GEOLOGY AND PHYSIOGRAPHY OF THE WISCONSIN STATE PARKS

by

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MASTER OF ARTS

UNIVERSITY OF WISCONSIN

1927

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CHAPTER I

INTRODUCTION

State Parks in Wisconsin

"A state park every hundred miles"[1] is the slogan of the National Conference on State Parks. On Plate I the locations of the eleven state parks and the four proposed parks have been plotted. In order to see how near the situation in Wisconsin approaches the ideal stated above, a circle with a radius of fifty miles has been drawn around each state park. The areas in excess of fifty miles have been shaded. This diagrammatic representation shows that southern and northern Wisconsin are well supplied with parks and that there is a large area extending across the central part of the state which is without state park facilities.

A closer study, however, shows that this diagram does not present all the facts. Southeastern Wisconsin, for example, is the most densely populated portion of the state and is served by one park[2] which has an area of but eight acres[3]. It is, therefore evident that this portion of the state is without adequate state park facilities and should

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[1] Torrey, R. H., State parks and recreational uses of state forests: The National Conference on State Parks, Report of a survey, p. 36, 1926.

[2] Urge state park for southeastern Wisconsin area: Wisconsin State Journal, April 20, 1927.

[3] State Parks of Wisconsin: Pamphlet by State Conservation Commission, p. 23, April, 1926.

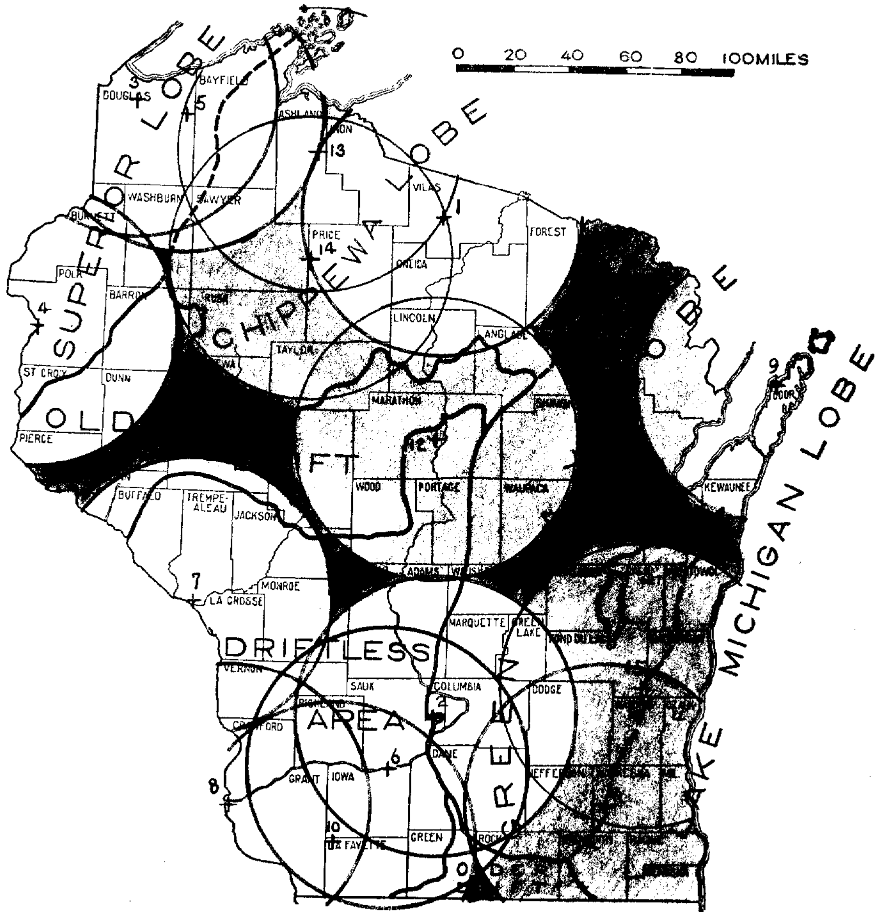
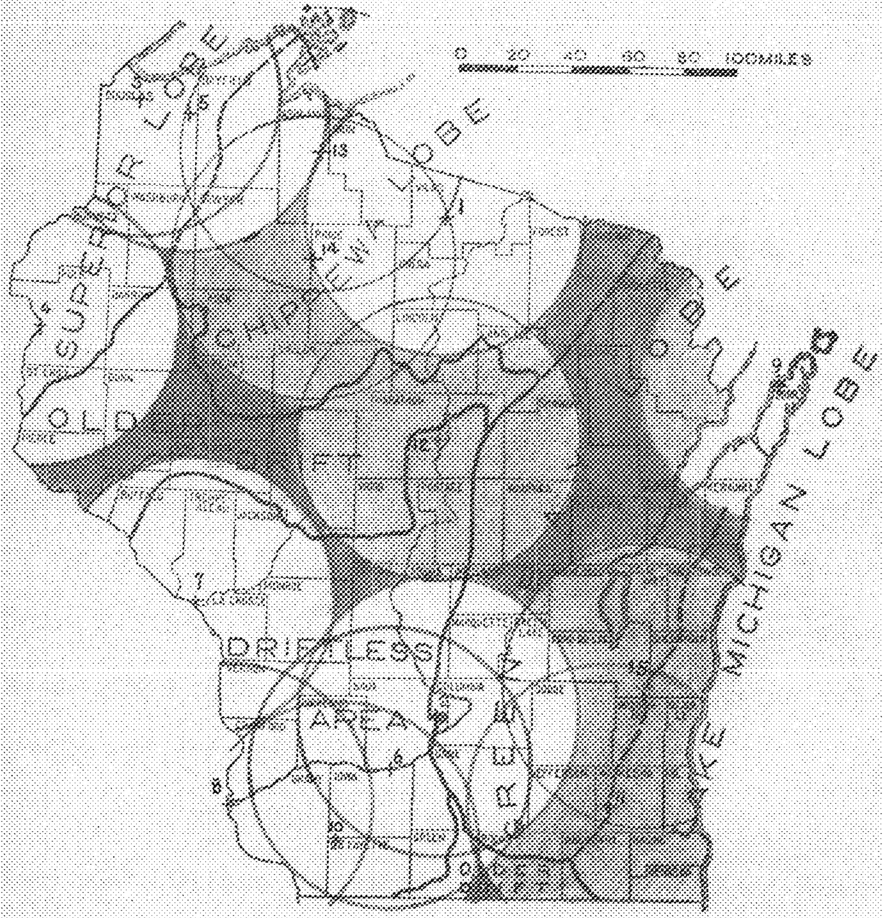


PLATE I. "A STATE PARK EVERY HUNDRED MILES"

+ = site of a state park
+ = site of a proposed state park

1. Northern Forest State Park
2. Devils Lake State Park
3. Pattison State Park
4. Interstate Park
5. Brule State Park
6. Tower Hill State Park
7. Perrot State Park
8. Nelson Dewey State Park
9. Peninsula State Park
10. Belmont State Park
11. Cushing Memorial Park
12. Rib Hill
13. Copper Falls
14. Northern Lakes
15. Moon Lake Area

The radius of each circle is fifty miles. The shaded areas represent distances between state parks in excess of one hundred miles. The areas with light shading surrounded by blue circles are the ones which will be eliminated when the four proposed state parks are added to the system. The light brown shading denotes areas which are in reality without adequate state park facilities.



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be shaded like the area in central Wisconsin. The blue circle shows clearly that even if the proposed park is located in the vicinity of Kewaskum[4], a large part of southeastern Wisconsin will still be without adequate facilities.

To show conditions as they really are the shading should also extend into southern Marinette and Oconto counties. Though Peninsula Park is but fifty miles distant in an air line, it is a considerably greater distance by road. Green Bay is a barrier to all who visit the park from this vicinity except those who wish to go by boat.

If the Rib Hill area is accepted by the state and Northern Lakes and Copper Falls parks are created, a large part of the shaded area will be provided with state parks, but areas in eastern and western Wisconsin will still remain without state parks.

Attractions of the State Parks

With possibly two exceptions, Belmont and Cushing Memorial, the parks of Wisconsin have been selected for their scenic beauty. Even these two which are mainly of historic interest are not without their peculiar charm. Belmont is associated with the Platte Mounds; Cushing Memorial Park with the adjacent lakes and the distant view of Government Hill.

There are, however, other attractions for the tourist if he has but time to tarry. Where Indian Mounds are present as at Nelson Dewey and Devils Lake state parks, a brief account of the size and shape of the mounds, the contents of those excavated, and the probable builders is of

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[4] Urge state park for southeastern Wisconsin area: Wisconsin State Journal, April 20, 1927.

considerable interest. A description of the flora and fauna of the parks furnishes an incentive to hikes about them. If the trees and flowers are labeled near the camp ground, the tourist will take delight in recognizing other specimens. If the physiographic features are pointed out and their probable history given, the tourist will take pleasure in finding them and in postulating how the region looked at various times during its development.

Purpose of this Discussion

It is the latter that the writer has attempted to portray in the following chapters. Though all but one of the parks have been visited by the writer, the discussion is based upon the material available and not upon any special field study. In fact the material presented furnishes a basis for such a study.

With regard to maps the writer has attempted to find the best available for each park. Wherever possible such a map has been a United States Geological Survey contour map. If the tourist learns how to interpret these in the field, he will find delight later in visualizing areas for which he has maps but which he has not seen. The maps for the various parks include much contiguous territory because the writer feels that the interpretation of the surroundings is essential to a comprehensive understanding of the immediate area of the park.

Geological Column

In the geological column, figure 1, the oldest rocks, the pre-Cambrian, are at the bottom. This group is divided into the Archean, Huronian, and Keweenawan. Above the pre-Cambrian are the Paleozoics which are divided into the Cambrian, Ordovician, Silurian, and Devonian. Above this group are the Quaternary and Recent deposits.

Figure 1.- Geological Column for Wisconsin.

System	Formation	Character and thickness
Quaternary	Recent Pleistocene or glacial	Till, clay, sand, gravel and bowlders, of glacial, fluvial, and lacustrine origin, maximum thickness about 600 feet
Devonian	Milwaukee Formation	Shale; black to brown, calcareous. Dolomite; gray, shaly. Maximum thickness 168 feet
Silurian	Niagara Group Waubakee Guelph Racine Coral Byron Mayville	Dolomite; light gray; chert, local red layers, beds thick to thin. 300 to 670 feet
	Clinton or Neda	Hematite, oolitic in local patches
Ordovician	Cincinnati, Richmond, or Maquoketa	Shale, blue calcareous; thin beds of dolomite, especially in upper part. 35 to 550 feet.
	Galena-Black River	Dolomite; gray and buff.Limestone in southwestern Wisconsin; in lower part, beds thin to medium; cherty. Hard blue beds. 167 to 415 feet
	St. Peter	Sandstone; fine to medium; gray to buff. Maximum thickness 285 feet.
	Lower Magnesian Shakopee and Oneota	Dolomite; gray; beds medium to thick, cherty. Good coarse aggregate. 40 to 250 feet.
Cambrian	Madison	Sandstone; fine buff, calcareous. Maximum thickness 40 feet.
	Mendota	Dolomite, local near Madison. 0 to 20 feet
	Jordan	Sandstone; medium to coarse; white. Maximum thickness 40 feet.
	St. Lawrence	Sandstone; fine, yellow. Lower part sandy dolomite; yellow, purple, thin-bedded. Good shale surfacing. 50 to 110 feet.
	Mazomanie	Sandstone; fine gray, glauconitic, calcareous; occurs east of Baraboo. Maximum thickness 160 feet.
	Franconia	Sandstone; fine, gray to yellow, glauconitic; thin-bedded; sandy shale at base; good shale surfacing. 120 to 173 feet.
	Dresbach	Sandstone; medium, white to yellow, heavily bedded. 50 to 300 feet.

Figure 1.- Geological Column for Wisconsin. (cont.)

System	Formation	Character and thickness
Cambrian	Eau Claire	Sandstone; fine, yellow, brown, white; shaly at top and bottom. Fair shale surfacing. 90 to 340 feet.
	Mt. Simon	Sandstone; coarse, yellow to gray; heavily bedded. Some shale beds. Maximum thickness 700 feet.
Pre-Cambrian	Keweenawan	Ancient dark colored lava flows, conglomerates, and sandstone. Copper ore and crushed stone. 40,000 to 55,000 feet.
	Huronian	Quartzite, slate, marble, iron formation. Iron ore and ganister. 8,000 to 12,500 feet.
	Archean	Granites, greenstones, schists, used for monument and crushed stone.

CHAPTER II

NORTHERN FOREST STATE PARK

Geographic Location

Northern Forest State Park, Plate II, is located in northern Wisconsin (T's. 41 and 42, R's. 6, 7, and 8 E.). Although situated in this portion of the state, it is easy of access. F.T.H. 51 traverses the park and T. H.155 runs to Sayner on the southern border. The Chicago, Milwaukee & St. Paul Railroad has two branches in the park and the Chicago & Northwestern line is a short distance southwest of the park.

Physiographic Location

This park is located in the northeastern portion of the Northern Highland of Wisconsin (fig. 2). More specifically it is in a pitted outwash plain of that highland and therefore abounds in lakes (fig. 3).

Features of Interest

Though some parts of the park are covered with virgin timber, the greater part is covered with second growth timber which has become very attractive. It is the lakes, however, which are the chief attractions for the tourist. In 1879 the lakes of northern Wisconsin were described by F. H. King as follows[1]:

"Nearly all of these lakes, so far as observed, possess the characteristics peculiar to those of broad, morainic belts. They are beautiful sheets of water, clear, soft and deep, encircled by bold, fantastic rims, and dotted with tree-clad island cones of such varied beauty in the autumn season that as one toils in unexpectedly upon them up the rapids of the narrow shaded rivers, he forgets his fatigue and revels in an exquisite

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[1] Martin, Lawrence, The Physical Geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 384, 1916. Dr. Birge of the Biology Division has done considerable research work at Trout Lake.

NORTHERN FOREST STATE PARK

VILAS COUNTY—WISCONSIN

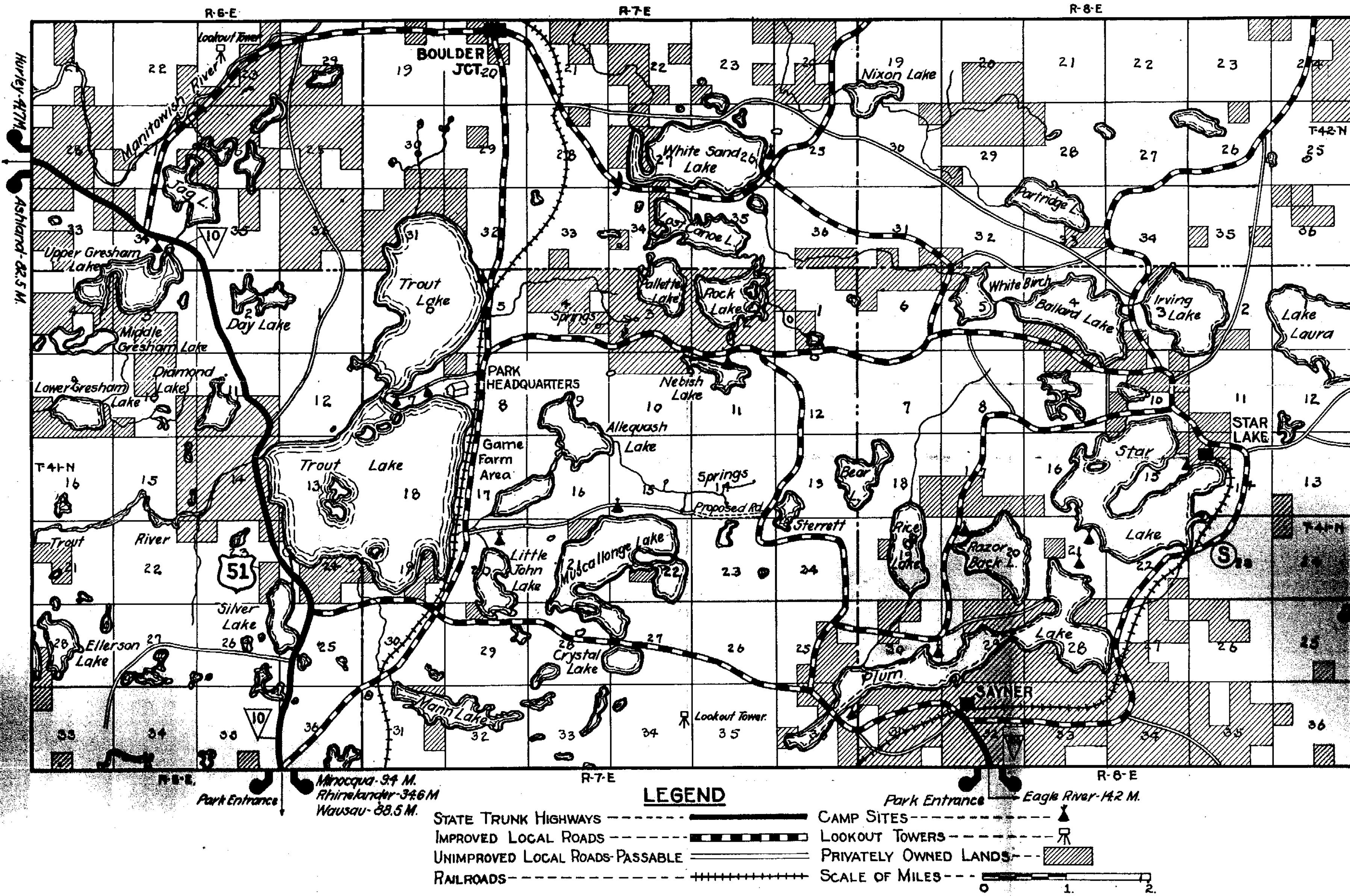
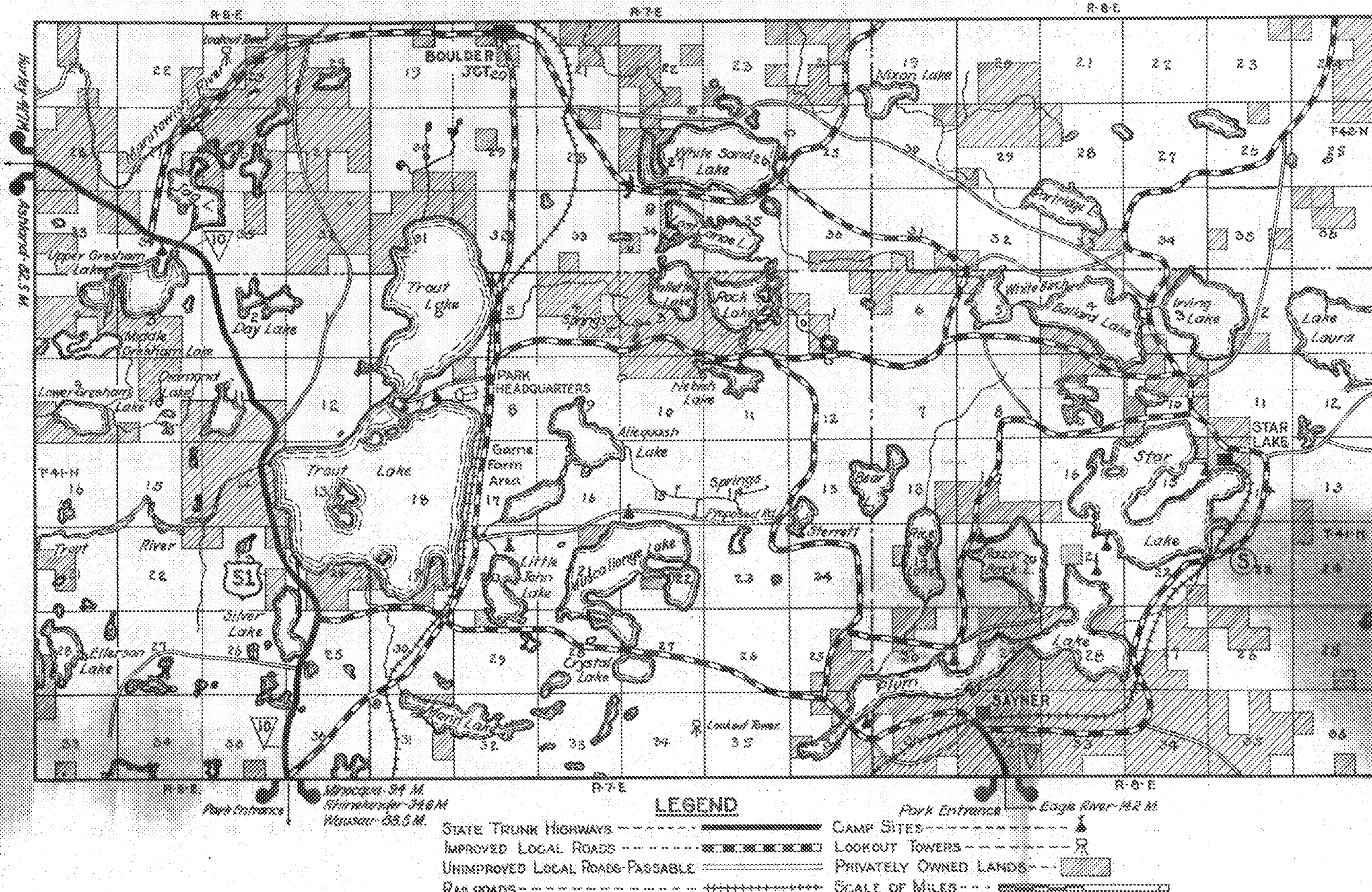


PLATE II

NORTHERN FOREST STATE PARK

VILAS COUNTY—WISCONSIN



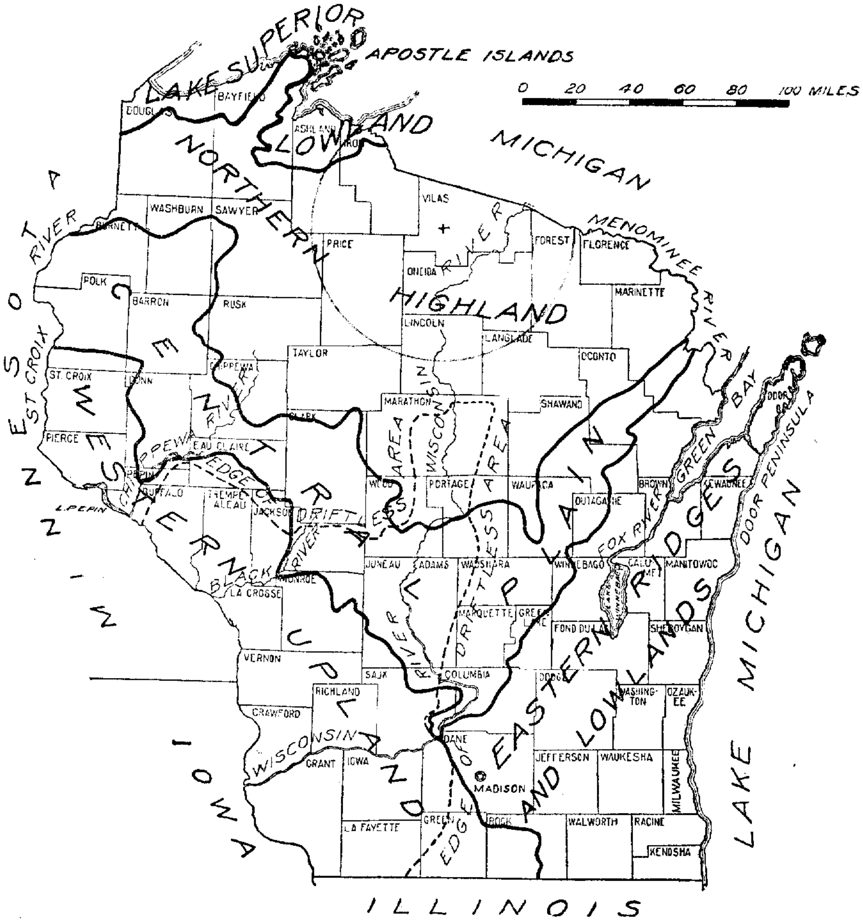


Figure 2.- Northern Forest State Park is located in the Northern Highland of Wisconsin. Courtesy of Wisconsin Geological and Natural History Survey.

RULES AND REGULATIONS FOR STATE PARK LANDS

FOR FIRE PREVENTION: Campers must not leave fires without knowing they are out. Smokers must not throw matches, cigarettes, or pipe ashes where there is a chance of fire starting.

PREVENT FIRES
Leave a
Green Camp and

NORTHERN FOREST STATE PARK
INFORMATION

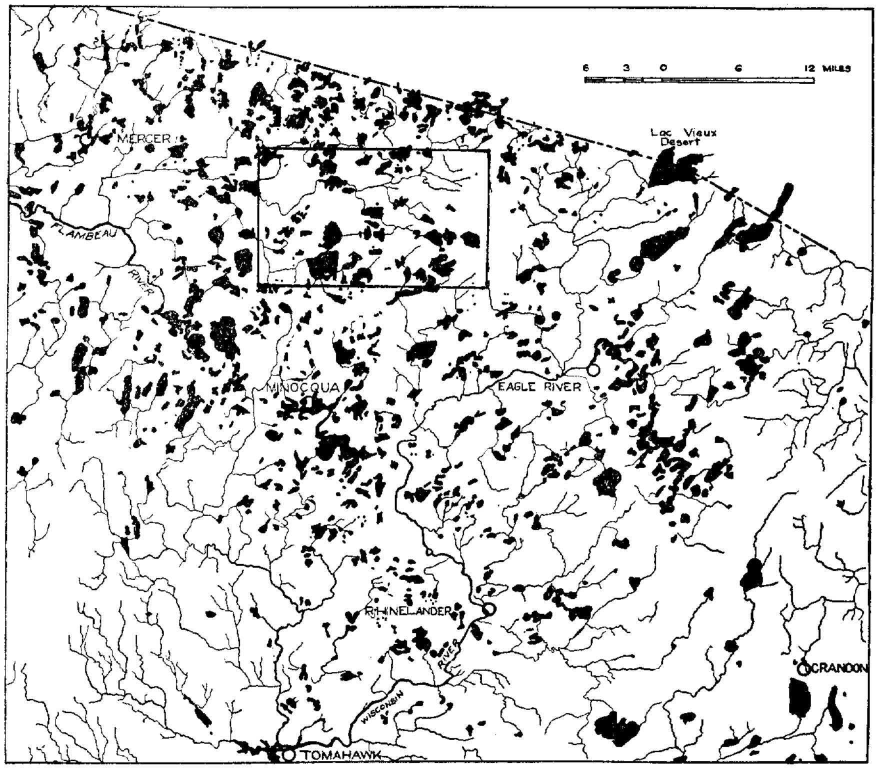


Figure 3 - Northern Forest State Park is located in a pitted outwash plain and therefore abounds in lakes. Courtesy of Wisconsin Geological and Natural History Survey.

garden of foliage plants. Sometimes a fringe of white cedar lies upon the water's edge; higher up a wreath of white birch, then a belt of poplar, and, capping the rounded hilltops, maple and yellow birch, throughout all of which there is a generous setting of rich green white and Norway pines."

Geological History

Although there are no rock exposures in this vicinity, this region is probably underlain by Algonkian[2] granites, gneisses, and schists. Like the rest of Wisconsin this region was peneplained during pre-Cambrian time and was probably covered by sediments during the Paleozoic. In the erosion interval which followed, these sediments were worn away and the surface of the old peneplain was removed.

When the continental glacier passed over this region in the Pleistocene, it carried away the residual soil which had formed from the disintegration of the underlying rocks. When the glacier retreated, it left an uneven surface of drift, in the depressions of which lakes were formed. The largest, Trout Lake, has an area of 6 1/2 square miles[3].

Geology

This region is underlain by Algonkian granites, gneisses, and schists which are covered by a deep mantle of glacial drift. The surface is dotted with lakes whose origin has been described by Martin as follows[4]:

"They are, as a rule, small lakes, closely spaced, irregular in outline, and connected by streams which have the most irregular courses. All this is typical of lakes in a glaciated region. These bodies of water are all glacial, but the origins of the lake basins are diverse.

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2 Allen, R. C., and Barrett, L. P., Contributions to the pre-Cambrian geology of northern Michigan and Wisconsin: Michigan Geol. and Biol. Survey Pub. 18, Geol. Series 15, fig. 1, pp. 116-117, 1925.

3 Martin, Lawrence, op cit., p. 388.

4 Idem, p. 390.

Some are in shallow depressions in the ground moraine, some are held in by recessional moraines, and some are in hollows in the outwash gravel plains. The smaller hollows are kettles formed at the close of the Glacial Period by the melting of buried ice blocks. Few, if any, are in glacially excavated rock basins, for this part of the state has the rock ledges deeply buried by glacial drift."

CHAPTER III

DEVILS LAKE STATE PARK

Geographic Location

Devils Lake State Park, Plate III, is located in Sauk County a few miles south of Baraboo. T. H. 123, the Warner Memorial Road, leads from Baraboo to the park.

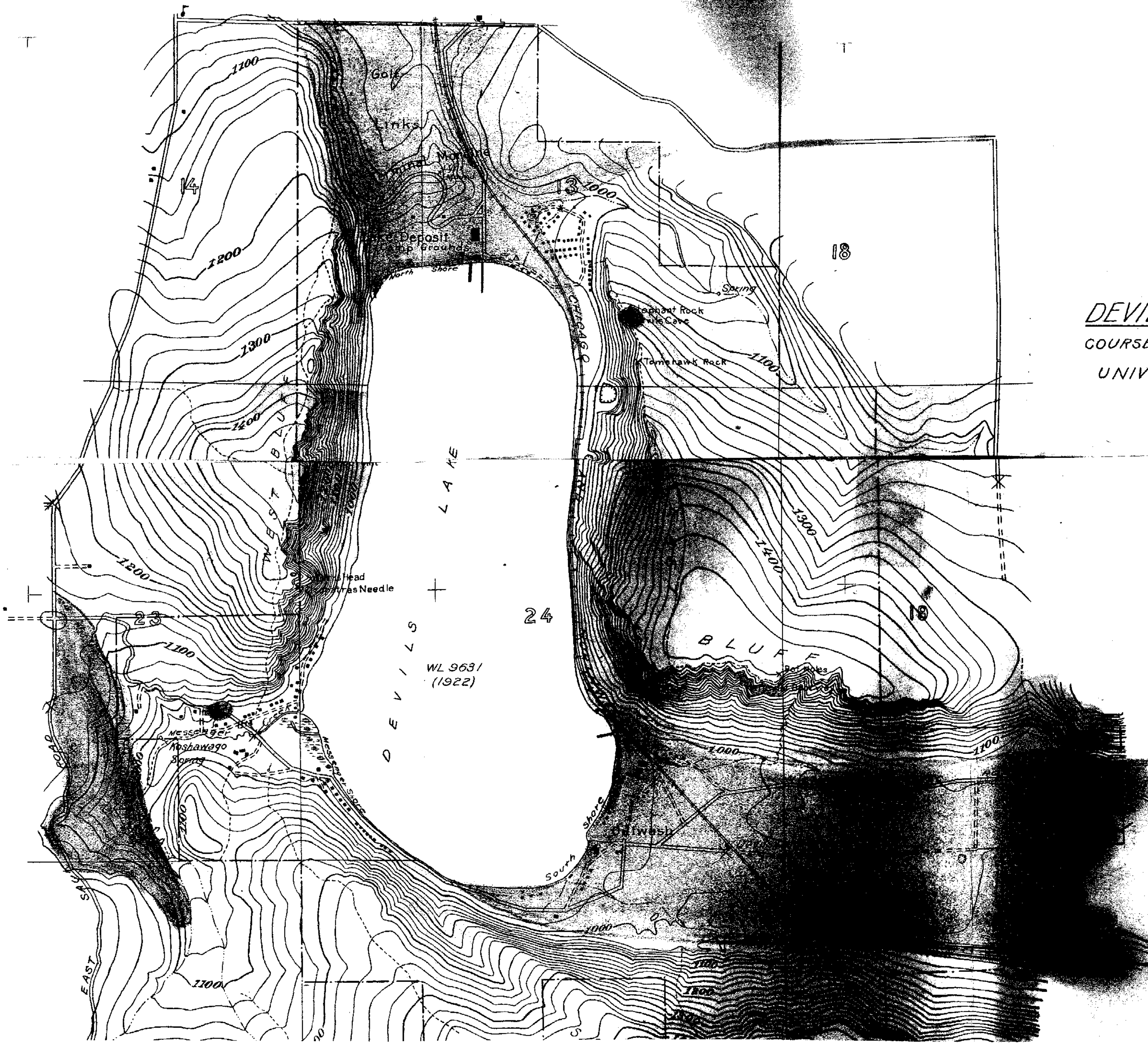
Physiographic Location

Devils Lake State Park is located near the eastern margin of the Western Upland (fig. 4). At this point the boundary of the glaciated area has a peculiar configuration due to the retardation of the ice advance by the East Bluff and the waning of the glacial period before the bluff was covered (fig. 5).

Features of Interest

The observer who has studied the geological history of the region is able to gain a great deal of pleasure from his trip through the park. When he walks over the level ground at the north end of the lake, he realizes that he is walking on an outwash plain and in his imagination he can see the glacial front a short distance to the north. When he ascends the East Bluff, he realizes that the steep walls are those of an old river valley. Devil's Doorway (fig. 6) was caused by the falling away of the angular blocks which once surrounded it.

When he reaches the summit of the East Bluff, he can picture several scenes. He can imagine the preglacial Wisconsin about 1,000 feet below; he can imagine tongues of ice to the north and south and a lake about 180 feet higher than the present and covered perhaps with small icebergs. Today he looks down upon a true mountain lake (fig. 7).



STATE PARK

DEVILS LAKE WISCONSIN

COURSE IN PLANE TABLE SURVEYING

UNIVERSITY of WISCONSIN

SUMMER SCHOOL

OF

SURVEY[illegible]

Scale [illegible]

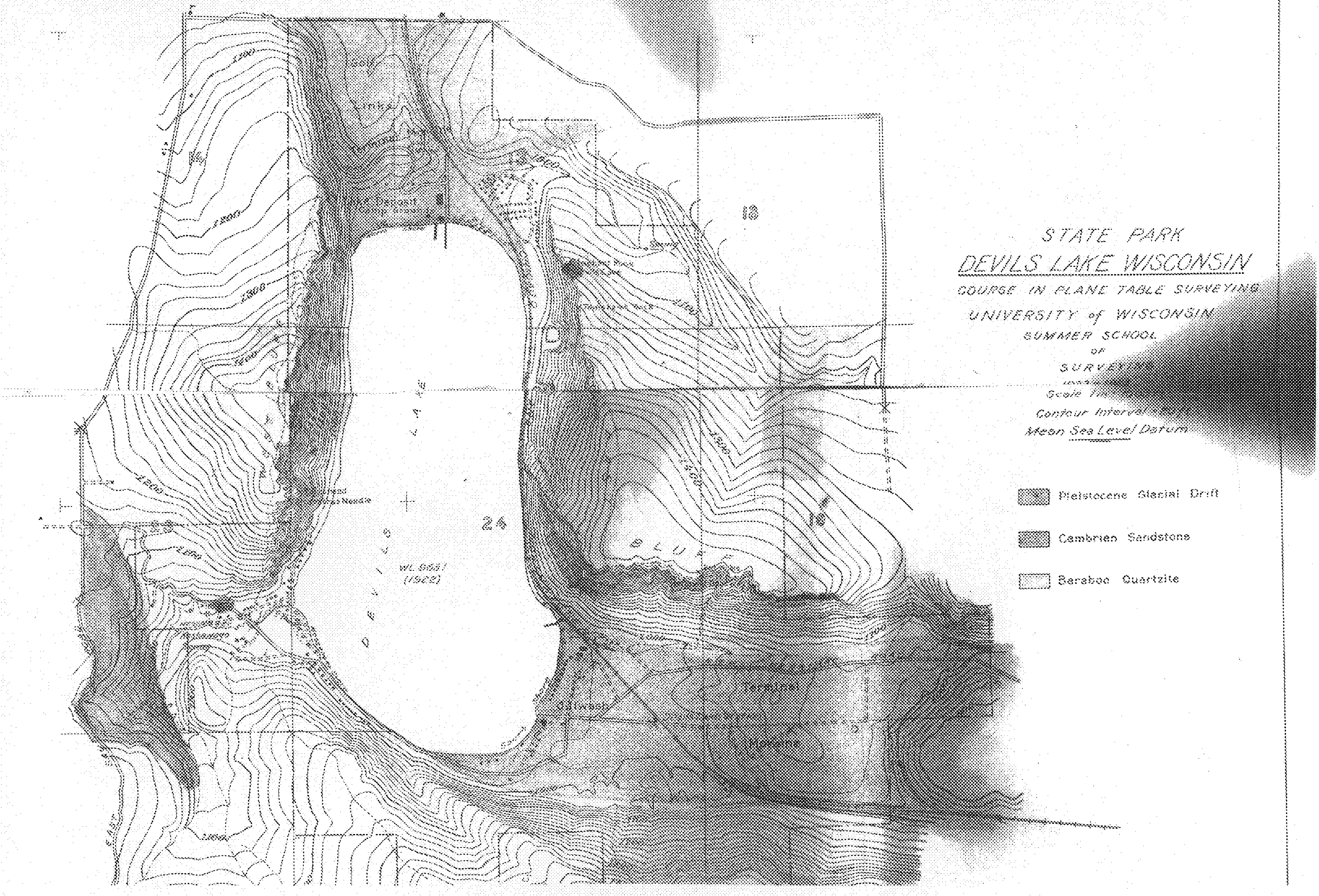
Contour Interval [illegible]

Mean Sea Level Datum

Pleistocene Glacial Drift

Cambrian Sandstone

Baraboo Quartzite



DEVILS LAKE
24
18
W.L. 963.1
(1922)
BLUFF
Terminal
Moraine
Outwash
STATE PARK
DEVILS LAKE WISCONSIN
COURSE IN PLANE TABLE SURVEYING
UNIVERSITY of WISCONSIN
SUMMER SCHOOL
OF
SURVEYING
Contour Interval
Mean Sea Level Datum
Pleistocene Glacial Drift
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Baraboo Quartzite

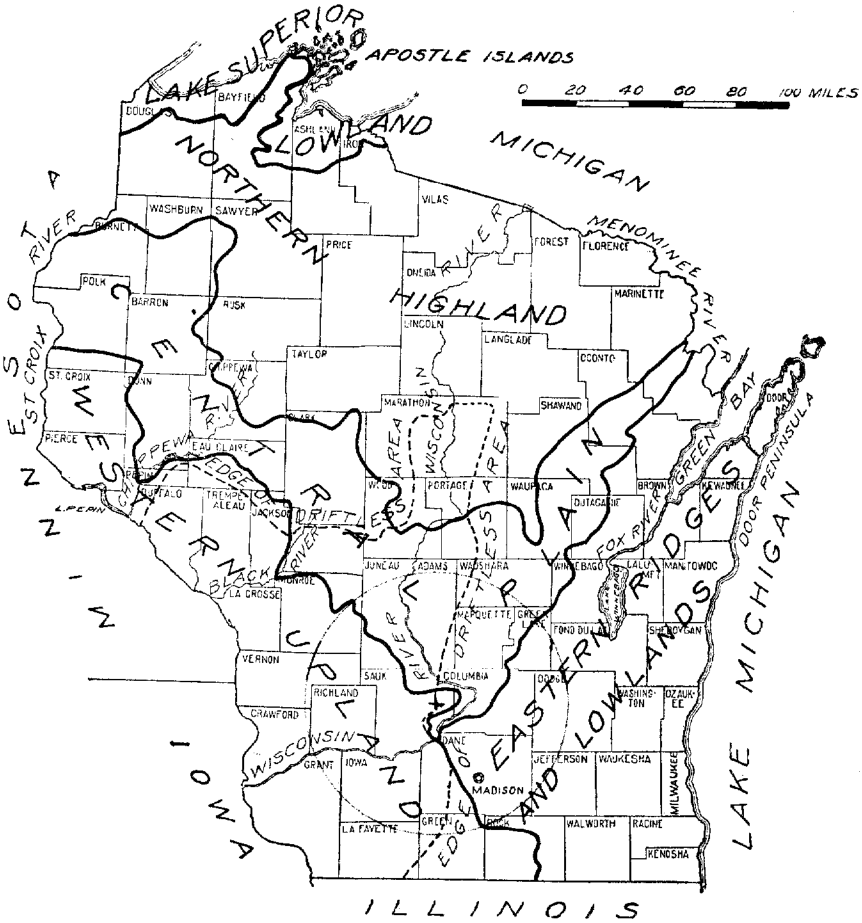


Figure 4. - Devils Lake State Park is located in the Western Upland. Courtesy of Wisconsin Geological and Natural History Survey.

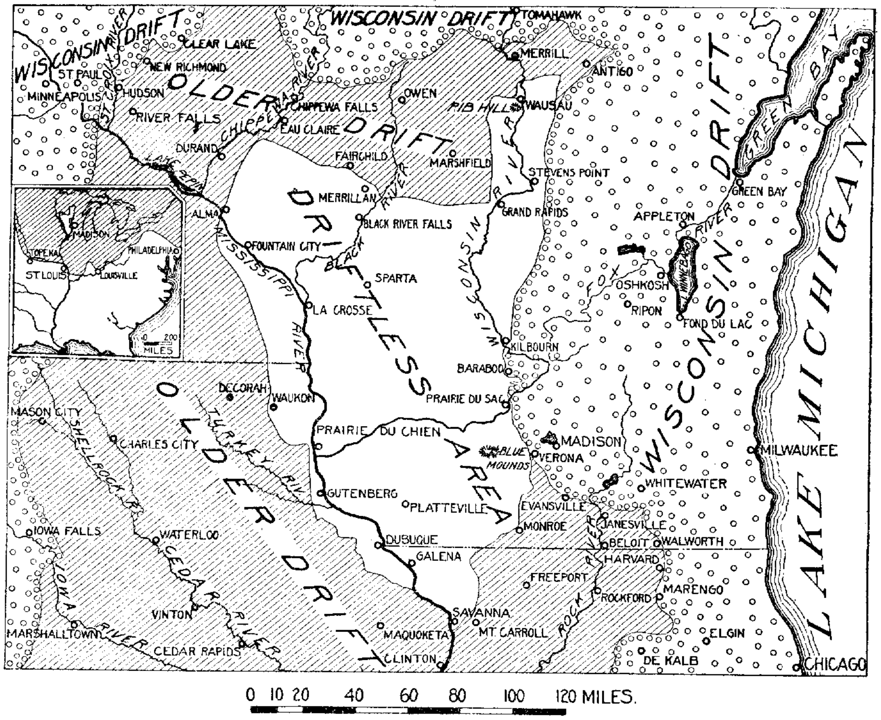


Figure 5.- The boundary of the glaciated area has a peculiar configuration in the vicinity of Devils Lake. Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 6.- Devil's Doorway was caused by the falling away of the angular blocks which once surrounded it.

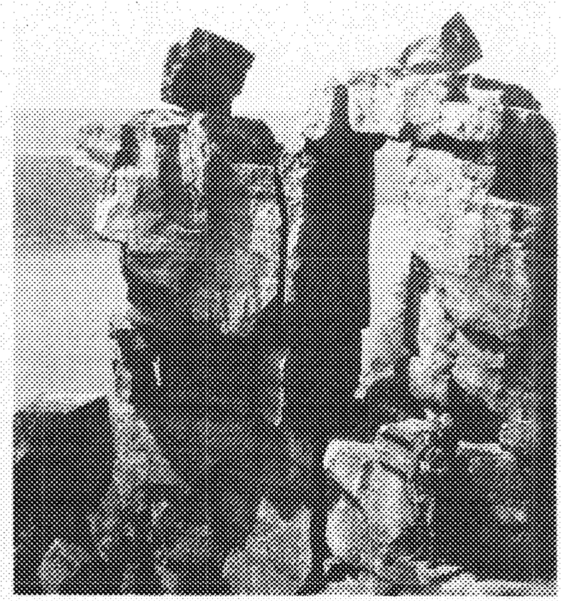
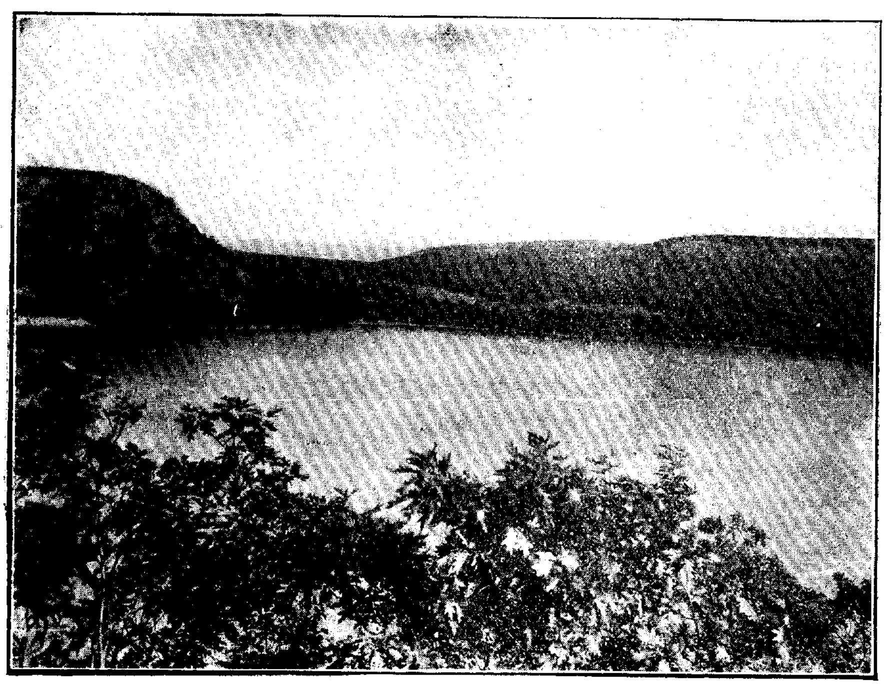


Figure 6.- Devil's Doorway was caused by the falling away of the angular blocks which once surrounded it.

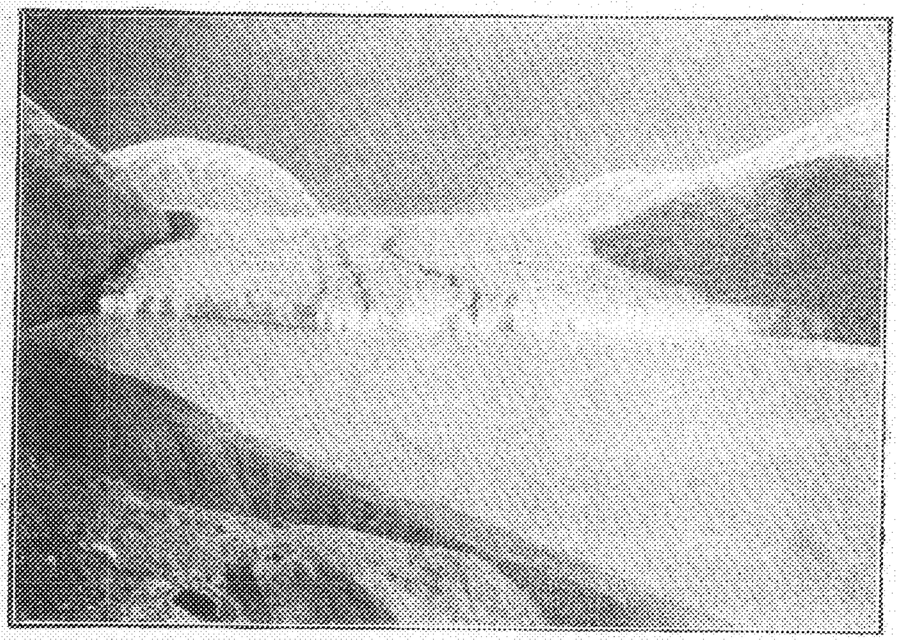
As Devils Lake appeared in glacial times.



Devils Lake today.

Figure 7.- Devils Lake in the past and today. Courtesy of the Wisconsin Geological and Natural History Survey.

DESCRIPTION OF SURFACE FEATURES



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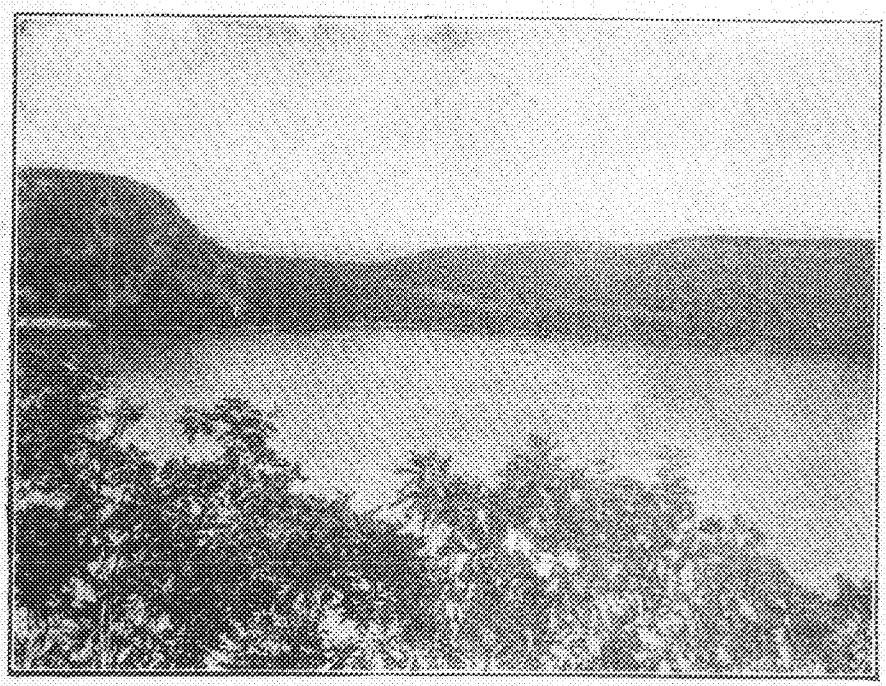

Devils Lake today.

