from true moraines is a matter of some difficulty. Moraines have much stratified material in them it is true, but they also show till with many boulders and display a great irregularity in the height of hills. The pitted plains are composed wholly of water deposited material and the hills between the pits rise to a common level with occasional level tops. Local islands of till are to be expected. It is a matter of surprise how large boulders are found in some places on the plains. Some

of these were probably washed from such till islands. The fresh deep cuts made in the new grading of the State Trunk Highways have now made the separation of these features infinitely easier than it was 12 years previously. The shallow cuts then seen were in slumped and weathered loess and gravel, a mixture which is apt to deceive persons more experienced than I then was. Add to this that I did not consider the water wear on bowlders and possibly some excuse may be found for the gross errors in mapping that I committed. East of the St. Croix moraine nothing but pitted outwash is found until within a few miles of Turtle Lake. Chamberlin's mapping of the St. Croix Dalles quadrangle (1) is entirely

(1) Chamberlin, R. T., The glacial features of the St. Croix Dalles region. Jour. Geol. Vol. 13, pp. 238-256, 1905.

correct and Weidman's criticisms were absolutely unjustified. Apparently Weidman never even considered the work of water in connection with glaciation. Another feature in connection with these pitted plains which we did not interpret correctly in 1908 is the fact that the melting of ice blocks would change the base level of streams thus causing the erosion of channels through the plains. This phenomenon is well illustrated by the valley of Rocky Run near Deer Lake and the valley of Horse Creek farther south.

I was also interested to examine the drift section at Taylors Falls. This is currently described (2) as red drift

(2) Chamberlin, R. T., op. cit.

overlain by water deposited material and than in turn by gray till. I failed to find that the gray drift had anything like the heterogenous mixture of material which is characteristic of ice deposits. It is assorted though not stratified. It seems to me to be a cemented gravel. The red drift at the base of the section is stratified but shows many large water-worn boulders. I could find no sure-enough till in the entire section, it all looked to me like stream deposits.

(f) The age of the valley terraces and the presence of high level pre-Wisconsin gravels is taken up in the special report on the pre-Wisconsin terraces of the Driftless Area.

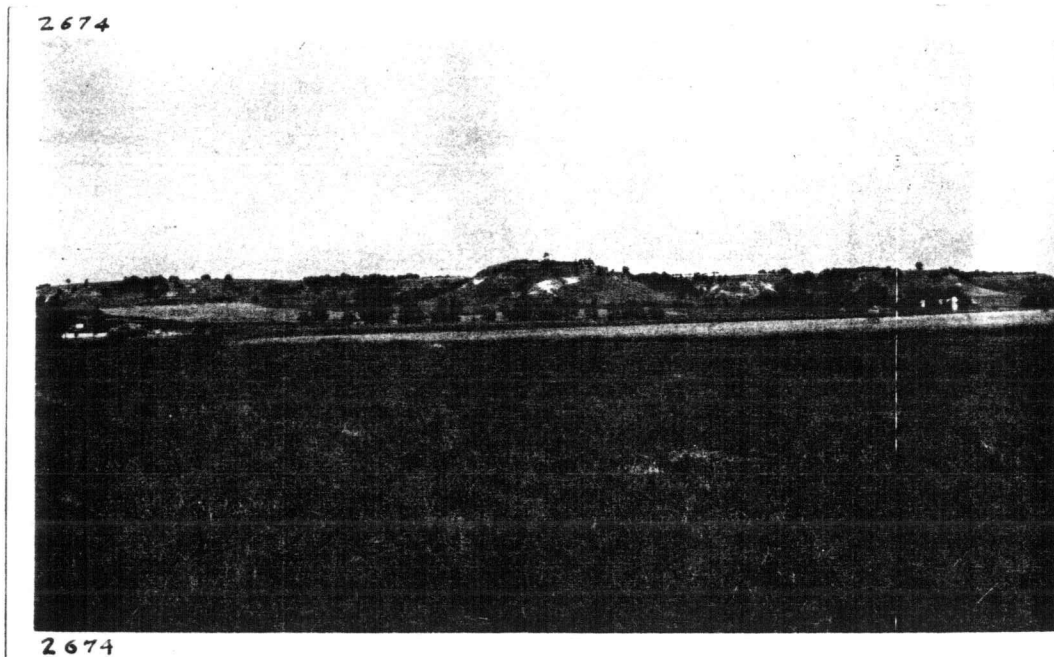
(g) The upland gravels of Buffalo County are considered in the paper on the Windrow formation. These gravels contain only water worn pebbles of quartz and quartzite. They must have been deposited before the valleys were formed. The question arises have all the crystalline rocks of the drift been destroyed by weathering? They have not been destroyed in equally thin deposits with similar soil and topographic conditions in adjoining areas as south of Durand and on the Minnesota and Iowa bluffs. The rare igneous pebbles one finds there are not especially weathered. I am strongly of the opinion that the eastern upland gravels are not residual from till or outwash but are pre-glacial, possibly a part of the Windrow formation.