Figure 7.— Devils Lake in the past and today. Courtesy of the Wisconsin Geological and Natural History Survey.

The observer then passes over the other outwash plain and along the Messenger Shore, and climbs the West Bluff. At Koshawago Springs he sees water issuing from the Cambrian sandstone which fills an old pre-Cambrian valley. Turk's Head (fig. 8) and Cleopatra's Needle (fig. 9) like the Devil's Doorway are due to the falling away of the blocks which once surrounded them.

At Prospect Point he will gain another magnificent view of the lake. If he consults his map of the park, Plate III, he will find that the summit of this bluff is at the same elevation as that of East Bluff.

Points of Interest adjacent to the Park

The visitor to this park will not be satisfied with this one glimpse of mountain scenery, but will want to see more. He will tarry long enough to see the glens, Parfrey's and Dorward's (fig. 10) in the South Range, and Fox Glen in the North Range; "Pine Hollow; Pewit's Nest; the post-glacial gorge of Skillet Creek southwest of Baraboo (fig. 11); the Natural Bridge in the sandstone two miles north and a little west of Denzer (fig. 12)[1]."

Geological History

In interpreting the history of any region the geologist begins with the present and traces that history back step by step. In the Devils Lake region he has traced it back to pre-Cambrian time.

In this discussion the writer will begin with pre-Cambrian time and trace the development of this region down to the present. In that part of pre-Cambrian time which geologists call the Huronian Wisconsin lay beneath

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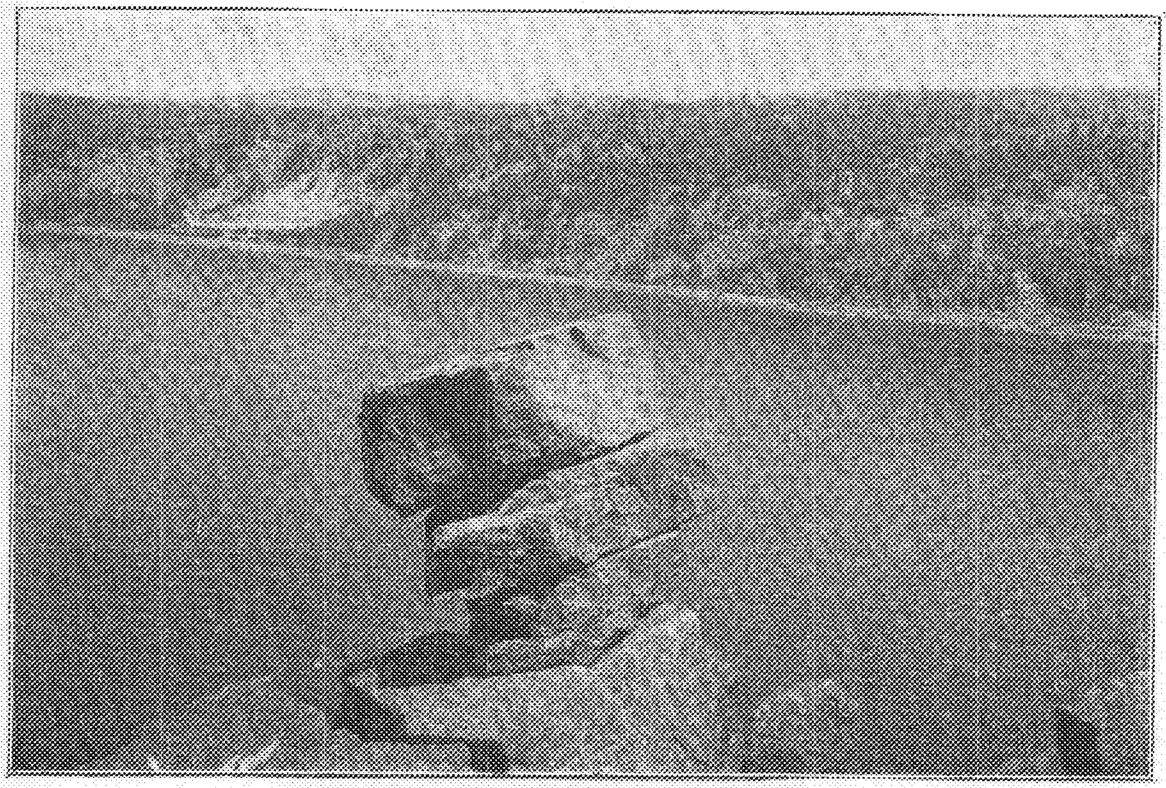
1 Bean, E. F., Description of the surface features of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 67, p. 22, 1925.

Figure 8.- Like the Devil's Doorway, Turk's Head is the result of erosion in the quartzite. Courtesy of the Wisconsin Geological and Natural History Survey.



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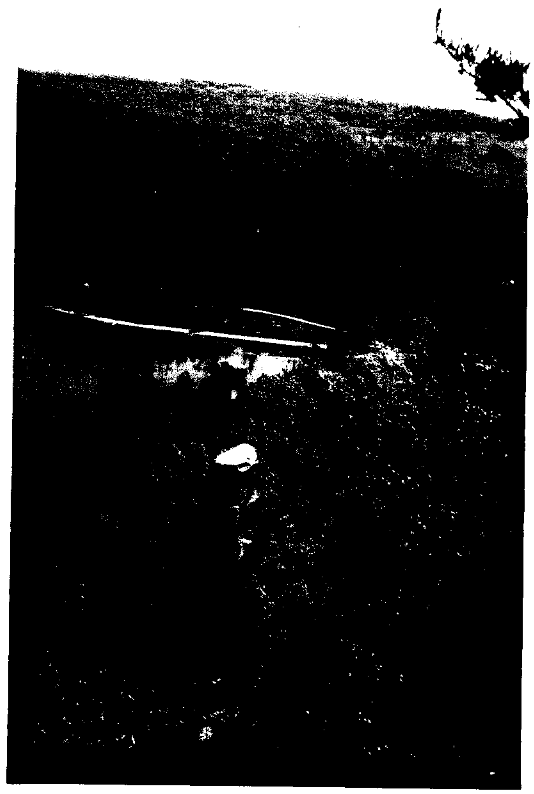
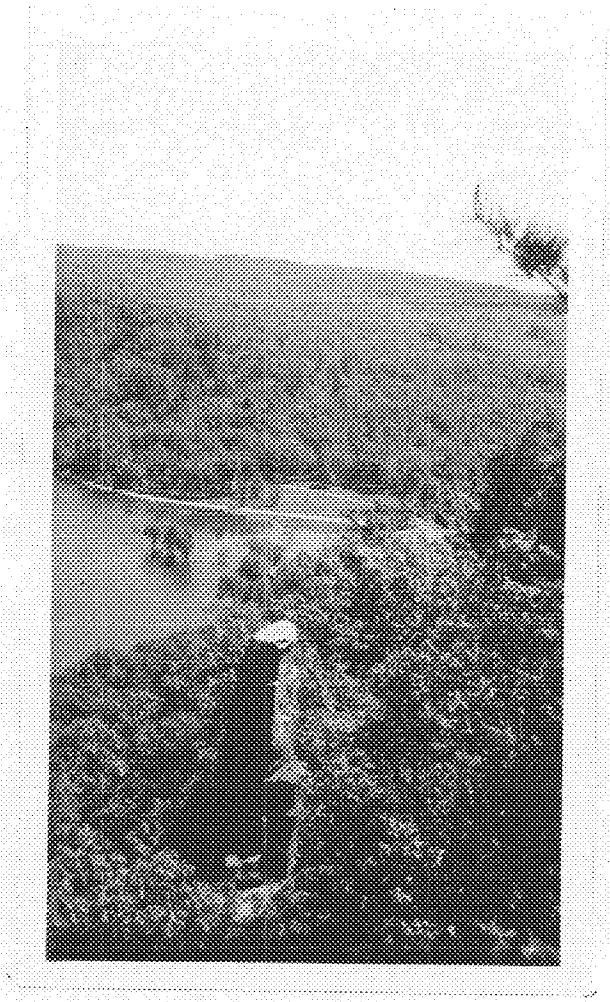


Figure 9.- Cleopatra's Needle is the result of erosion in the quartzite. - Courtesy of F. T. Thwaites.



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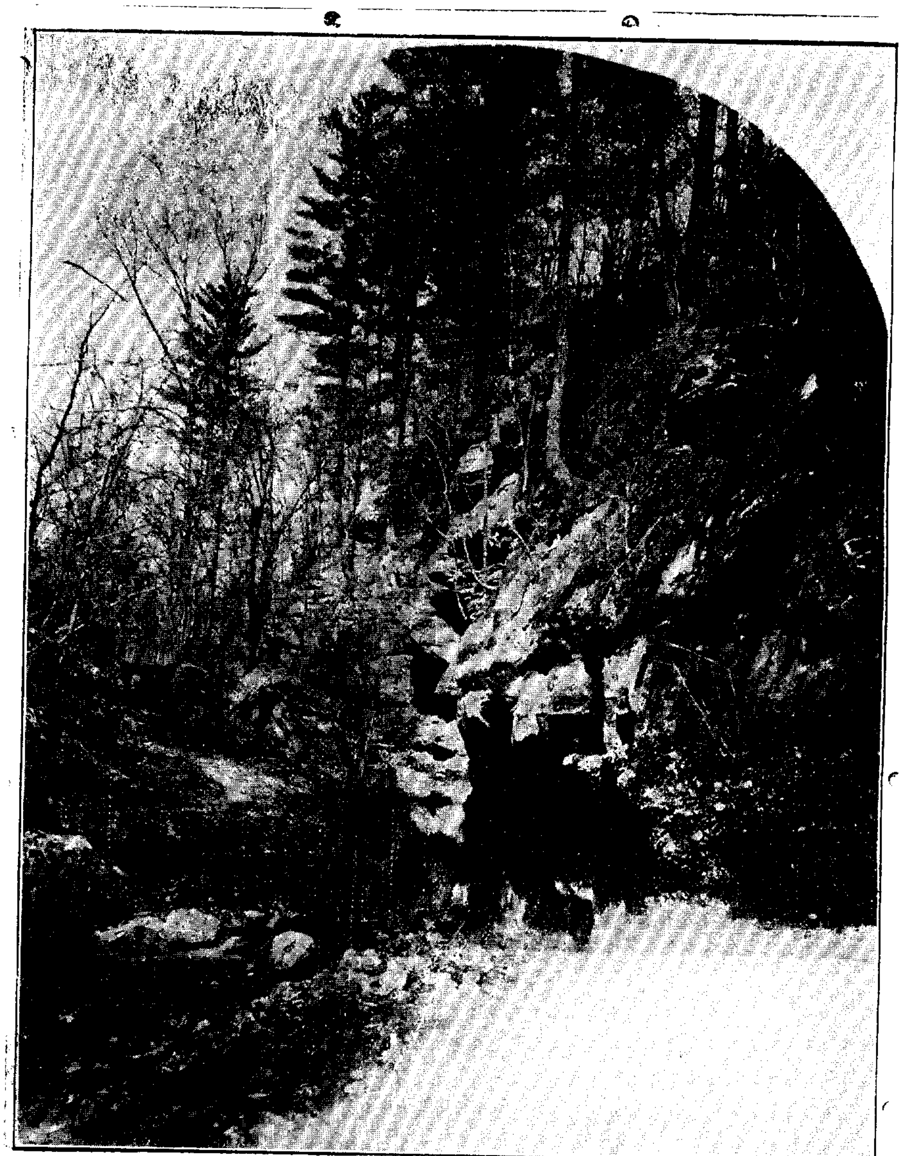
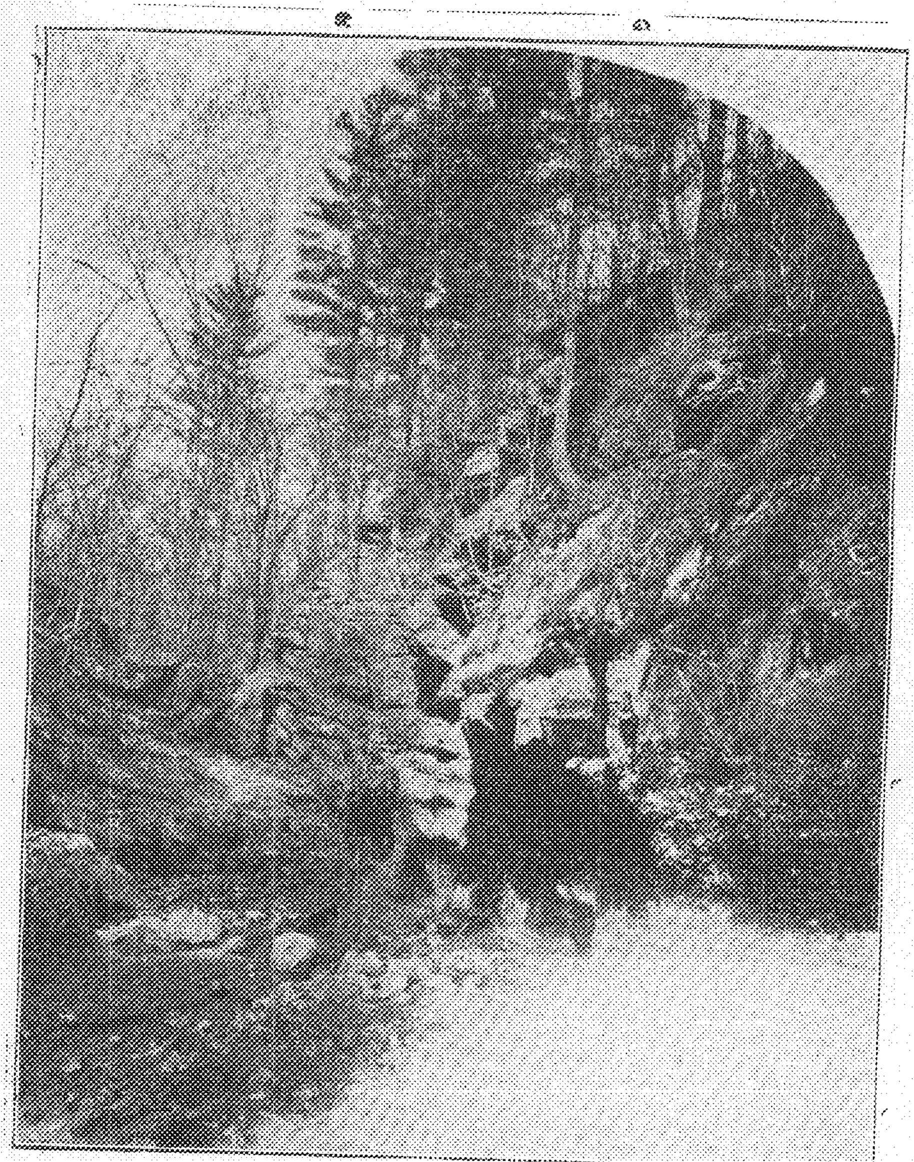


Figure 10.- Dorward's Glen. The basal conglomerate of the Cambrian formation is shown at the lower right-hand corner, and is overlain by sandstone. - Courtesy of the Wisconsin Geological and Natural History Survey.



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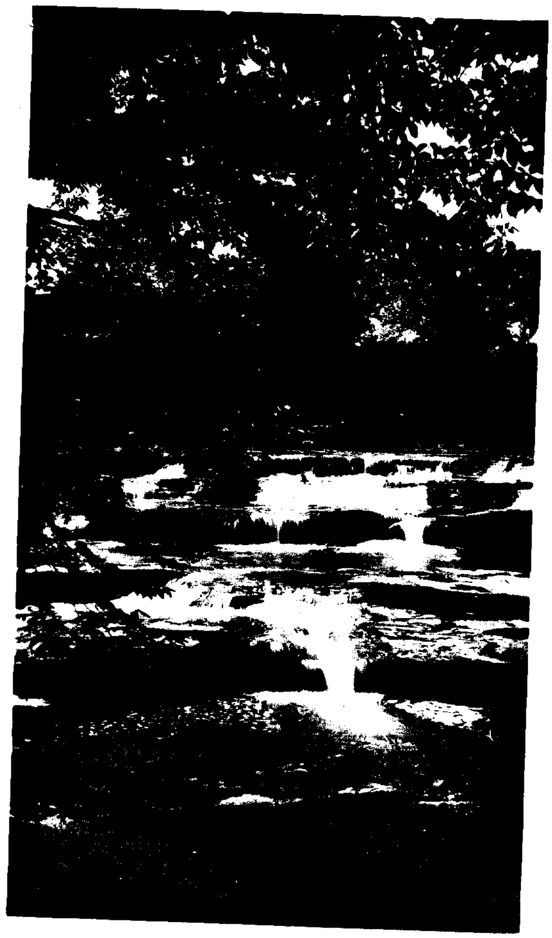
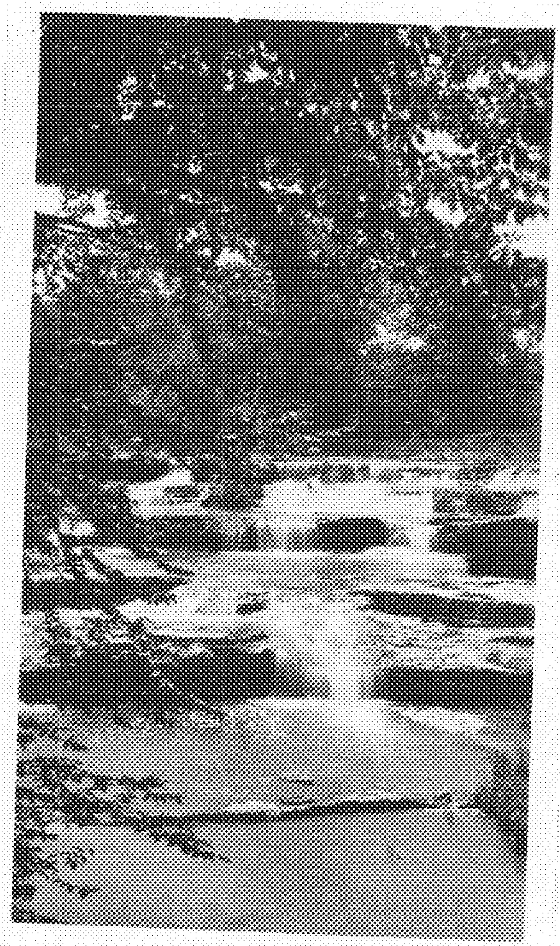


Figure 11. Skillett Falls is due to inequalities in the hardness of the layers of the Cambrian sandstone. - Courtesy of F. T. Thwaites.



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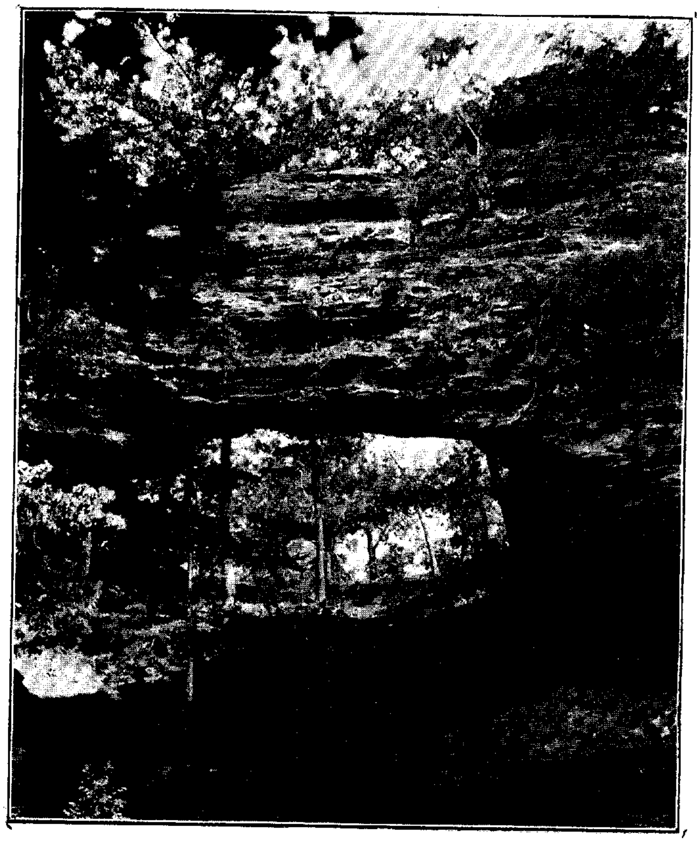

Figure 12.- The Natural Bridge at Denzer is the result of unequal weathering in the Cambrian sandstone. - Courtesy of the Wisconsin Geological and Natural History Survey.

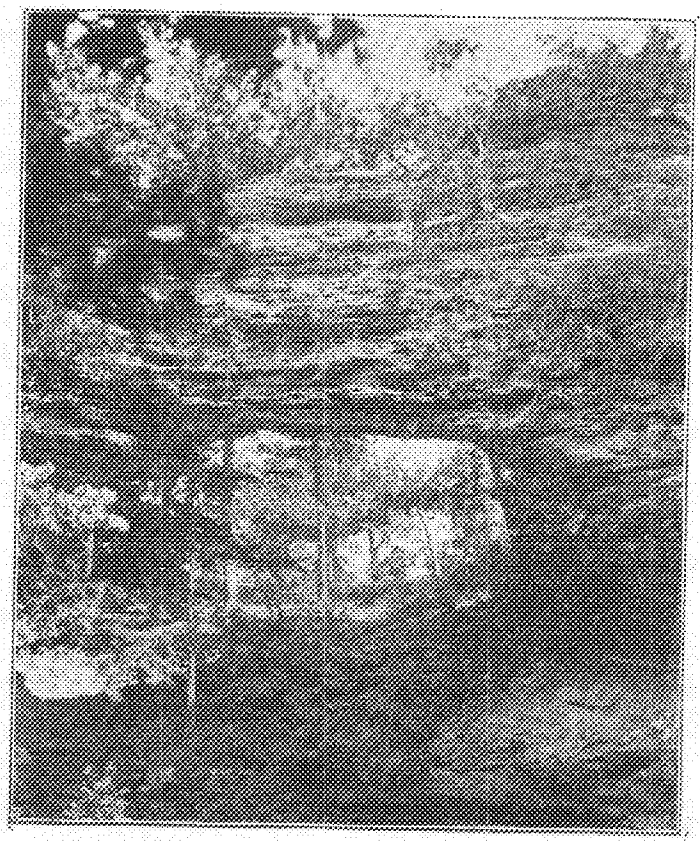

Figure 12.- The Natural Bridge at Denzer is the result of unequal weathering in the Cambrian sandstone. - Courtesy of the Wisconsin Geological and Natural History Survey.

the sea and sediments were being deposited upon the old Archean rocks (figs. 13 and 14). The sea was at first shallow and became progressively deeper.

At this point it may be well to state how the geologist reads this history of the pre-Cambrian sea from the rocks. In the present oceans the sediments are segregated in accordance with their weight. As the sands are relatively heavy, the water cannot carry them far and therefore deposits them in shallow depths where ripple marks develop. The finer sediments known as silts or clays the water is able to transport a greater distance and therefore deposits them in deeper water. Finally the chemical sediments such as calcium carbonate, the main constituent of limestone, are deposited in the deepest water. To return to the pre-Cambrian sea, the first sediments were sands in which ripple marks are still preserved and in the light of what is occurring in our present oceans these sands indicate shallow water. The next were clays and indicate deeper water; the last were chemical precipitates and indicate still deeper water.

Wisconsin was then raised above the sea and waters which carried silica in solution circulated among the sand grains and deposited the silica about them until all the spaces or interstices were filled. The rock was then no longer a sand or sandstone, but a quartzite.

The quartzite and the sediments above it were then folded into mountains (fig. 15). In the adjustment of the heavy beds of quartzite consequent to this folding one bed in places slipped along on the surface of another and formed a zone of shear or of schistose rock[2]. Figure 16 is a

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[2] Salisbury, R. D., The geography of the region about Devil's Lake and the Dalles of the Wisconsin with some notes on its surface geology: Wisconsin Geol. and Nat. Hist. Survey Bull. 5, p. 17, 1900.

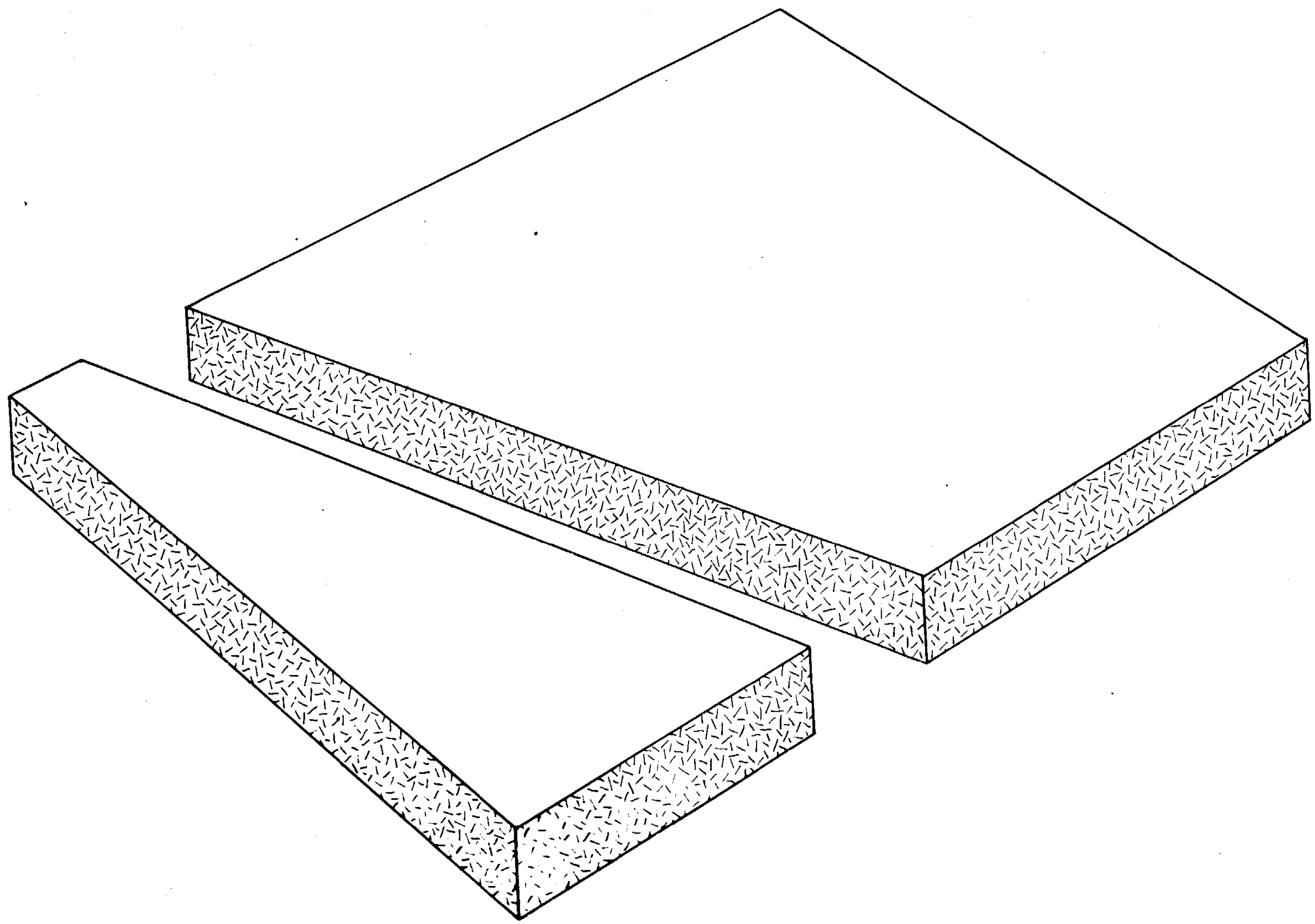

Figure 13.- This block represents the old Archean basement of complex igneous and metamorphic rocks. - Courtesy of Dr. Guy-Harold Smith.

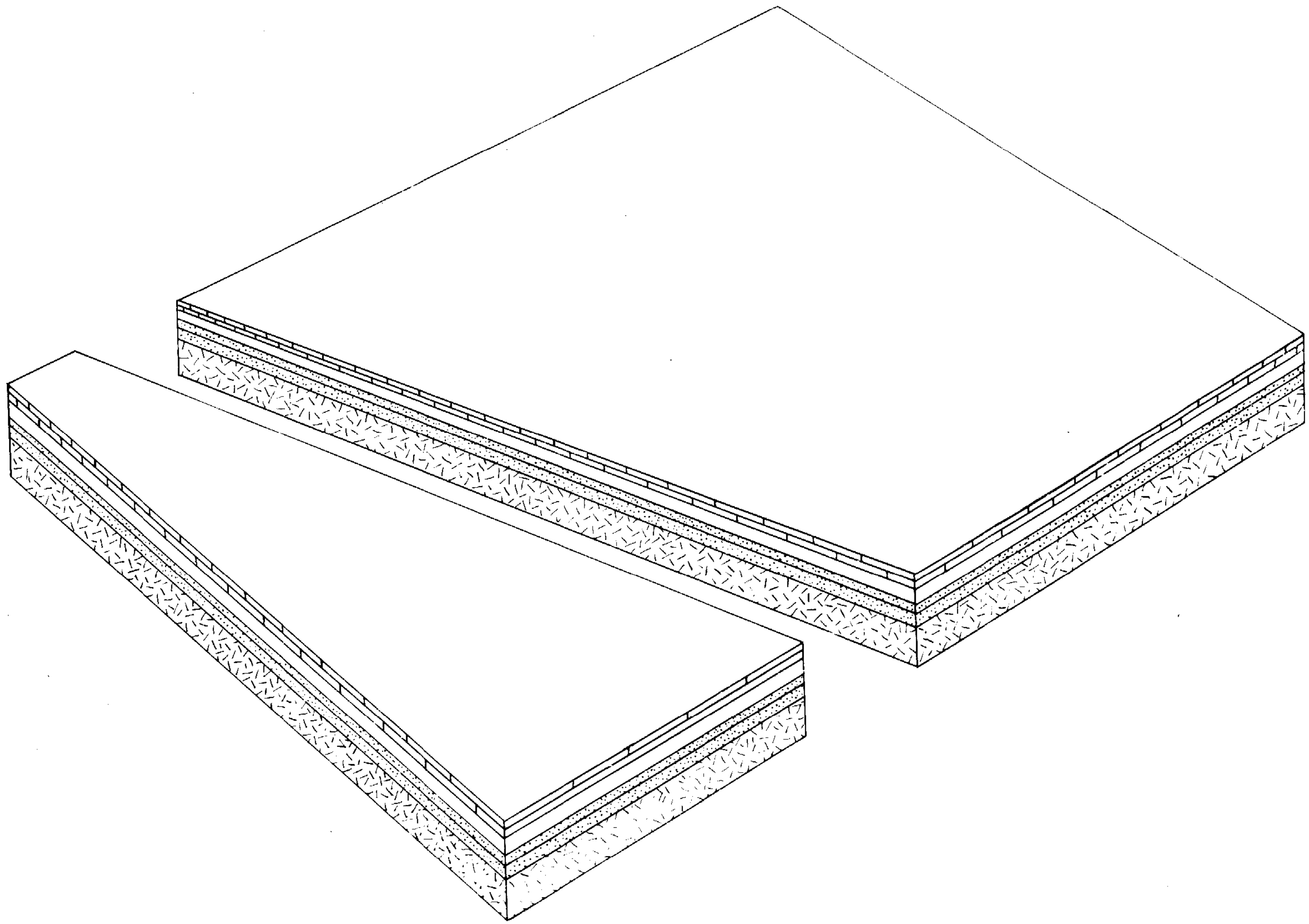

Figure 14.- The Algonkian sediments were deposited upon the old Archean rocks. - Courtesy of Dr. Guy-Harold Smith.

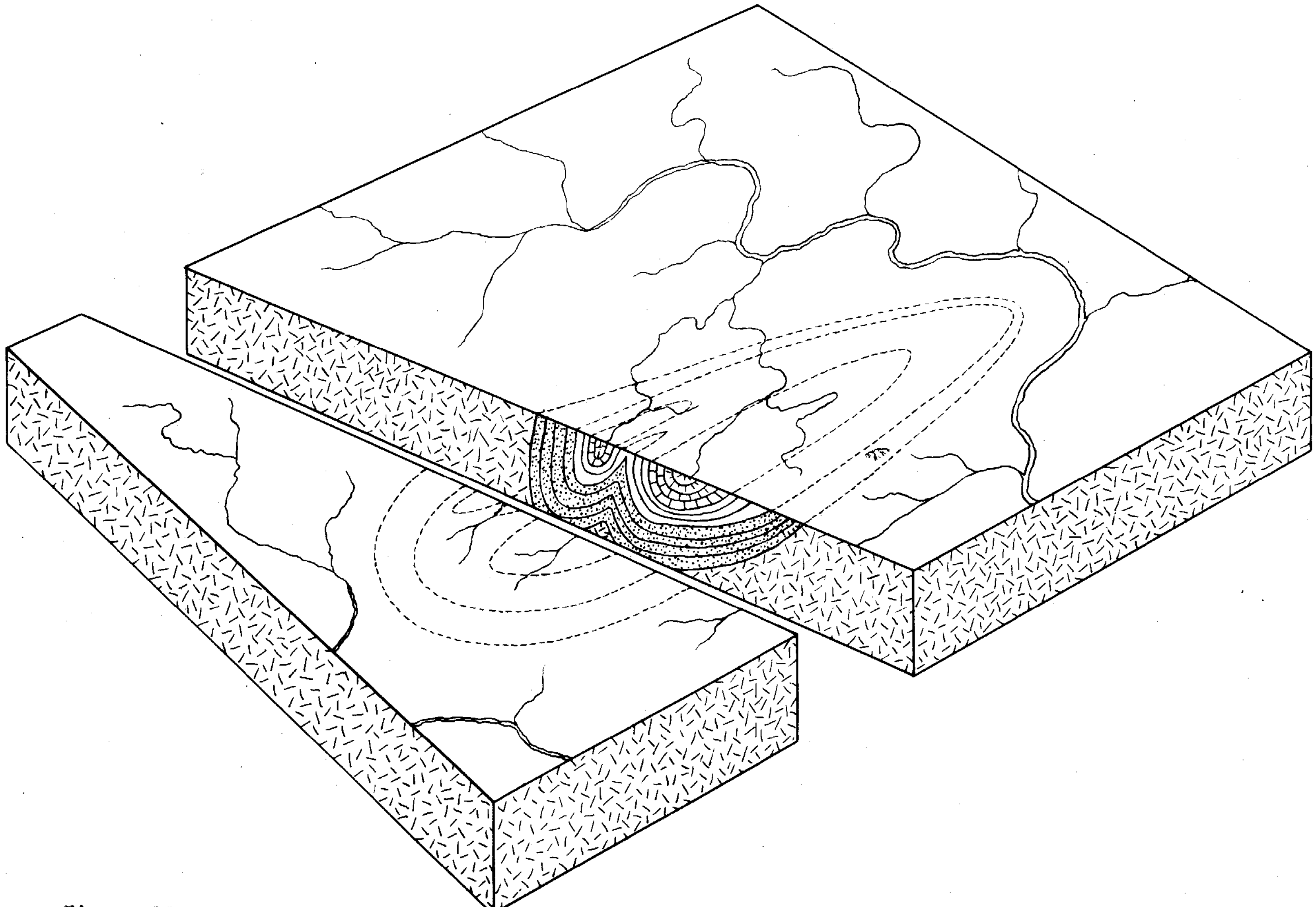

Figure 15-A - The Algonkian sediments were folded into mountains and then worn down to a peneplain, called the "earlier peneplain."

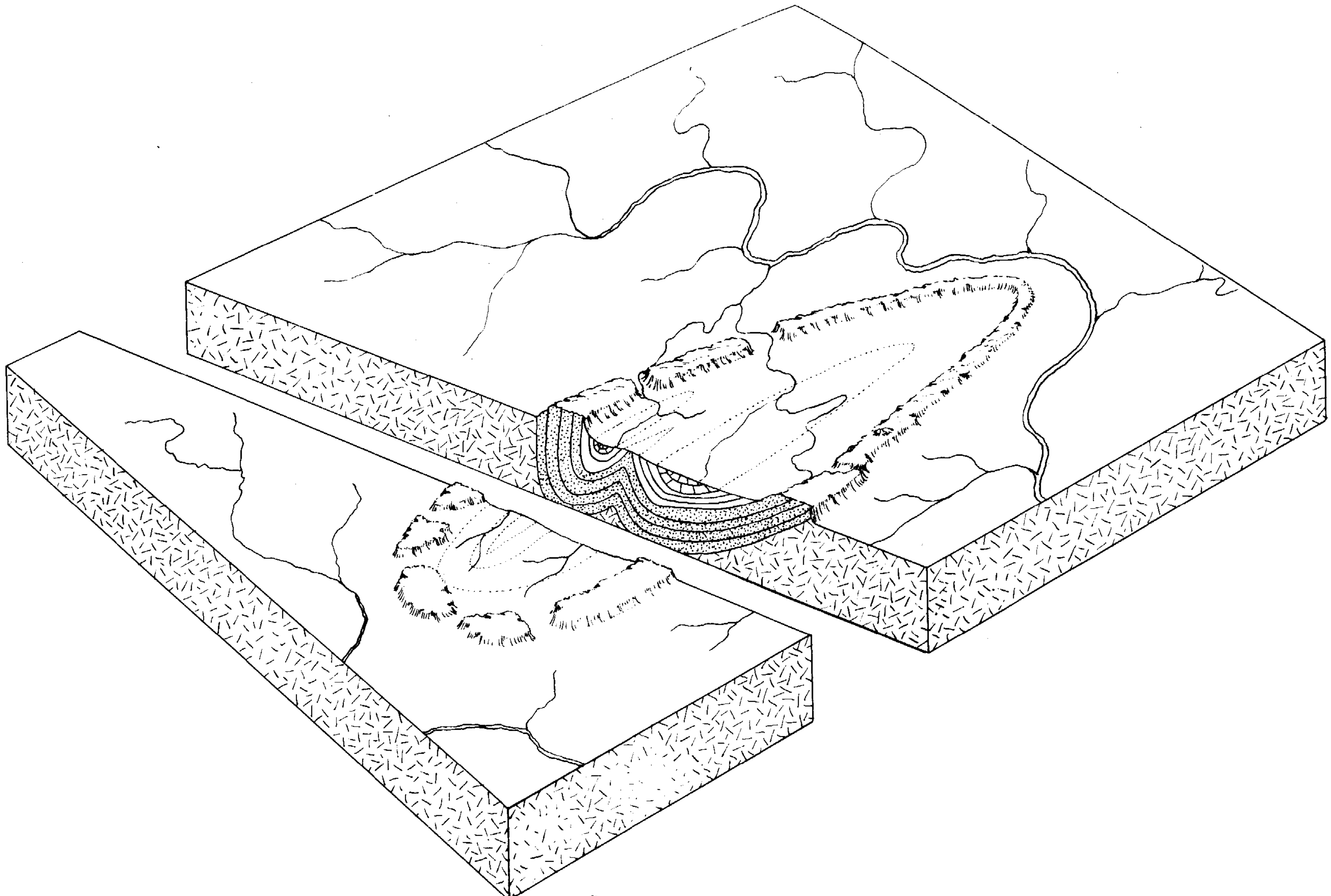

Figure 15-B.- In the development of the pre-Cambrian peneplain the Baraboo Range was notched by valleys but was not worn down to the new base level. It remained as a monadnock upon the pre-Cambrian peneplain. - Courtesy of Dr. Guy-Harold Smith.

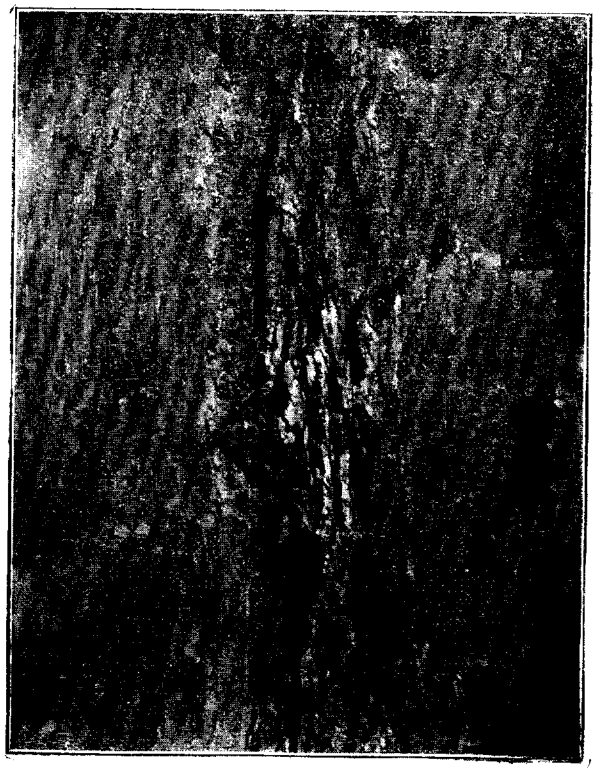

Figure 16. Vertical shear zone in the face of East Bluff at Devil's Lake. Courtesy of the Wisconsin Geological and Natural History Survey.

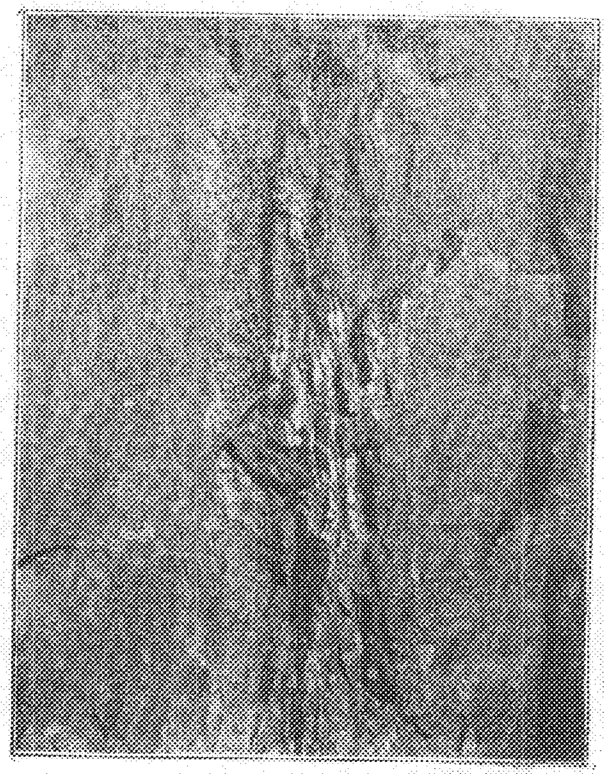

Figure 16. Vertical shear zone in the face of East Bluff at Devil's Lake. Courtesy of the Wisconsin Geological and Natural History Survey.

picture of one of these zones which is exposed on the East Bluff. In some places the quartzite was actually crushed during this folding and was later cemented to form a breccia by the deposition of silica from percolating waters just as occurred before when the sand was changed to quartzite. A section of this breccia is shown in figure 17.

The processes of weathering which began as soon as the area was raised above sea level were much more active upon the tops of these pre-Cambrian mountains or anticlines than they were upon the valleys or synclines because erosion carried the material away from the tops as soon as it was loosened whereas in the valleys it remained for long periods and formed a protecting cover. These processes of weathering and erosion finally wore down the mountains and produced a peneplain which beveled across the tops of the bluffs. This peneplain surface is shown in figure 18. A close examination shows clearly that this surface bevels across the strata. During the next erosion interval when the pre-Cambrian peneplain[3] was developed over Wisconsin the bluffs were not worn down to the new level but were notched with valleys (fig. 19). It also seems probable that there was a low divide in the center of the present Devils Lake depression (fig. 18) from which one stream drained to the north and another to the south. The latter joined the main stream which probably flowed to the southwest through the valley in which Koshawago Springs is now located[4].

The Cambrian sea then advanced over the region and these valleys or gaps became bays in which coarse materials such as the conglomerate of

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3 The earlier peneplain, remnants of which are preserved on the summits of the bluffs, was destroyed with the development of what is known as the pre-Cambrian peneplain.

4 Thwaites, F. T., personal communication.

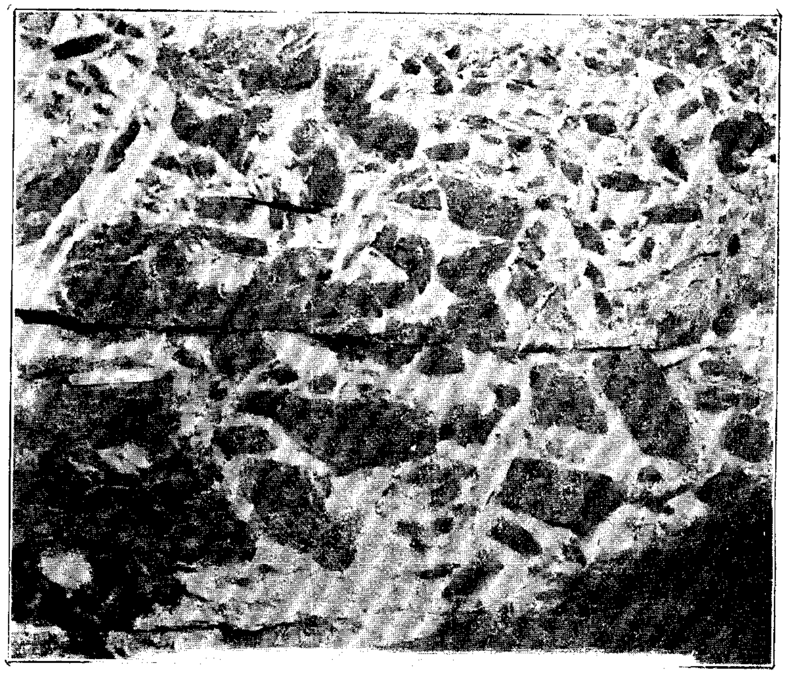

Figure 17.- Brecciated quartzite near Ablemans in the Upper Narrows. The darker parts are quartzite, the lighter parts the cementing quartz. - Courtesy of the Wisconsin Geological and Natural History Survey.

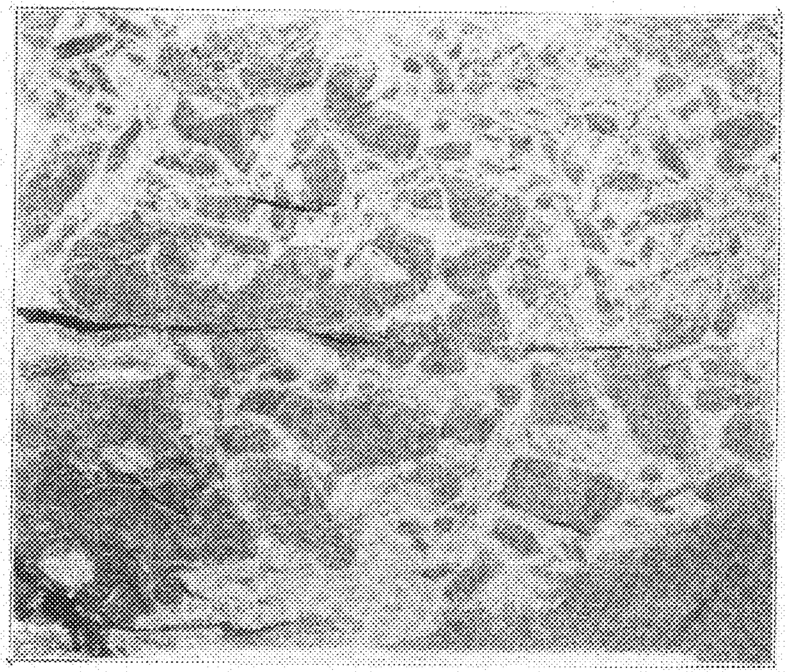

Figure 17.- Brecciated quartzite near Ablemans in the Upper Narrows. The darker parts are quartzite, the lighter parts the cementing quartz. - Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 18.- East Bluff from talus on South Bluff. Point of Rocks may be remnant of old pre-Cambrian divide. The level top is a remnant of the earlier pre-Cambrian peneplain mentioned on page 32. E. 1/2 24, T. 11, R. 6 E. - Courtesy of the Wisconsin Geological and Natural History Survey.

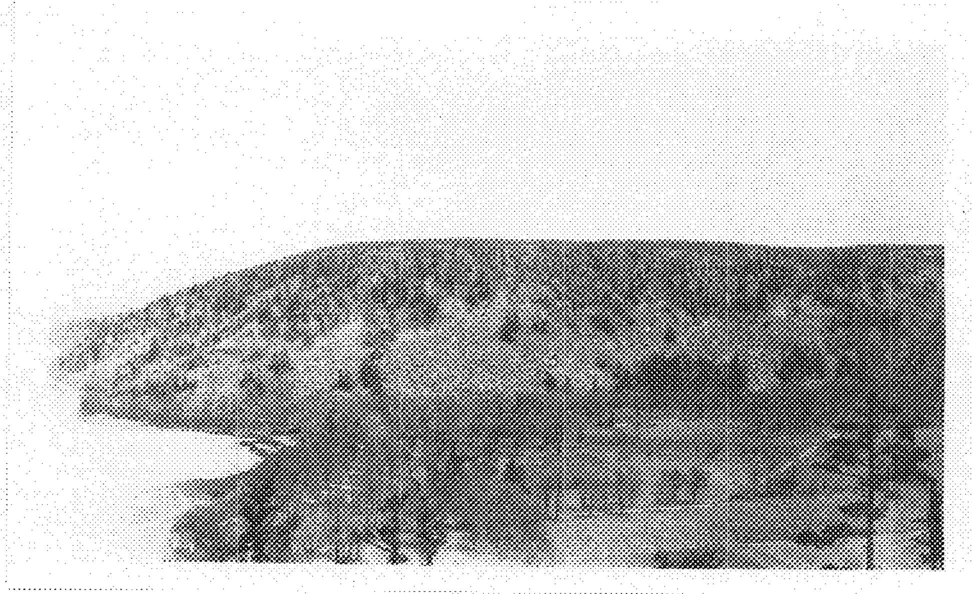

Figure 18.- East Bluff from talus on South Bluff. Point of Rocks may be remnant of old pre-Cambrian divide. The level top is a remnant of the earlier pre-Cambrian peneplain mentioned on page 32. E. 1/2 24, T. 11, R. 6 E. - Courtesy of the Wisconsin Geological and Natural History Survey.

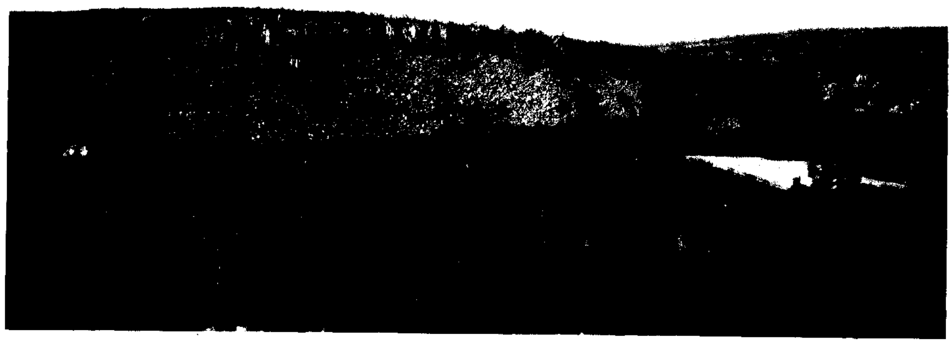

Figure 19.- East Bluff from South Bluff. Shows the earlier peneplain slightly notched by valleys which developed during the erosion of the pre-Cambrian peneplain. Deer Gap on the right is a hanging valley. E. 1/2 24, T. 11, R. 6 E. - Courtesy of F. T. Thwaites.

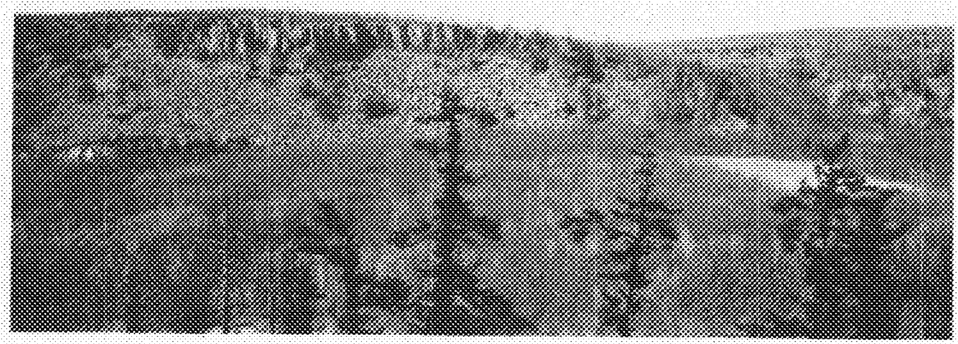

Figure 19.- East Bluff from South Bluff. Shows the earlier peneplain slightly notched by valleys which developed during the erosion of the pre-Cambrian peneplain. Deer Gap on the right is a hanging valley. E. 1/2 24, T. 11, R. 6 E. - Courtesy of F. T. Thwaites.

Dorward's Glen (fig. 10) were deposited. As this sea oscillated in depth, sandstones, shales, and dolomites were deposited. After the deposition of the Lower Magnesian dolomite[5], Wisconsin was raised above the sea, processes of erosion worked upon the surface, and the rivers carved it into a succession of ridges and valleys. When the region again sank beneath the sea, the St. Peter sandstone was deposited on the erosion surface at the top of the Lower Magnesian dolomite. Such a break in the continuity of deposition is known as an unconformity.

With a deepening of the sea the Galena-Black River dolomite, the Maquoketa shale, and the Niagara dolomite were deposited (see geological table, fig. 1, p. 6), figure 20.

At the close of this period of sedimentation Wisconsin was raised above the sea, but in this uplift it was arched into a great dome with its apex at the north. Due to its greater height the surface was attacked by erosion more vigorously at the apex than on the surrounding slopes. As soon as the Niagara was worn away from the summit, erosion worked very rapidly in the soft Maquoketa shale and undermined the Niagara. As a consequence a cliff of the Niagara faced inward toward the center of the dome. As erosion continued, this cliff retreated farther and farther from the center of the dome. Such a cliff caused by the more rapid erosion of the weaker formation in gently dipping strata is known as a cuesta and is illustrated in figure 21.

It is easy to imagine the Niagara and Galena-Black River cuestas retreating past the site of the present Devils Lake. When the next cuesta, the Lower Magnesian, was stripped from the eastern part of the range,it

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[5] Salisbury, R. D., The geography of the region about Devil's Lake and the Dalles of the Wisconsin with some notes on its surface geology: Wisconsin Geol. and Nat. Hist. Survey Bull. 5, p. 31, 1900.

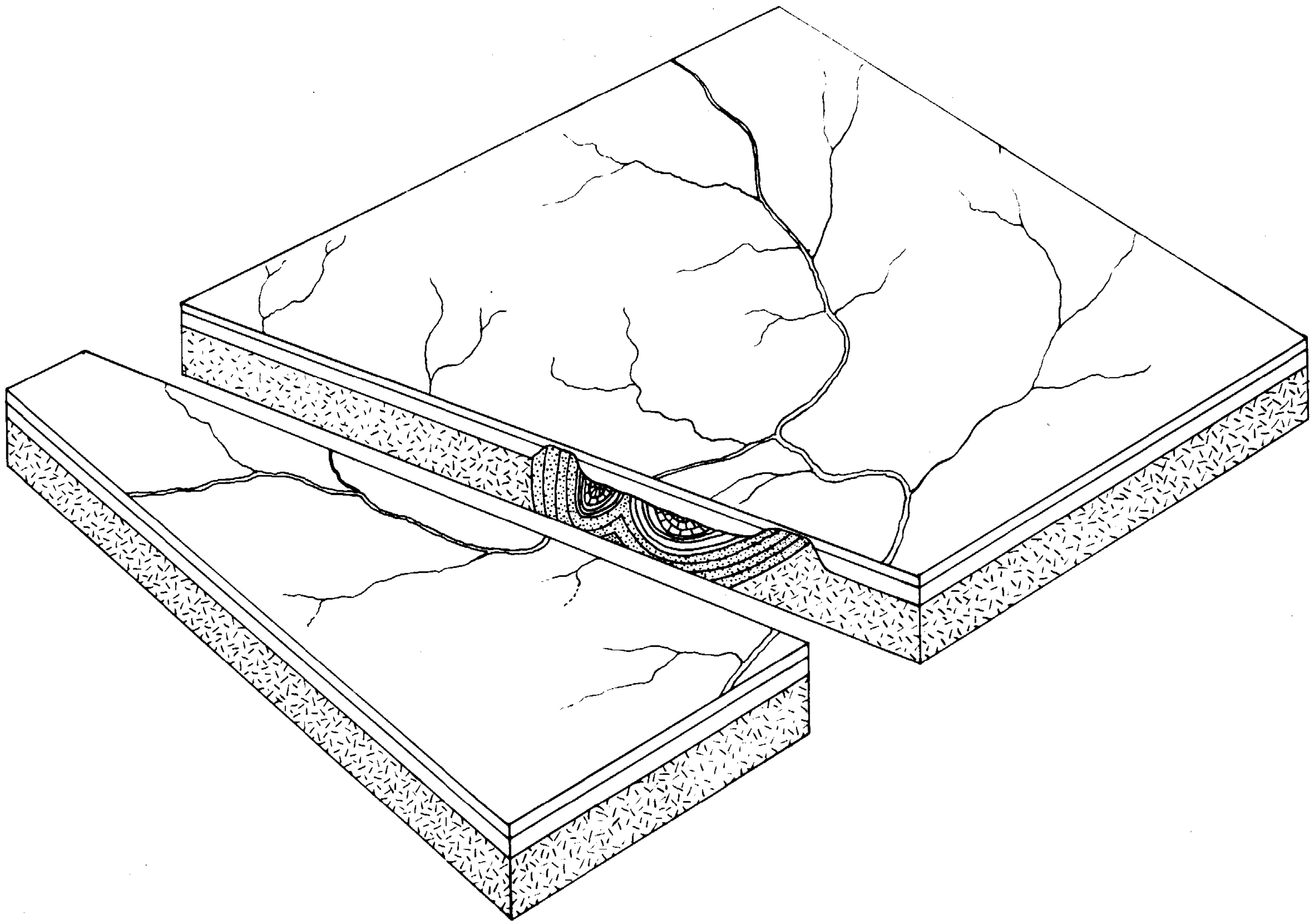

Figure 20.- The Paleozoic rocks were deposited upon the old erosion surface of the pre-Cambrian peneplain. - Courtesy of Dr. Guy-Harold Smith.

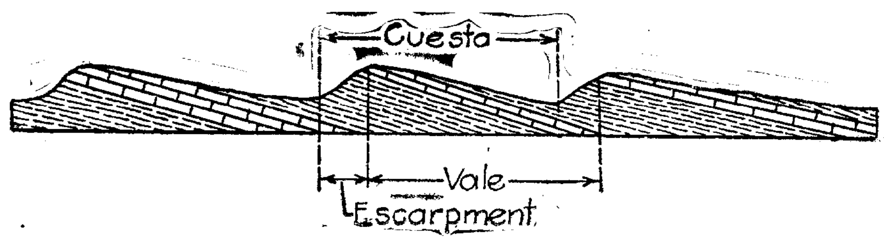

Figure 21. A series of cuestas and escarpments. Courtesy of the Wisconsin Geological and Natural History Survey.

exposed the old Huronian rocks and partially exhumed the old monadnock[6], figure 22. The western part of the range is still covered by Lower Magnesian rocks.

The streams carried some parts of these formations away in solution, others in suspension, and rolled the heavier particles. Some of the resistant parts of these formations or chert pebbles remained and as erosion continued were gradually let down from one layer to the next. Today some of these pebbles may be found upon the East Bluff[7].

As these pebbles were let down from one surface to the next, the ancestral Wisconsin eroded its way through first one formation and then the next. The pot holes which occur on the East Bluff show that at one time the Wisconsin flowed over its crest[8].

The river made little progress in eroding this resistant quartzite, but as time went on it found less resistant Cambrian sandstone a short distance to the west[9]. It is not hard to visualize the way the river "found" the sandstone. As the valley in the sandstone at the base of the quartzite ledge became deeper and deeper, a tributary gully started in a general northwest direction and wore farther and farther back through the

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6 Such an exhumed monadnock is known as a Baraboo.

7 Salisbury, R. D., Preglacial gravels on the quartzite range near Baraboo, Wisconsin: Jour. Geology, vol. 3, pp. 655-667, 1895.

8 Bean, E. F., Description of the surface features of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 67, p. 20, 1925.

9 Salisbury, R. D., The geography of the region about Devil's Lake and the Dalles of the Wisconsin with some notes on its surface geology: Wisconsin Geol. and Nat. Hist. Survey Bull. 5, pp. 62, 68, 1900.

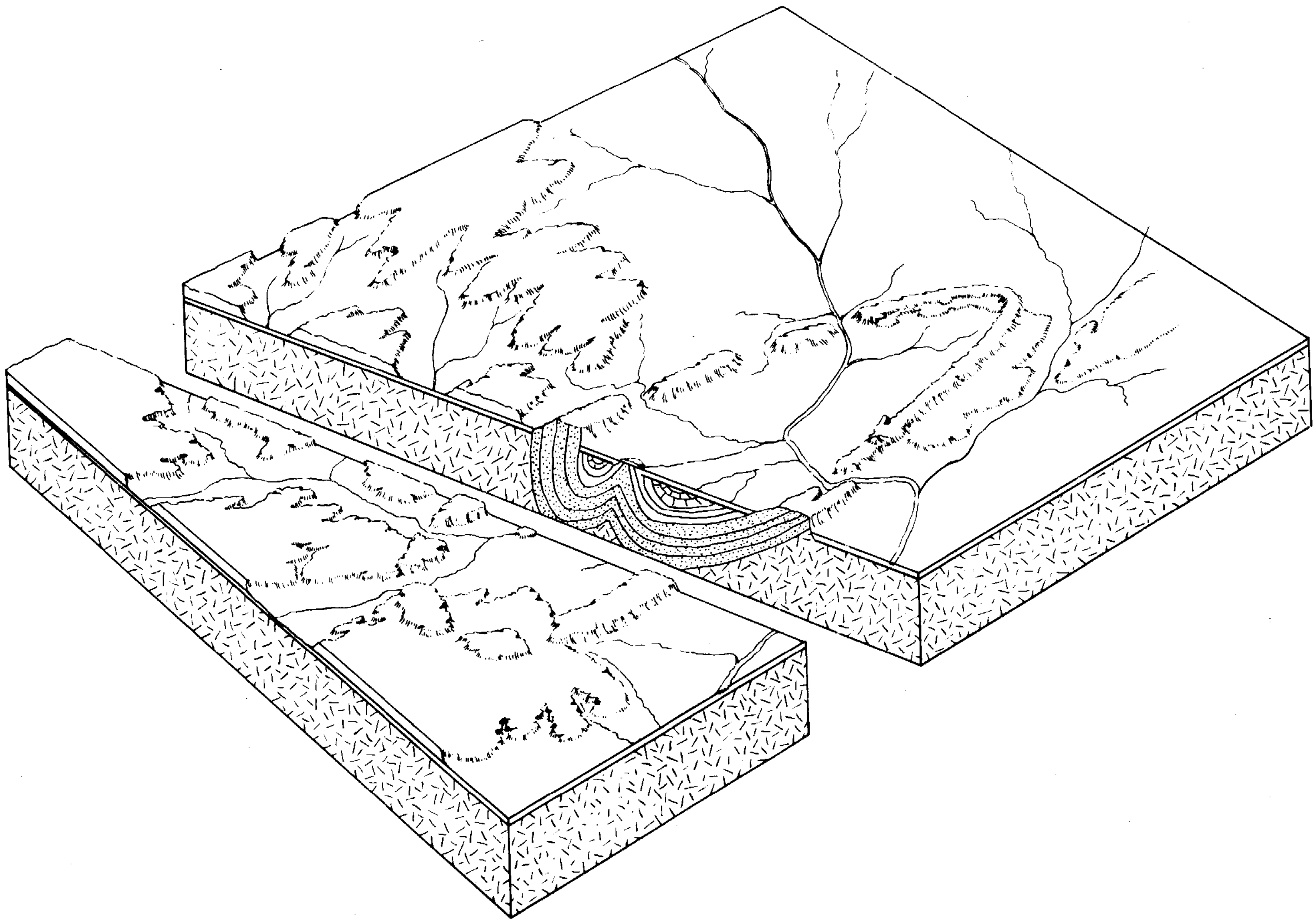

Figure 22.- Before the Glacial Period the buried monadnock (Baraboo Range) was partially exhumed. - Courtesy of Dr. Guy-Harold Smith.

sandstone. As time went on this gully tapped the main stream somewhere north of the summit of the East Bluff and thus became the new channel. Down-cutting then became rapid and the river cleared these sands from the old pre-Cambrian valleys.

During the Illinoian and early Wisconsin epochs one must postulate a vigorous stream, indeed one capable of eroding a valley in resistant quartzite to a depth in excess of 200 feet, for the fresh talus slope and hanging valleys (fig. 19, p.35) indicate that the depression was occupied recently by such a stream. It is probable that the old divide was worn away at this time (fig. 18, p.34).

When the glaciers invaded Wisconsin during the Pleistocene, they followed the paths of least resistance. When the ice sheet encountered the East Bluff, it passed around it rather than over it. The Wisconsin River valley was therefore blocked by one tongue of ice at the present north end of the lake and another at the south end (fig. 7, p. 19). Just when this point was reached the wasting of the glacier exceeded its forward movement and the ice front began to retreat. Had the glacial period lasted longer, the East Bluff would have been overtopped by the ice, figure 23.

When both ends of the lake were blocked by ice, it is thought the lake drained to the southwest. It is probable, however, that the ice withdrew from the north end first,[10] for the moraine is much smaller than the one at Kirkland. The outwash plain is also of limited extent and may be largely the result of wave action. With this recession the lake drained to the north through the gully which the railroad now occupies. With this change in outlet the lake level dropped about 150 feet in consequence of which a more extended plain was developed at the south end, figure 24.

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[10] Loft, G. E., personal communication.

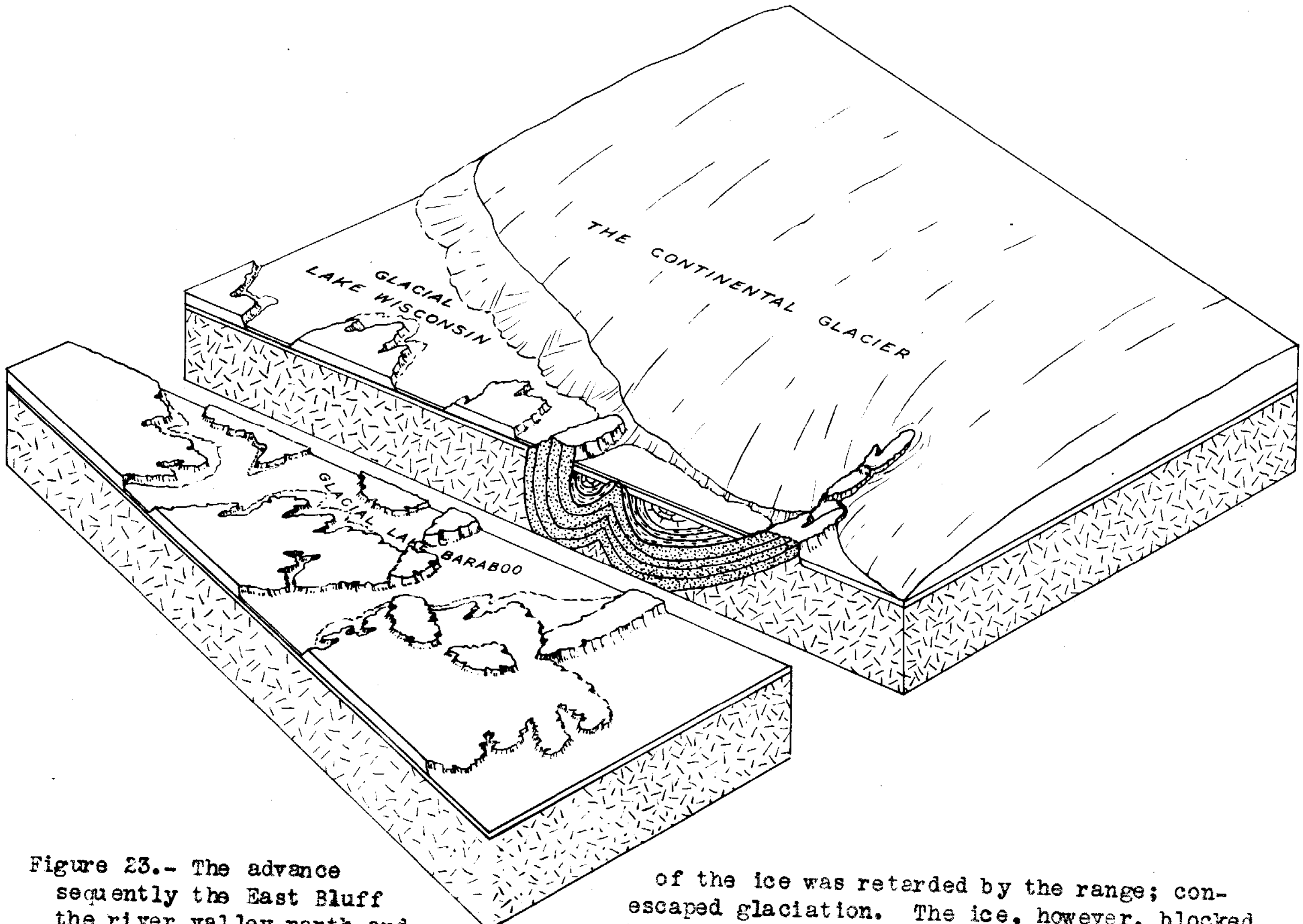


Figure 23.- The advance of the ice was reterded by the range; consequently the East Bluff escaped glaciation. The ice, however, blocked the river valley north and south of Devils Lake. - Courtesy of Dr. Guy-Harold Smith.

Figure 24.- The level summit of the bluff is a remnant of the earlier peneplain. The flat is the Kirkland outwash plain. Secs. 23 and 24, T. 11, R. 6 E. - Courtesy of F. T. Thwaites.

Figure 24.- The level summit of the bluff is a remnant of the earlier peneplain. The flat is the Kirkland outwash plain. Secs. 23 and 24, T. 11, R. 6 E. - Courtesy of F. T. Thwaites.

The post-glacial modifications have been very slight, figure 25.

Geology

On the contour map, Plate III, the areas of Huronian quartzite, Cambrian sandstone, and Pleistocene drift have been plotted.

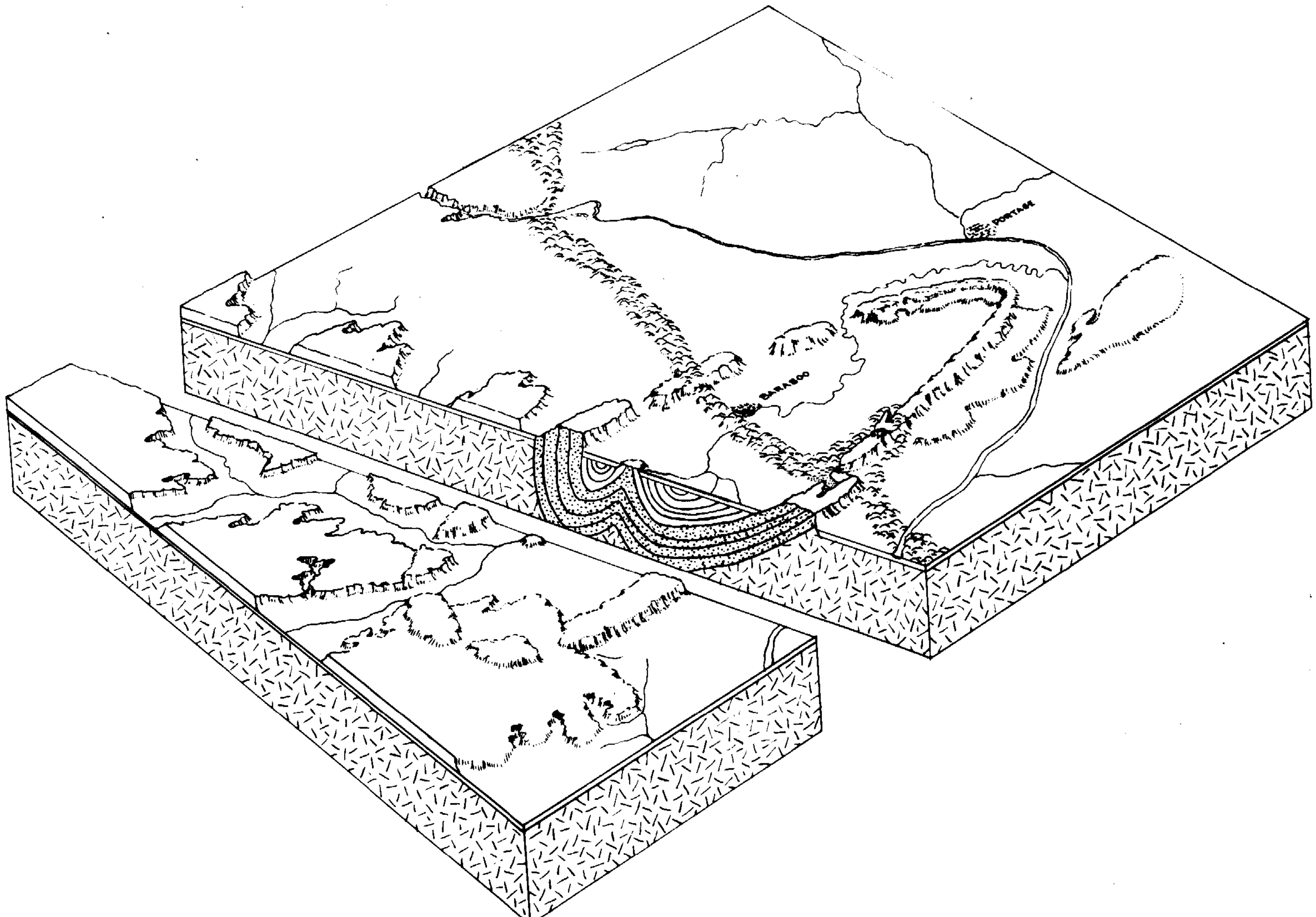


Figure 25.- Devils Lake as it is today, blocked at the north by a dam composed of glacially transported sands and gravels and known as a moraine and at the south by a similar moraine. It drains through the sands and gravels of the southern moraine. - Courtesy of Dr. Guy-Harold Smith.

CHAPTER IV

PATTISON STATE PARK

Geographic Location

Pattison State Park, Plate IV, is located in northwestern Douglas County. T. H. 35 and county trunk highway "B" intersect within the confines of the park. The nearest railroad station is Dedham on the Great Northern about three miles west of the park. Superior, a short distance to the north, may be reached over several railroad lines.

Physiographic Location

The portion of the park below Manitou Falls is located in the Lake Superior Lowland whereas that portion above the falls is in the Lake Superior Highland, figure 26. The upland, moreover, is a somewhat eroded portion of the pre-Cambrian peneplain which stretched far to the north into Canada and far to the south.

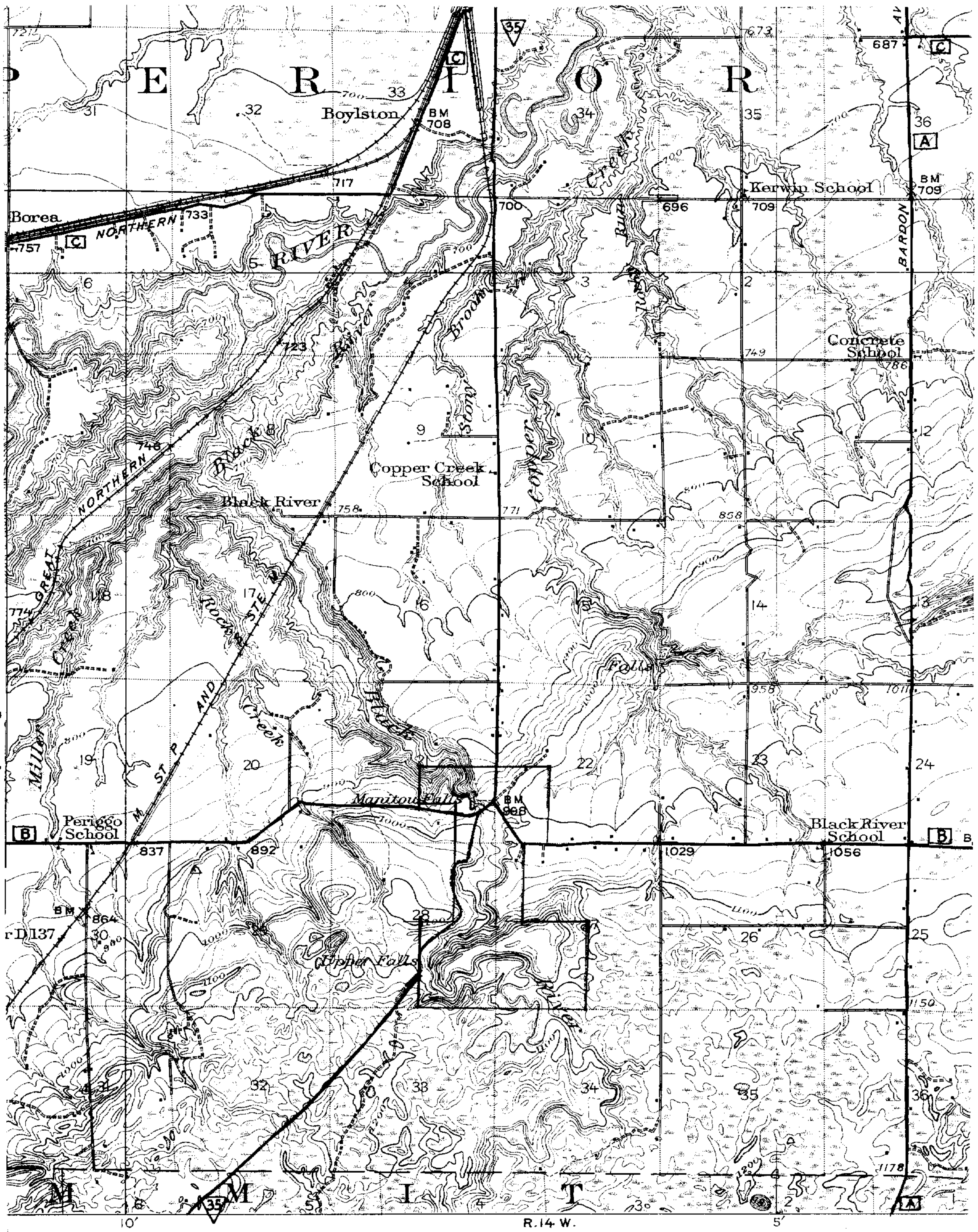
Features of Interest

Manitou Falls (fig. 27) in which the Black River cascades for a distance of 160 feet and Upper Falls which represents a drop of 30 feet are noted for their beauty. Due to the presence of the cross fault the contact between the volcanics and sediments on the east side of the river is about 250 feet north of the contact on the west side. Moreover the rocks on the east side are brecciated and slickensided[1].

If the visitor follows the 1060 foot contour (Pl. IV) outside the im-

1. "A smoothe, striated, polished surface of rock produced by the sliding of one body on another." - Webster.
Township report: Wisconsin Geol. and Nat. Hist. Survey, T. 47, R. 14 W., p. 27, 1925. (Unpublished)

PLATE IV



Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.

APPROX DECLI

PATTISON STATE PARK

(Superior Quadrangle)

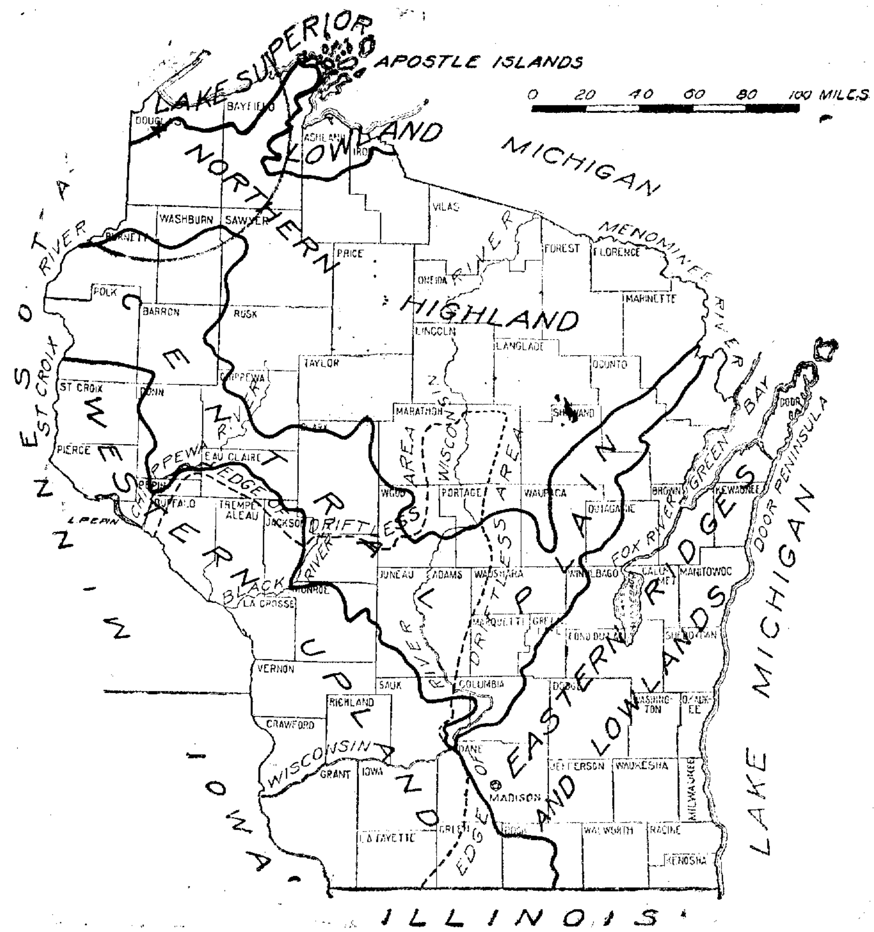
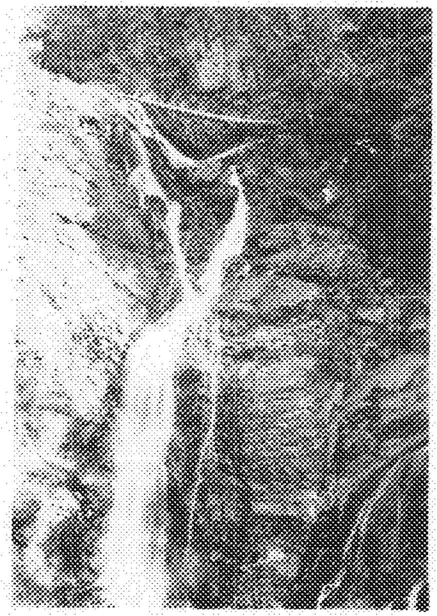


Figure 26.- Pattison State Park is located on the border between the Lake Superior Lowland and the Lake Superior Highland. Courtesy of the Wisconsin Geological and Natural History Survey.

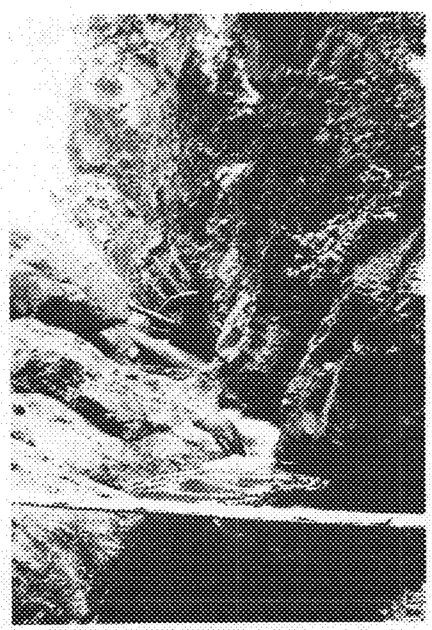
A.- Manitou Falls (camera facing east). Outcrops are diabase flows. Sec. 21, T. 47, R. 14 W.

B.- Base of Manitou Falls (camera facing northeast). The stream is cutting its channel at the contact between two diabasic flows. Sec. 21, T. 47, R. 14 W.

Figure 27.- Manitou Falls. - Courtesy of the Wisconsin Geological and Natural History Survey.



A.- Manitou Falls (camera facing east). Outcrops are diabase flows. Sec. 21, T. 47, R. 14 W.



B.- Base of Manitou Falls (camera facing northeast). The stream is cutting its channel at the contact between two diabasic flows. Sec. 21, T. 47, R. 14 W.

Figure 27.- Manitou Falls. - Courtesy of the Wisconsin Geological and Natural History Survey.

mediate confines of the park, he will locate remnants of the 1060 foot beach of glacial Lake Duluth. The concentrations of gravel will attract his attention and will be of considerable interest to him when he learns that such beaches are the source of most of the gravel used for road construction in this vicinity.

Geological History

In giving the geological history of this park the writer will employ a theory advanced by W. O. Hotchkiss, former director of the Wisconsin Geological Survey. At the time the Huronian sediments were being deposited over Wisconsin it is thought that the Lake Superior region was an anticline instead of a syncline as it is today.[2] This huge anticline was held up by molten lava[3] and was probably submerged. From time to time effusions were poured forth into the sea water. It is these effusions which are thought to be the source of the iron formation.

The deposition of the Huronian was followed by that of the Lower Keweenawan "sandstone or quartzite and conglomerate.[4]" The lava in the huge bathylith, however, soon welled up through long fissures and began to spread out upon the surface of the land in what is known as a flow or an extrusion. One can best imagine how this lava cooled by comparing it with a plate of creamy fudge. When the fudge is poured out upon the cold platter, the part in contact with the platter cools quickly and solidifies. The middle portion cools more slowly; the upper surface cools rapidly like the lower surface. If a

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[2] Hotchkiss, W. O., The Lake Superior geosyncline: Geol. Soc. of America Bull. vol. 34, pp. 669 - 678, 1923.

[3] A large buried mass of lava whether molten or solidified is known as a bathylith.

[4] Hotchkiss, W. O., op. cit., p. 670.

piece of the fudge is examined, it will be found that the lower portion contains a considerable number of air bubbles[5]; the middle portion contains a lesser number; and the upper portion contains the largest and most numerous air bubbles. Thus a lava flow cools and solidifies. Sometimes the top solidifies while the flow is still moving. Then the top is broken and a rough or clinkery top results.

As stated above the middle portion of these Keweenawan flows cooled more slowly than the top or bottom. With the cooling of the middle portion gases were given off. One of these,carbon dioxide, united with the hydrogen which is known to be present in such flows and formed water or rather steam. As this steam ascended to the top, it changed the ferrous iron to ferric iron and the color of the flow from black to red.[6]

As soon as a Keweenawan flow solidified, agents of weathering attacked it and broke down its upper surface. The thin laminae of a fine material known as clasolite also indicate these erosion intervals. Weathering, however, was interrupted by the extrusion of another flow and the same process was repeated until the flows and underlying conglomerates reached an estimated thickness of 38,000 feet[7].

In accordance with the theory herewith presented the vent from which most of this lava came was located somewhere in the basin of Lake Superior.

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5 In a lava a cavity formerly occupied by steam is called a vesicle; hence vesicular tops of flows. When this cavity is filled with secondary materials, it is called an amygdule; hence amygdaloidal tops of flows.

6 Drill cores from Keweenawan flows show this change in color from the bottom to the top of a flow. Hansell, J. M., A cross section of the Keweenawan of Wisconsin, Unpublished thesis, University of Wisconsin, 1926.

7 Hotchkiss, W. O., and Thwaites, F. T., Map of Wisconsin showing geology and roads: Wisconsin Geol. and Nat. Hist. Survey, 1911.

As each flow was poured forth, the dip toward the center of the basin became greater and the Lake Superior syncline was thus developed. The more fluid or basic flows spread farther from the source than the more viscous or acid[8] flows. Thus, "at the time of the final extrusion there was most probably a high central range largely composed of acid flows. From this range was derived a goodly part of the Upper Keweenawan conglomerates, sandstones, and shales which have been estimated by Thwaites to have a maximum thickness of nearly 25,000 feet.[9]"

While flows were being poured out upon the surface and for a short time after their cessation, hot acid solutions carrying copper sulphate emanated from the magma and circulated along the clinkery and vesicular tops of the flows. These waters deposited copper in the cavities of the flow tops[10].

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[8] An acid rock contains an abundance of quartz.

[9] Hotchkiss, W. O., The Lake Superior geosyncline: Geol. Soc. of America Bull. vol. 34, p. 677, 1923.

[10] The chemical reactions that resulted in the formation of metallic copper are as follows:

"Hot acid solutions containing copper and sulphur, assumed for the sake of simplicity to be equivalent in their chemical activity to acid solutions carrying cuprous sulphide, meet ferric oxide. The acid is decreased by solution of some ferric oxide. The ferric salt thus formed exerts an oxidizing influence, which is, however, at once balanced by the reducing action of cuprous sulphide, with the production of ferrous sulphate and cupric sulphate, as indicated by the following reactions

$$Cu_2S + 5Fe_2O_3 + 11H_2SO_4 = 10FeSO_4 + 2CuSO_4 + 11H_2O$$

"If there is available a further quantity of cuprous sulphide in solution, its presence, the decrease of acidity, and the formation of water, ferrous sulphate, and cupric sulphate would all favor the reactions

$$Cu_2S + 8\ CuSO_4 + 4H_2O = 5Cu_2SO_4 + 4H_2SO_4$$

$$Cu_2S + 3CuSO_4 + 4H_2O = 5Cu + 4H_2SO_4$$

"The second of this pair of reactions may possibly occur at a very high temperature but has not yet been realized experimentally. However, Thus the weak amygdaloidal and vesicular tops of flows are the best places to prospect for copper.

This period of vulcanism was followed by the deposition of Upper Keweenawan sediments and the Lake Superior sandstone. During or immediately after the deposition of this sandstone the Lake Superior graben[11] was

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the first reaction yields cuprous sulphate, which deposits copper on cooling. The consumption of cuprous sulphide in these ways would obviously leave less of it to be deposited as the solution cooled, whereas copper would still be deposited on cooling. Conditions favoring the deposition of copper would be an initial high temperature, the reduction of acidity to the point where no more ferric oxide would be attacked or the local exhaustion of the ferric oxide by solution and reduction as outlined, and lastly cooling and dilution of the initially heated solutions. In this way the sulphur would make its exit as ferrous sulphate. A reaction that embraces all the steps mentioned would be:

$$Cu_2S + 3Fe_2O_3 + 5H_2SO_4 = 2Cu + 6FeSO_4 + 5H_2O$$

"A qualitative verification of the possibility of such a reaction in the presence of an excess of sulphuric acid is recorded in experiment 119.

"This is essentially the theory advanced by the geologists of the Calumet & Hecla Consolidated Mining Co. to account for the deposition of native copper rather than copper sulphide in the Lake Superior district, where ferric oxide has apparently been the oxidizing agent. It appears that laboratory evidence supports this hypothesis under certain conditions, the principal experimental limitation being the necessity of working in acid solutions. As it is obvious that every natural condition could not be reproduced in the laboratory it would probably be unwise to claim that acidity is a necessary condition for the reaction, but it is the only key the writer has found to start the chain of reactions noted. In fact, all the theories here proposed permit the use of solutions of at least sufficient acidity to carry significant quantities of dissolved copper. It is only fair to state that on account of experimental difficulties solutions of mild acidity, such as those containing large quantities of carbon dioxide or hydrogen sulphide under great pressure, have not yet been thoroughly studied." Wells, R. C., Chemistry of deposition of native copper from ascending solutions: U. S. Geol. Survey Bull. 778, pp. 40-41, 1925.

11 A graben is a block of the earth's crust which has dropped below the level of the blocks on either side. The Rhine Valley between the Vosges and the Black Forest is a graben; the Dead Sea Valley is a graben; the geyser basins of Yellowstone National Park are grabens.

formed (fig. 28)[12]. The fault[13] at the southern end of this graben is a thrust fault or one which combines vertical and horizontal movement. The formation of such a fault is illustrated in figure 29[14].

With the development of the pre-Cambrian peneplain erosion beveled across the sandstone and trap and produced a smooth surface. So far as exposures in this region are concerned, it may be said that it has been above sea level since the deposition of the Lake Superior sandstone, but it is probable that Paleozoic sediments were deposited in the Lake Superior syncline[15].

When the old peneplain was exposed to erosion after the removal of the Paleozoic sediments or simply with uplift, erosive processes were not as potent in their work upon these resistant Keweenawan flows as they were upon the soft sandstones to the north. These sandstones were therefore worn down to a level considerably below the igneous rocks. The thrust fault over which the rivers cascaded in falls was thus exposed and stood out as a ridge[16] above the sandstone.

The results of erosion in the traps were very different from those in

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12 "After the deposition of the Upper Keweenawan sediments orogenic pressure from the southeast resulted in tilting the sediments and increasing the northward dip of the south limb of the syncline. This stress resulted in the great thrust-fault across northern Douglas County." Hotchkiss, W. O., The Lake Superior geosyncline: Geol. Soc. of America Bull. vol. 34, p. 678, 1923.

13 A fault is a crack or zone in the earth's crust along which there is movement or slipping of the rocks.

14 The same type of fault occurs in the Lewis overthrust in Glacier National Park. Campbell, M. R., Origin of the scenic features of the Glacier National Park; Department of the Interior, 1914.

15 Thwaites, F. T., Sandstones of the Wisconsin coast of Lake Superior: Wisconsin Geol. and Nat. Hist. Survey Bull. 25, p. 108, 1912.

16 This ridge is known as the Douglas County Copper Range.

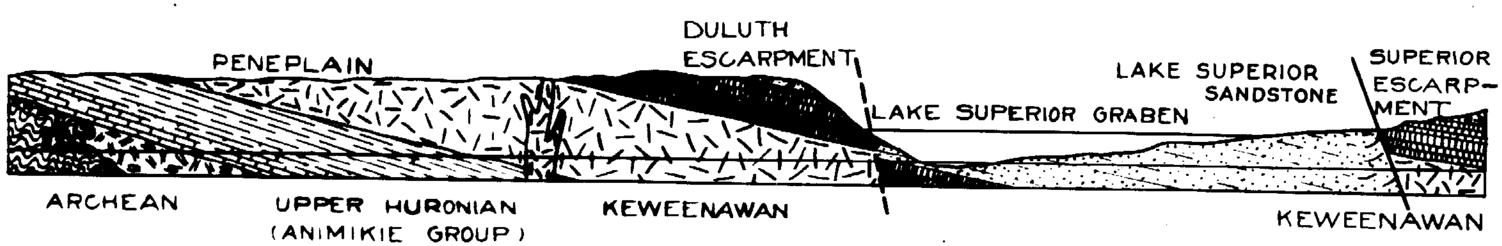

Figure 28.- The Lake Superior graben is a down-dropped block of the earth's crust and is bounded by faults. - Courtesy of the Wisconsin Geological and Natural History Survey.

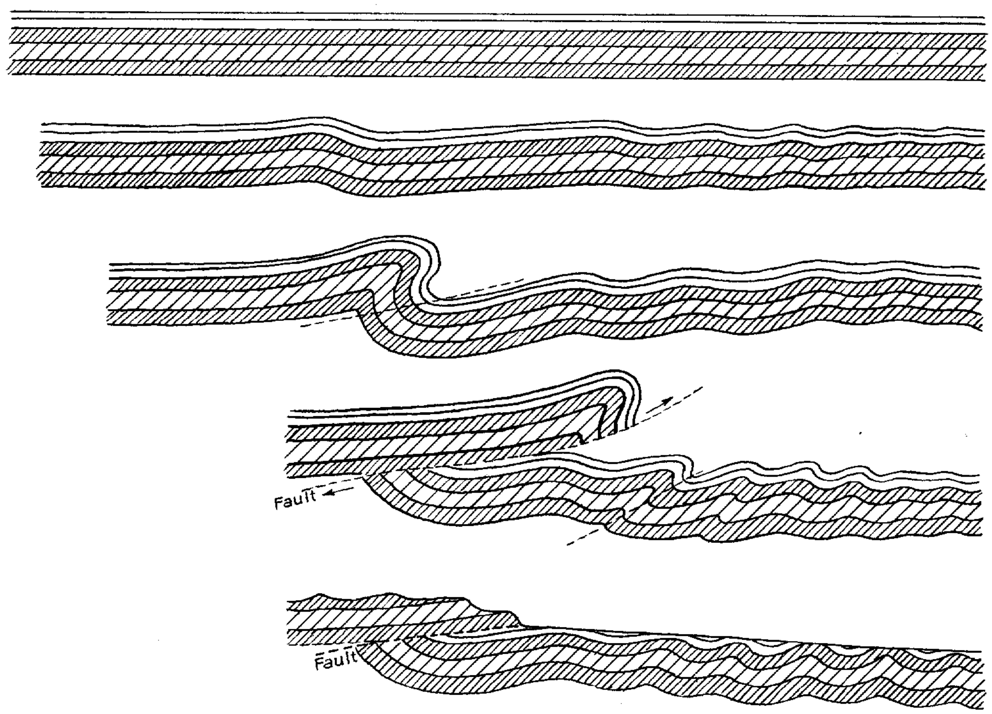

Figure 29.- The development of a thrust fault. - After Campbell.

the sandstone. Wherever the pre-Cambrian peneplain beveled across an amygdaloidal top, erosive processes in this new period of erosion produced a valley; wherever it beveled across a resistant middle portion of a flow, erosive processes were less potent than in the adjacent top and bottom. In this manner a series of ridges and valleys was produced and the drainage became trellis. The main streams cut across the ridges at right angles, but their tributaries[17] were located in the valleys between the parallel ridges. As time went on, the falls which occurred where the main streams descended to the level of the sandstone retreated up stream, that is they wore back into the traps.