Another interesting question is the true position of the glacial border in Dunn County. Chamberlin and Salisbury show

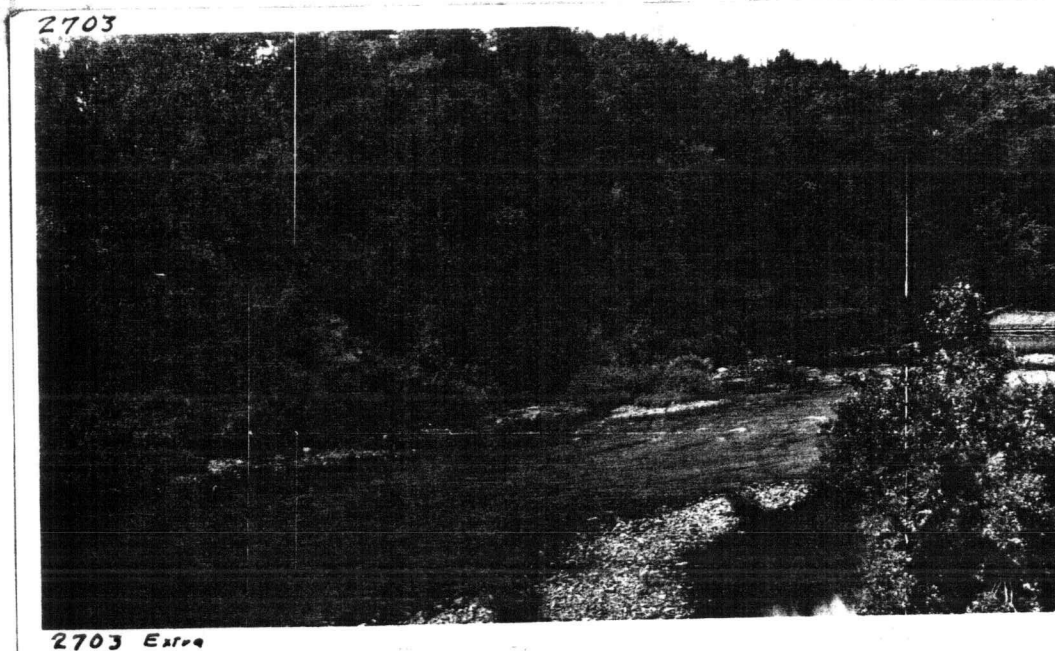
a reentrant expending far north of Menomonie (1). I failed