When the Superior Lobe covered this region during the Pleistocene, it probably rounded the ridges to some extent and deposited materials in the parallel valleys. The net result was a topography of less relief than the pre-glacial topography[18], figure 30.

With the retreat of the ice from the region marginal lakes were formed at successively lower levels due to the wearing down of old outlets or the exposure of new outlets. Whenever the level remained stationary for a considerable period of time, a beach was formed. The 1060 foot beach of glacial Lake Duluth is present in this vicinity[19], but has probably been destroyed within the confines of the park by the development of the Black River valley, figure 31.

Since the withdrawal of the glacial lake waters, the effects of erosion

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17 Such streams are called subsequent streams because they are dependent upon rock structure and develop after the main or consequent streams.

18 Murphy, R. E., The glacial geology of an area in northwestern Wisconsin, Unpublished thesis, University of Wisconsin, 1926.

19 Idem, p. 45.

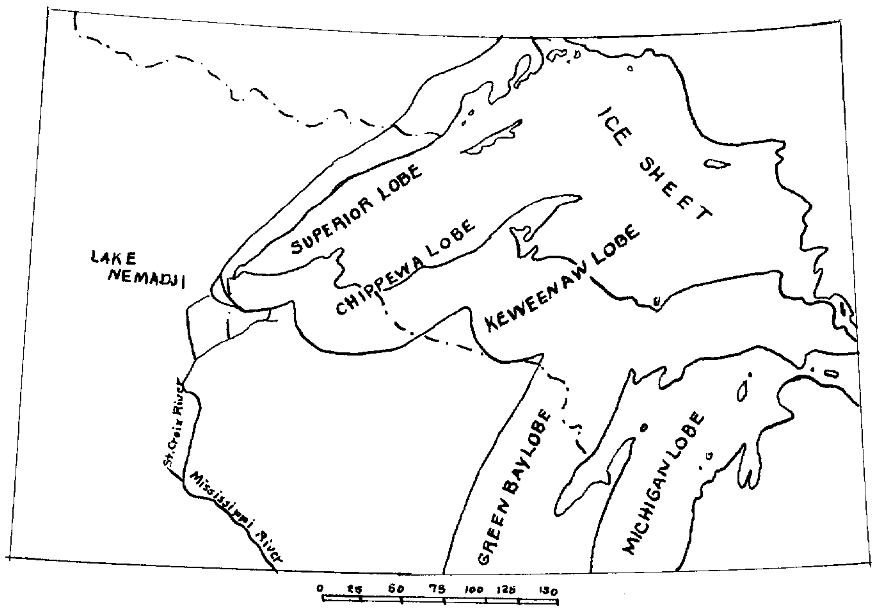

Figure 30.- Glacial Lake Nemadji and the Kettle River outlet. - After Martin.

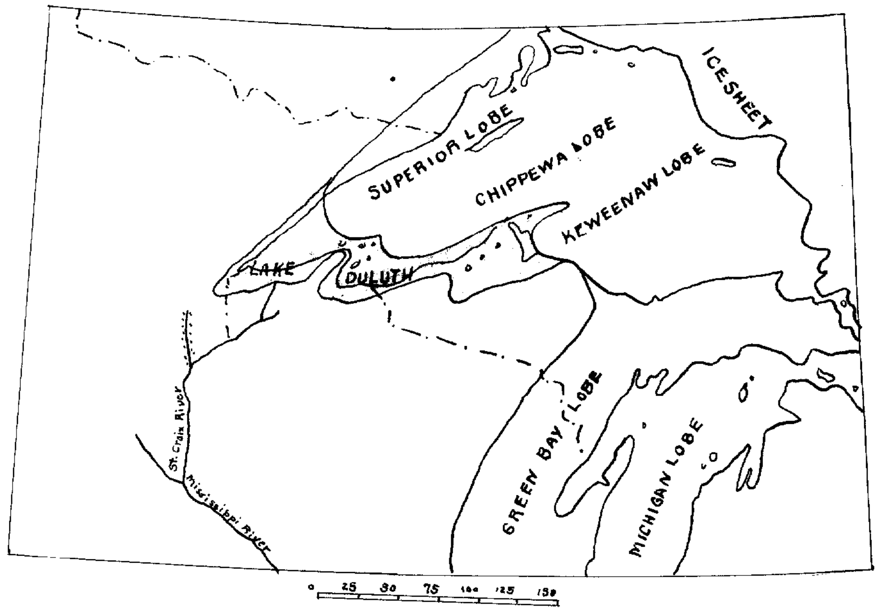

Figure 31.- Glacial Lake Duluth and the Bois Brule outlet. - After Martin.

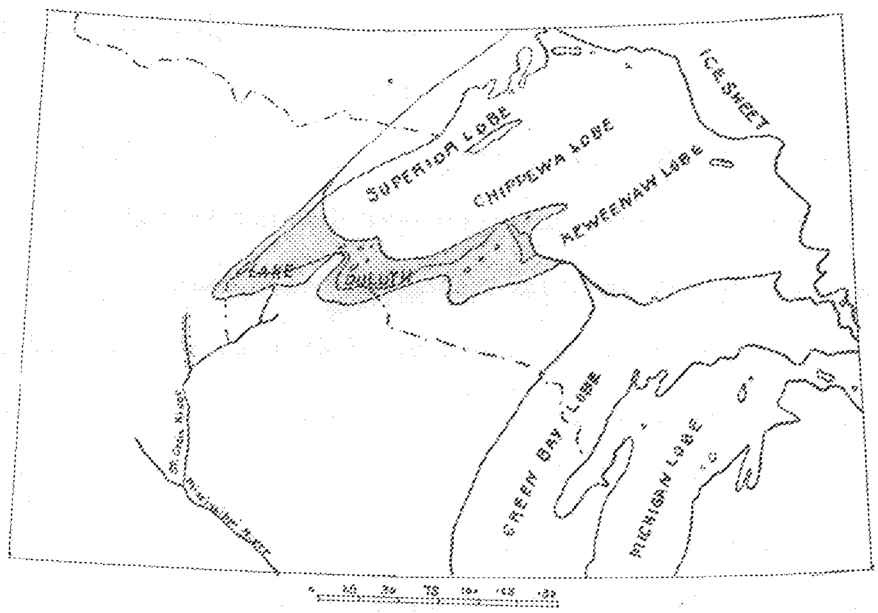

Figure 31.- Glacial Lake Duluth and the Bois Brule outlet. - After Martin.

have been much more pronounced in the clay flats at the base of the trap range than in the range itself.

Geology

A cross fault has greatly facilitated the task of the Black River in cutting its channel through the resistant traps, but has so mashed and contorted the formations that it is difficult to give a geological section (fig. 32). Figure 33 is an idealized section and shows that the upland is formed on the resistant trap whereas the lowland below the falls is developed on the soft sandstones.

Upper Falls is due to a resistant flow which the river has encountered in its task of wearing down its channel. "The Upper Black River Falls are about 30 feet high, flowing over a black fine grained basaltic flow, the top of this flow being at the top of the falls and the base at the bottom.[20]"

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[20] Emrick, D. G., Field Notes: Wisconsin Geol. and Nat. Hist. Survey Notebook 973, p. 80. (Unpublished)

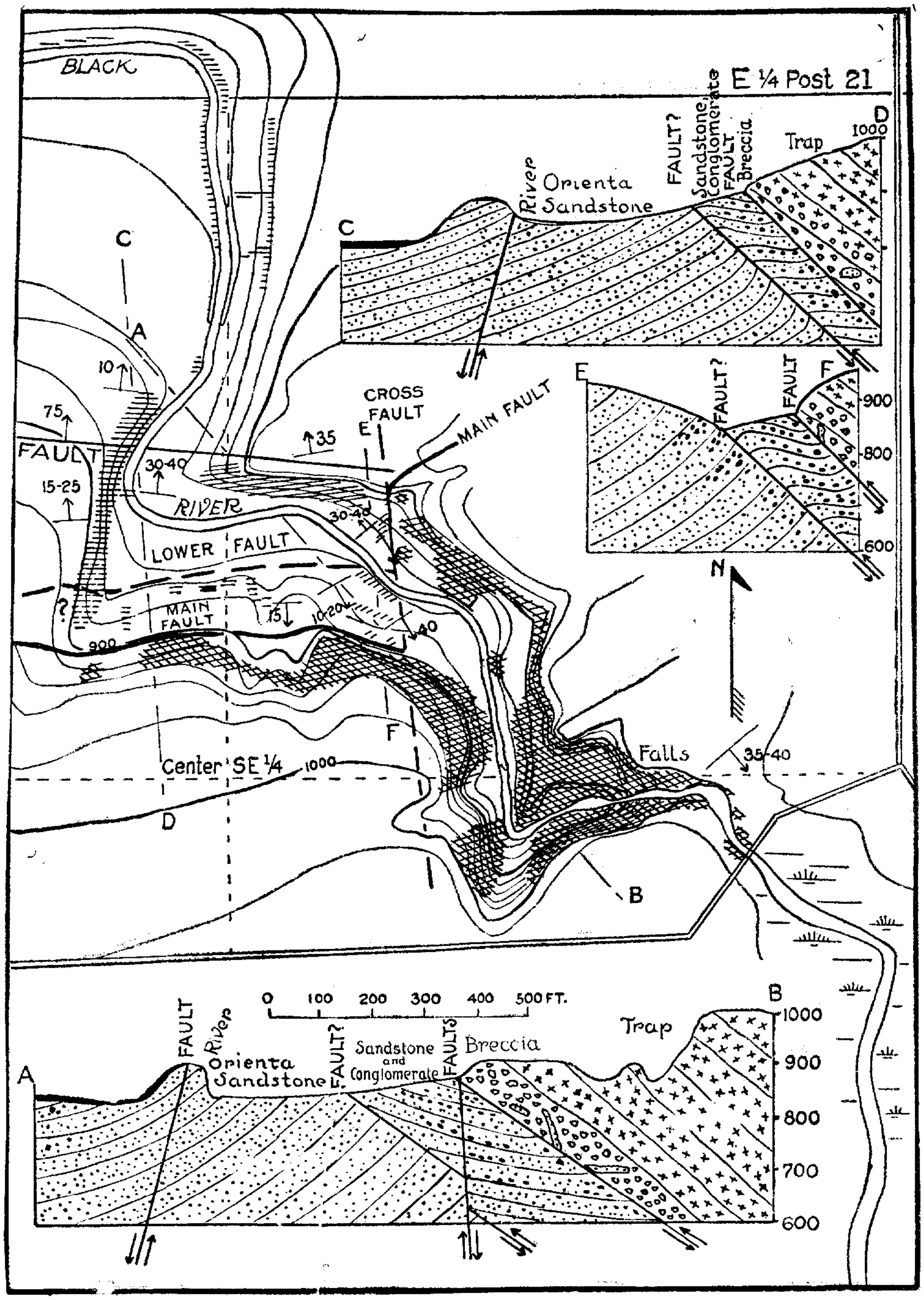

Figure 32.- Map of vicinity of Black River Falls. Courtesy of the Wisconsin Geological and Natural History Survey.

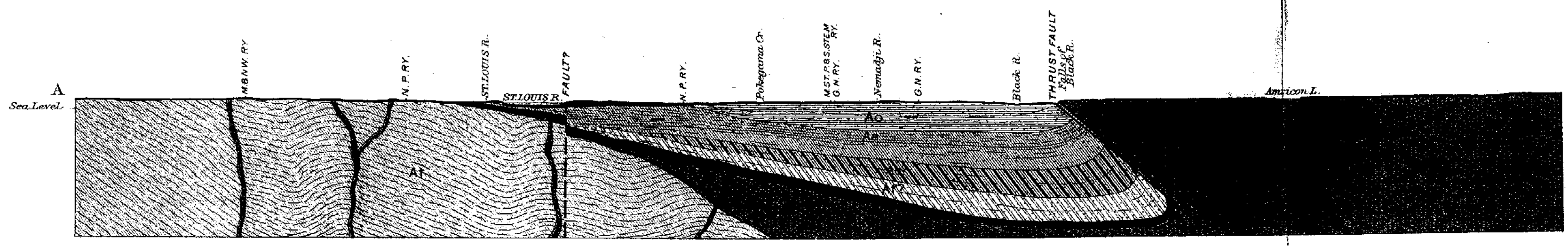

Figure 33.- Northwest-southeast cross section through Black River Falls. Section shows that the older strata (Akt) have been thrust up over the younger strata (Ao, Aa, Ae, Af, etc.). Courtesy of the Wisconsin Geological and Natural History Survey.

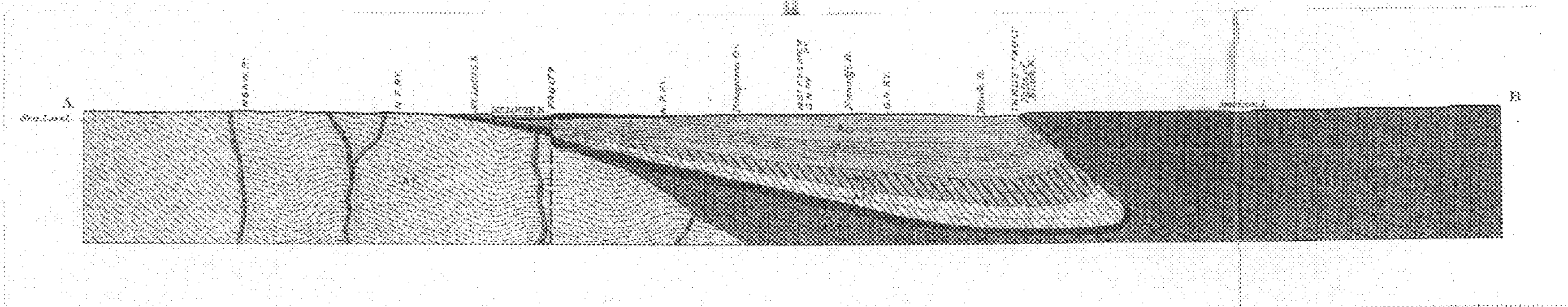

Figure 33.- Northwest-southeast cross section through Black River Falls. Section shows that the older strata (AXt) have been thrust up over the younger strata (Ao, Aa, Ae, Af, etc.). Courtesy of the Wisconsin Geological and Natural History Survey.

CHAPTER V

INTERSTATE PARK

Geographic Location

Interstate Park[1] is located along the St. Croix River between Taylor Falls, Minnesota and St. Croix Falls, Wisconsin. In Wisconsin it is located in secs. 30 and 31 of T. 34, R. 18 W. and sec. 36 of T. 34, R. 19 W. (Pl. V). As its name implies, a part is in Wisconsin and a part is in Minnesota. Taylor Falls is reached by the Northern Pacific Railroad and by Minnesota T. H. 46; St. Croix Falls by the Minneapolis, St. Paul & Sault Ste Marie Railroad and Wisconsin T.H's. 14, 35, and F.T.H. 8.

Physiographic Location

The park is located in the western portion of the central plain of Wisconsin (fig. 34). As it is located near the border, it represents a transition zone. Indeed the main valley was cut in Keweenawan strata and was filled with Cambrian sediments which have been largely removed. A section of this Cambrian filling is shown in figure 35.

Features of Interest

The whole region is known as "Friendly Valley". A view from the summit of the moraine on the Wisconsin side convinces one that it is a friendly valley, and a brief sojourn shows that the people have caught this friently spirit.

The valley is an ideal spot in which to spend a summer vacation. As figures 36, 37, 38, and 39 indicate, the scenery is superb.

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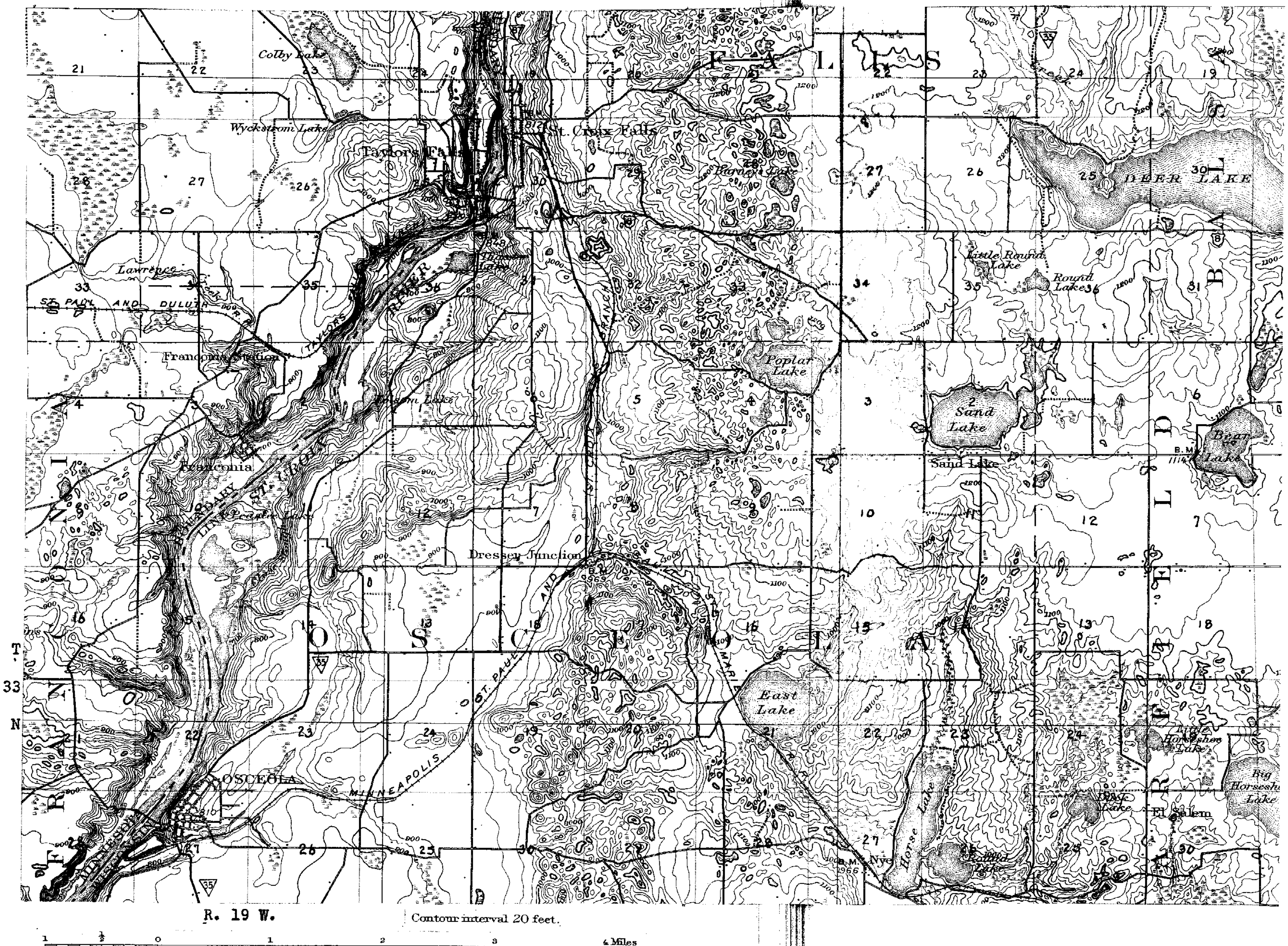
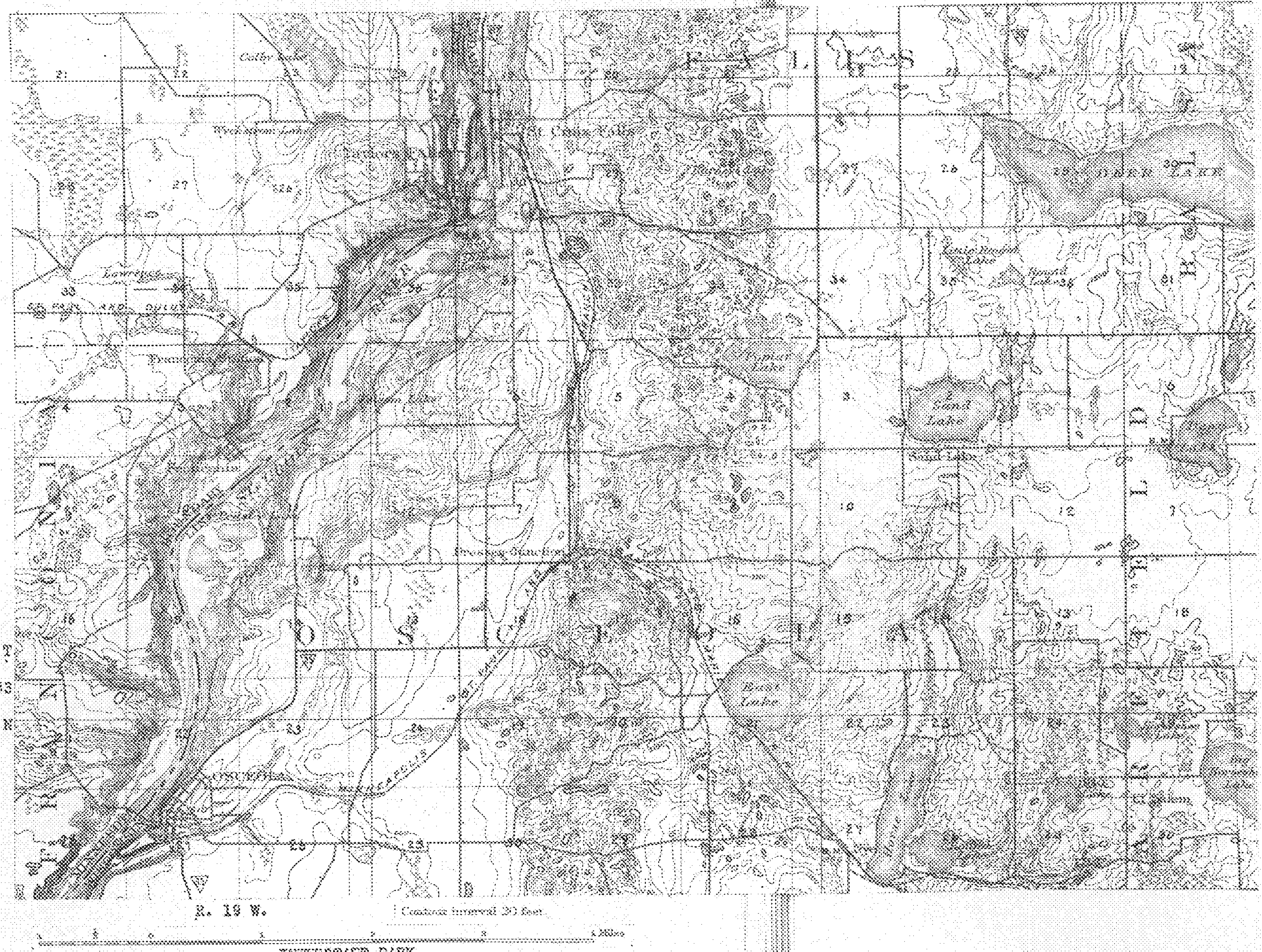
[1] It is interesting to note that this is the first interstate park established in the United States. Torrey, Raymond H., State Parks and the recreational uses of State Forests: The National Conference on State Parks, p. 14, 1926.

PLATE V



INTERSTATE PARK
(St. Croix Dalles Quadrangle)

PLATE V



INTERSTATE PARK
(St. Croix Dalles Quadrangle)

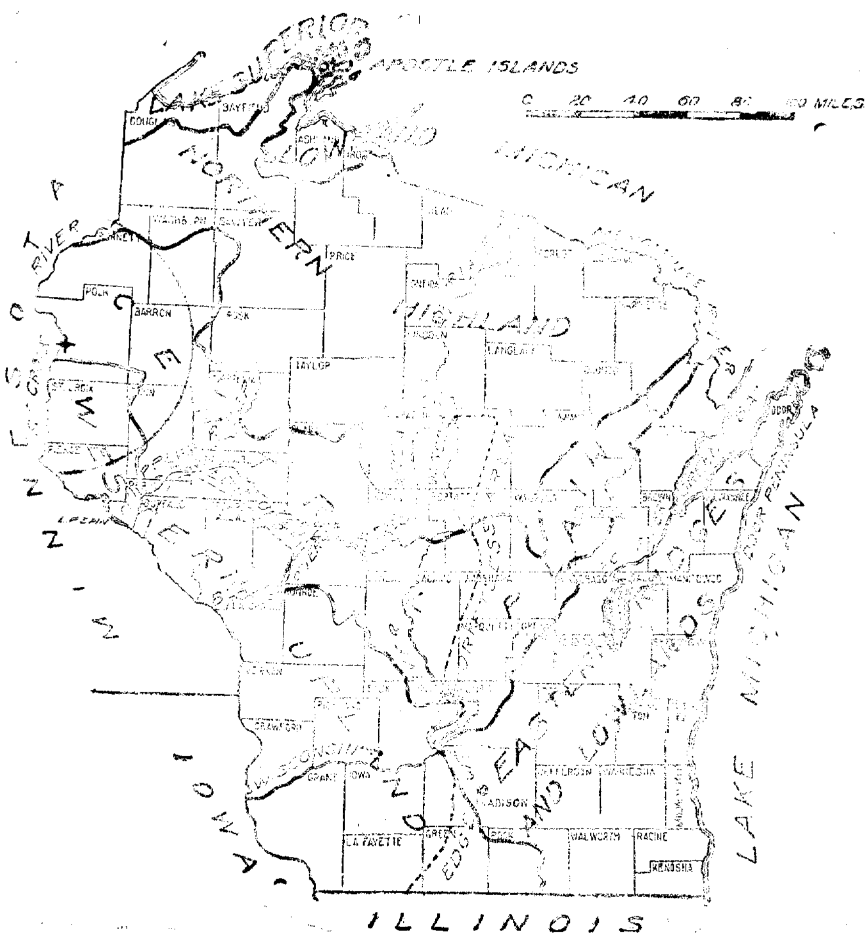


Figure 34.- Interstate Park is located in the Central Plain. Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 35.- Section of Cambrian filling. Shale face near Osceola showing contact of St. Lawrence and beds below. Hammer on base of St. Lawrence. - Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 35.- Section of Cambrian filling. Shale face near Osceola showing contact of St. Lawrence and beds below. Hammer on base of St. Lawrence. - Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 36.- St. Croix River from Eagle Point, Osceola. W. 1/4 post sec. 27, T. 33, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

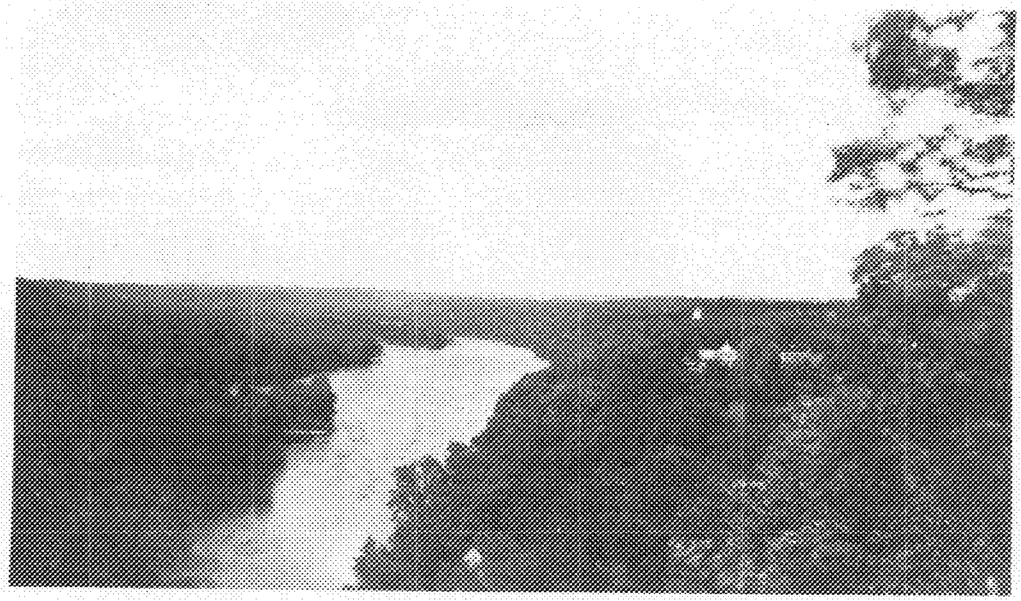


Figure 36.- St. Croix River from Eagle Point, Osceola. W. 1/4 post sec. 27, T. 33, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

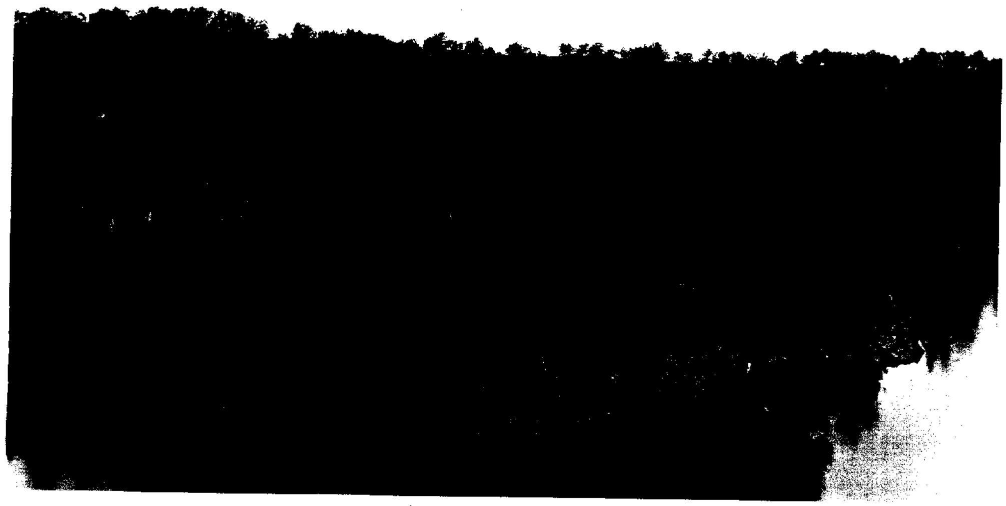


Figure 37.- Lower Dalles of St. Croix. NW. SE. 2, T. 33, R. 19 W.
Courtesy of the Wisconsin Geological and Natural History Survey.

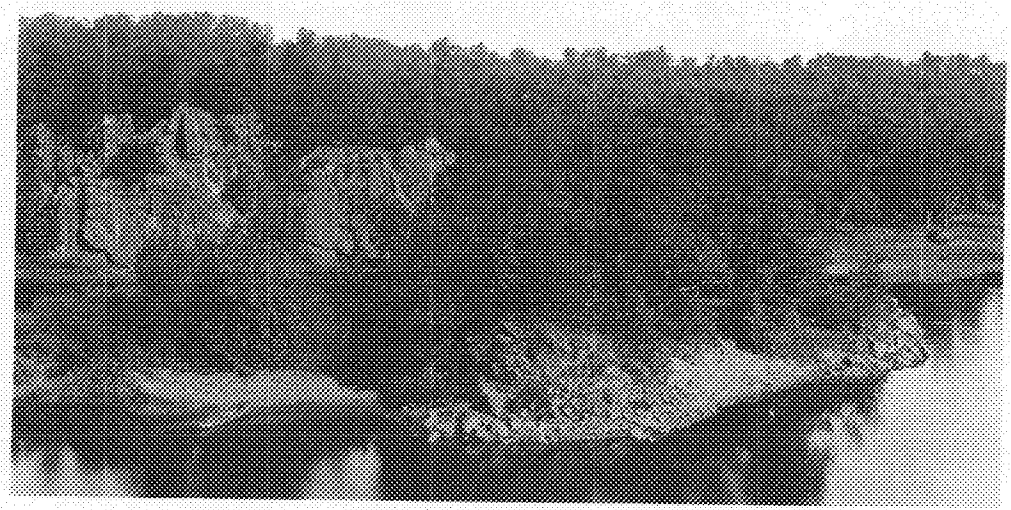


Figure 37.- Lower Dalles of St. Croix. NW. SE. 2, T. 33, R. 19 W.
Courtesy of the Wisconsin Geological and Natural History Survey.

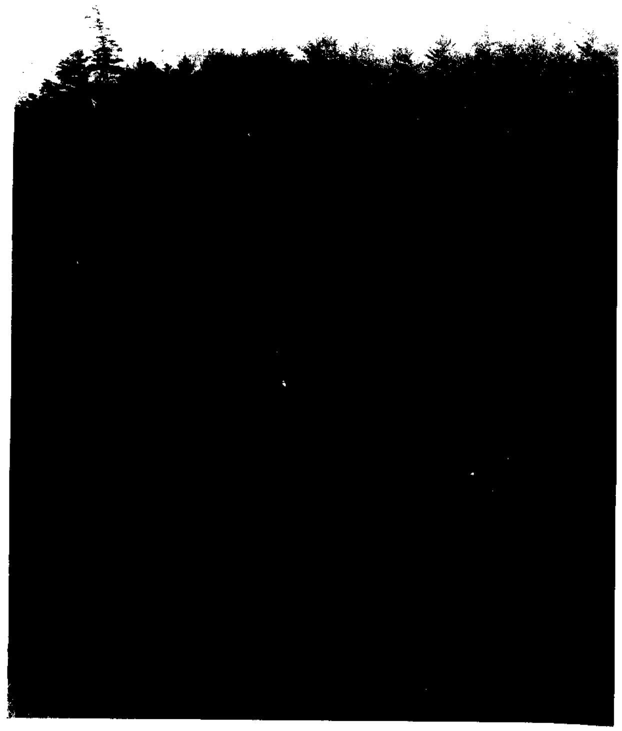


Figure 38.- Upper Dalles of St. Croix, opposite Pulpit Rock. SE. SE. 25, T. 34, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

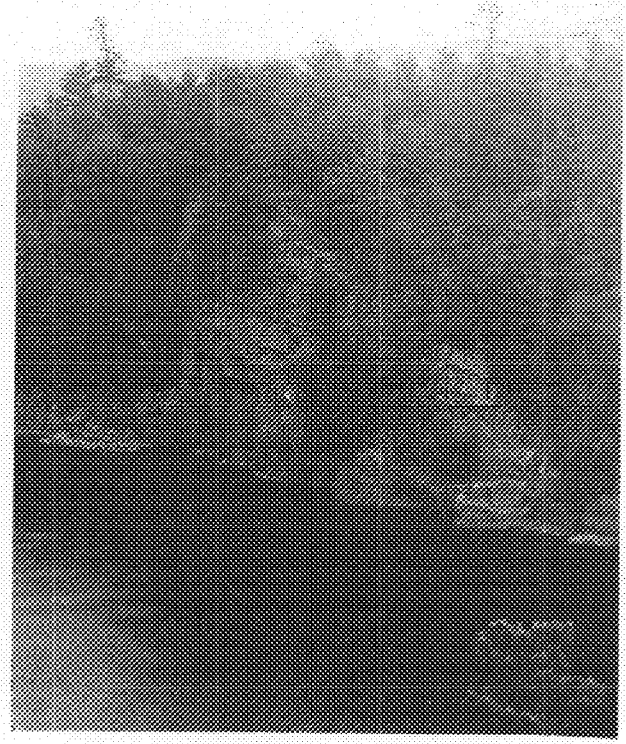


Figure 38.- Upper Dalles of St. Croix, opposite Pulpit Rock. SE. SE. 25, T. 34, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

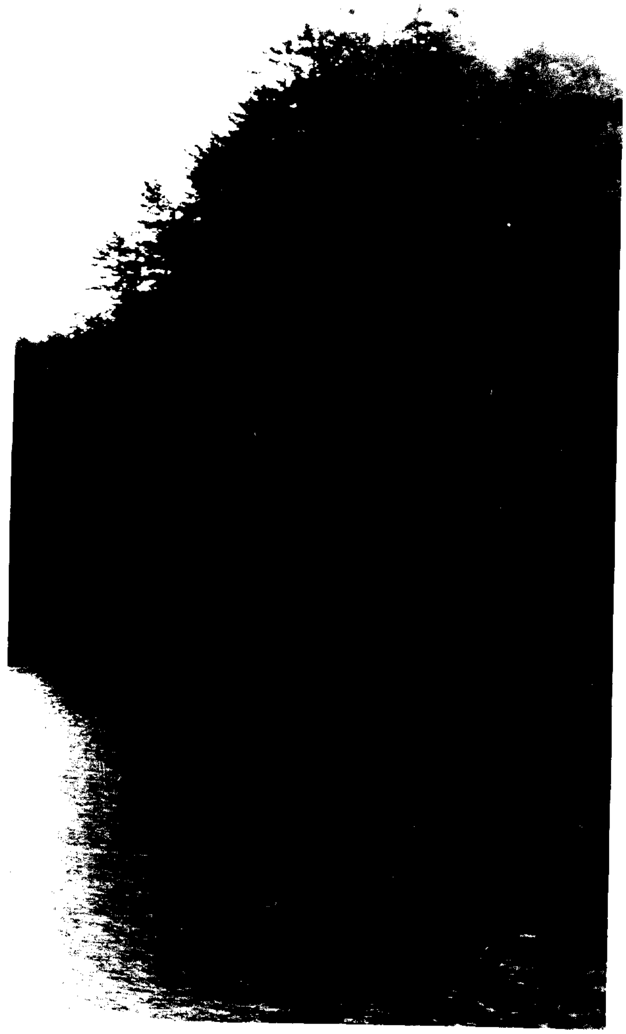


Figure 39.- Upper Dalles of St. Croix, Taylor Falls, Minnesota. SW. SW. 30, T. 34, R. 18 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

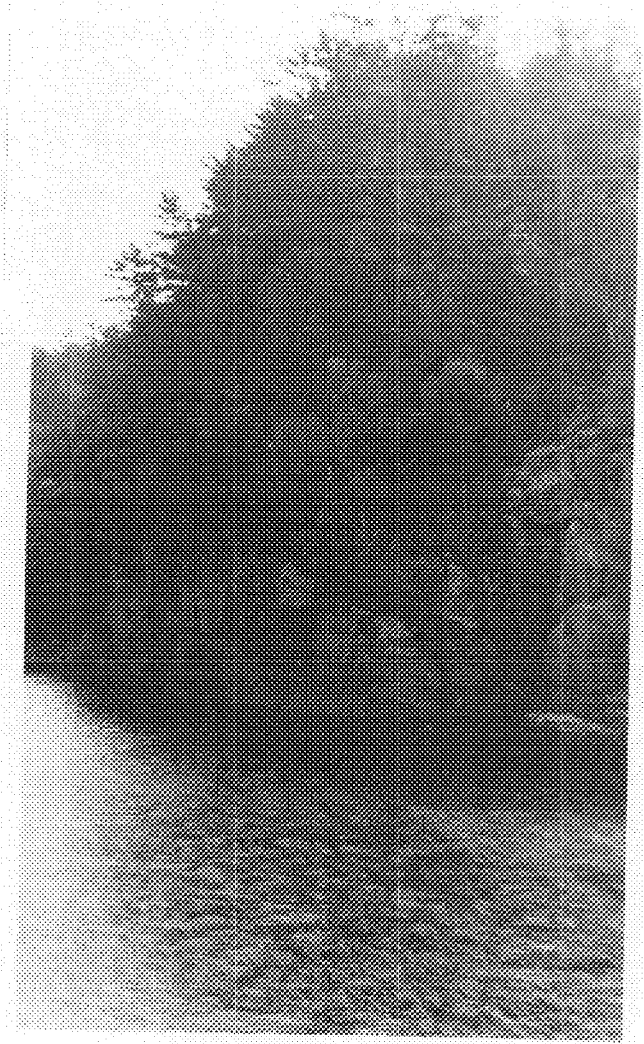


Figure 39.- Upper Dalles of St. Croix, Taylor Falls, Minnesota. SW. SW. 30, T. 34, R. 18 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

The park exhibits well the results of erosion in a series of flows, in which the joints are confined to individual flows and do not persist through the series. Figure 40 shows the steps which have been developed.

The park and its immediate environs also exhibit many striking instances of stream diversion. In some of the abandoned channels huge pot holes have been preserved in the resistant trap. The barriers down stream not only caused the river to seek new channels but also caused the development of terraces upstream, five of which may be distinguished in the immediate vicinity, figure 41.

The springs which furnish an abundance of fresh, pure water for the trout ponds at the foot of the slope never fail to attract the attention of the visitor. As he gazes upon them, he begins to wonder where all the water comes from. If he will go to the east, he will find an extensive plain which contains many pits, some of which contain lakes. This area is underlain by sand and gravel and thus forms an ideal catchment basin for whatever water falls upon the surface. This water percolates through the sands and gravels and underlying sandstone until it reaches the impervious shale horizon. It can penetrate no farther and is held above this level. Where erosion has cut into this impervious layer as at St. Croix Falls, the water flows forth, figure 42.

Geological History

Like Pattison Park the history of this region can be traced to Keweenawan time when flows of molten lava were spreading out over the land surface. Exposures in this vicinity, however, tell the geologist that there probably was an interval of volcanic quiescence in the midst of this series of extrusives. At the corner of Government and West streets in Tay-

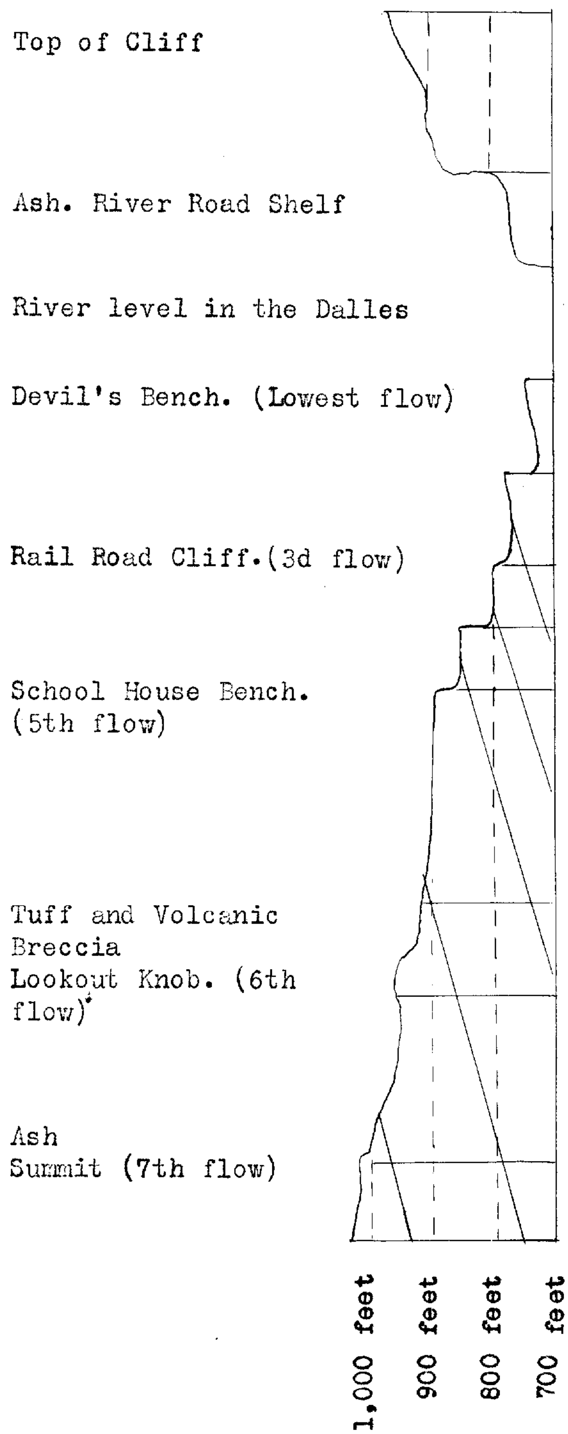


Figure 40.- "Profile of igneous rocks at the Upper Dalles, Taylors Falls, showing the separate flows." The flows have a dip of 15°. (After C. P. Berkey)

Figure 41.- St. Croix Falls from Taylor Falls. The main business street is located on the 810 foot terrace which was probably formed as the result of a barrier in the S. 1/2 of sec. 36, T. 34, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

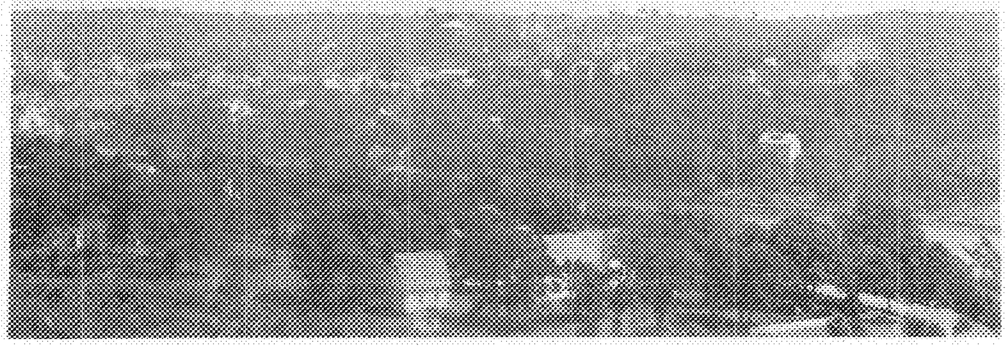


Figure 41.- St. Croix Falls from Taylor Falls. The main business street is located on the 810 foot terrace which was probably formed as the result of a barrier in the S. 1/2 of sec. 36, T. 34, R. 19 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

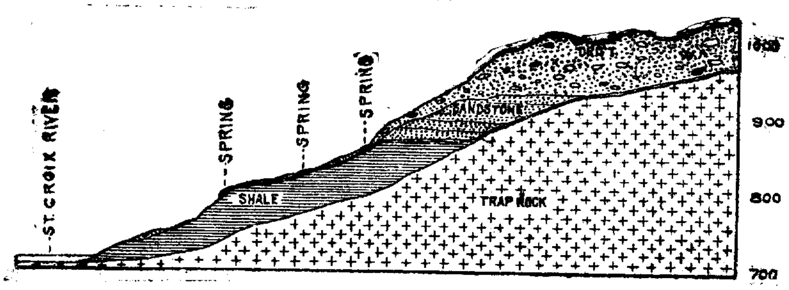


Figure 42.- In the St. Croix Falls district the springs occur above the impervious shale. Courtesy of the Wisconsin Geological and Natural History Survey.

lor Falls there is a conglomerate which grades upward into finer material[2]. This period of erosion and sedimentation was followed by a renewal of igneous activity and a continuation of the series of extrusives. Indeed it is probable that there was not a cessation of igneous activity but simply of the extrusives, for the fine material above the conglomerate may be volcanic ash.[3]

After these flows were poured out upon the surface, they were tilted so that they now dip 15° S. and strike N. 20° W. During this deformation extensive jointing and some minor faults were developed[4]. It is seldom, however, that these joints extend through the amygdaloidal zones or upper portions of the flows. As a result the flows outcrop in a series of steps in the vicinity of St. Croix Falls (fig. 40, p. 72).

Like adjacent areas these flows were probably peneplained during pre-Cambrian time. During early Cambrian time when the sea was advancing slowly over Wisconsin, this region was the scene of vigorous erosion. The jointing and minor faulting were favorable to erosion and a deep valley was developed[5].

The second conglomerate (Cambrian) was deposited in the arm of the sea

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2 Winchell, N. H., The significance of the fragmental eruptive debris at Taylor Falls, Minnesota: Am. Geol. vol. 22, pp. 74, 78, 1898.

3 Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol. vol. 21, p. 147, 1898.

4 Grout, F. F., Contribution to the petrography of the Keweenawan: Jour. Geol. vol. 18, p. 636, 1910.

5 Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol. vol. 20, p. 369, 1897.

which advanced over the lower part of this region,[6] figure 43. This was followed by the deposition of the Franconia shale and the St. Lawrence dolomite (fig. 35, p. 66). Other formations were probably deposited over this region.

When the region emerged from the sea, erosion began to strip away the formations and finally exposed the resistant flows or traps. As time went on, the old pre-Cambrian valley was encountered and partially re-excavated. During this time, however, the St. Croix River was probably located to the west in Minnesota[7].

During the early Pleistocene the region was probably covered by one of the early drift sheets. During the late Pleistocene or Wisconsin period of glaciation the region was covered by first one drift sheet and then another, figure 44. The first or red drift glacier came from the Labrador center and in this region moved in a general southeasterly direction[8], figure 45. Just east of St. Croix Falls it deposited a recessional moraine and a pitted outwash plain[9]. Just west of the present St. Croix gorge it deposited another recessional moraine. The waters ponded between the glacial front and the recessional moraine to the east finally broke through the latter just east of Dresser Junction. After this Labrador ice

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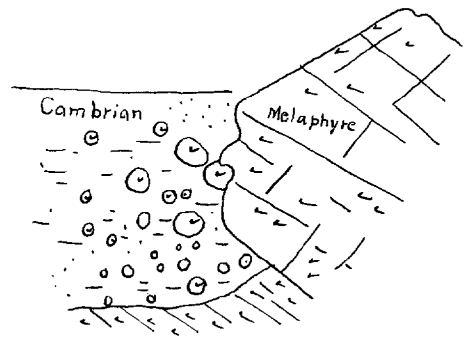
6 Strong, Moses, The geology of the Upper St. Croix District: Geol. of Wisconsin vol. 3, p. 417, 1880.

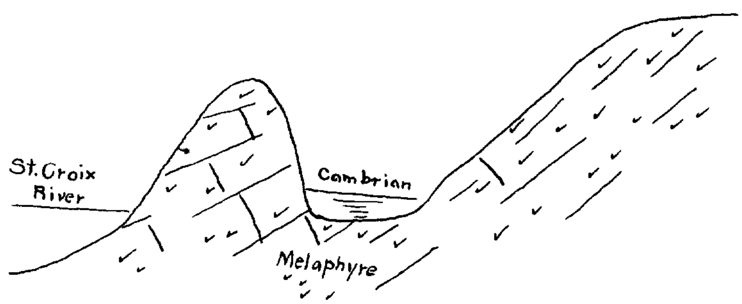
7 Martin, Lawrence, The physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 345, 1916.

8 Chamberlin, R. T., The glacial features of the St. Croix Dalles region: Jour. Geol. vol. 13, p. 241, 1905.

9 Deer Lake, Sand Lake, and East Lake occur in pits in this plain.



A. Showing the relations of the Keweenawan or copper-bearing melaphyre to the Cambrian sandstone and conglomerate at Taylors Falls. - After Strong.



B. Showing the relations of the Cambrian sandstone to the cupriferous melaphyre at St. Croix Falls. - After Strong.

Figure 43.- The Cambrian lies unconformably upon the Keweenawan traps.

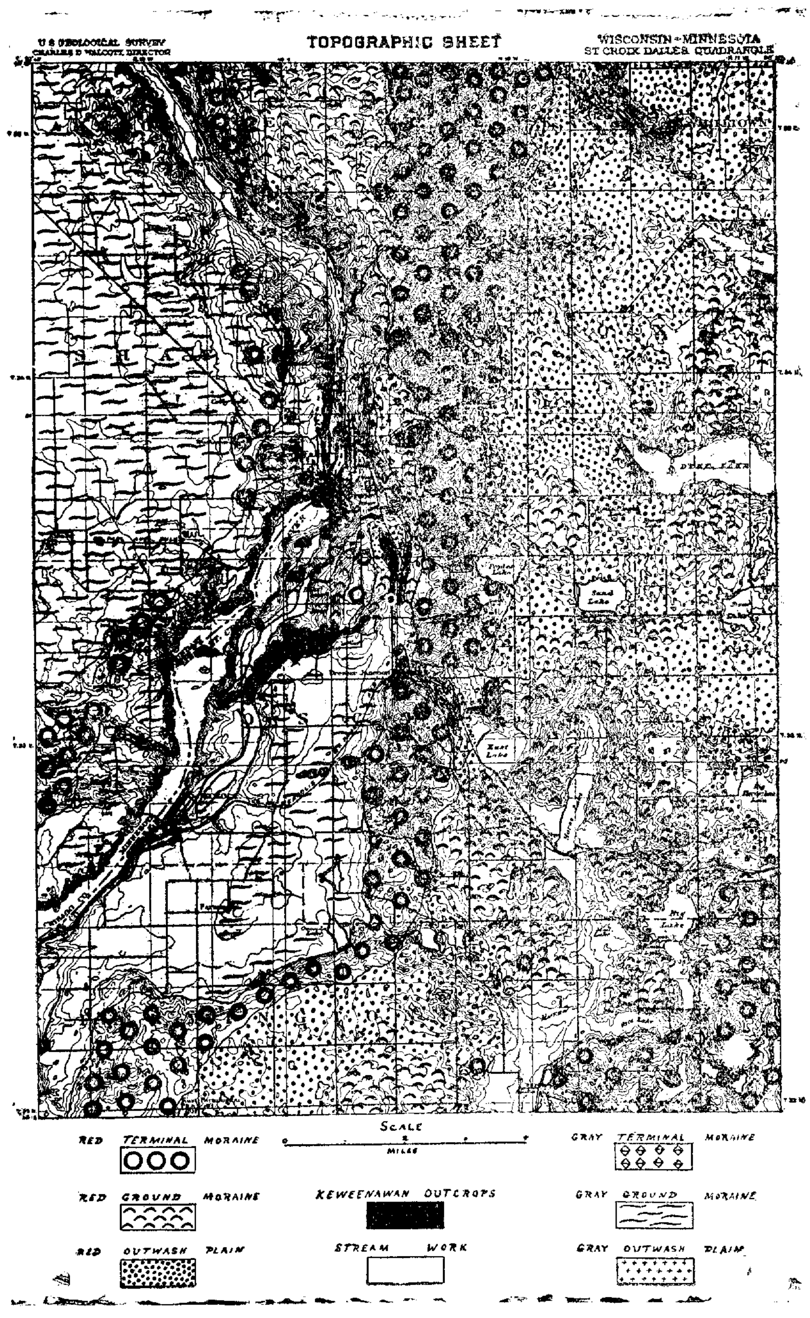


Figure 44.- Glacial deposits near the Interstate Park at the Dalles of the St. Croix. (R. T. Chamberlin)

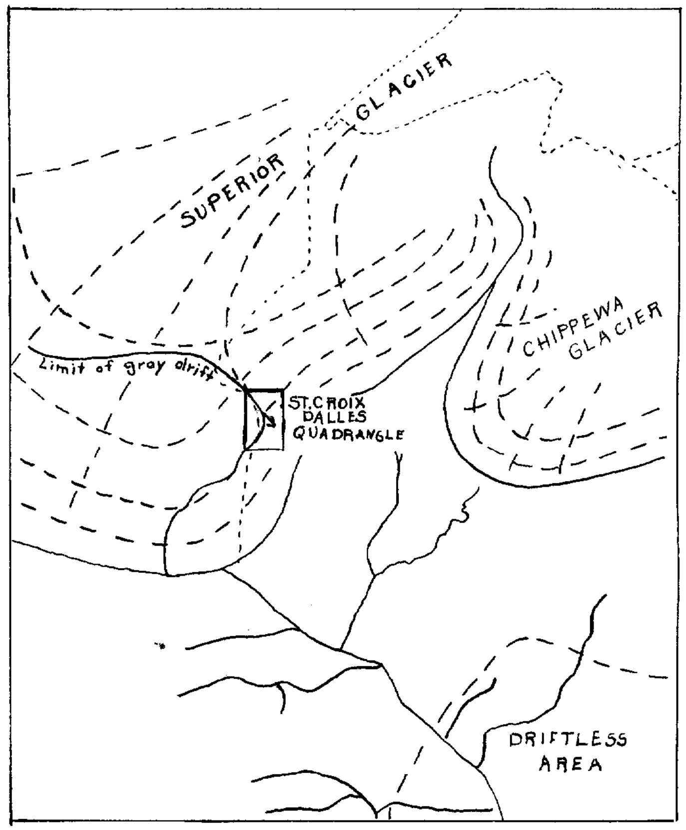


Figure 45.- "Sketch map, showing the general relations of the area of the St. Croix Dalles quadrangle. Data from maps of Wisconsin and Minnesota State Reports." - After R. T. Chamberlin.

had retreated, a lobe came from the Kewatin center and deposited the gray drift. This invasion was not as vigorous as the former, for it failed to ascend the red drift terminal just east of St. Croix Falls[10]. It did, however, partially destroy the red drift recessional west of the river[11] and deposited an area of ground moraine to the west.

When the last ice sheet withdrew to the north the old channel of the St. Croix was blocked with glacial drift and the river formed a new course through the present dalles region. The shifts in the channel are interesting and can be read from the St. Croix Dalles quadrangle, Plate V.

The first post-glacial channel below the elbow is about a mile east of the present channel and can be easily traced on the topographic map. This channel was abandoned in favor of the present only gradually. As barriers of Keweenawan trap were encountered down stream, one segment after another was abandoned progressing from the south to the north. Before the river found the rock fissure at the elbow, it drained southward through a narrow gap in the resistant Keweenawan. When the waters rushed forth from this narrow gap, they swirled around and formed an immense whirlpool (Thaxter Lake)[12]. Thaxter Lake and its outlet now occupy this old channel below the gap. Since the river adopted its present course through the elbow, there has been a tendency for the channel to shift to

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10 Chamberlin, R. T., the glacial features of the St. Croix Dalles region: Jour. Geol. vol. 13, p. 252, 1905.

11 Idem, p. 247.

12 Berkey, C. P., Geology of the St. Croix Dalles: Am. Geologist vol. 20, pp. 379, 352, 1897.

the west below Taylor Falls[13]. On the east bank the river encountered the resistant Keweenawan traps and has abandoned them in favor of the soft Cambrian sedimentaries which occur to the west. As a result the slope of the east bank is gentle and the west bank steep.

Just east of Taylor Falls another old channel may be seen. When this was cut down to about 760 feet, the river adopted the channel to the east.

In this region five distinct river terraces or river levels may be distinguished, each of which corresponds with some barrier which the river encountered in its process of down-cutting. The highest or 920 foot terrace is best developed in Taylor Falls and corresponds approximately with the original level of the glacial drift.[14] The 810 foot terrace corresponds with the main business street of St. Croix Falls[15] (fig. 41, p. 73) and was probably formed when the river encountered a barrier in the S. 1/2 of sec. 36, T. 34, R. 19 W. The 780 foot terrace was formed when the river was flowing in the channel immediately east of Taylor Falls[16]. In this case the barrier to the north was removed and the river abandoned its former channel. The 750 foot terrace is best developed on the Minnesota side.[17] This terrace, however, "is

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13 Chamberlin, R. T., op.cit., p. 254.

14 Idem, p. 256.

15 Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol. vol. 20, p. 353, 1897.

16 Idem, p. 353.

17 Chamberlin, R. T., op. cit., p. 255.

easily traced on both sides of the river for a mile above the Dalles. It is the most pronounced of all and marks probably three events: 1st, it awaited erosion of the narrow gorge from the elbow to the toll bridge, which made it possible for outflow at a lower level; 2d, it marked the period of most prominent pot hole erosion; 3d, it seems reasonable to conclude that it marked at least the beginning stage of a very considerable decrease in the amount of water discharged by the St. Croix[18]." The 725 foot terrace is belt developed on the Wisconsin side and represents a halt in the erosion of the channel through the Dalles[19]. The next terrace will be above the falls[20] or rather power dam.

Geology

Interstate Park exhibits deposits ranging in age from Keweenawan to the present but not a continuous series: Keweenawan flows and intercalated sediments, Cambrian sediments, two Pleistocene drifts, and recent slope wash and river sediments. A series of this sort postulates a number of unconformities (or periods of erosion) which have been detected. Indeed it is possible that one exists within the Keweenawan flows[21].

The flows have been tilted so that they now dip 15° S. 70° W. and have been considerably jointed and in some cases faulted[22]. The jointing

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18 Berkey, C. P., Geology of the St. Croix Dalles: Am. Geol. vol. 20, p. 353, 1897.

19 Idem, p. 353.

20 Chamberlin, R. T., op. cit., p. 256.

21 Winchell, N. H., The significance of the fragmental eruptive debris at Taylors Falls, Minnesota: Am. Geol. vol. 22, pp. 74, 78, 1898.

22 Grout, F. F., Contribution to the petrography of the Keweenawan: Jour. Geol. vol. 18, p. 636, 1910.

has influenced the development of the valley and the faulting, especially at the lower narrows, has determined the course of the river.

CHAPTER VI

BRULE STATE PARK

Geographic Location

Brule State Park is located in eastern Douglas County (in sec. 23, T. 47, R. 10 W.). County trunk highway "H" traverses the park. Brule on the Northern Pacific is located about one quarter mile north of the park and Winneboujou on the Duluth, South Shore & Atlantic is approximaterly one and one-half miles southwest of the park.

Physiographic Location

Though the park is located within the Northern Highland, it is not underlain directly by igneous rocks but on the contrary by sediments, figure 46. In further detail it is located on the northwest limb of the Keweenawan syncline[1].

Beginning at the bottom and progressing to successively younger formations the rocks of this syncline are: the sandstone, quartzite, and conglomerate of the Lower Keweenawan; the extrusives or flows of the Middle Keweenawan; and the sandstones, shales, and conglomerate of the Upper Keweenawan.

Near the northwest and southeast corners of the park beaches of Glacial Lake Duluth are found at an elevation of approximately 1060 feet. In the southwest quarter of the park beaches at 1060, 1120, and 1160 feet may be seen surrounding a small island which existed in a bay of Glacial Lake Duluth[2], figure 47.

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1 A syncline is a down-warped section of the earth's crust. It is bounded by folds in contrast to a graben which is bounded by faults.

2 Township report: Wisconsin Geol. and Nat. Hist. Survey, T. 47, R. 10 W., Map p. 18, 1925. (Unpublished)

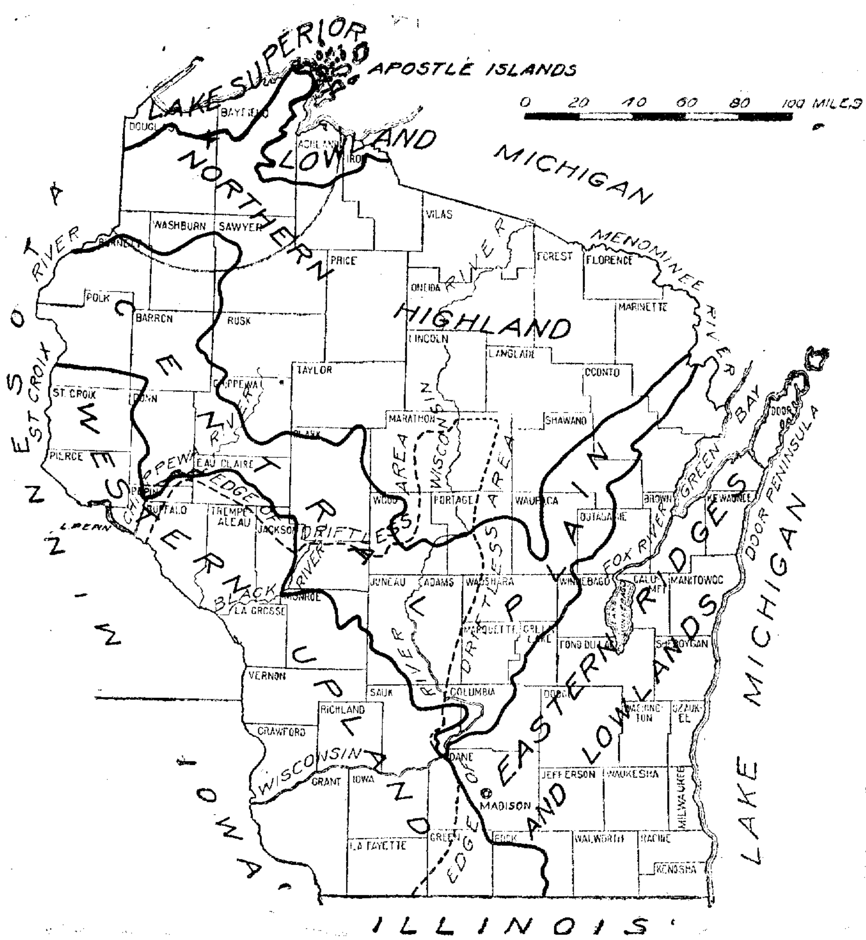

Figure 46.- Brule State Park is located in the Northern Highland. Courtesy of the Wisconsin Geological and Natural History Survey.

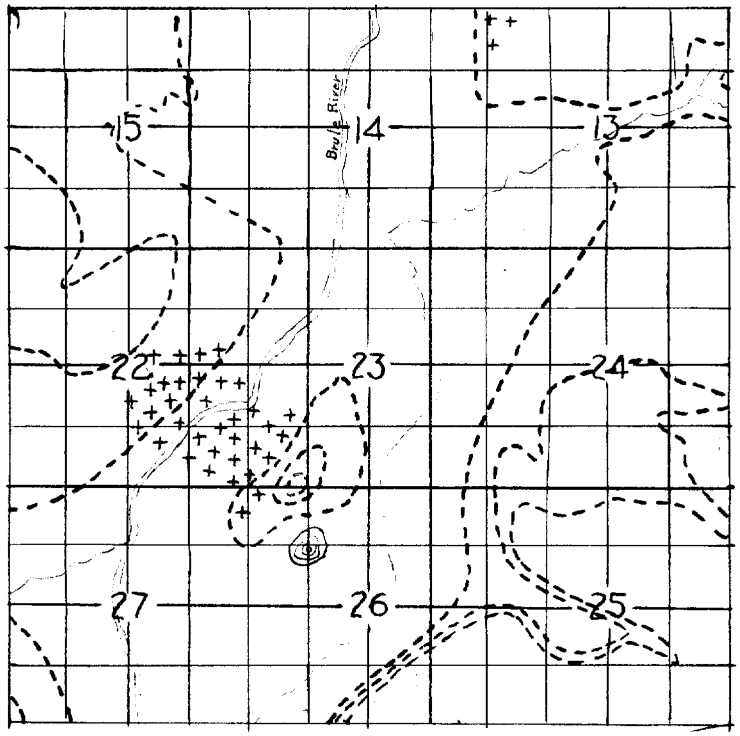

Figure 47.- Brule State Park is located in sec. 23, T. 47, R. 10 W. The terraces on the hill in the southwestern portion of the park are beaches which were formed by a lake which covered this area near the close of the glacial epoch.

= 1160 beach line
- - - - = 1120 beach line
= 1060 beach line

Map is from an unpublished report of the Wisconsin Geological and Natural History Survey.

When the visitor goes trout fishing in the Brule, it will be hard for him to visualize a river flowing in the opposite direction; yet that is the direction in which the Brule first flowed.

Features of Interest

Fishing is perhaps the chief attraction for the sportsman, but the tracing of old lake beaches and the search for cross bedding in river bars will furnish interesting studies for the hiker.

Geological History

Huronian deposition in the area of the park was followed by that of the Lower Keweenawan sandstone, quartzite, and conglomerate. During the Middle Keweenawan the region was covered by a great thickness of lava flows. Finally the Upper Keweenawan sandstones, shales and conglomerate were deposited in this area.

While the flows were being poured out upon the surface the whole region was being warped into a huge syncline or trough.

When the pre-Cambrian peneplain was developed, erosion beveled across the strata in the vicinity of the park, but did not cut down to the flows[3]. With the renewal of deposition during the Paleozoic this region was probably covered by those sediments. Later erosion wore away these later sediments but failed to uncover the Middle Keweenawan flows.

Then the region was covered by the Superior Lobe of the continental ice sheet. During its advance it rounded whatever hills existed on the preglacial surface. The kettle holes which occur immediately east and west of the park indicate that the glacial front halted in the vicinity of the

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[3] Magnetic readings show us that these flows are near the surface a short distance north of the park. Township report: Wisconsin Geol. and Nat. Hist. Survey, T. 47, R. 10 W., p. 10, 1925. (Unpublished)

park and deposited a recessional moraine with its typical knobs and sags[4].

On further retreat of the ice front Glacial Lake Duluth was formed, an arm of which extended to the south across the area of the park, figure 48. When the lake level was at 1160 feet a beach was formed around a small island in the southwestern part of the park. With further retreat of the ice to the north, or as a result of the deepening of the old outlet or the uncovering of a new and lower outlet, the level fell to 1120, whereupon beaches were developed around the island and also west and southeast of the park area. A further drop brought the lake to an elevation of 1060 feet and the development of beaches around the island and in the northwest and southeast corners of the park.

When, however, the lake level fell to 1021 feet[5], an arm of the lake no longer existed in this region, but the outlet was by way of the Brule to the St. Croix and the Mississippi. If the visitor will look closely, he may find bars in which the beds dip to the south, remnants of the days when the Brule flowed to the south. With a further lowering of the lake level, the lower reaches of the Brule flowed into the lake instead of away. Erosion in the headwaters of this new stream captured the old stream bit by bit until finally a valley which formerly contained a southward flowing stream now contains a northward flowing stream. The visitor may be able to find some modern bars which contain beds which dip to the north.

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4 Township report: Wisconsin Geol. and Nat. Hist. Survey, T. 47, R. 10 W., p. 12, 1925. (Unpublished)

5 Martin, Lawrence, The Pleistocene in The Geology of the Lake Superior region by Van Hise, C. R., and Leith, C. K.: U. S. Geol. Survey Mon. 52, p. 444, 1911.

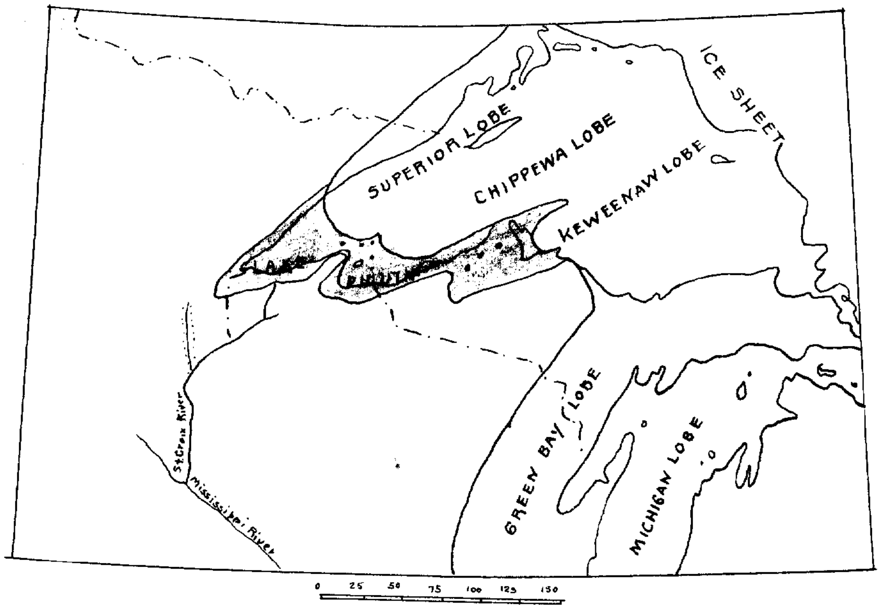

Figure 48.- Glacial Lake Duluth and the Bois Brule outlet. - After Martin.

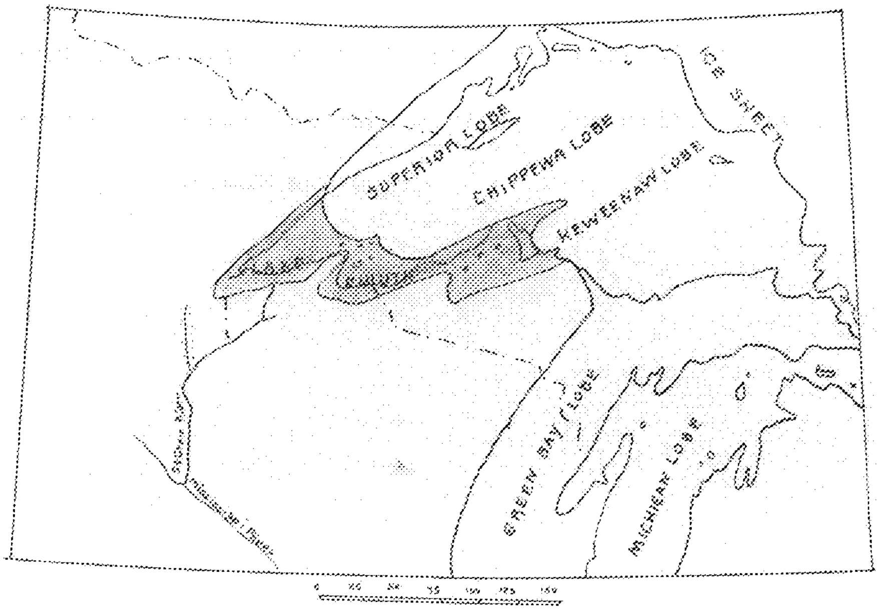

Figure 48.- Glacial Lake Duluth and the Bois Brule
outlet. - After Martin.

Geology

The park is covered by drift, probably recessional moraine, which has been reworked by glacial lake action. The drift is underlain by sediments of Upper Keweenawan age.

CHAPTER VII

TOWER HILL STATE PARK

Geographical Location

Tower Hill State Park, the gift of Mrs. Jenkin Lloyd Jones, is located on the south bank of the Wisconsin southeast of the village of Spring Green (in Lot 4, sec. 20, T. 8, R. 4 E.), figure 49. The park is on T. H. 41; the village of Spring Green about three miles distant is located on the Chicago, Milwaukee & St. Paul Railroad.

Physiographic Location

The park is located in the driftless portion of the Western Upland, figure 50. From the summit of the bluff one has a splendid view of a valley with a broad flat floor, the result of aggradation when the river was clogged with debris during the glacial period. The bluff within the park is a characteristic result of erosion in a sandstone which case-hardens.

Features of Interest

The sandstones within the park were ideal for the construction of a shot tower[1], figure 51. They were easily worked with the tools at hand, pick and shovel, and after the tower was constructed, they case-hardened and became fairly resistant to erosion. If the visitor will take the passageway at the base of the cliff and view the tower from below, he will see the marks of the picks still preserved on the sides of the shaft.

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1 See Wis. Hist. Colls. vol. 13, pp. 335-374, also Campbell, H. C., Wisconsin in three centuries, 1634 - 1905, vol. 2, p. 272, 1906.

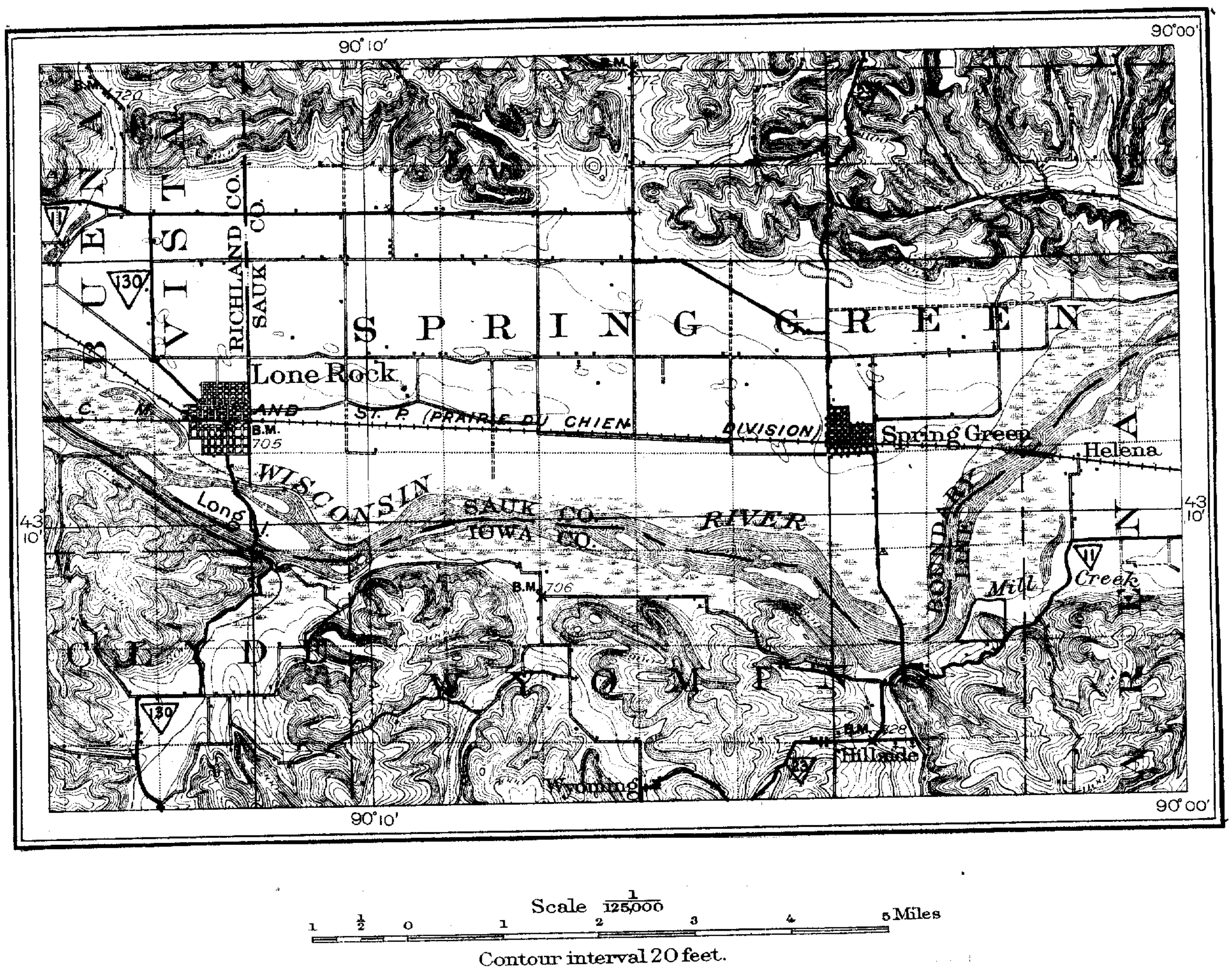

Figure 49.- Tower Hill State Park is located on a bluff south of the Wisconsin at the site of the old Helena Shot Tower. Map shows the broad portion of the Wisconsin gorge cut chiefly in weak sandstone. ▭ = Approximate boundary of park. (Richland Center quadrangle)

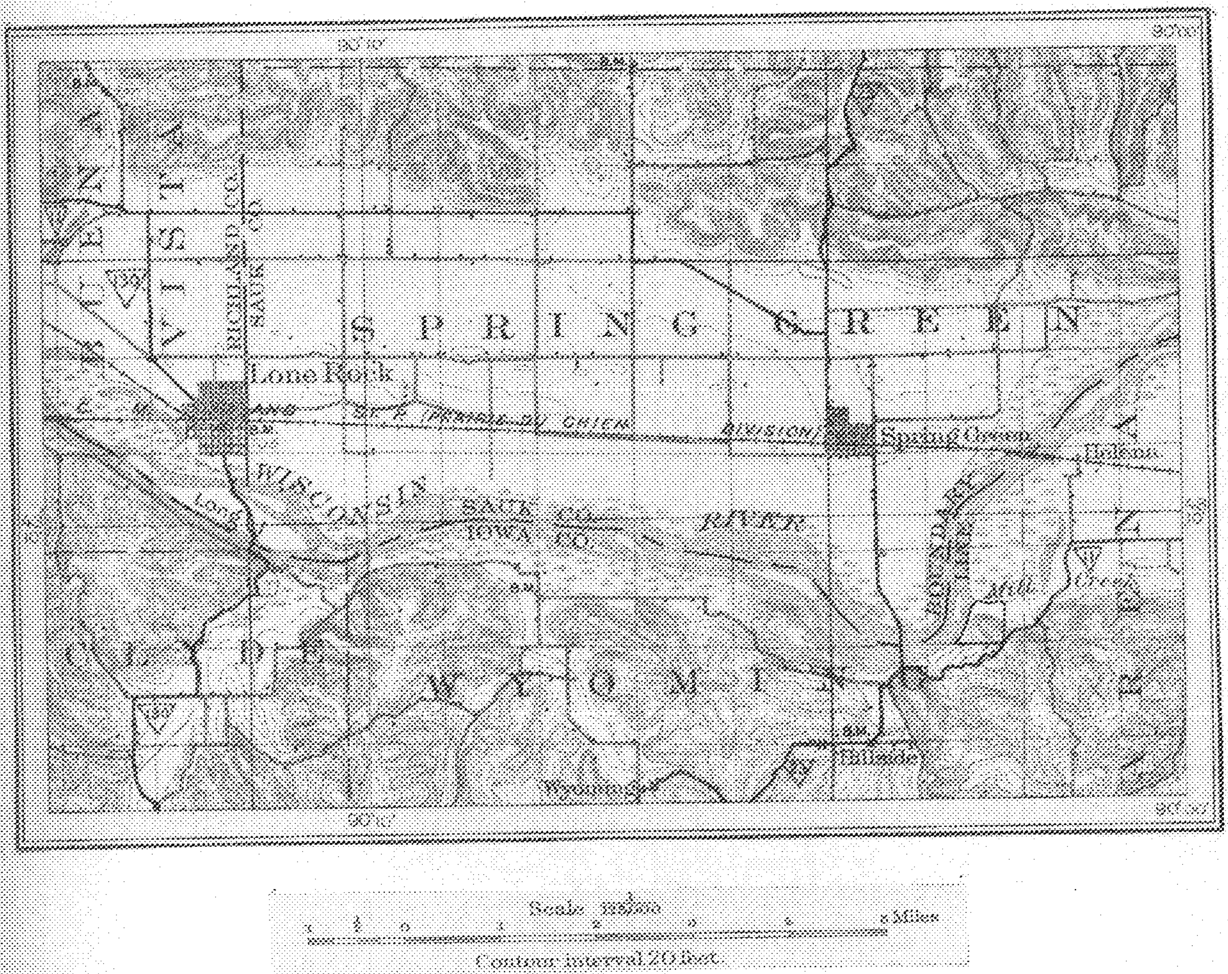

Figure 49.- Tower Hill State Park is located on a bluff south of the Wisconsin at the site of the old Helena Shot Tower. Map shows the broad portion of the Wisconsin gorge cut chiefly in weak sandstone. ▭ = Approximate boundary of park. (Richland Center quadrangle)

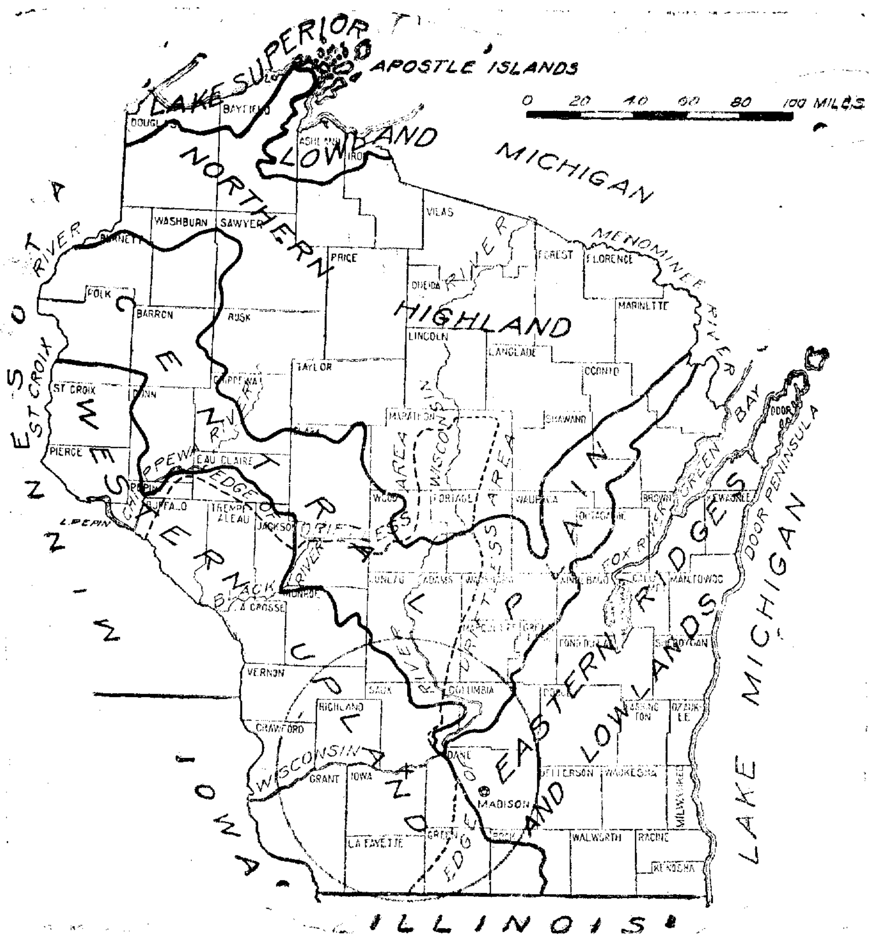

Figure 50.- Tower Hill State Park is located in the driftless portion of the Western Upland. Courtesy of the Wisconsin Geological and Natural History Survey.

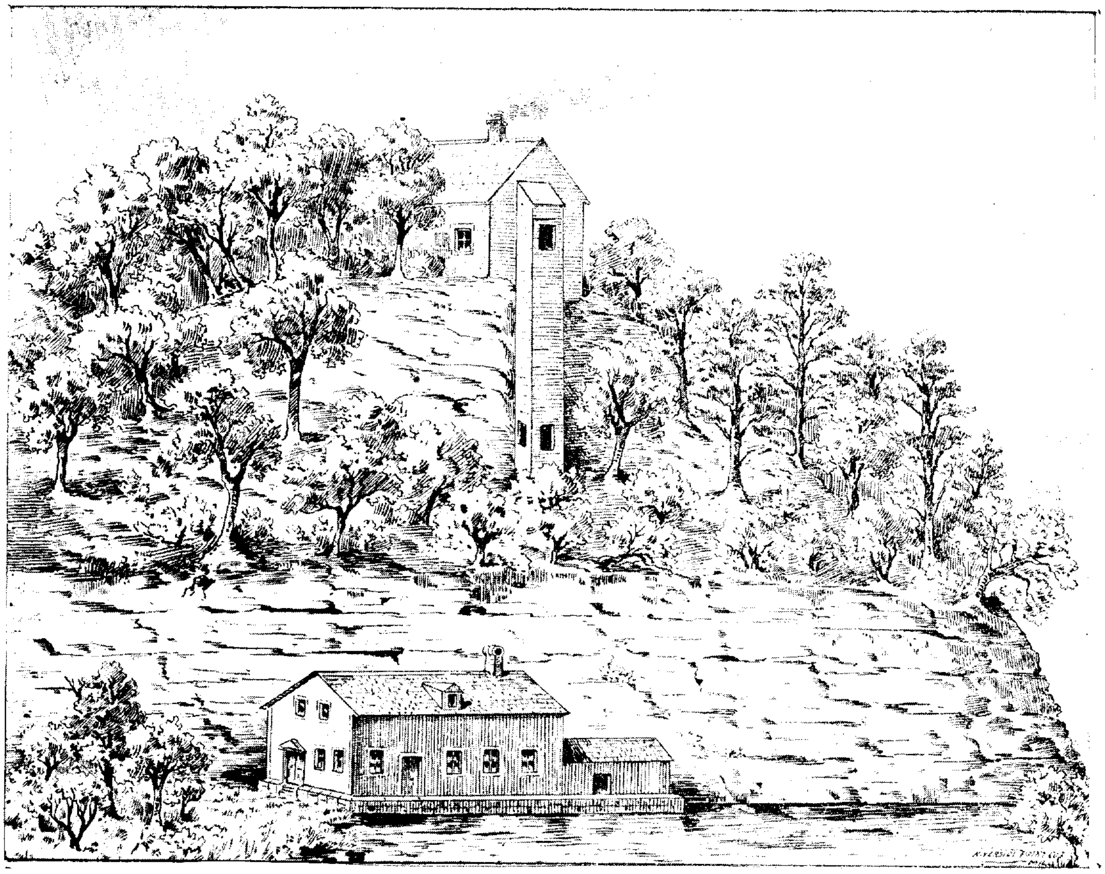

Figure 51.- Sketch of the original shot-tower buildings. Courtesy of the Wisconsin Historical Society.

From the summit of the cliff the observer will see the bottomlands of the Wisconsin to the north. The rock floor is probably 125 to 150 feet below the present surface[2]. As one stands upon the summit of the bluff, he can imagine the much larger Wisconsin which flowed in the valley during the glacial period. He can imagine a swift river but also one that was choked with sand bars. For a time the river would flow on the south side of the valley, would build natural levees, and fill its channel; then a flood would come, the river would break through its levees and flow in a new channel in the center or at the north side of the valley.

Geological History

As the oldest rock exposed within the park is the Dresbach sandstone of Cambrian age, the writer will begin the present discussion of the geological history with Wisconsin submerged beneath the sea and receiving the Cambrian sediments. Adjacent outcrops show that this region was at one time covered with sediments of Ordovician and Silurian age. It may be mentioned that the nearest outcrop of Silurian rock or Niagara limestone is at the summit of Blue Mounds, about 15 miles to the southeast.

After the deposition of the Niagara, Wisconsin was raised above the sea and the forces of erosion began to wear away the surface formations. In the vicinity of the park all the Silurian and Ordovician formations and even the upper part of the Cambrian have been worn away.

As shown in figure 49, the Wisconsin River valley is wide at this point because it is cutting in non-resistant Cambrian sandstone, but is

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[2] Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 176, 1916.

narrow down stream at the outcrop of the more resistant Lower Magnesian dolomite.

Though this region is in the Driftless Area, the valley was much modified by glacial drainage. When the Wisconsin glacier stood at its terminal in the vicinity of Prairie du Sac, the river was much increased in volume by the waters which were heavily ladened with silt and debris from the melting ice. This sediment the river could not transport far and therefore began to aggrade or build up its channel. When the glacial front withdrew from the terminal and Glacial Lake Wisconsin (fig. 52) found a new and lower outlet to the south, the waters of the river were clear and the Wisconsin rapidly sank its channel in these sediments and left terraces at the sides of the valley. Just as in the Mississippi degradation was followed by aggradation, for the Wisconsin is now engaged in a period of flood plain deposition.

Geology

The Lower Magnesian dolomite does not outcrop in the park but is found on the uplands both to the north and the south. Indeed the Lower Magnesian cuesta is a considerable distance north of the park.

In the cliff which borders the Wisconsin about 140 feet of Mazomanie sandstone and 6 feet of Dresbach sandstone is exposed. When the visitor stands on the sand flat at the base of the cliff, he can examine the contact between the two sandstones, for it occurs but 6 feet above the base. The upper sandstone is yellowish and fine grained; the lower is white and much coarser grained. Though these sandstones

Figure 52.- Glacial Lake Wisconsin formed by glacial damming of the Wisconsin River. The melting back of the ice front permitted the lake to find a new outlet through the terminal moraine to the southeast. As this outlet was lowered by erosion, the lake was drained. (After Martin)

Figure 52.- Glacial Lake Wisconsin formed by glacial damming of the Wisconsin River. The melting back of the ice front permitted the lake to find a new outlet through the terminal moraine to the southeast. As this outlet was lowered by erosion, the lake was drained. (After Martin)

are very soft, they stand in vertical cliffs because percolating waters bring iron, silica, and calcite to the exposed surface where the water evaporates and deposits these minerals as a protecting cover. This process is called casehardening.

CHAPTER VIII

PERROT STATE PARK

Geographic Location

Perrot Park, Plate VI, is located along the Mississippi River in southern Trempealeau County. More specifically the park contains about 910 acres in secs. 19, 20, and 21, T. 18, R. 9 W. The park is not located on a county or state trunk highway but may be reached from the village of Trempealeau. The Chicago, Burlington & Quincy and the Chicago & Northwestern railroads pass through or immediately adjacent to the park.

Physiographic Location

The park is located within the driftless portion of the western upland, figure 53. The bluffs and Trempealeau Mountain form the eastern wall of the Mississippi gorge.

Features of Interest

The park is noted for its beauty as well as its historical connections. The most widely known feature of the park is Trempealeau Mountain, figure 54. "The Winnebago Indians are said to have called this whole rocky eminence Hay-nee-ah-chah, or soaking mountain, the Dakota Indians Min-nay-chon-ka-hah, or bluff in the water, and the Sioux Pah-hah-dah, or mountain separated by water. Accordingly the French continued the same name in the form La Montagne qui trempe à l'eau, or the hill which

PLATE VI

STATE OF WISCONSIN

GEOLOGICAL AND NATURAL HISTORY SURVEY

E. F. BEAN, DIRECTOR AND STATE GEOLOGIST

(Whitehall)

...PARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

GALESVILLE QUADRAN...