- (1) Chamberlin, T. C. and Salisbury, R. D., Preliminary report on the Driftless Area of the Upper Mississippi valley: U. S. Geol. Survey, 6th Ann. Report, Plate XXVII, p. 259, 1885.
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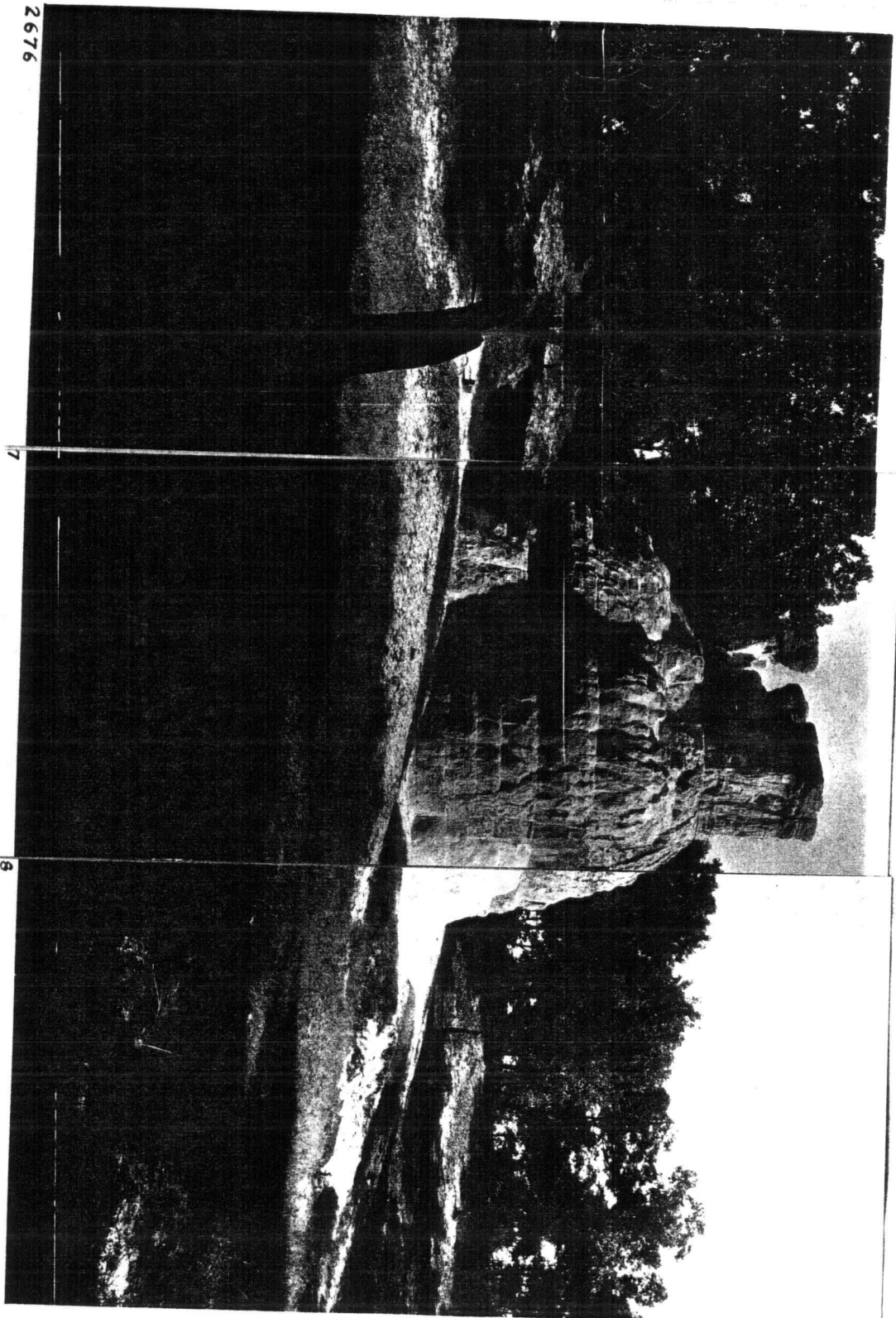
to find any glacial material above the terraces from a point a little way south of Ridgeland to Menomonie. There are numerous road cuts and we also climbed onto the upland at a point north of Wheeler. It would seem that the border of the Driftless Area would bear remapping here.



A. Hills east of River Falls showing mature erosion topography at contact between Trenton dolomite and St. Peter sandstone. This topography shows that the drainage lines have been much sharpened since glaciation.

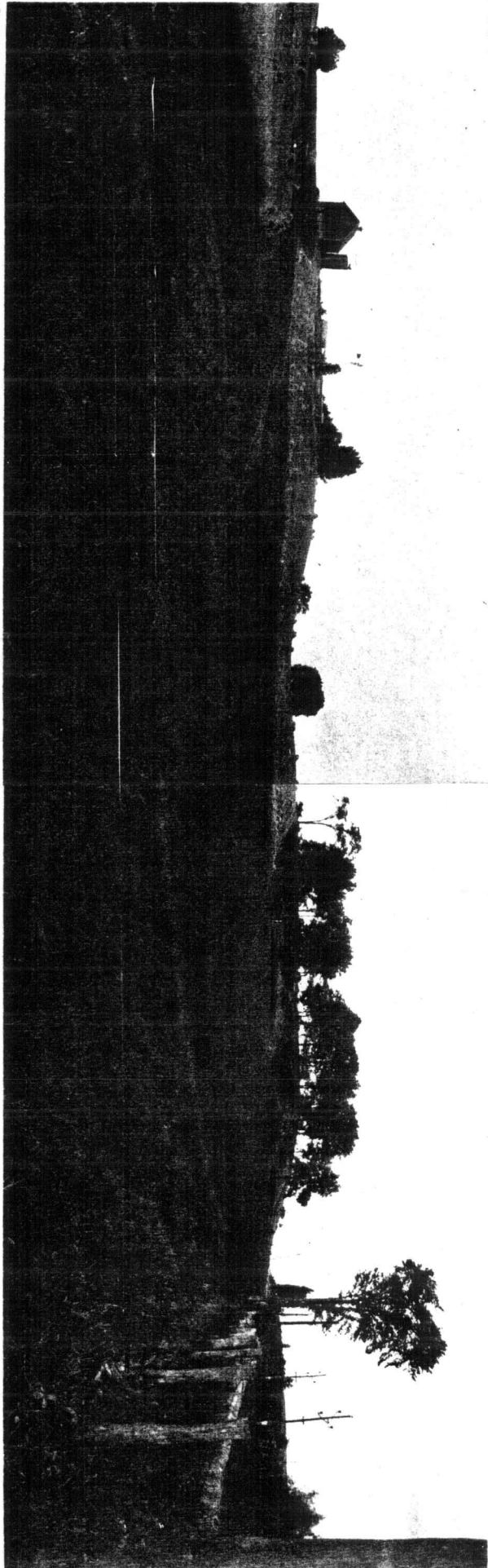


B. Post glacial rock gorge at Mitchell, Iowa. A small valley filled with Windrow conglomerate is concealed by the trees at the left. To what extent may this valley have been due to waters from the melting ice?