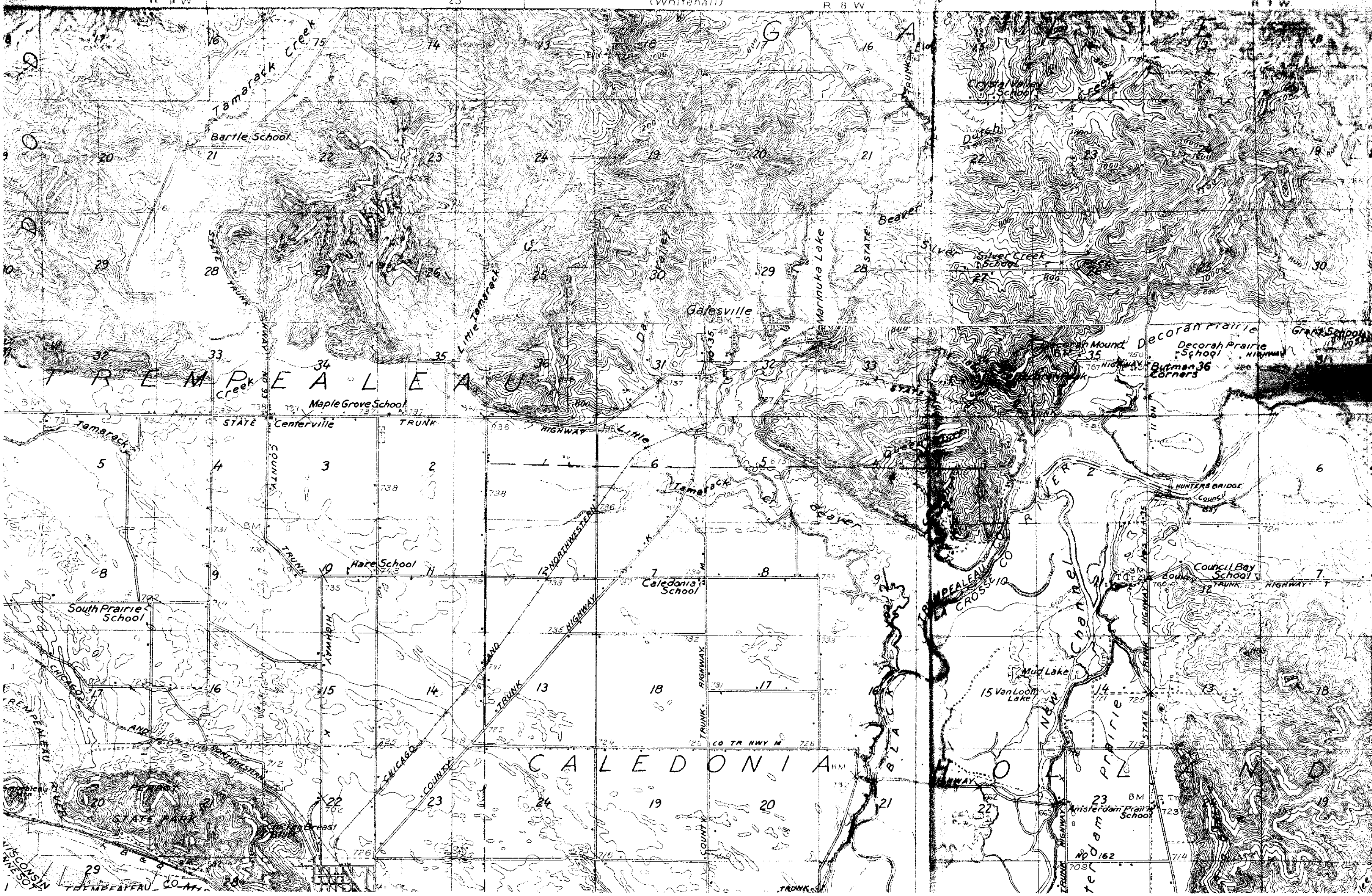
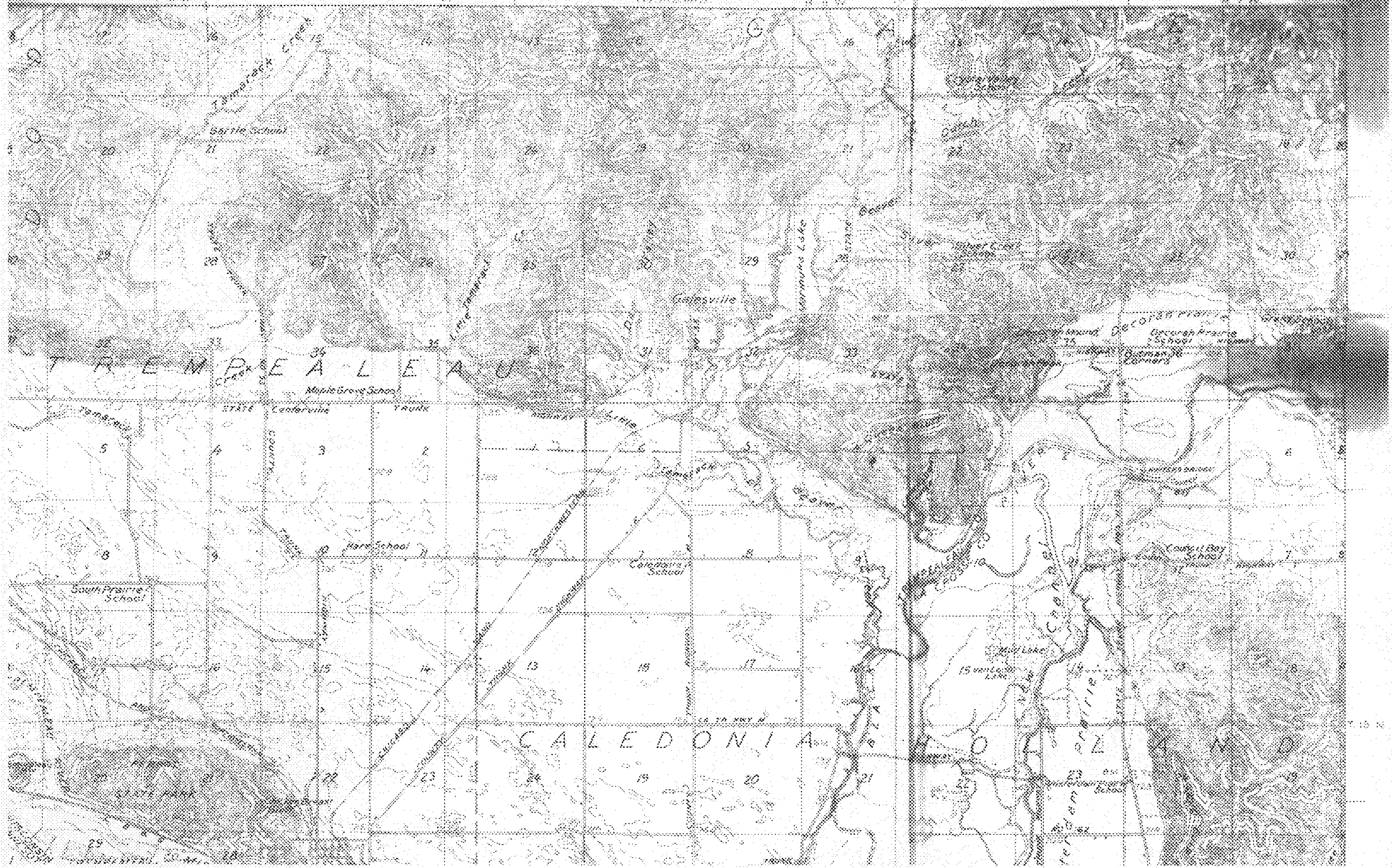
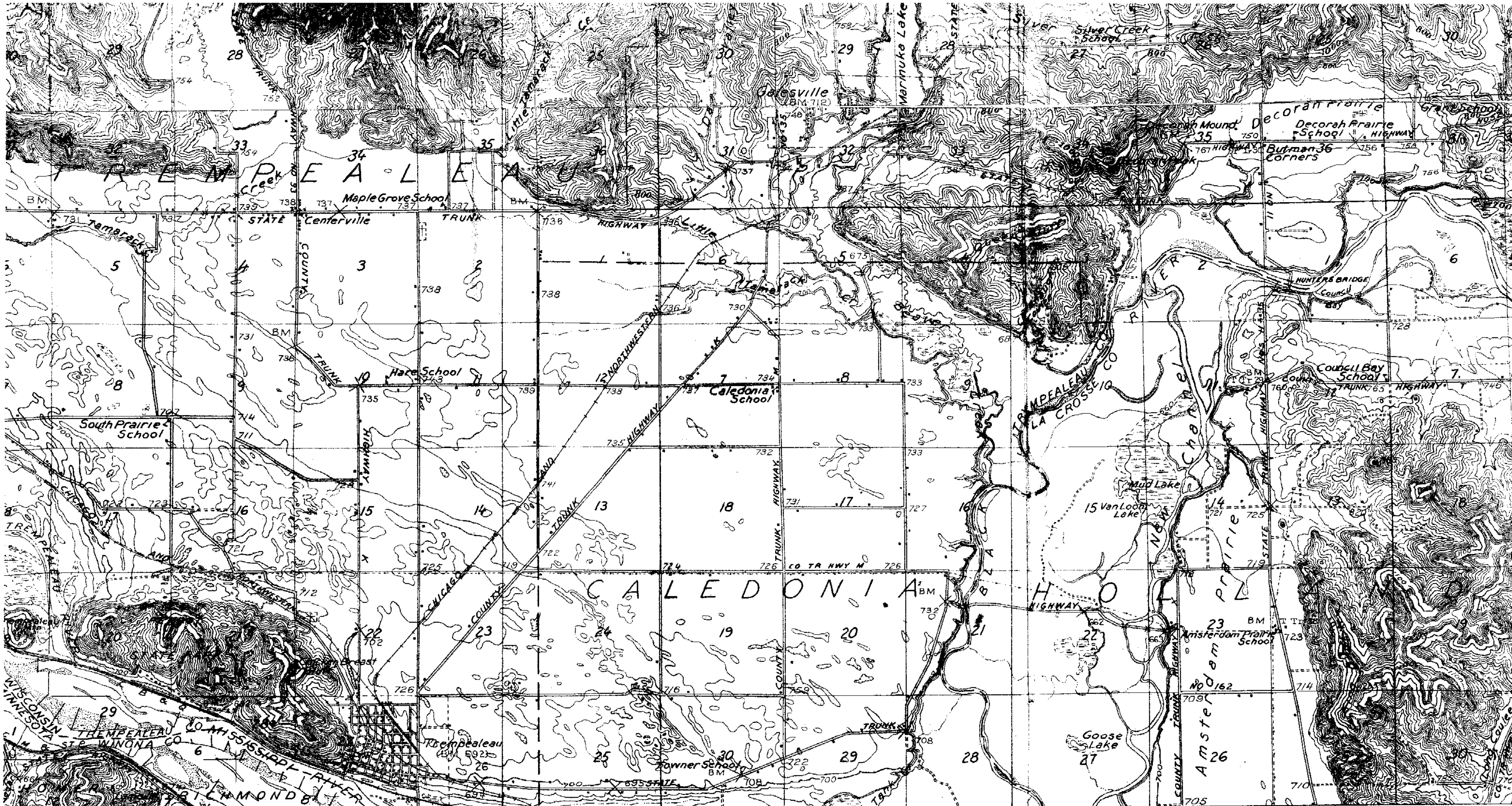


PLATE VI

STATE OF WISCONSIN

GALESVILLE QUADRANGLE





R. 6 W. R. 5 W. 785000 YARDS

Topography by J.G. Staack, O.H. Nelson, and J.C. Hillard
Control by U. S. Geological Survey
Surveyed in 1923 and 1926

Hillard	
	O.H. Nelson
Staack	

TRUE NORTH
MAGNETIC NORTH
5°
APPROXIMATE MEAN DECLINATION, 1926

Scale $\frac{1}{48,000}$

1 ½ 0 1 2 3 4 Miles

5,000 0 5,000 10,000 15,000 Feet

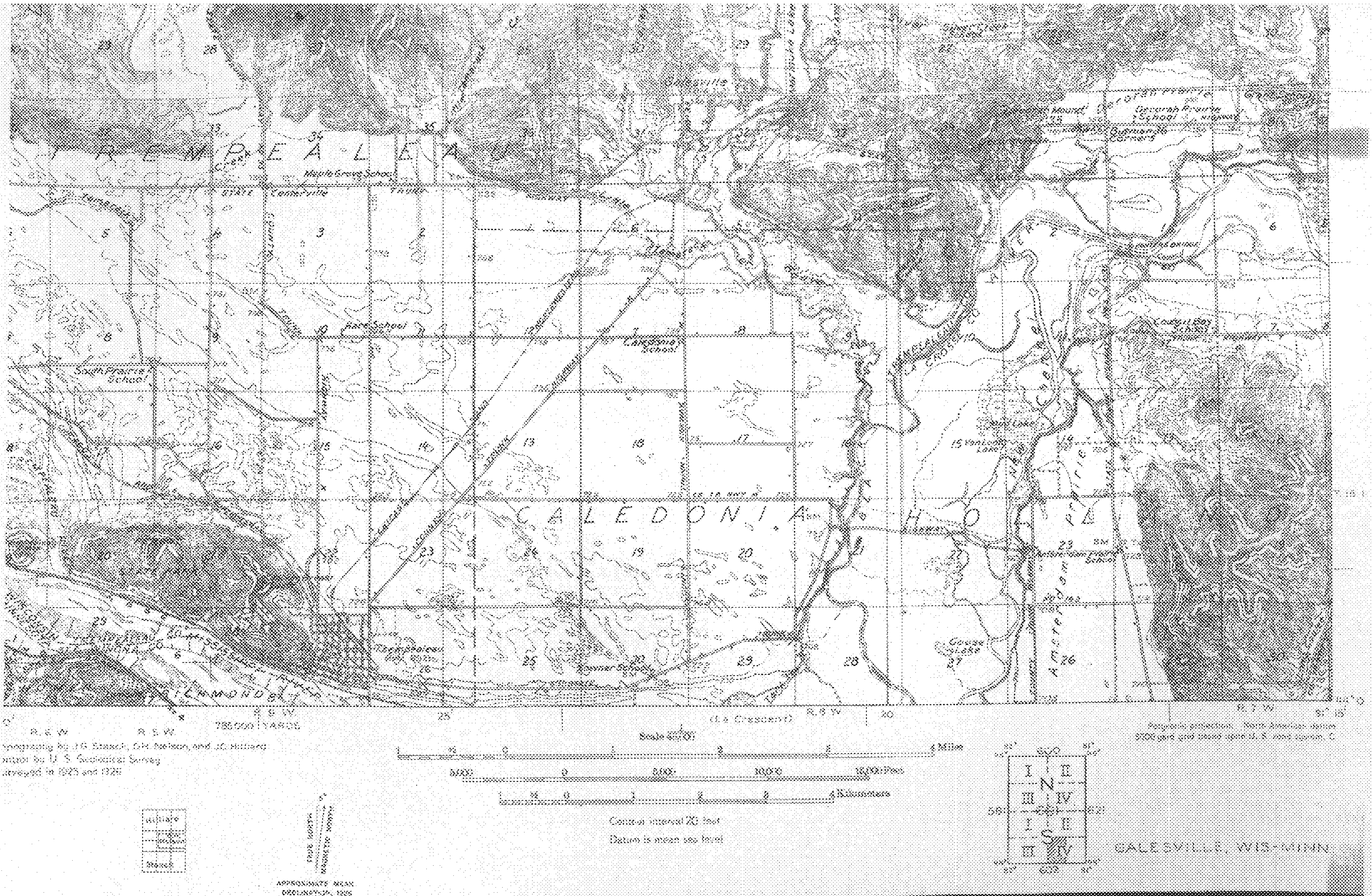
1 ½ 0 1 2 3 4 Kilometers

Contour interval 20 feet
Datum is mean sea level

Polyconic projection. North American datum
5000 yard grid based upon U. S. zone system, C

92° 45°	600	91° 45°
I	N	II
III		IV
581	601	621
I	S	II
III		IV
44° 92°	602	44° 91°

GALESVILLE, WIS.-MINN.


Galesville
Maple Grove School
Centerville
Hare School
Caledonia School
South Prairie School
CALEDONIA
Amsterdam
Prairie
Sommer School
Goose Lake
Decorah Prairie School
R. 8 W.
R. 7 W.
785 000 YARDS
(La Crescent)
Scale
Miles
Feet
Kilometers
Contour interval 20 feet
Datum is mean sea level
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1926
Surveyed in 1925 and 1926
GALESVILLE, WIS.-MINN.

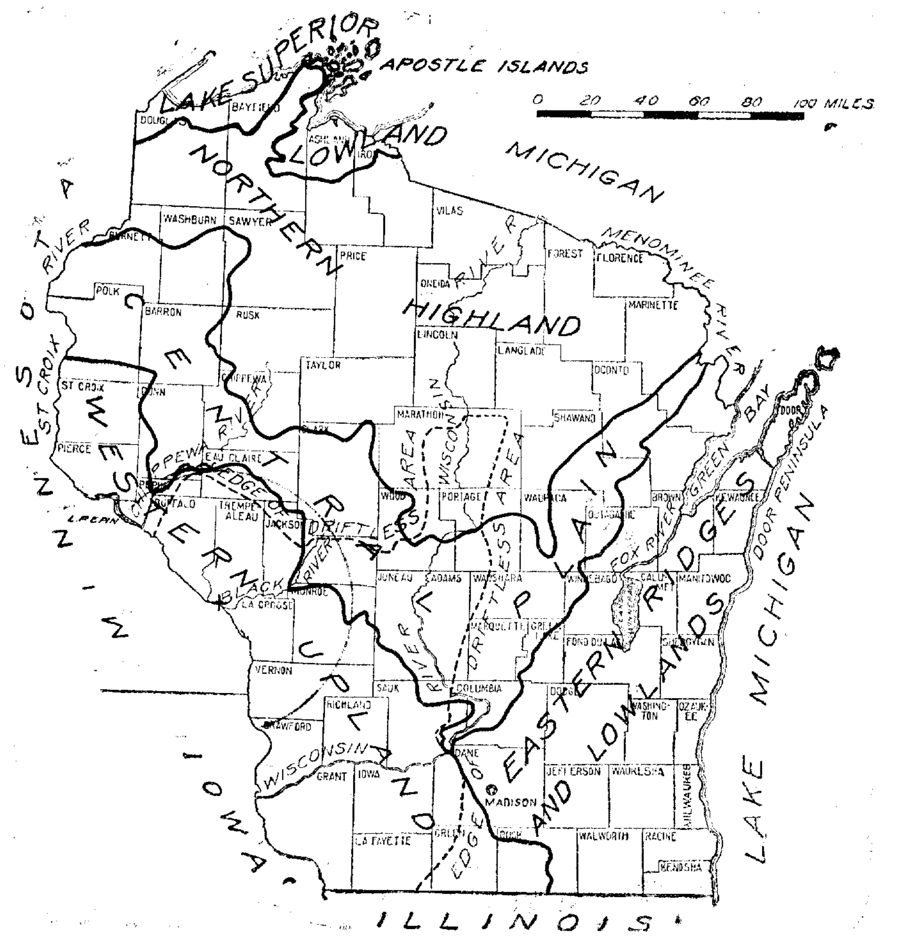


Figure 53.- Perrot Park is located within the driftless portion of the western upland. Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 54.- Looking upstream at Trempealeau Mountain. - Courtesy of the Wisconsin Geological and Natural History Survey.

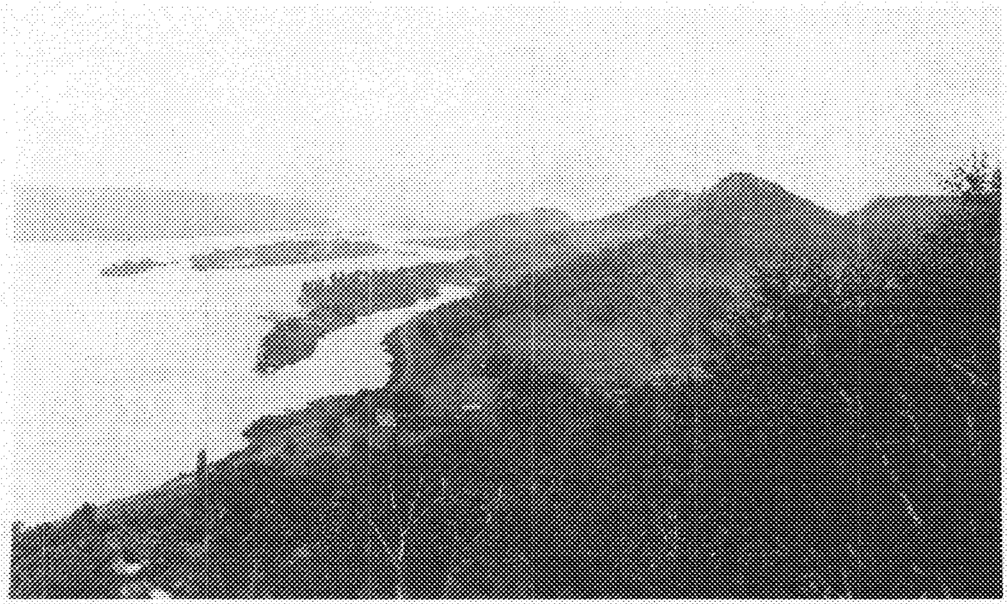


Figure 54.- Looking upstream at Trempealeau Mountain. - Courtesy of the Wisconsin Geological and Natural History Survey.

soaks in the water[1]." The bluffs, figures 55 and 56, are also worthy of note but have not attracted as much attention.

The park is named after Nicolas Perrot whom the autumn of 1786 found "on the upper Mississippi. Overtaken by cold weather before he could mount to the Sioux country, he built a wintering post 'at the foot of a mountain, behind which was a great prairie abounding in wild beasts.' Although it was chosen for utility, the French trader must have recognized the beauty of the site, beside the mountain that steeps itself in the water - Mount Trempealeau, facing the cliffs behind which each night the sun drops in golden glory[2]."

In 1731 Linctot was sent to command a post in the Mississippi Valley. "Linctot on his outward voyage mounted the Mississippi only as far as Mount Trempealeau, and there on the site of Perrot's old wintering post he built a fort which was maintained for five years, and which has left to posterity the only remains yet discovered of a French post in Wisconsin (fig. 57)[3]."

It is interesting to note that Perrot mentions that the country is prairie and that Moses Strong calls attention to this same feature: "Very little timber grows in this town (T. 18 N., R. 9 W); it is known as

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[1] Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 137, 1916.

[2] Kellogg, L. P., The French Regime in Wisconsin and the Northwest: State Historical Society of Wisconsin, Wisconsin History Series vol. 1, pp. 231-232, 1925.

[3] Idem, pp. 328-329.

Figure 55.- Looking downstream from Trempealeau Bluffs. - Courtesy of the Wisconsin Geological and Natural History Survey.

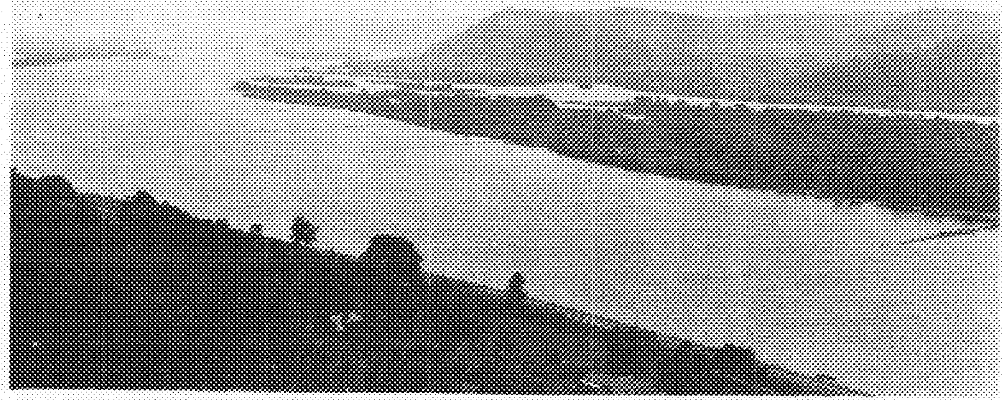

Figure 55.- Looking downstream from Trempealeau Bluffs. - Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 56.- Top of Trempealeau Bluff. The light colored formation at the summit is Lower Magnesian dolomite; the underlying darker colored formation is Jordan sandstone. NW. 1/4 27, T. 18, R. 9 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

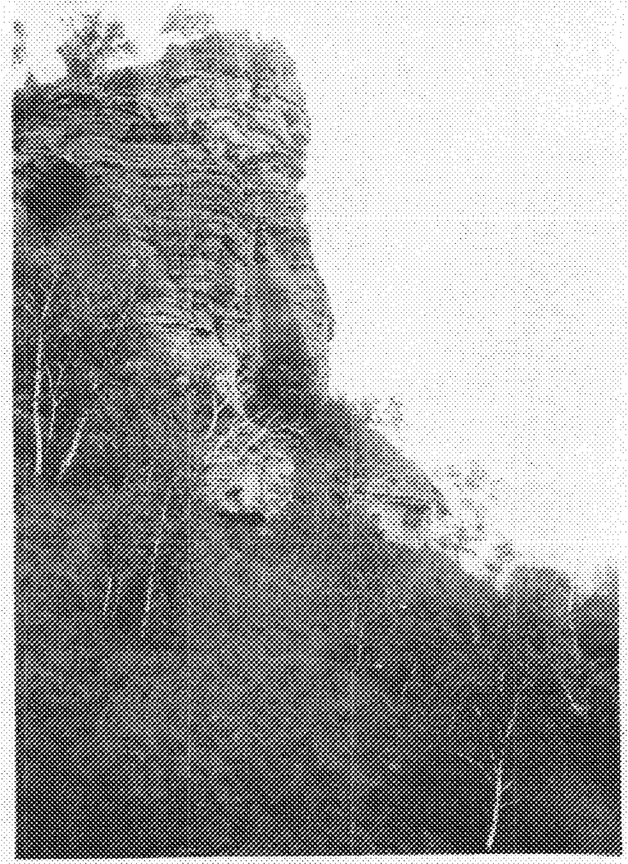

Figure 56.- Top of Trempealeau Bluff. The light colored formation at the summit is Lower Magnesian dolomite; the underlying darker colored formation is Jordan sandstone. NW. 1/4 27, T. 18, R. 9 W. - Courtesy of the Wisconsin Geological and Natural History Survey.

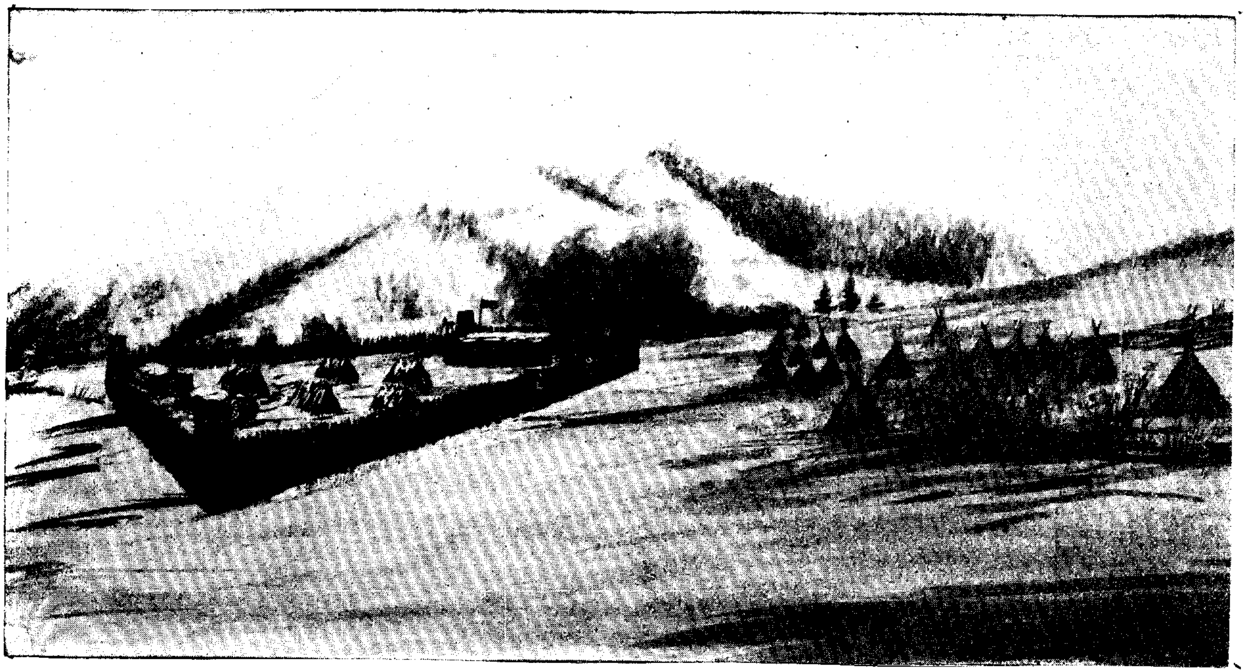

Figure 57.- The French post near Trempealeau. - Courtesy of the Wisconsin Historical Society.

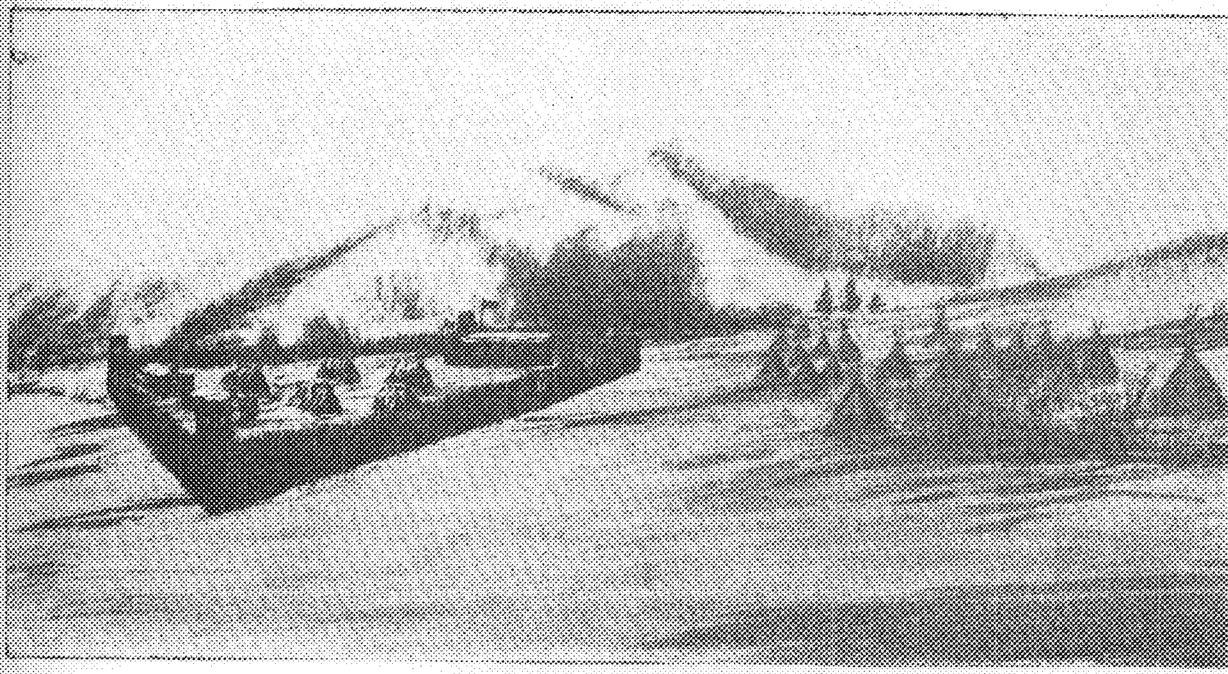

Figure 57.- The French post near Trempealeau. - Courtesy of the Wisconsin Historical Society.

the Trempealeau prairie[4]."

Geological History

So far as the oldest rock exposed within the park is concerned, the geological history begins with submergence in the Cambrian sea during the deposition of the Dresbach sandstone. This formation was followed by the Franconia, St. Lawrence, Jordan, and Madison formations and finally the Lower Magnesian dolomite of Ordovician age (see section p. 116). To be sure the Galena-Black River dolomite and the Niagara dolomite were deposited over this region, but they have long since been eroded from this region. In fact the Lower Magnesian dolomite remains only in isolated remnants where it caps the higher hills of the region.

The first effect of the glacial period in the Mississippi valley was doubtless an increase in the rate of cutting the gorge due to waters issuing from the melting ice far to the north. When this ice lay in the vicinity of its terminal, degradation was changed to aggradation, for the glacial waters were overburdened with debris. Thus the old channel was buried beneath a considerable thickness of sand, gravel, and silt. With recession of the glacial front marginal lakes were formed to the north and the immense volumes of clear water which drained from them began to clear the old channel. This task they accomplished, and probably deepened the rock bottom to a considerable extent, but "it may turn out that a few of the terrace remnants - all of which now seem to be of latest Wisconsin age - are related to one or another of the earlier drift

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4 Strong, Moses, Geology of the Mississippi Region: Geology of Wisconsin vol. 4, p. 30, 1882.

sheets[5]." An examination of Plate VI shows that the rock spurs on the northeast side of the main valley differ markedly from those in the tributary valleys. Such cut-off spurs postulate a vigorous stream of clear water such as probably coursed through here at this time.

The Wisconsin stage was initiated by a period of degradation which was followed by one of aggradation during which the gorge was buried to a depth of 100 to 200 feet[6]. With retreat of the ice front marginal lakes were again formed to the north and the clear waters which drained from them began to clear away the filling. When the present period of flood plain deposition began, the waters had not cleared away all the fill. Many remnants of this filling which formerly filled the whole gorge were left along the walls. These are known as terraces and those in the vicinity of Trempealeau are shown in figure 58.

At the time the valley was filled with this sediment an interesting stream diversion occurred in the vicinity of Trempealeau. The old channel of the river was to the east of Trempealeau Bluffs and Trempealeau Mountain. The gorge of Cedar Creek, a tributary of the Mississippi, separated Trempealeau Mountain from the bluffs to the south. Big Trout Creek drained the valley between the Trempealeau and Minnesota bluffs and entered the Mississippi to the south, figure 59. When the river was flowing upon the sand, gravel, and silt which had been deposited in the main channel, it probably broke through the natural levees and began to flow in the Cedar-Trout Creek valley to the west, a course which it has since maintained,

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[5] Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 153, 1916.

[6] Idem, p. 155.

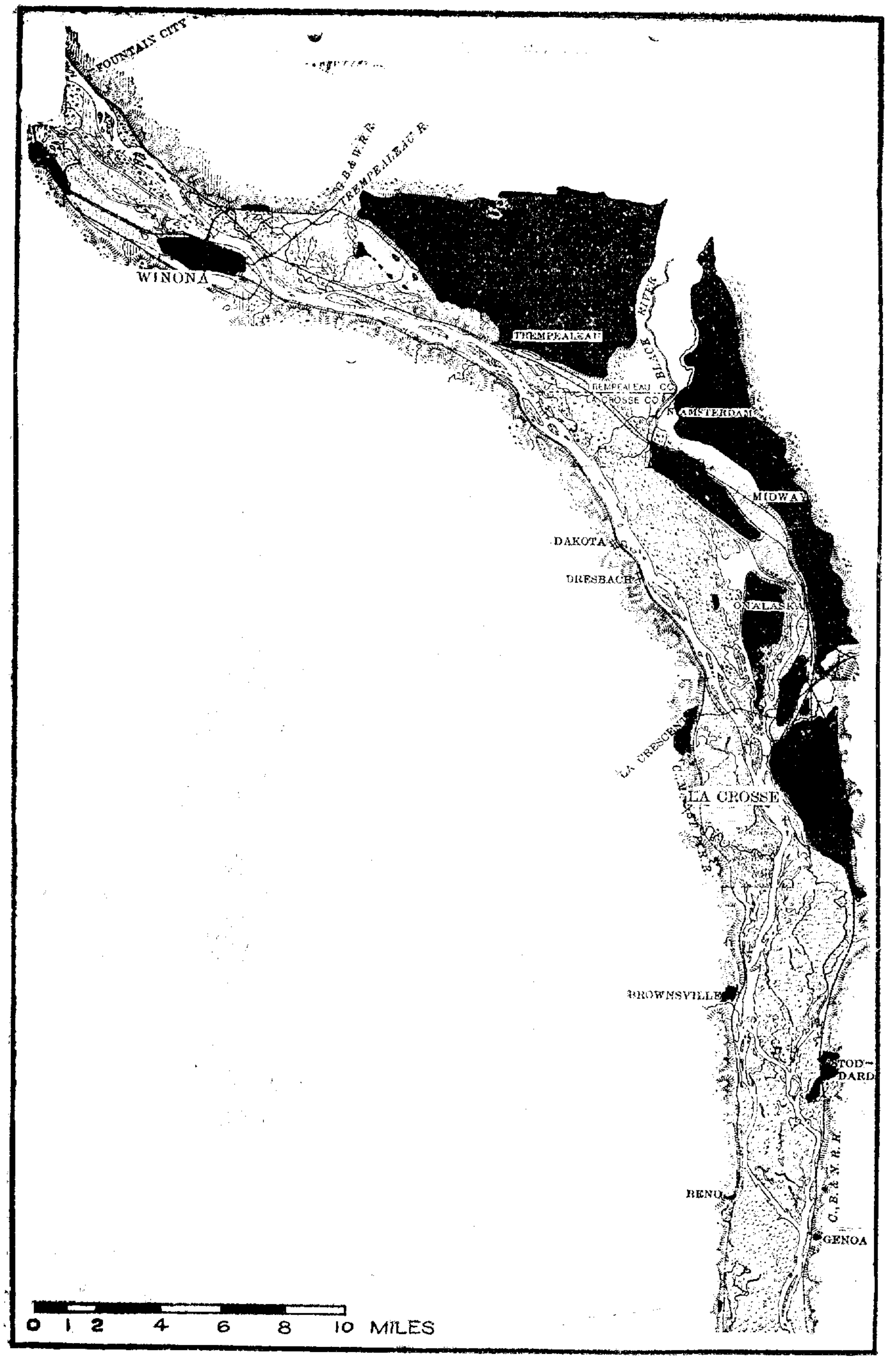


Figure 58.- The terraces- in black - in the Mississippi bottomlands near Trempealeau Mountain. Courtesy of the Wisconsin Geological and Natural History Survey.

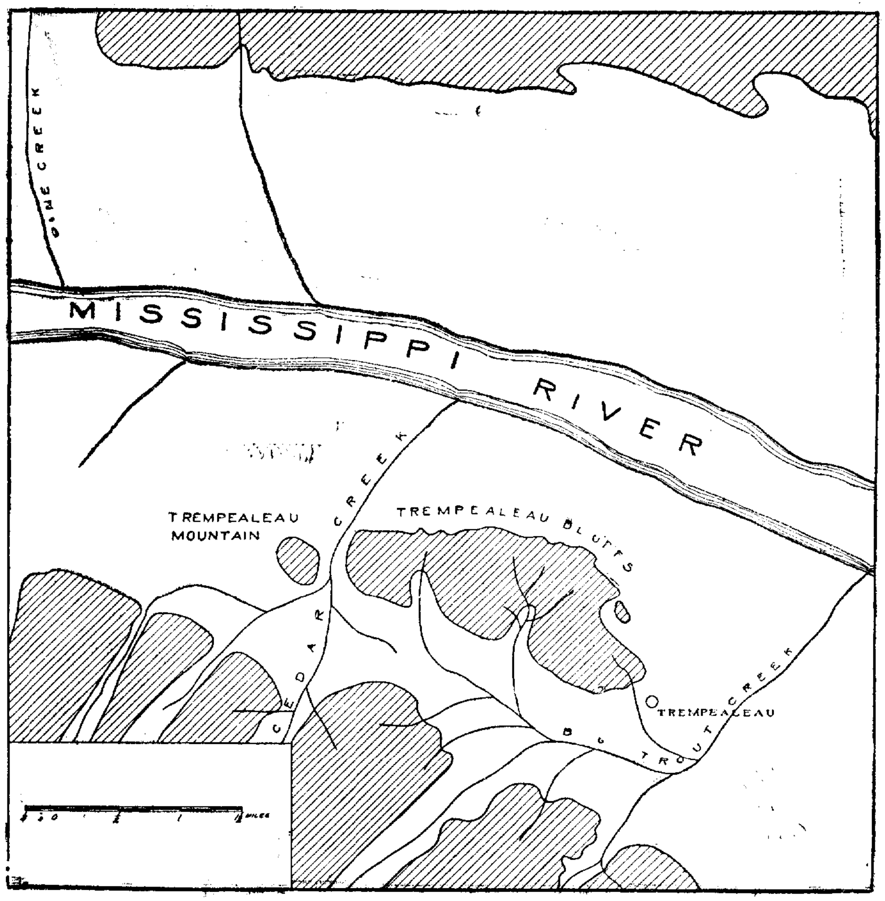


Figure 59.- The rock hill at Trempealeau when the Mississippi still flowed in the bottomlands to the northeast. Courtesy of the Wisconsin Geological and Natural History Survey.

figure 60. This diversion shows why such a large terrace has been preserved at Trempealeau (fig. 58, p.109).

The gorge of the Mississippi is wide in the vicinity of Trempealeau but is narrower both to the north and south, figure 61. The non-resistant Cambrian occurs in the vicinity of Trempealeau whereas the resistant Lower Magnesian dolomite occurs upstream at Prescott and downstream at Prairie du Chien, figure 62. Where the river is cutting in a soft rock, it is wide; where it is cutting in a hard rock, it is narrow. It is, indeed,strange that the resistant stratum which causes the gorge to narrow upstream also causes it to narrow downstream. This outcrops of a single formation both upstream and downstream is explained by the existence of a minor anticline or slight arch in the sediments in this vicinity which is shown graphically in figure 63.

Geology

The strata exposed in the park are best described in the following section:

Section at Trempealeau Mountain[7]

Description of bed	Approximate thickness Feet
Lower Magnesian. Fucoid beds from base of formation	20
Madison	
Sandy and shaly Sandstone fine grained Sandy dolomite	18
Jordan	
Silicified and agglomeration - botryoidal cemented	

[7] Ulrich, E. O., Field notes, section made in 1913.

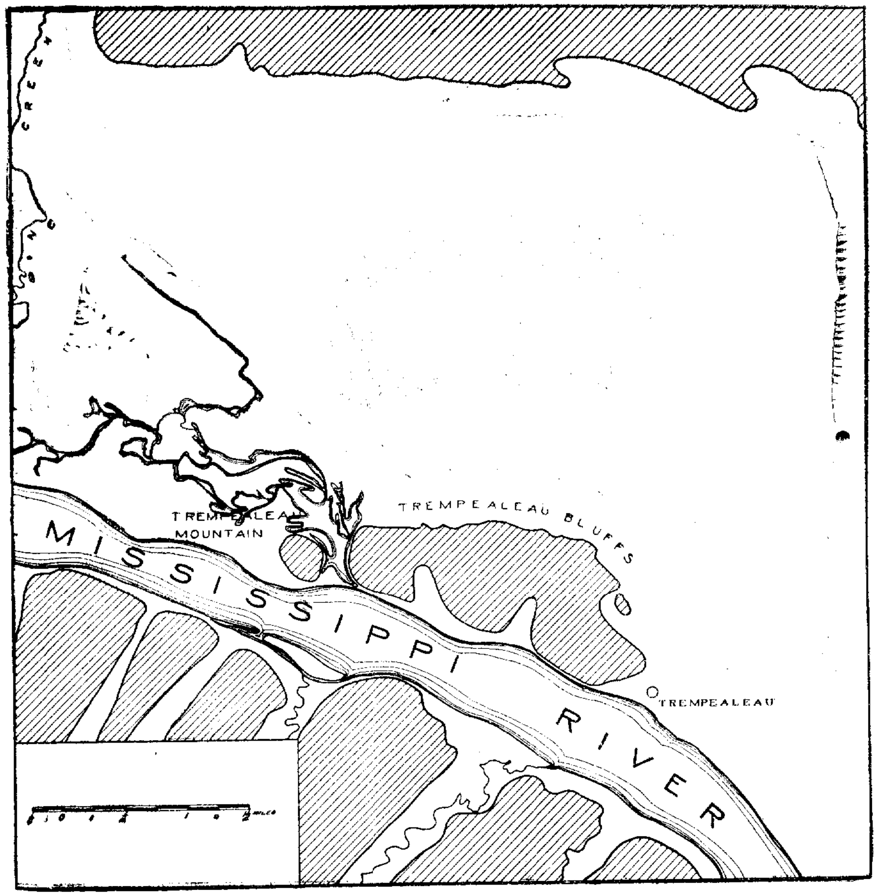


Figure 60.- The rock hill at Trempealeau with the Mississippi in its present channel on the southwest of La Montagne qui trempe à l'eau, or the hill in the river. - Courtesy of the Wisconsin Geological and Natural History Survey.

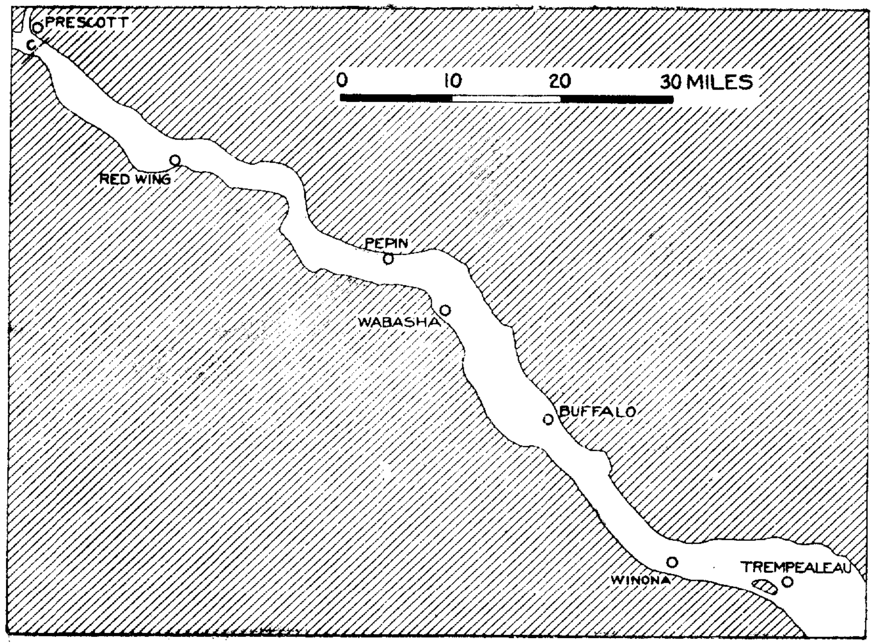


Figure 61.- The Mississippi in its broad gorge at Trempealeau in sandstone, and its narrow gorge at Prescott in limestone. Courtesy of the Wisconsin Geological and Natural History Survey.

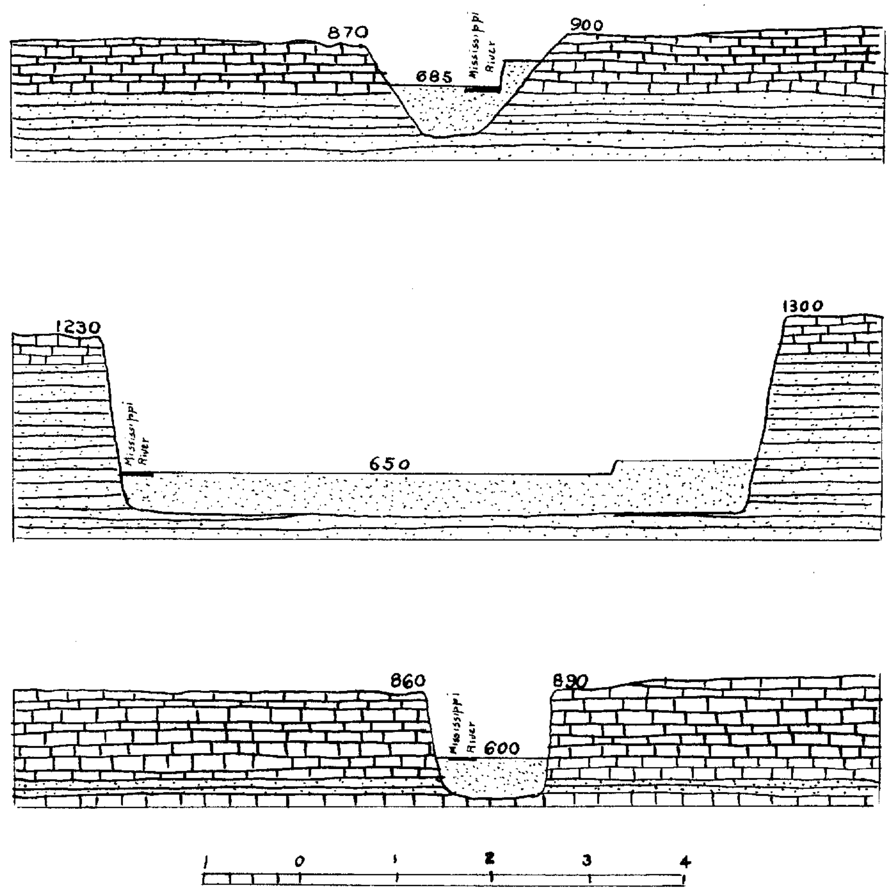


Figure 62.- Cross-sections to show the variations in the width of the Mississippi gorge and the height of the bluffs, from Prescott (upper), to Trempealeau (middle), and Grant County near Dubuque (lower). Brick pattern, limestone; dots between horizontal lines, sandstone; dots without lines glacial gravel and sand and floodplain alluvium. (After Martin)

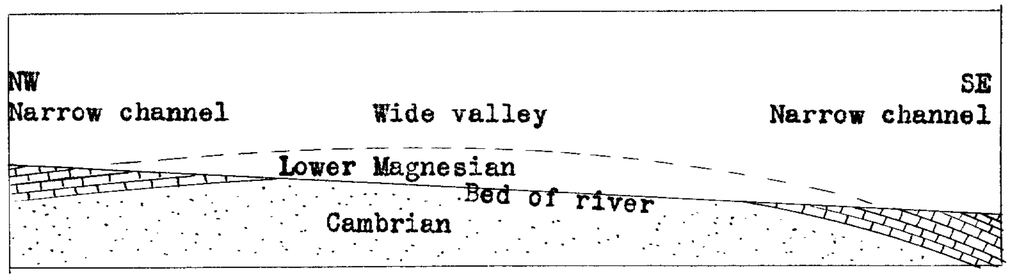


Figure 63.- Diagrammatic representation of the Mississippi cutting across the anticline in the vicinity of Trempealeau. Note that the resistant stratum occurs both upstream and downstream.

Description of beds	Approximate thickness Feet
aggregations of sand grains	77
St. Lawrence	
Zone with calcareous and dolomitic rock in upper part, the calcareous portions are in irregularly shaped pieces with fine clayey sandstone matrix. In lower part they make more continuous beds. All parts, however are largely made up of fine siliceous sand	9
Concealed	4
More or less limy, fine grained sandstone	7
Red, green, and yellow compact sandstone, dolomite layers	..
Pleasant Valley sandstone	..
Sandy, argillaceous dolomite	about 11
Green sand with other sands in part connected with dolomite. The lower 4 feet mostly dolomite and thicker bedded. Above thin layers, some flat pebbled conglomeratic layers	15
Thin bedded green and yellow sandstone	..
Soft greensand and green sandstone	..
Franconia	
Micaceous sandstone) Alternations of green and ferruginous sandstone 20 feet) Micaceous sandstone)	25
Green earth and thin green sandstone	36
Brown to light buff, siliceous, calcareous rock	4
Soft, thin bedded, green, micaceous sandstone	14
Greensand and soft green sandstone	6
Dresbach	
Coarse grits, especially fossiliferous toward the top. Part of this top bed may be initial Franconia deposit	104
River level	

Beneath river level there is a continuation of the Cambrian series, figure 1, p. 6 . Beneath the terrace there is a thickness of possibly 100 to 200 feet of sand, gravel, and silt.

CHAPTER IX

NELSON DEWEY PARK

Geographic Location

Nelson Dewey Park, Plate VII, is located in southwestern Wisconsin south of the junction of the Wisconsin with the Mississippi. To reach the park it is necessary to take F.T.H. 18 or 61 to the junction with county trunk "X" and the latter to its junction with the road which leads to the park. The Chicago, Burlington & Quincy Railroad runs through the park.

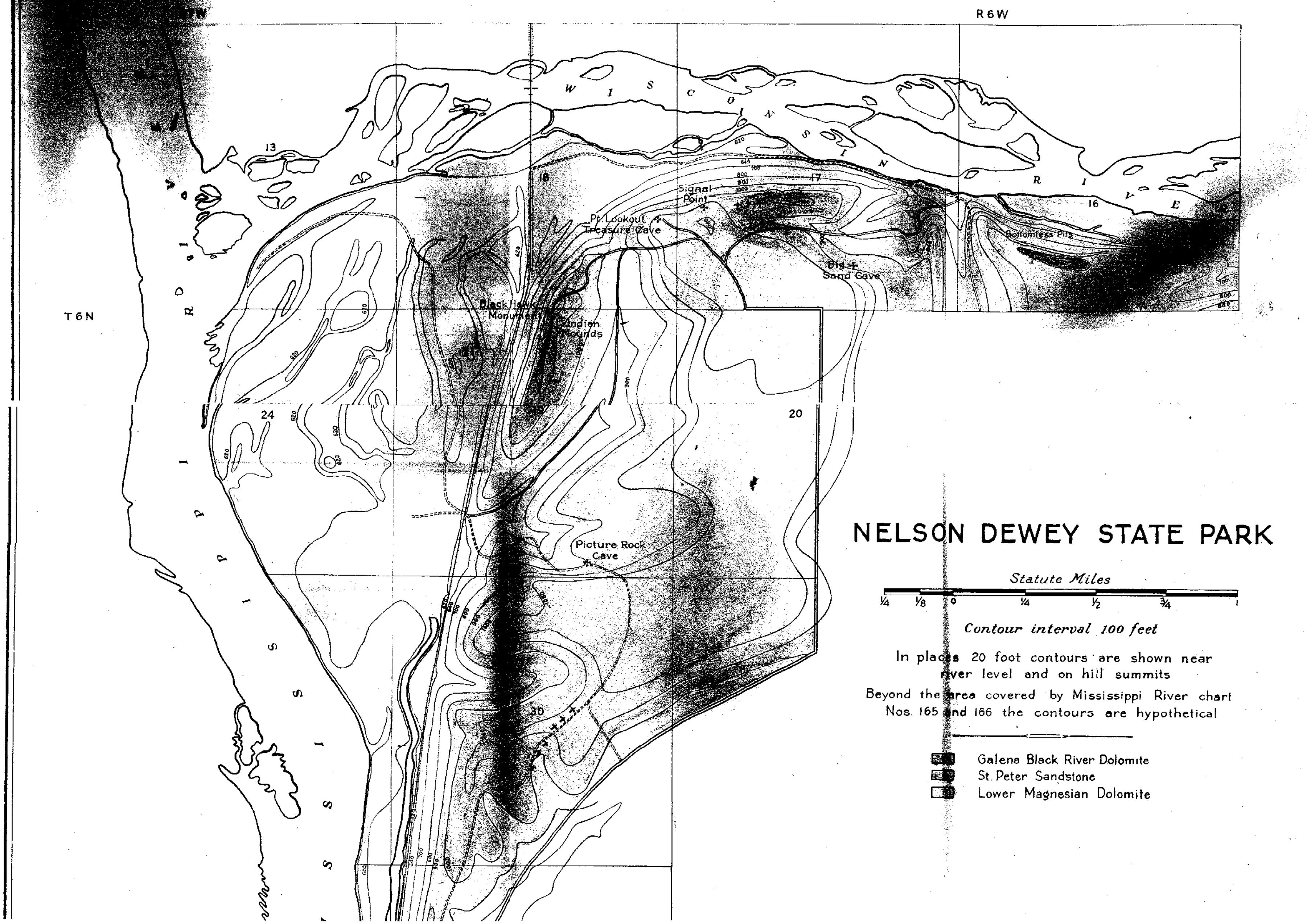
Physiographic Location

This park is situated in the Western Upland and in that part which is unglaciated and is known as the Driftless Area, figure 64. Furthermore it is situated at the northern margin of the Galena-Black River cuesta (second cuesta), figure 65.

Features of Interest

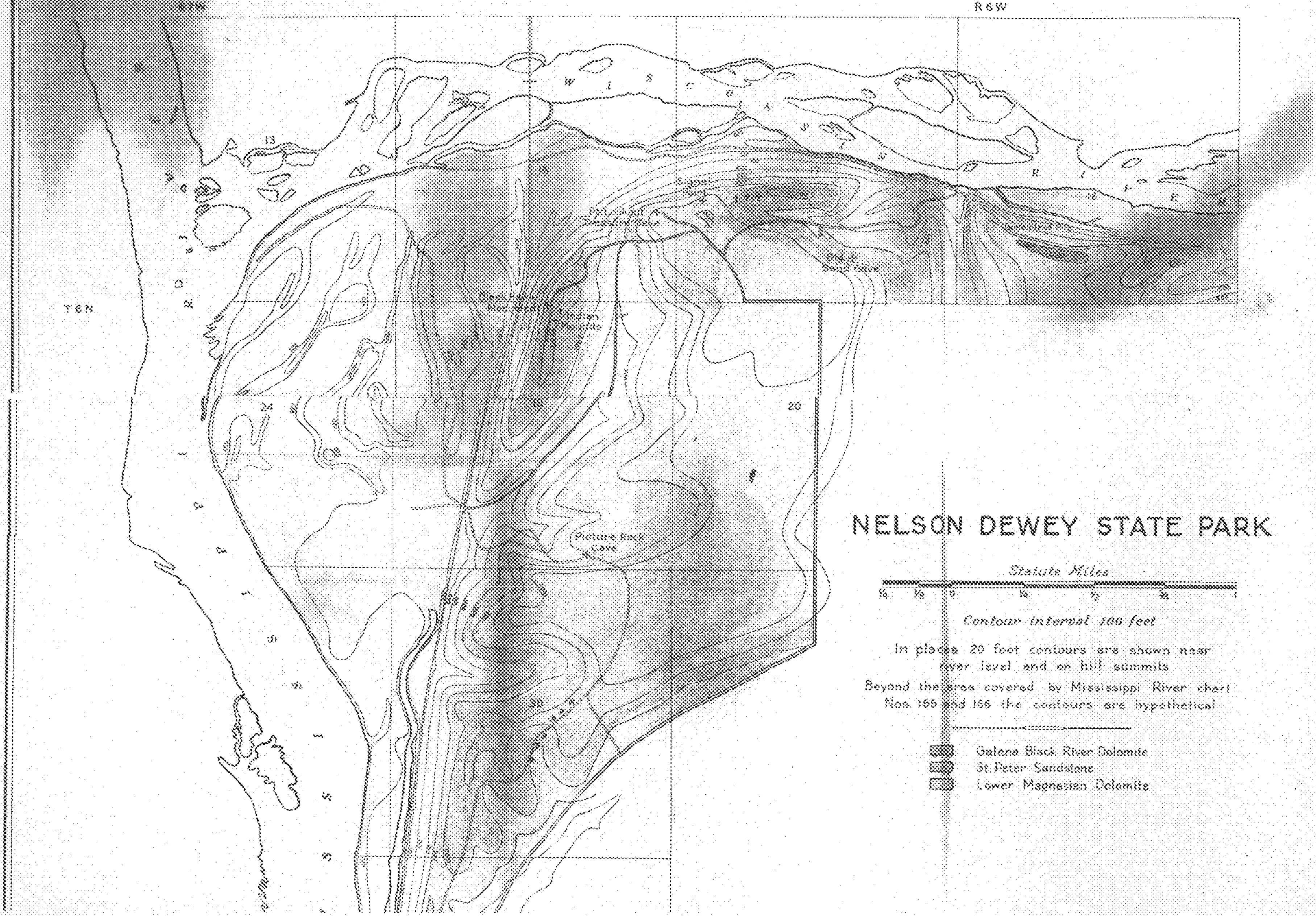
Big Sand Cave, figure 66, is in the northeastern portion of the park. The roof is formed by the resistant Platteville dolomite and the cave has been excavated in the weak St. Peter sandstone. This cave shows very clearly how a cuesta retreats. The capping formation is resistant as compared with the underlying formation and therefore remains little touched by the processes of weathering until the weak formation has been worn to its base and even a short distance beyond. The cap is undermined until a point is reached at which the roof can no longer endure and the resistant formation breaks off in a vertical cliff. The process of undermining will start anew as soon as the erosive forces have carried away the fallen

PLATE VII

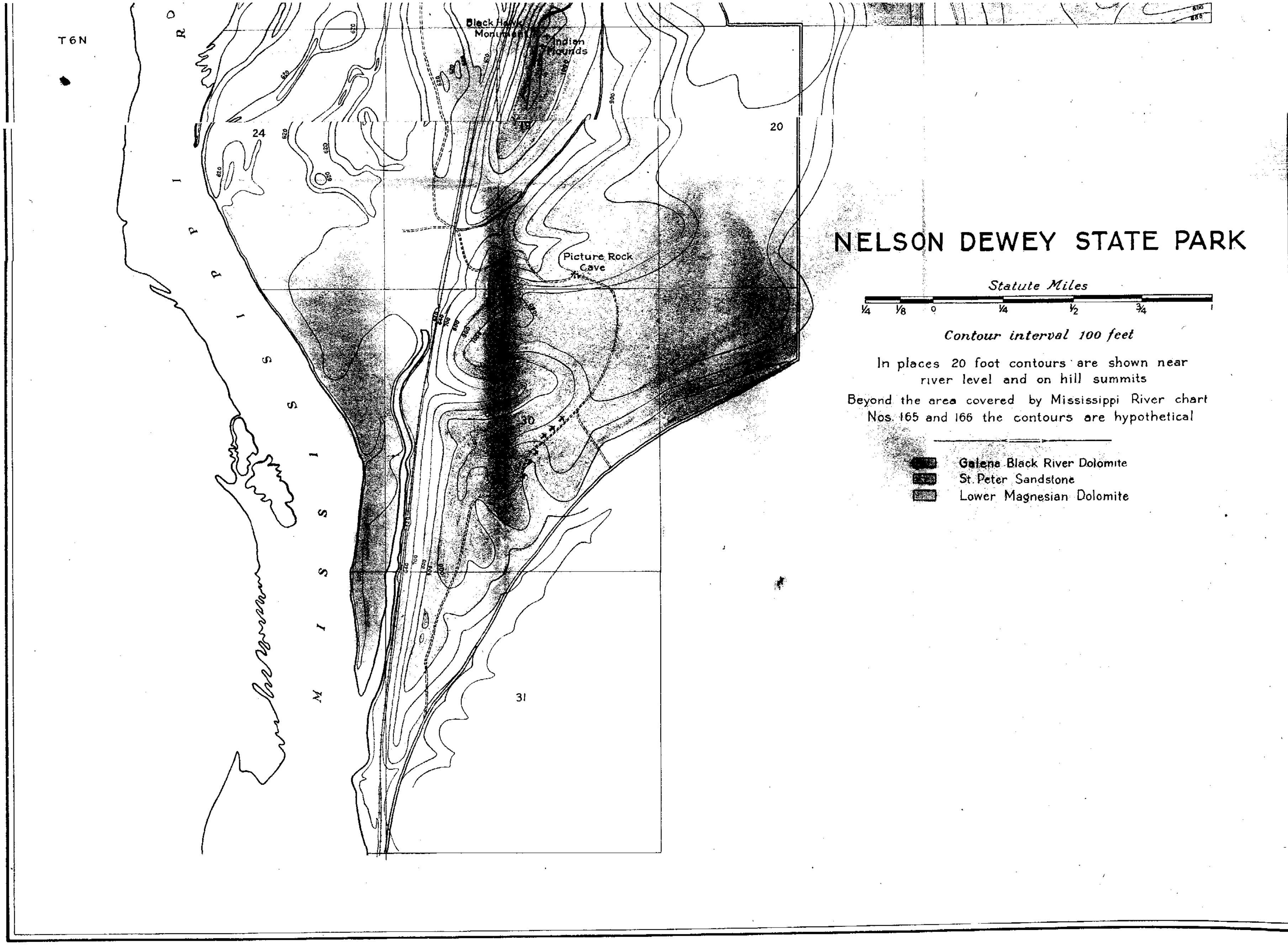


R6W
T6N
WISCONSIN RIVER
MISSISSIPPI
Signal Point
Pt. Lookout
Treasure Cave
Big Sand Cave
Bottomless Pit
Indian Mounds
Picture Rock Cave
NELSON DEWEY STATE PARK
Statute Miles
¼ ⅛ 0 ¼ ½ ¾ 1
Contour interval 100 feet
In places 20 foot contours are shown near river level and on hill summits
Beyond the area covered by Mississippi River chart Nos. 165 and 166 the contours are hypothetical
Galena Black River Dolomite
St. Peter Sandstone
Lower Magnesian Dolomite

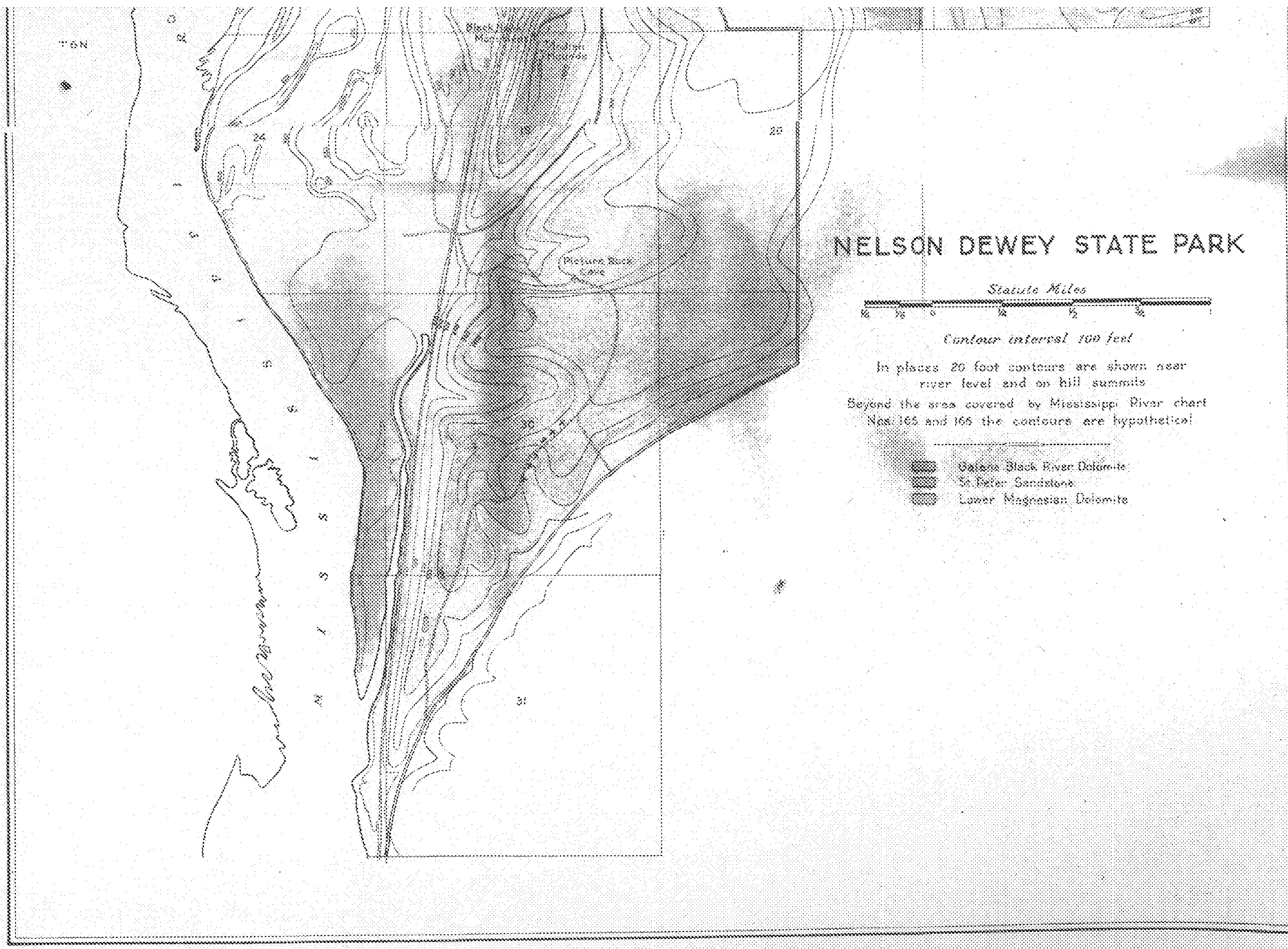
PLATE VII



R6W
T6N
13
24
20
Picture Rock Cave
NELSON DEWEY STATE PARK
Statute Miles
Contour interval 100 feet
In places 20 foot contours are shown near river level and on hill summits
Beyond the area covered by Mississippi River chart Nos. 165 and 166 the contours are hypothetical
Galena Black River Dolomite
St. Peter Sandstone
Lower Magnesian Dolomite



NELSON DEWEY STATE PARK
Statute Miles
¼ ⅛ 0 ¼ ½ ¾ 1
Contour interval 100 feet
In places 20 foot contours are shown near river level and on hill summits
Beyond the area covered by Mississippi River chart Nos. 165 and 166 the contours are hypothetical
Galena Black River Dolomite
St. Peter Sandstone
Lower Magnesian Dolomite
T6N
Black Hawk Monument
Indian Mounds
Picture Rock Cave
20
24
30
31
M I S S I S S I P P I R O



NELSON DEWEY STATE PARK
Statute Miles
Contour interval 100 feet
In places 20 foot contours are shown near river level and on hill summits
Beyond the area covered by Mississippi River chart Nos. 165 and 166 the contours are hypothetical
Galena Black River Dolomite
St. Peter Sandstone
Lower Magnesian Dolomite
Picture Rock Cave
T6N
24
20
30
31
M I S S I S S I P P I

Figure 64.- Nelson Dewey Park is in the driftless portion of the Western Upland. Courtesy of the Wisconsin Geological and Natural History Survey.

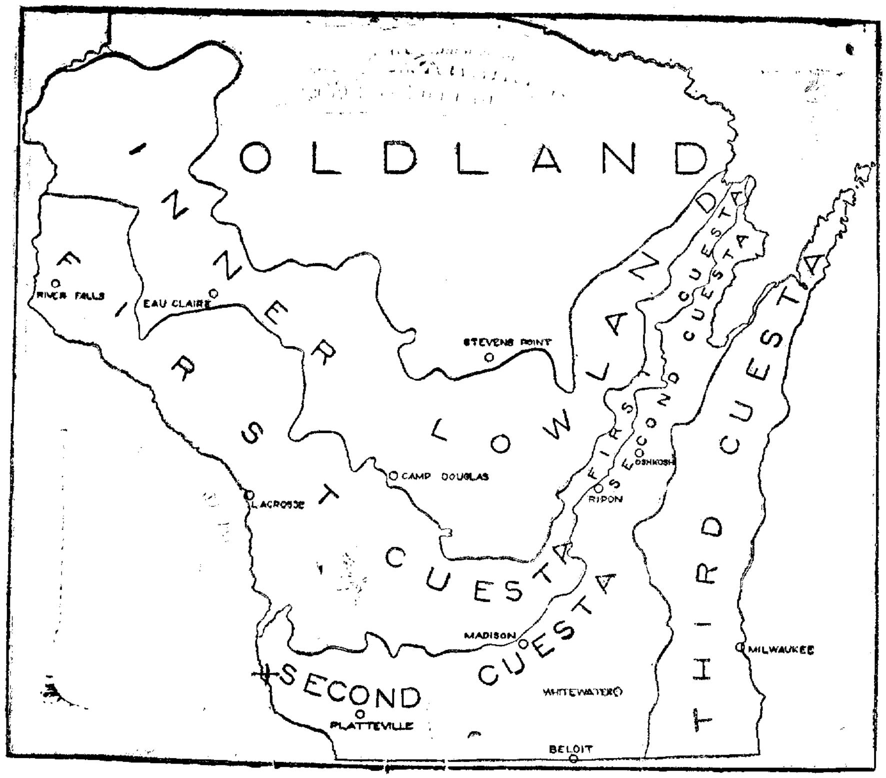


Figure 65.- Nelson Dewey Park is situated at the northern margin of the second cuesta. Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 66.- Big Sand Cave. Ledge is at base of Platteville. Cave is in St. Peter. - Courtesy of the Wisconsin Geological and Natural History Survey.

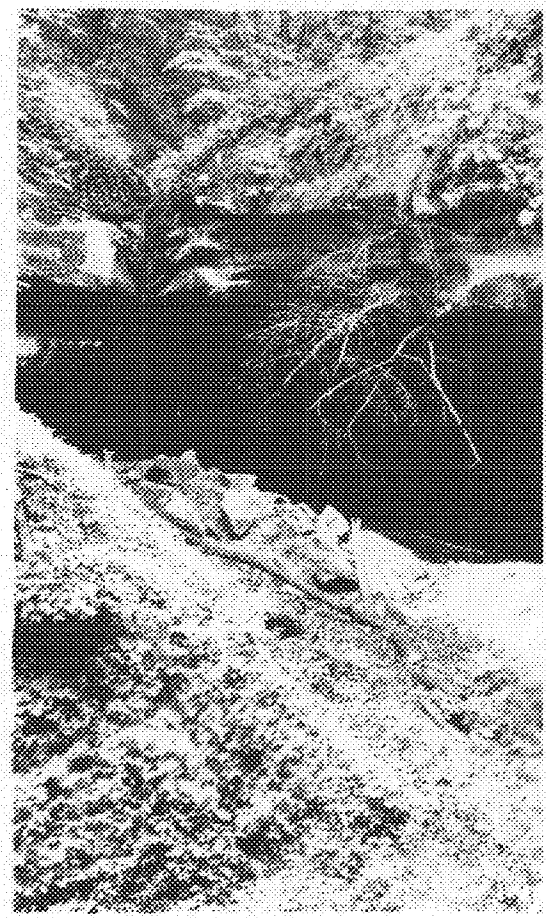


Figure 66.- Big Sand Cave. Ledge is at base of Platteville. Cave is in St. Peter. - Courtesy of the Wisconsin Geological and Natural History Survey.

debris at the base of the cliff.

The many steep slopes or cliffs in the park are developed along the outcrop of the St. Peter sandstone. A talus slope indicates a concealed outcrop of St. Peter sandstone, but in addition a recent retreat of the cliff caused by undermining in the St. Peter sandstone.

Figure 67 gives the view from Signal Point. The sand bars have always been a menace to navigation[1]. In the immediate foreground (not shown in panorama) may be seen the old military road.[2]

Figure 68 is a portion of the panorama from Point Lookout. The cave immediately below is probably due to solution along joint cracks in the limestone.

Black Hawk Monument is shown in figure 69. The rough weathering suggests Galena dolomite. This is an outlying remnant of Sentinel Ridge with which it was once connected. When this was a part of the main ridge, a crack traversed the latter parallel to the main trend. Roots of trees found the crack and widened it; waters carrying carbon dioxide widened it still further. With time the crack became larger and larger until

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1 "Father Marquette said in 1673 that the 'Meskousing' River 'is very wide; it has a sandy bottom, which forms various shoals that render its navigation very difficult. It is full of Islands covered with vines. On the banks one sees fertile land, diversified with woods, prairies, and hills.'" Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 175, 1916.

2 "Also, one can look down over the ledge hundreds of feet directly below upon the forest covered bottom lands of the rivers through which runs the old military road used by troops and immigrants to Iowa and Minnesota in the early forties and fifties." Nelson Dewey State Park - Information for visitors and campers: Wisconsin Conservation Commission, 1920.

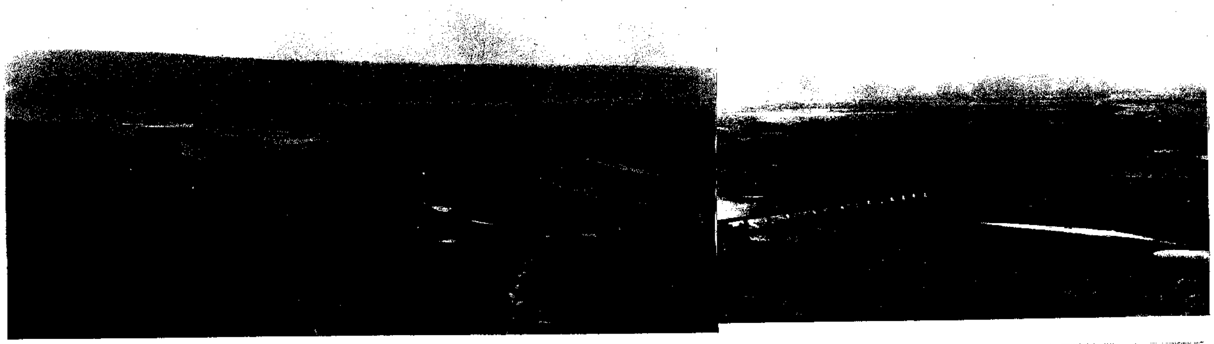
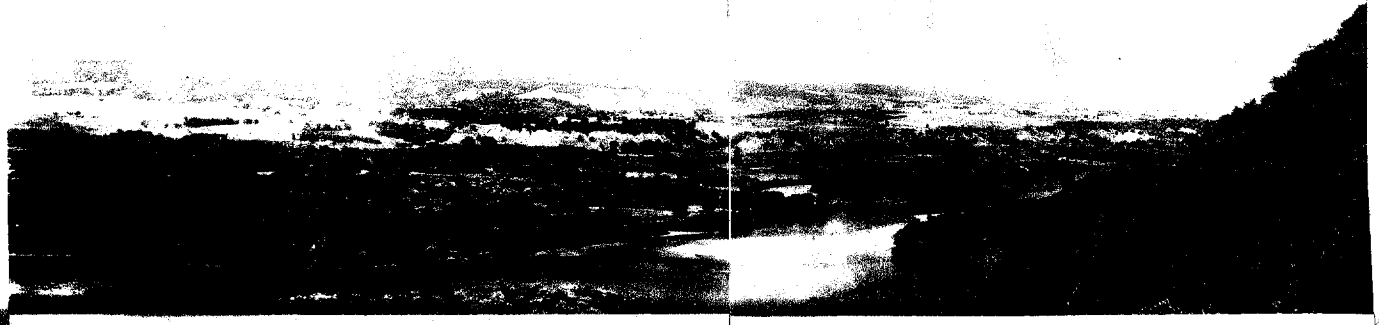


Figure 67.- Panorama from Signal Point, Nelson Dewey State Park. SE. sec. 18, T. 6, R. 6 W. Shows sand bars and floodplain in foreground, pre-Wisconsin terrace capped with weathered gravels in middle distance, and upland developed on the Galena-Black River formation in the distance. - Courtesy of the Wisconsin Geological and Natural History Survey.



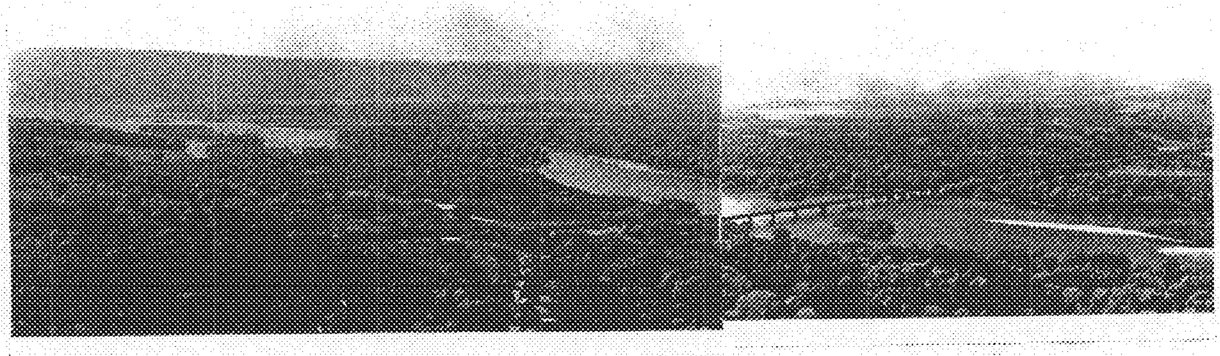


Figure 67.- Panorama from Signal Point, Nelson Dewey State Park. SE. sec. 18, T. 6, R. 6 W. Shows sand bars and floodplain in foreground, pre-Wisconsin terrace capped with weathered gravels in middle distance, and upland developed on the Galena-Black River formation in the distance. - Courtesy of the Wisconsin Geological and Natural History Survey.

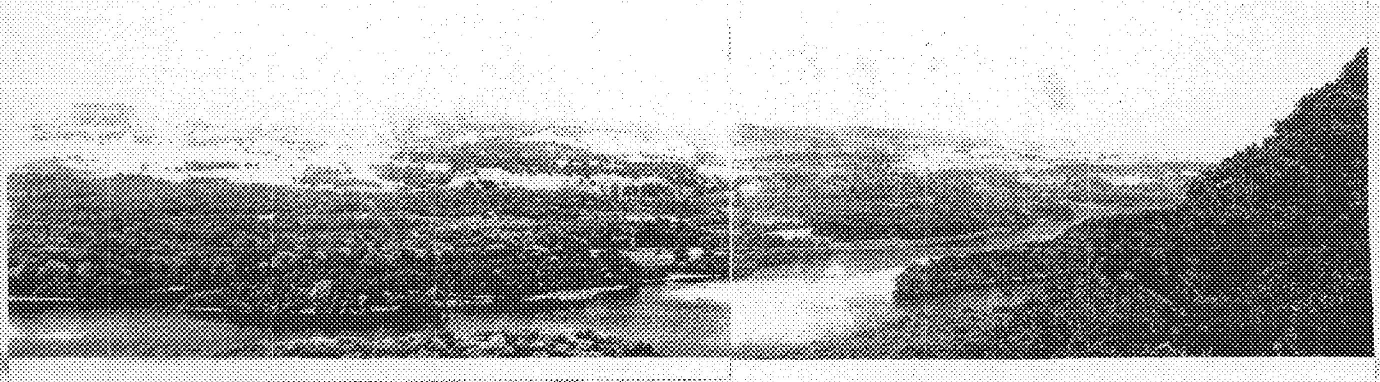


Figure 68.- Panorama from Point Lookout, Nelson Dewey State Park. SE. sec. 18, T. 6, R. 6 W. Shows the floodplain, Wisconsin outwash, pre-Wisconsin terrace, and upland developed on the Galena-Black River formation. - Courtesy of the Wisconsin Geological and Natural History Survey.

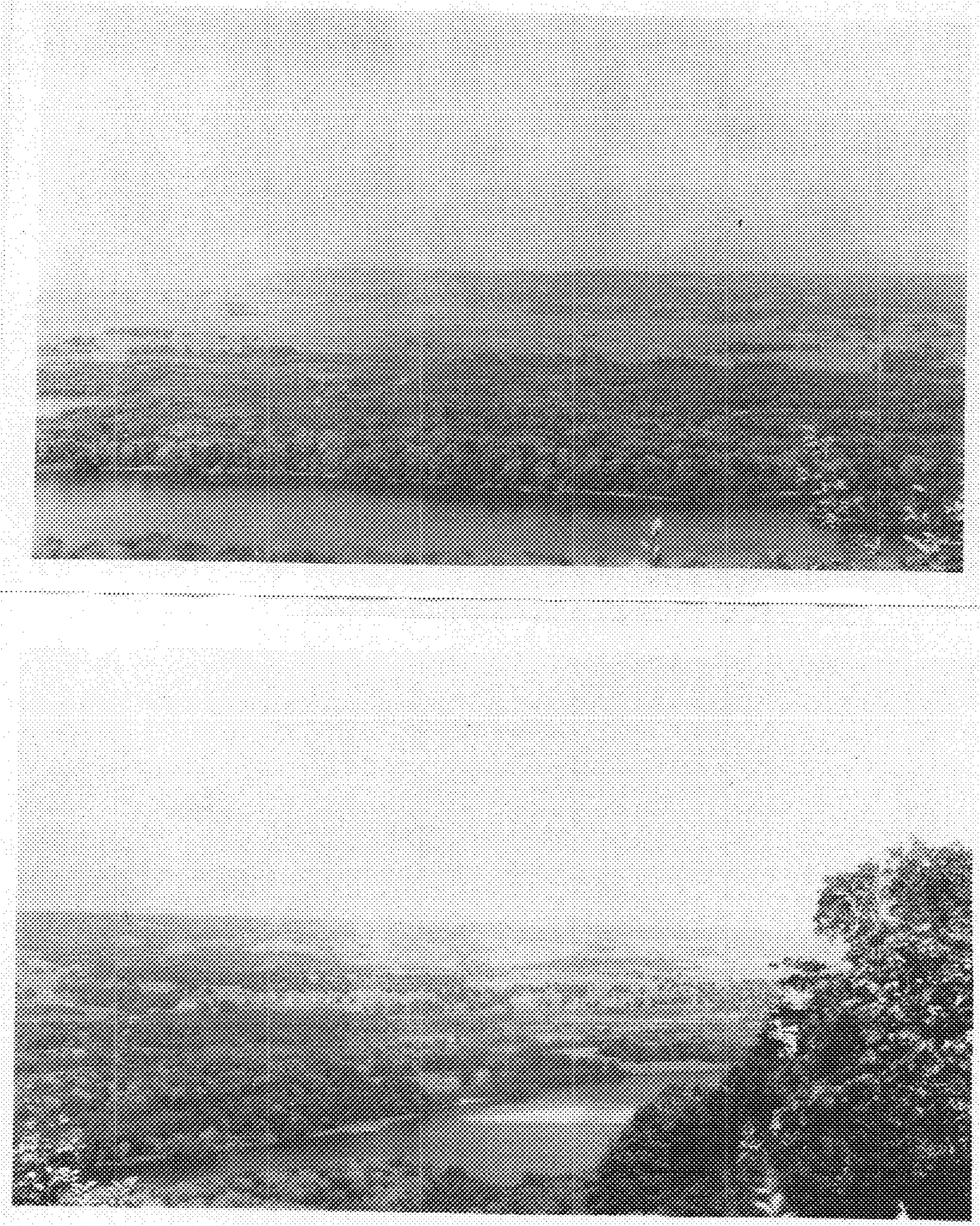


Figure 68.- Panorama from Point Lookout, Nelson Dewey State Park. SE. sec. 18, T. 6, R. 6 W. Shows the floodplain, Wisconsin outwash, pre-Wisconsin terrace, and upland developed on the Galena-Black River formation. - Courtesy of the Wisconsin Geological and Natural History Survey.

Figure 69. Black Hawk Monument. The pitted surface suggests Galena dolomite. - Courtesy of F. T. Thwaites.

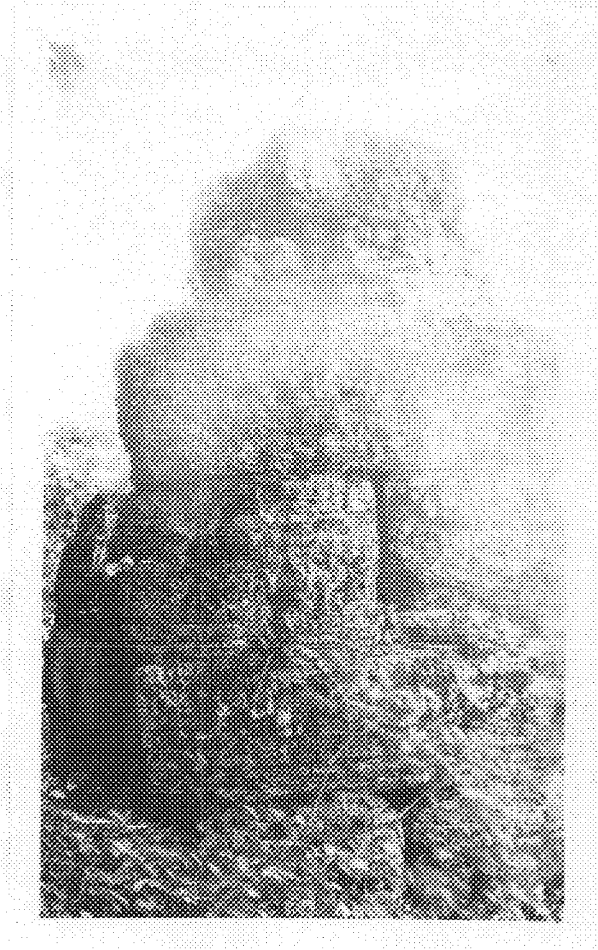


Figure 69. Black Hawk Monument. The pitted surface suggests Galena dolomite. - Courtesy of F. T. Thwaites.

today Black Hawk Monument is some distance from the main ridge.

Pictured Rock Cave is also in the St. Peter sandstone. This cave has been described as follows:[3]

"By going up the south miniature canyon, one comes to what is known as Pictured Rock Cave or Glenn Grotto, being about fifty feet in diameter, formed in brilliantly colored sandstone with a waterfall tumbling over its side, and a column of petrified moss forty feet high at the entrance. It is one of the many natural beauty spots in the park."

Geological History

The oldest formation exposed in this park is the Lower Magnesian dolomite, but a well in Prairie du Chien immediately north of the park has penetrated the Cambrian and our general knowledge of the rock formations of Wisconsin tells us that the latter is underlain by the old pre-Cambrian rocks. It is, therefore, convenient to begin the geological history of the park at the time when it was receiving the sediments which formed the Lower Magnesian dolomite. At the close of this period it was uplifted above the sea and carved into ridges and valleys. This region again sank beneath the sea and the St. Peter sandstone, the Galena-Black River dolomite, the Maquoketa shale, and the Niagara dolomite were deposited upon it. At the close of this period it was uplifted above the sea and its surface was attacked by erosion.

First the Niagara dolomite was stripped from the region. The retreat of this cuesta past the park was followed by the rapid removal of the soft Maquoketa shale. At present the next resistant formation, the Galena-Black River dolomite, forms a cuesta just south of the Wisconsin. This formation is underlain by the soft St. Peter sandstone and

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3 Nelson Dewey State Park - Information for visitors and campers: Wisconsin Conservation Commission, 1920.

the resistant Lower Magnesian dolomite, figure 70.

The Wisconsin immediately north of the park is eroding its course in this resistant Lower Magnesian dolomite and its channel is therefore relatively narrow, figure 71. Just to the east the river has worn through the dolomite and has eroded a broad valley in the underlying Cambrian sandstone. The Mississippi likewise is narrow immediately west of the park but is broader upstream where it is eroding in the soft Cambrian sandstone.

When the glaciers stood at or near their terminal moraines in the Pleistocene both the Mississippi and the Wisconsin received more sediment than they could transport and therefore built up their valleys. With the retreat of the glaciers to the north and east the waters of the rivers became clear and they began to entrench their channels. Some of this valley fill still remains as terraces along the river channels, figure 72. Adjacent to the park there are bottomlands of the Mississippi and terraces. Prairie du Chien immediately to the north is situated on one of these terraces, figure 73.

At the time the rivers were filling their channels with this glacial debris the prevailing winds were from the west just as they are today. They probably brought much dust from the arid lands to the west and in addition picked up a great deal of the loose sands along the river courses. The greater portion of this debris was deposited when the winds were checked in ascending the bluffs on the east side of the Mississippi. In some places (probably not in the park) this material or loess reaches a thickness of 60 feet.[4]

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[4] Martin, Lawrence, Physical geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 124, 1916.

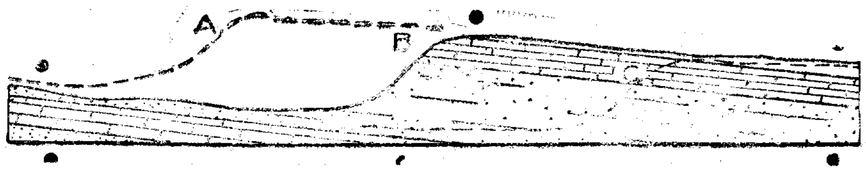

Figure 70.- Diagram shows the retreat of a cuesta from A to B and from B to C. Courtesy of the Wisconsin Geological and Natural History Survey.

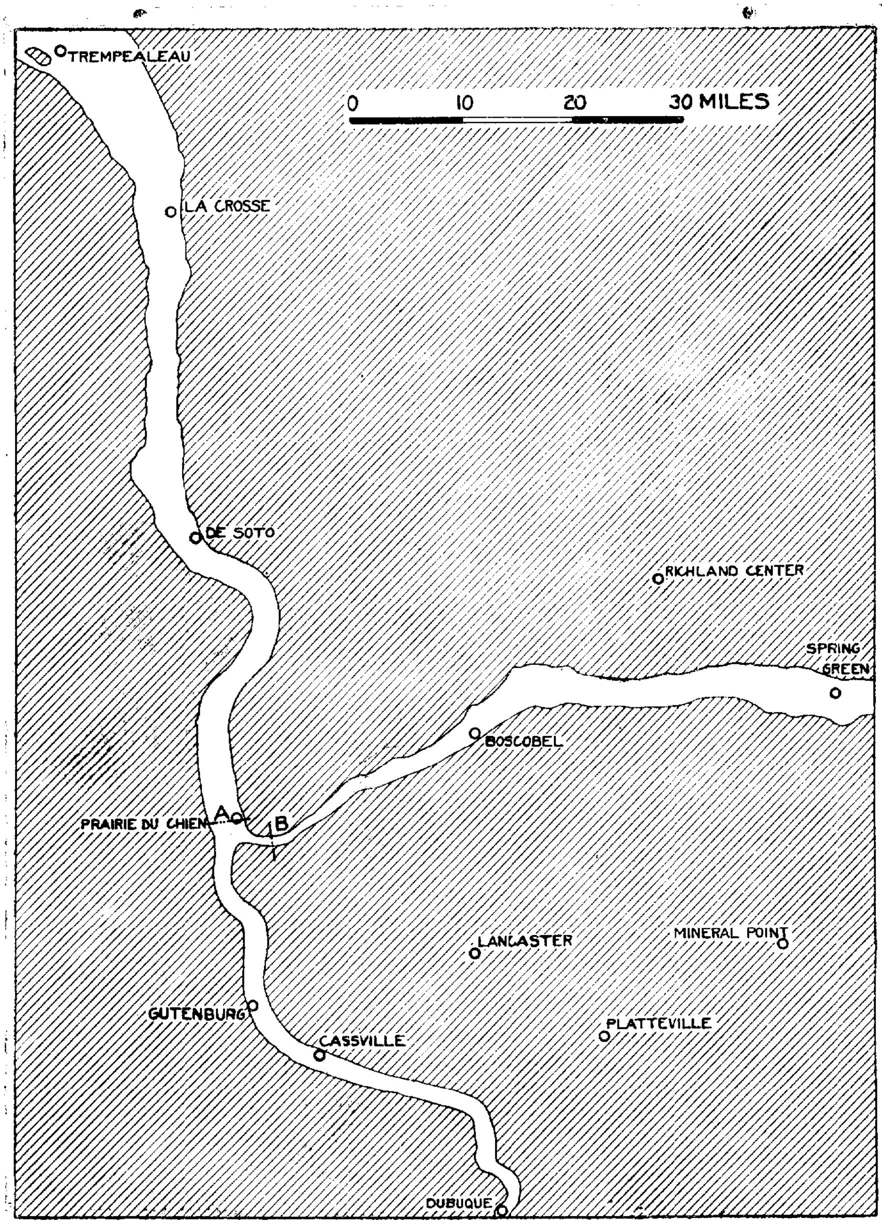

Figure 71.- The Mississippi and Wisconsin gorges narrow down stream in relation to resistant limestone at A and B. Broad portions of gorge are in weak sandstone. Due to the dip of the formations erosion has worn through the resistant formation upstream. Courtesy of the Wisconsin Geological and Natural History Survey.

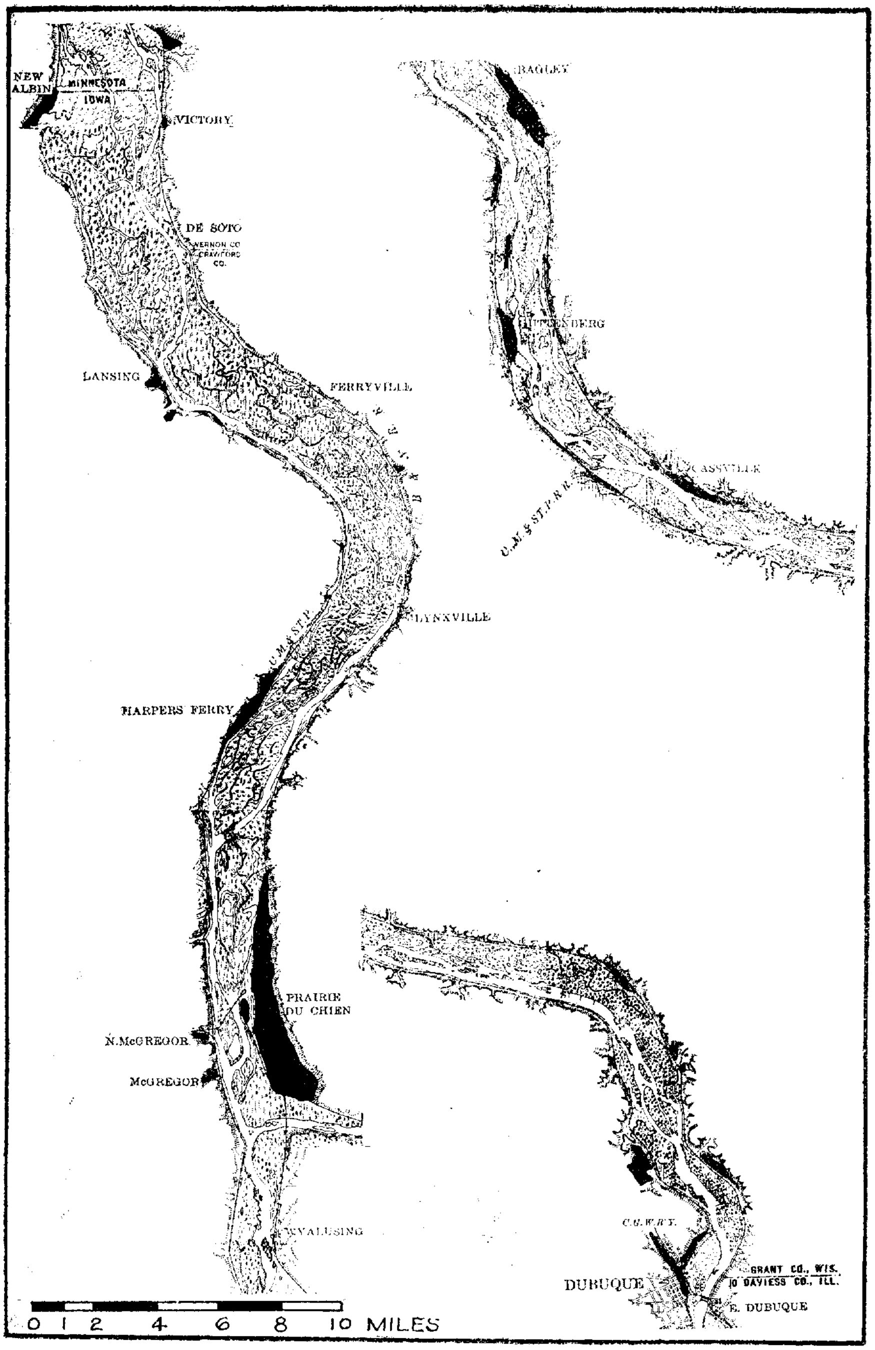

Figure 72. The terraces - in black - in the Mississippi bottomlands of the southwestern portion of Wisconsin. Courtesy of the Wisconsin Geological and Natural History Survey.

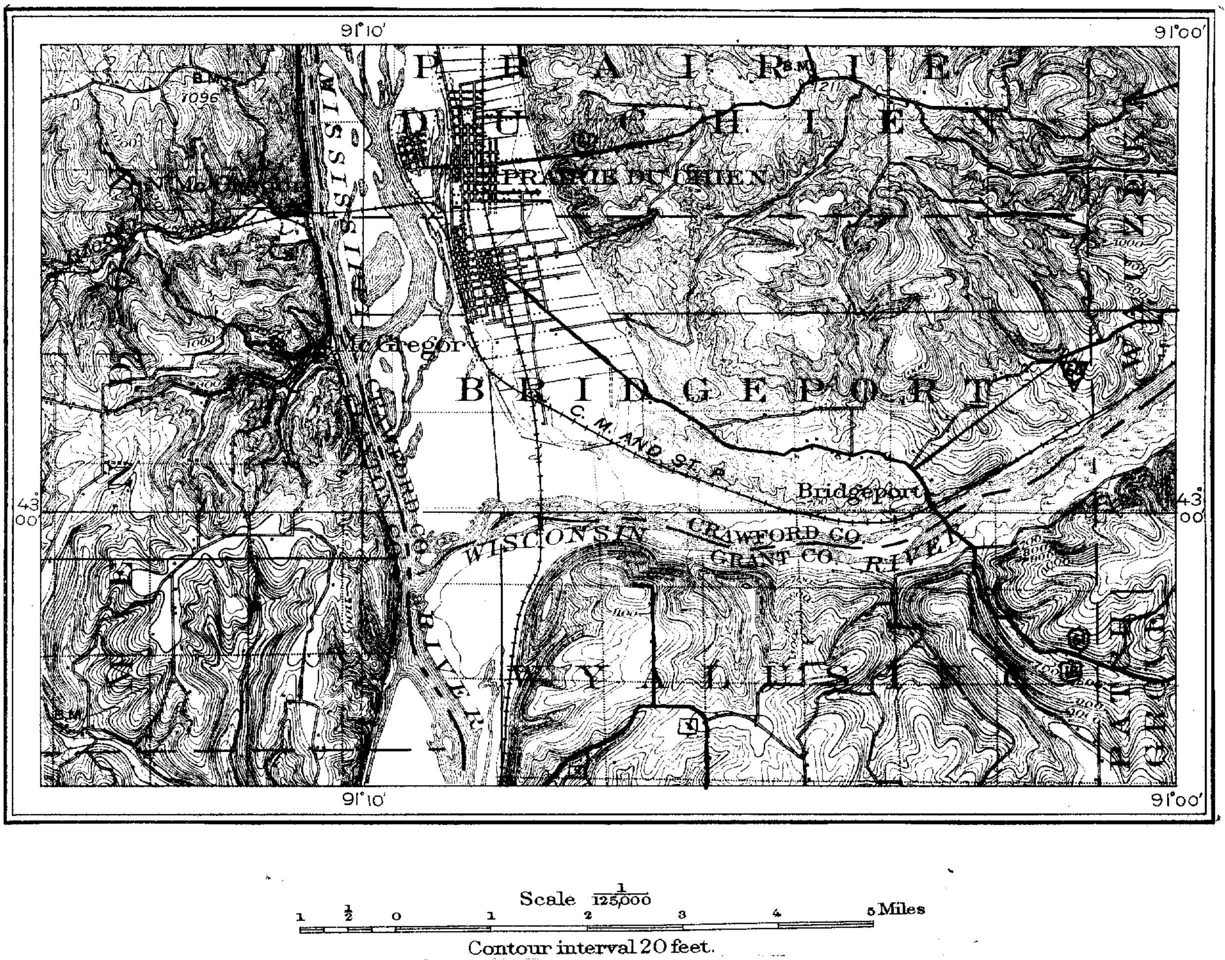

Figure 73.- Prairie du Chien is located on a river terrace. Note the flat surface. (Elkader and Waukon quadrangles)

Geology

The exact contacts have not been determined by field study, but the geological section of the park is probably approximately as follows:

	Thickness Feet	Elevation From	Elevation To
Galena-Black River dolomite	80	1,000	1,080
St. Peter sandstone	160	840	1,000
Lower Magnesian dolomite	220+	620	840

Grant and Burchard give the following generalized section[5] of the area immediately east of the park:

System	Formation Name	Thickness in Feet	Character of Rocks
	Galena limestone	235	Coarse-grained gray dolomite, cherty and thick bedded in middle portion, thin bedded at top, with thin, shaly, fine-grained limestone and locally carbonaceous shale at base. Sparingly fossiliferous. Basal portion locally contains zinc and lead ores.
	Unconformity?		
Ordovician	Platteville limestone	55	Fine grained limestone and very fossiliferous, calcareous shale. Thin, wavy-bedded, fine-grained, fossiliferous limestone. Thick-bedded magnesian limestone with thin, sandy shale at base.
	St. Peter sandstone	35-175	White or iron-stained quartz sandstone, massive and usually poorly cemented. Thin, sandy clay-shale at base.