Panoramic view of "The Monument" (SE 1/4, Sec. 9, T. 28, R. 18 W.) This crag is about 40 feet high and must be post-glacial.

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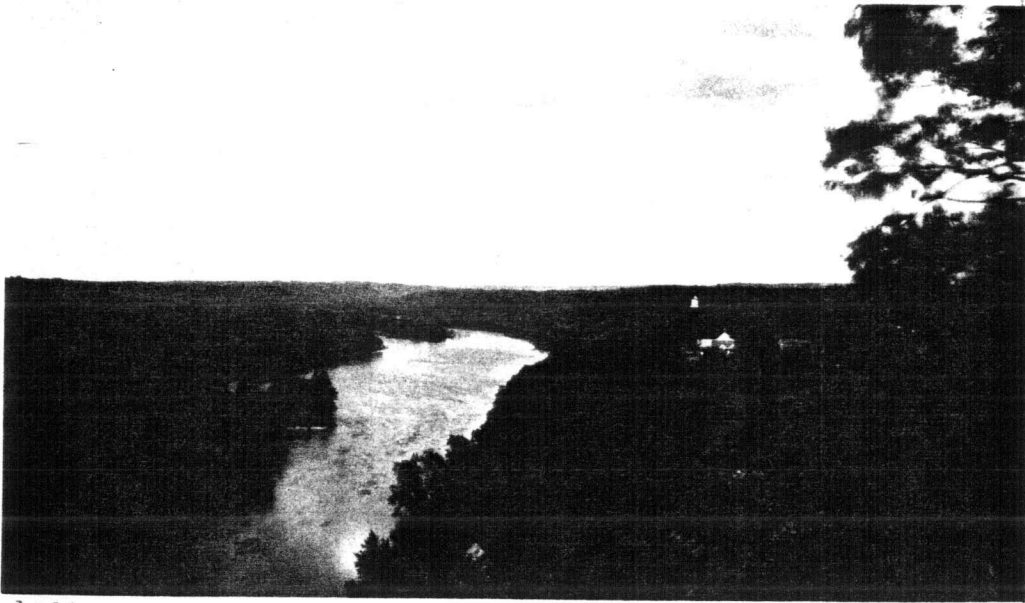


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Panoramic view of gravel ridge in NW corner, Sec. 1, T. 25, R. 17 W., southeast of Ellsworth. This style of topography is typical of gravel, which has superior resistance to erosion compared to the adjacent till.

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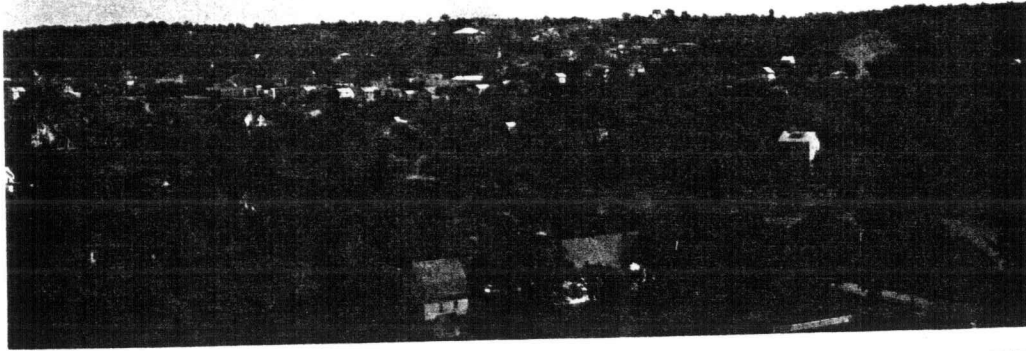
A. Valley of St. Croix river looking north from Eagle Point, Osceola. This valley is post Wisconsin in age and is in large part the work of the waters from Glacial Lake Duluth.



B. Gravel pit at Taylors Falls, Minn. The material at the top of the picture was formerly described as till but lacks boulders and clay. It is a cemented limestone gravel with very little stratification.

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A. St. Croix Falls from the highest terrace at Taylors Falls. The corresponding level at the Wisconsin side is at the level of the school house and top of the gravel pit. Lower terraces caused by rock obstructions can be seen at lower levels.

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B. Fresh cut in pre-Wisconsin gravel near Poskin Lake. A shallow cut in the weathered zone would certainly be mistaken for till but in a good exposure like this the stentified nature of the deposit can be seen.