[5] Grant, U. S., and Burchard, E. F., Description of the Lancaster and Mineral Point quadrangles: U. S. Geol. Survey Folio, 145, p. 14, 1907.

System	Formation Name	Thickness in Feet	Character of Rocks
Ordo-vician	Prairie du Chien[6]	100∓	Irregularly bedded, rough-weathering dolomite, cherty in places and locally containing thin beds and lenses of sandstone. A few fossils. Base not exposed.

The beds within the park are probably similar in character to the corresponding ones in the Lancaster-Mineral Point area immediately to the east.

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6 "This same formation is commonly known in the upper Mississippi Valley as the 'Lower Magnesian' limestone." Grant, U. S., and Burchard, E. F., op. cit., p. 3.

CHAPTER X

PENINSULA STATE PARK

Geographic Location

Peninsula Park, Plate VIII, is located in Door County, the long peninsula which juts out into Lake Michigan. More specifically the park is located twenty-five miles north of the city of Sturgeon Bay and between the villages of Fish Creek and Ephraim.

The motor tourist can reach the park via T.H. 17; the tourist who comes by rail will take the Ahnapee & Western to Sturgeon Bay and an auto stage to the park; the tourist who comes by water can reach the park "by the Goodrich boats from Milwaukee, or by the local boats which ply between points on both sides of the Green Bay shore.[1]"

Physiographic Location

Of the five geographic provinces shown in figure 74, Peninsula Park is located in the eastern ridges and lowlands. This province, however, includes both the Galena-Black River and the Niagara cuestas; the park is located on the Niagara cuesta, figure 75. In the park this escarpment is shown in Svens Bluff - 45 feet in height[2], Norway Bluff, and Eagle Bluff - 75 feet in height[3].

Features of Interest

The tourist who enjoys tramping will take great pleasure in following the strand lines shown in figure 76. He will find beaches and bars

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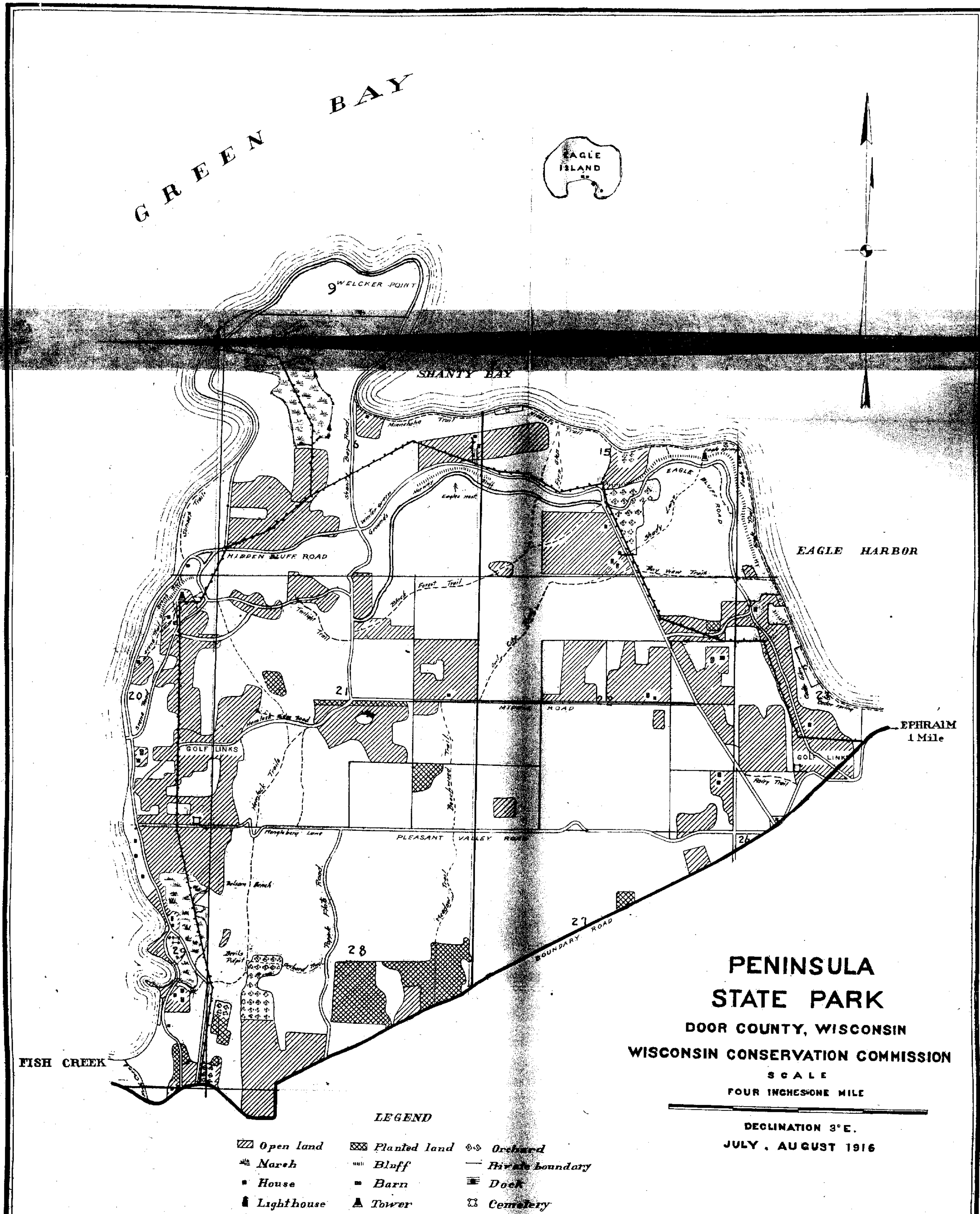
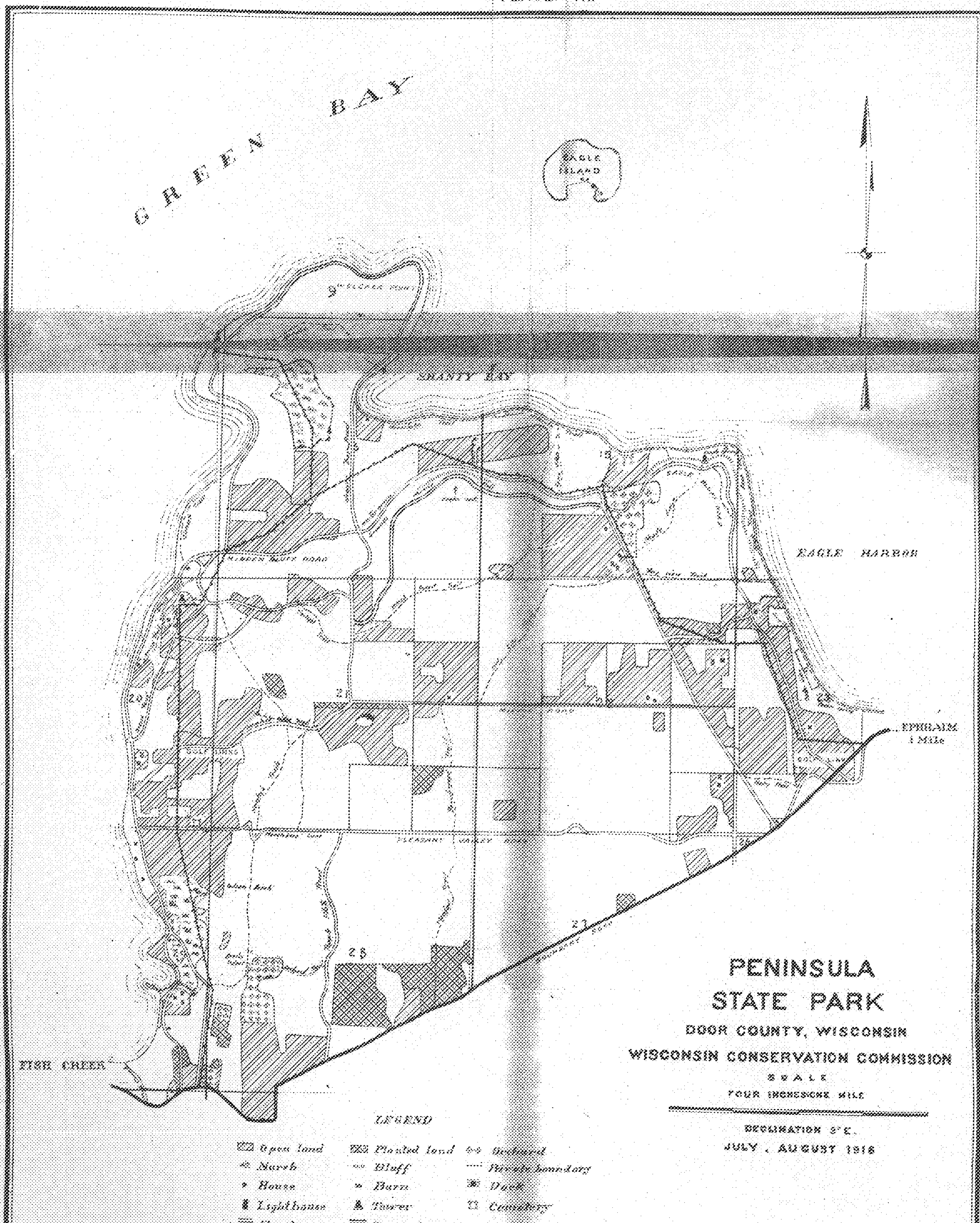
1 Peninsula State Park - Information for visitors and campers: Wisconsin Conservation Commission,

2 Idem.

3 Idem.


GREEN BAY
EAGLE ISLAND
WELCKER POINT
SHANTY BAY
EAGLE HARBOR
EPHRAIM
1 Mile
FISH CREEK
HIDDEN BLUFF ROAD
PLEASANT VALLEY ROAD
BOUNDARY ROAD
EAGLE BLUFF ROAD
GOLF LINKS
GOLF LINKS
PENINSULA
STATE PARK
DOOR COUNTY, WISCONSIN
WISCONSIN CONSERVATION COMMISSION
SCALE
FOUR INCHES=ONE MILE
DECLINATION 3° E.
JULY . AUGUST 1916
LEGEND
Open land
Planted land
Orchard
Marsh
Bluff
Private boundary
House
Barn
Dock
Lighthouse
Tower
Cemetery
Road
Proposed road
Trail
Telephone line
Spring
Camp site
TOWN 31 N RANGE 27 E. SEC. 9,14,15,16,17,20,21,22,23,26,27,28,29,32,33


GREEN BAY
EAGLE ISLAND
SHANTY BAY
EAGLE HARBOR
EPHRAIM 1 Mile
FISH CREEK
PLEASANT VALLEY
PENINSULA
STATE PARK
DOOR COUNTY, WISCONSIN
WISCONSIN CONSERVATION COMMISSION
SCALE
FOUR INCHES ONE MILE
DECLINATION 3° E.
JULY . AUGUST 1916
LEGEND
Open land
Planted land
Orchard
Marsh
Bluff
House
Barn
Dock
Lighthouse
Tower
Cemetery
Road
Proposed road
Trail
Telephone line
Spring
Camp site
TOWN 31 N RANGE 27 E.

ninsula Park

TION—HOW TO GET THERE

Park is located on the Door County venty-five miles north of the city of y, and between the villages of Fish phraim. Within this park

tensive, but the forests (some of which are of virgin growth) of white and red pine, hemlock, balsam and hardwoods are beautiful. Several stands of beech show a forest type that is rather unusual. Dense stands of white cedar are found along the shore and on the well moistened ledges, while in some of the fields, juniper and more rarely the shrubby

region are generally cool, being moderated by the breezes from Lake Michigan and Green Bay. Good drinking water is to be had in unlimited quantities, and fresh fruits and garden vegetables can be obtained from nearby farms, during the proper seasons.

Accommodations

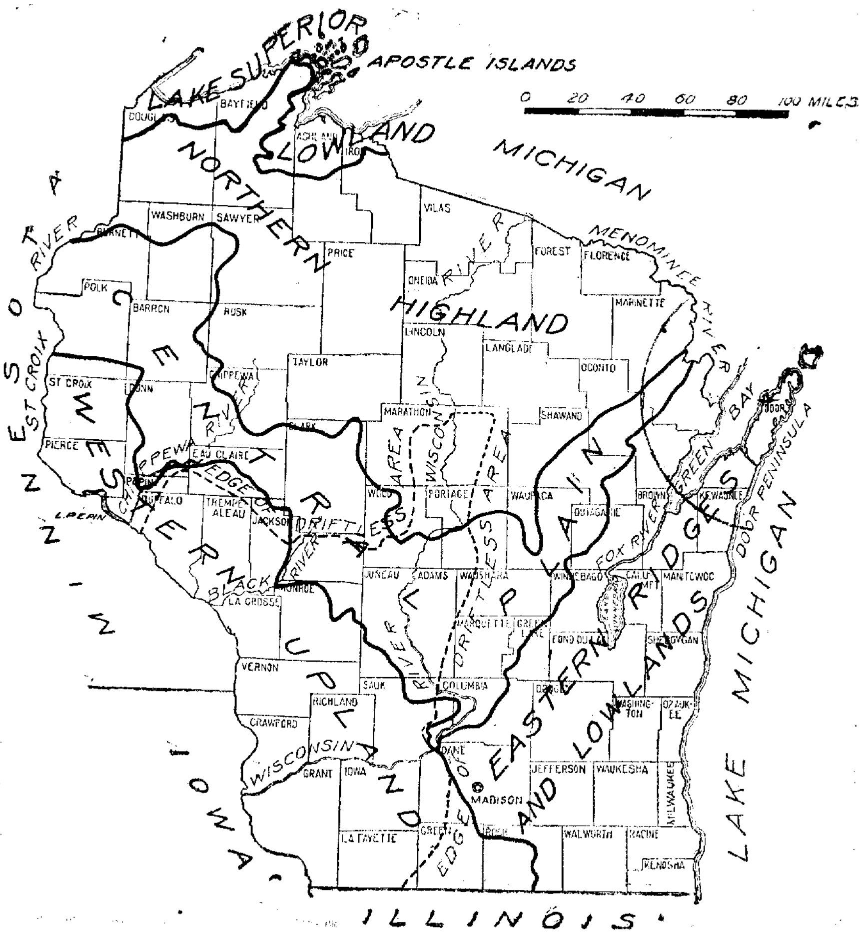


Figure 74.- Peninsula Park is located in the Eastern Ridges and Lowlands. Courtesy of the Wisconsin Geological and Natural History Survey.

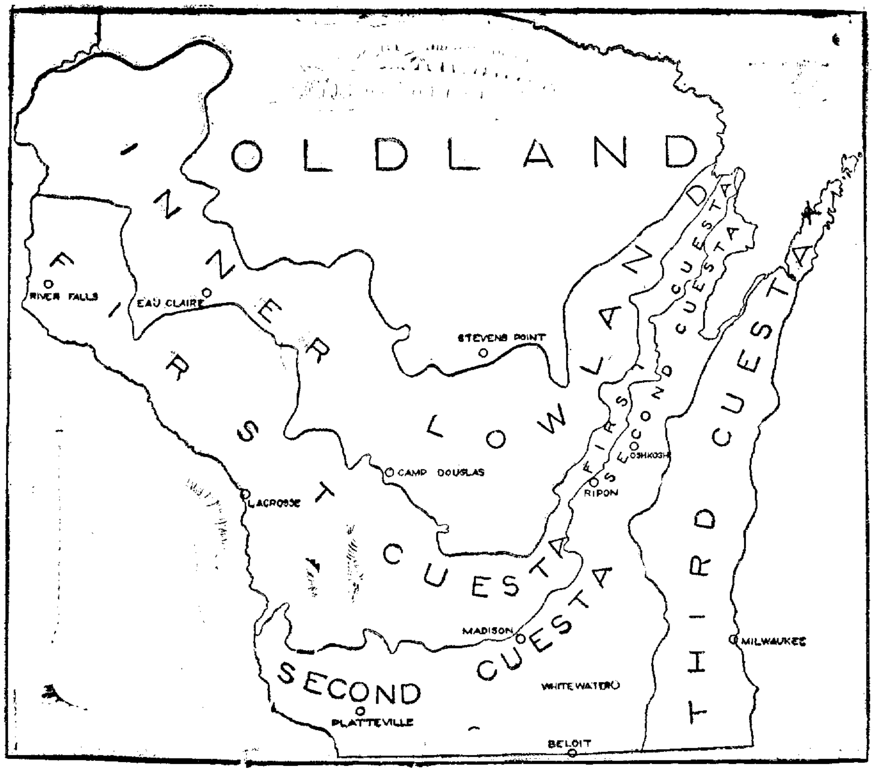


Figure 75.- Peninsula Park is located on the third or Niagara cuesta. Courtesy of the Wisconsin Geological and Natural History Survey.

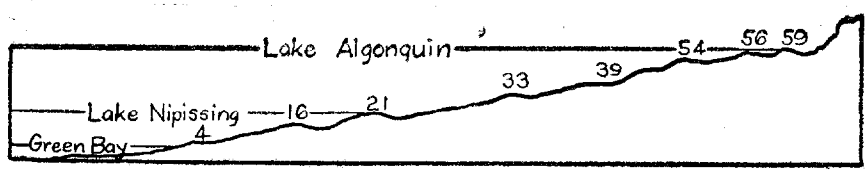


Figure 76.- Abandoned beaches at Fish Creek, Peninsula Park. (After Goldthwait.) Courtesy of the Wisconsin Geological and Natural History Survey.

at various levels up to about 60 feet above the present shore line; on the north face of the cliffs he will find terraces cut by predecessors of the present lake, in some he will find caves fashioned by the waves of these old lakes, figures 77 and 78.

"The park is well timbered. The flora is not extensive, but the forests (some of which are of virgin growth) of white and red pine, hemlock, balsam and hardwoods are beautiful. Several stands of beech show a forest type that is rather unusual. Dense stands of white cedar are found along the shore and on the well moistened ledges, while in some of the fields, juniper and more rarely the shrubby yew (Taxus canadensis) give the effect of formal planting. The trails and pathways, which have been constructed through the fields and woods to the points of chief interest in the park are always delightful to the nature lover.[4]"

Geological History

Although outcrops to the west and well records on the peninsula show us that Door County is underlain by Cambrian and Ordovician sediments, the oldest formation within the park is the Byron of the Niagaran group. The geological history of the park, therefore, may begin in the present discussion with submergence in the Silurian sea. Deposition of the Byron was followed by that of the coral and Racine beds. When Wisconsin was arched into a gentle dome, this area was raised above the sea and the processes of weathering and erosion immediately began to wear down the surface.

Due to its greater height these processes were the most active and effective at the apex of the dome. As the Niagara was underlain by a

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[4] Peninsula State Park - Information for visitors and campers: Wisconsin Conservation Commission.

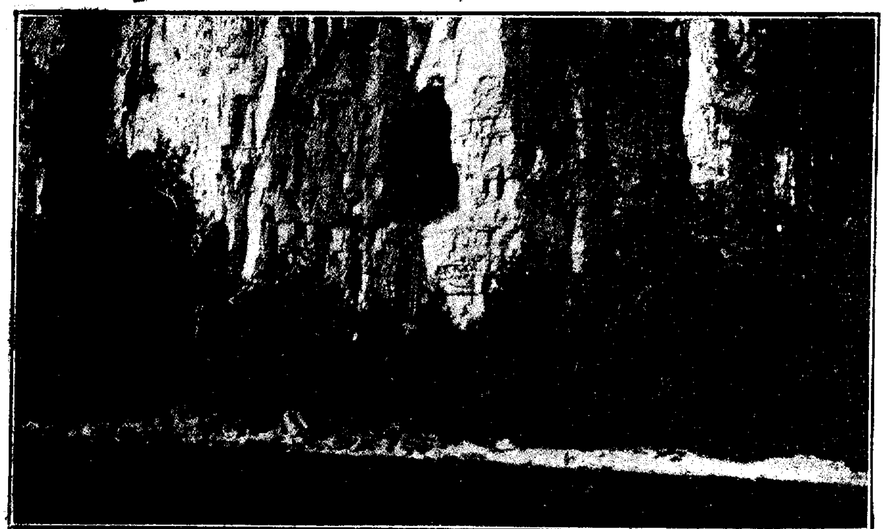

Figure 77.- Cave eroded in the Niagara limestone at Peninsula Park near Ephraim. It was made during the later stages of Glacial Lake Algonquin. Courtesy of the Wisconsin Geological and Natural History Survey.

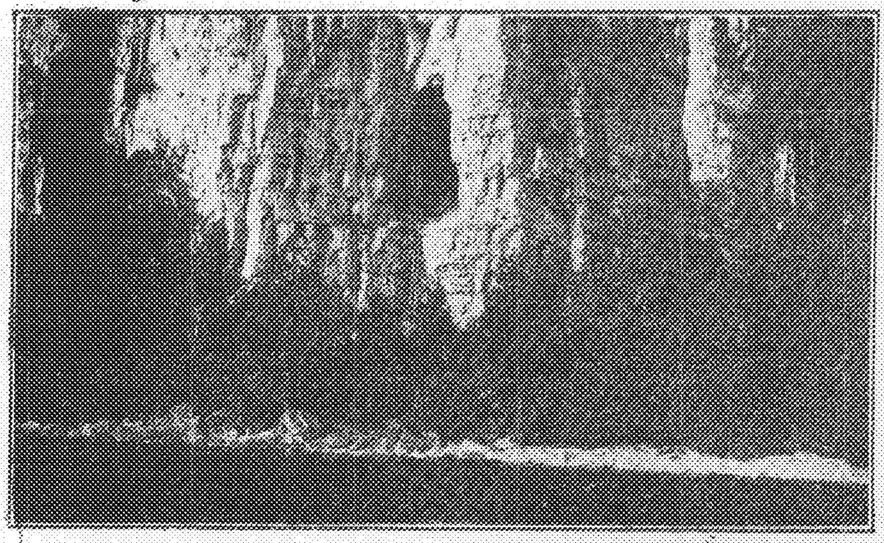

Figure 77.- Cave eroded in the Niagara limestone at Peninsula Park near Ephraim. It was made during the later stages of Glacial Lake Algonquin. Courtesy of the Wisconsin Geological and Natural History Survey.

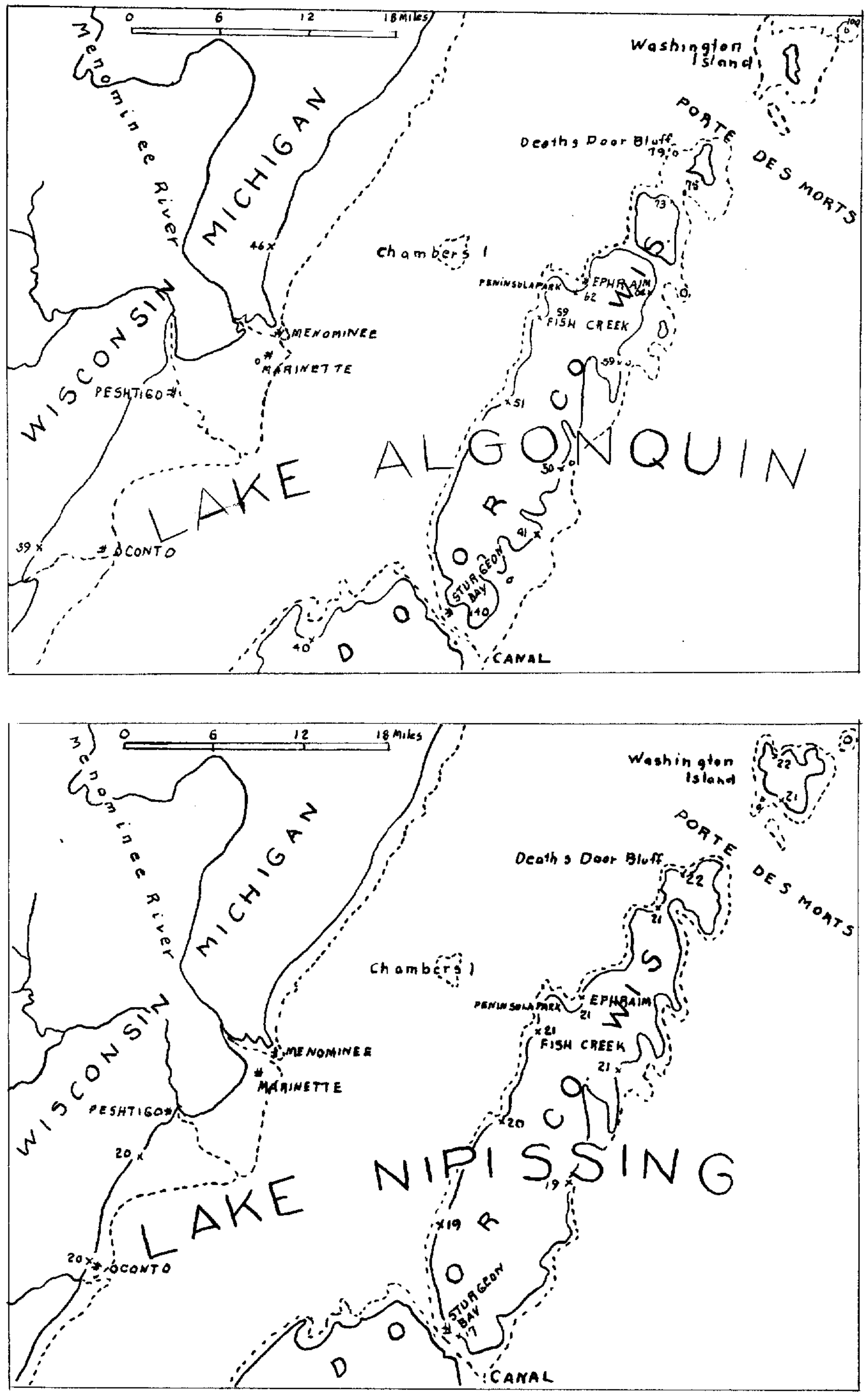

Figure 78.- Two stages of the Glacial Great Lakes in northeastern Wisconsin. Coast of Lake Michigan shown by dashed lines. Figures show heights of abandoned beaches in feet above present lake level. (After Martin)

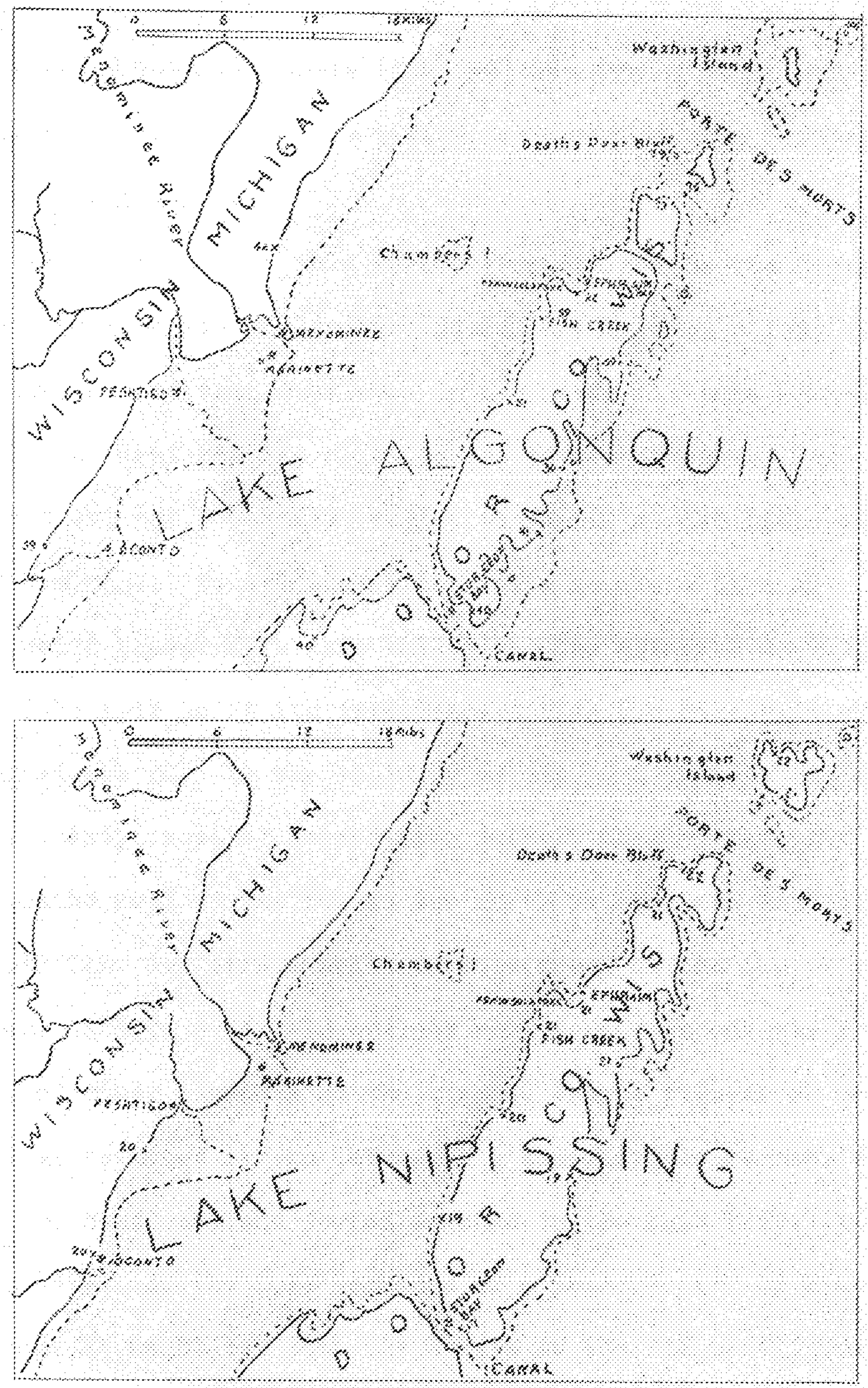

Figure 78.- Two stages of the Glacial Great Lakes in northeastern Wisconsin. Coast of Lake Michigan shown by dashed lines. Figures show heights of abandoned beaches in feet above present lake level. (After Martin)

weak shale, an escarpment or cuesta (fig. 79) was formed which retreated farther and farther down the dip or more specifically to the east-southeast in this region (fig. 79).

When the glaciers came to this region from the north, the Niagara cuesta was in approximately its present position (fig. 75, p.138) and a considerable lowland had been developed in the Green Bay-Lake Winnebago depression, but the drainage was still to the east-southeast. The Sturgeon Bay channel and the filled valley southwest of Brillion tell us of the old drainage. No evidence exists of a separate lobe of Illinoian ice which passed down this valley but the abundant deposits of the Green Bay lobe tell us of its importance during the Wisconsin stage of glaciation, figure 80. In the vicinity of the park the results of glaciation are mainly those of degradation rather than aggradation[5].

With the withdrawal of the ice to the north in the Lake Michigan basin a marginal lake was formed which fell in level as the ice retreated and opened lower outlets or as old outlets were worn down and which rose in consequence of minor advances of the glacial front, figures 81 and 82. Whenever the lake remained at one level for a considerable period, it cut bluffs on the headlands and formed beaches in the bays (fig. 76, p.139 and fig. 78, p.142). If the lake remained at a lower level for a considerable period, it might cut back the bluffs to the old cliff, but in the bays it would form beaches at a lower level. It would be an easy matter to find the evidences of these former lake levels at one

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5 "North and west of Sturgeon Bay the drift is for the most part very thin, a thickness of over 15 feet being considered unusual." Thwaites, F. T., and Lentz, R. C., Structure and oil possibilities in Door County, Wisconsin, 1922. (Unpublished)

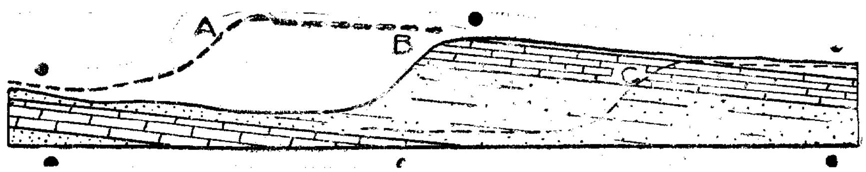

Figure 79.- Diagram shows the retreat of a cuesta from A to B and from B to C. In the Door County region the esker retreated to the south-southeast. Courtesy of the Wisconsin Geological and Natural History Survey.

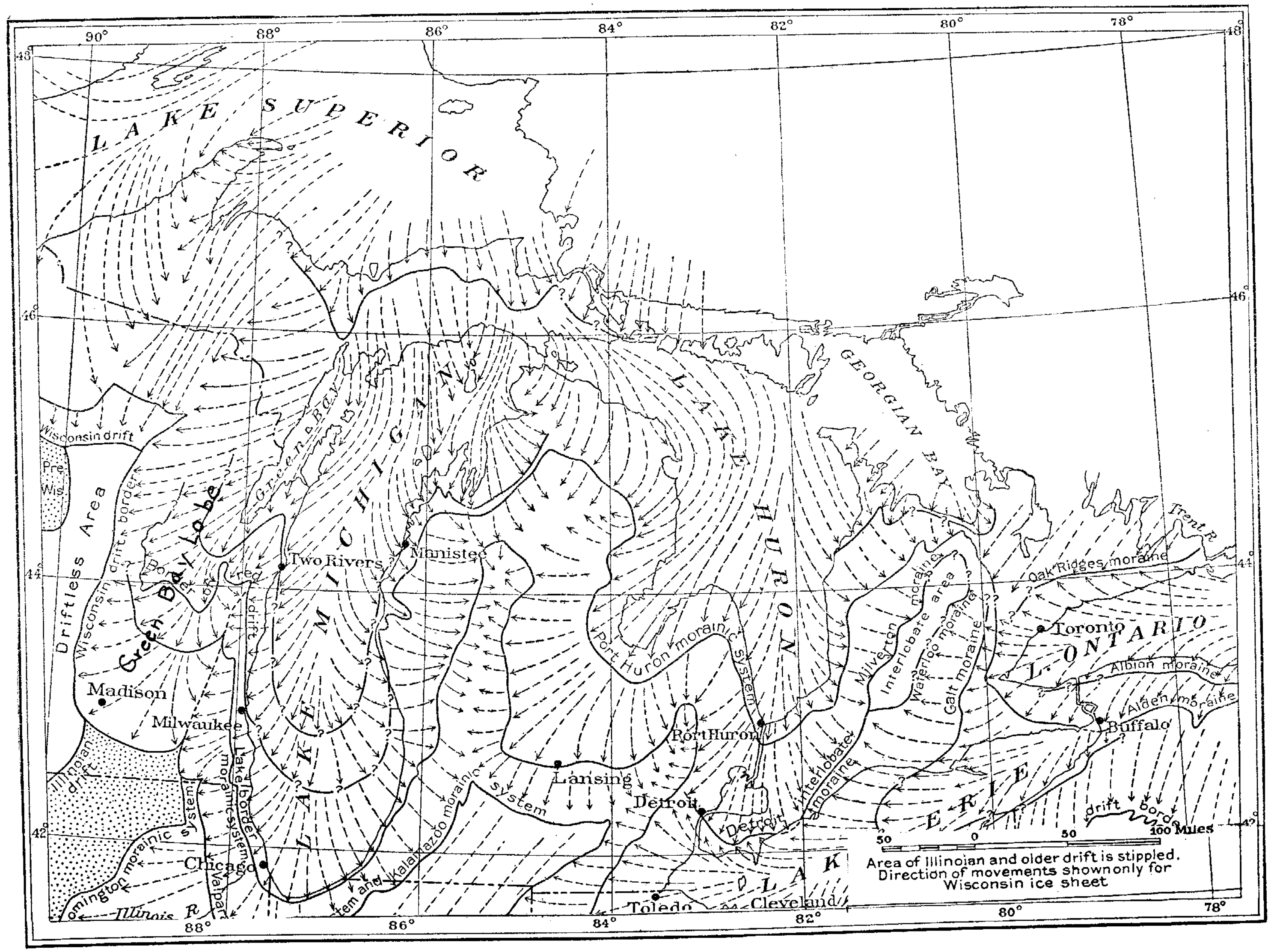

Figure 80.- The Green Bay Lobe was of great importance during the Wisconsin stage of glaciation. (After Frank Leverett, F. B. Taylor, W. C. Alden, and Samuel Weidman.)

U. S. GEOLOGICAL SURVEY

PROFESSIONAL PAPER 106 PLATE XXXVII

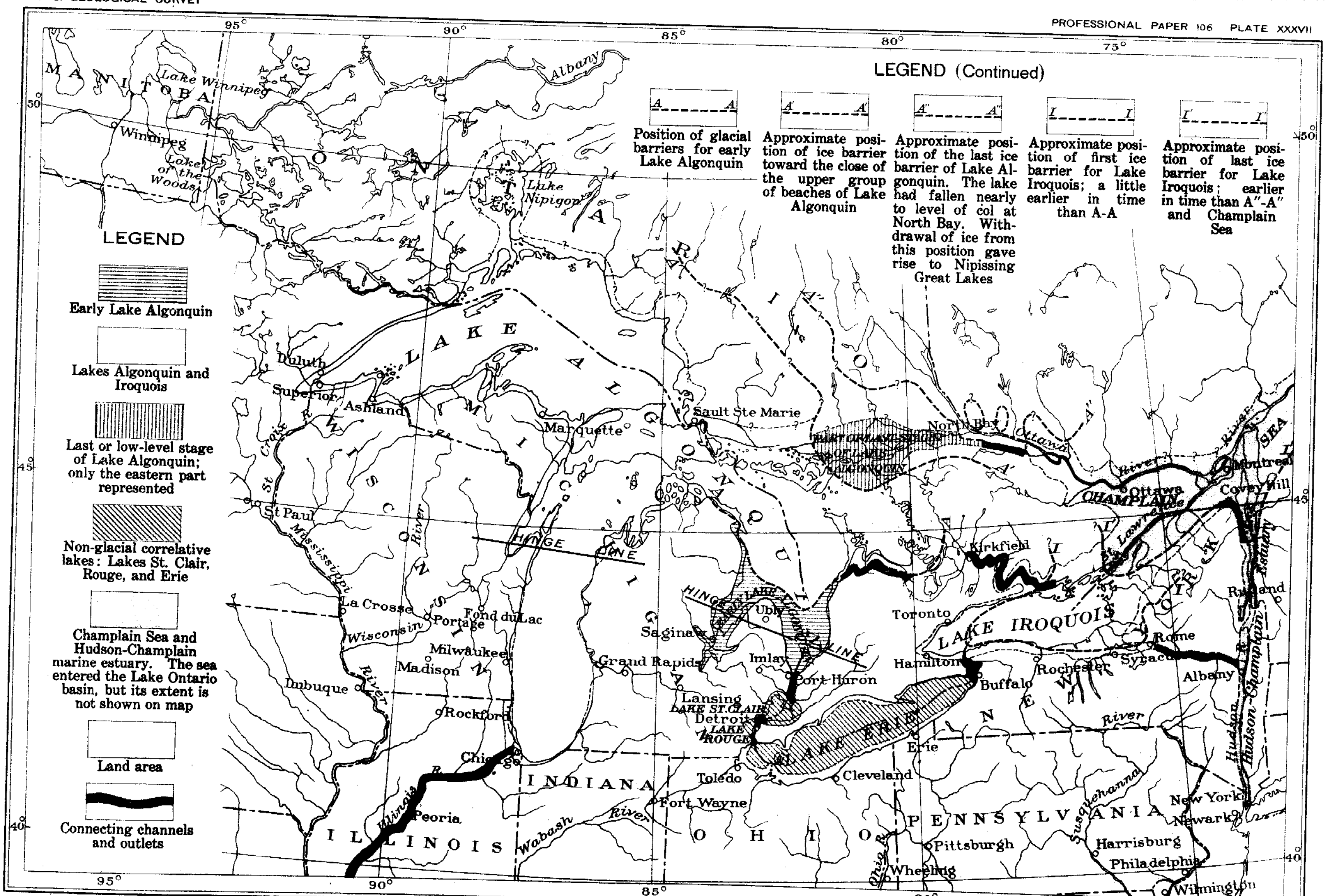

Figure 81.- MAP OF GLACIAL LAKE ALGONQUIN AND ITS CORRELATIVES

100 0 100 200 300 Miles

1917

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U. S. GEOLOGICAL SURVEY

PROFESSIONAL PAPER 106 PLATE XXVII

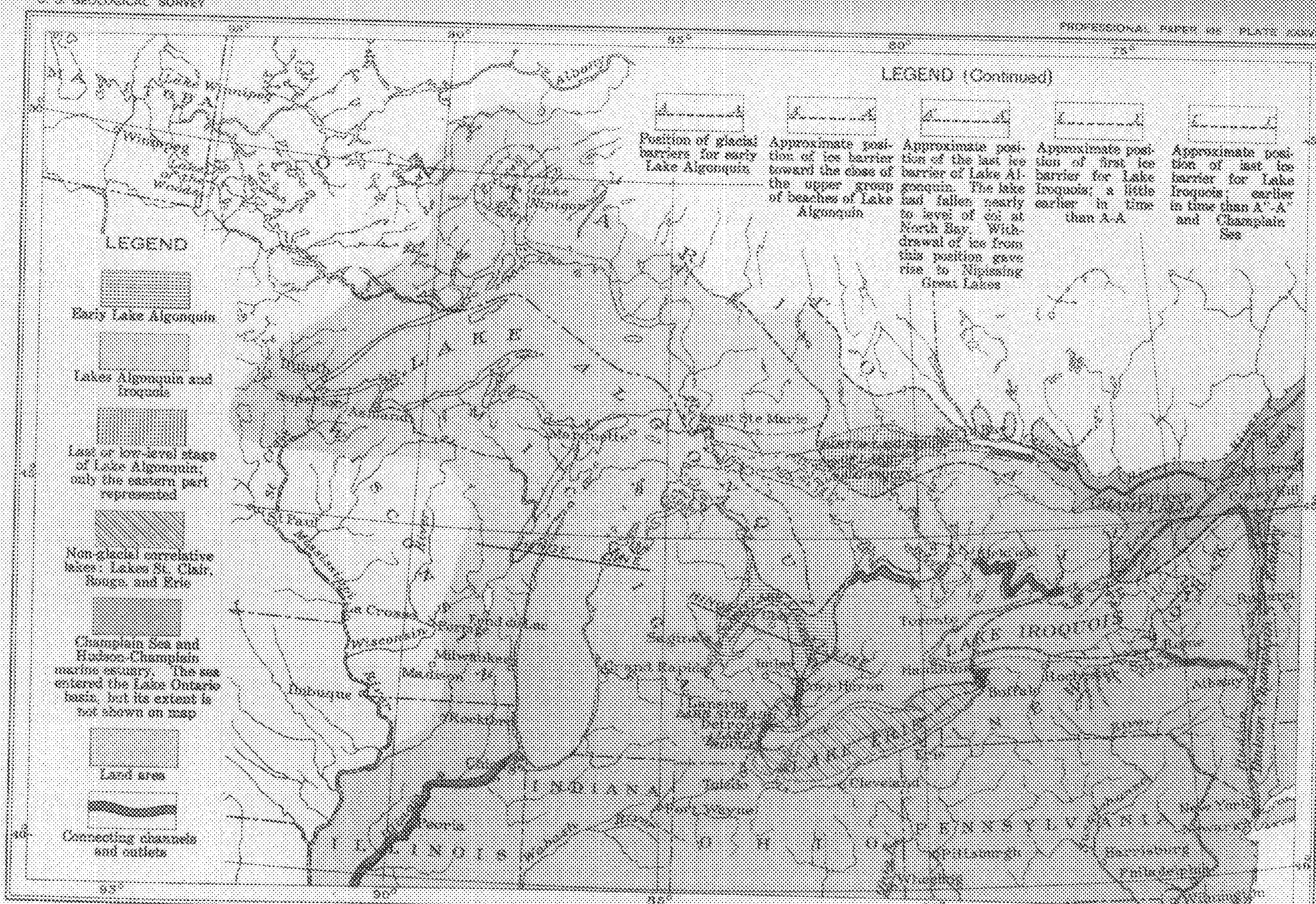

Figure 81.- MAP OF GLACIAL LAKE ALGONQUIN AND ITS CORRELATIVES

100 0 100 200 300 Miles

1917

House Doc. No. ; 64th Cong., 2d Sess.

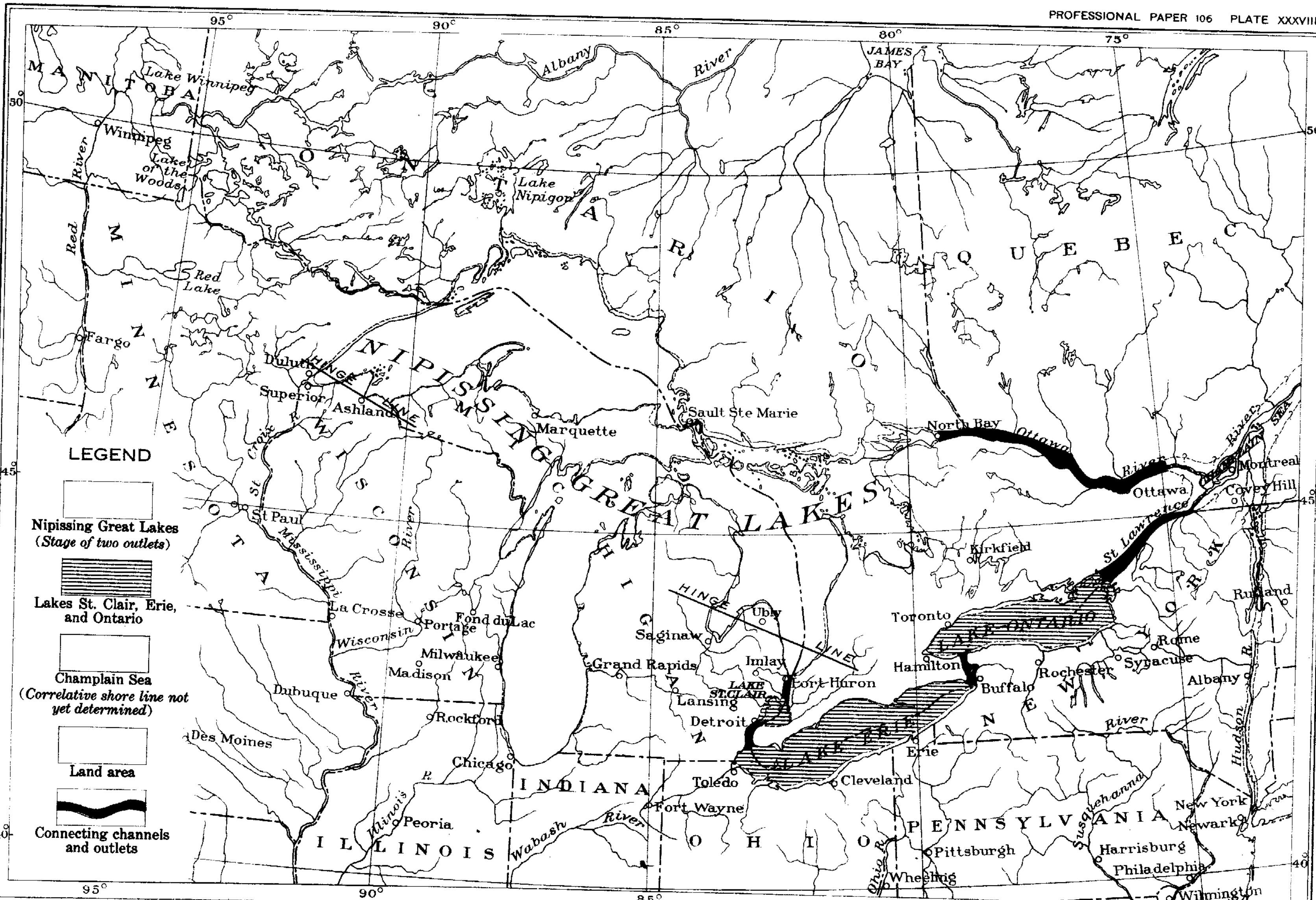

Figure 82.- MAP OF NIPISSING GREAT LAKES AND CORRELATIVES

100 0 100 200 300 Miles

1917

By Frank B. Taylor and Frank Leverett

House Doc. No. ; 64th Cong., 2d Sess.

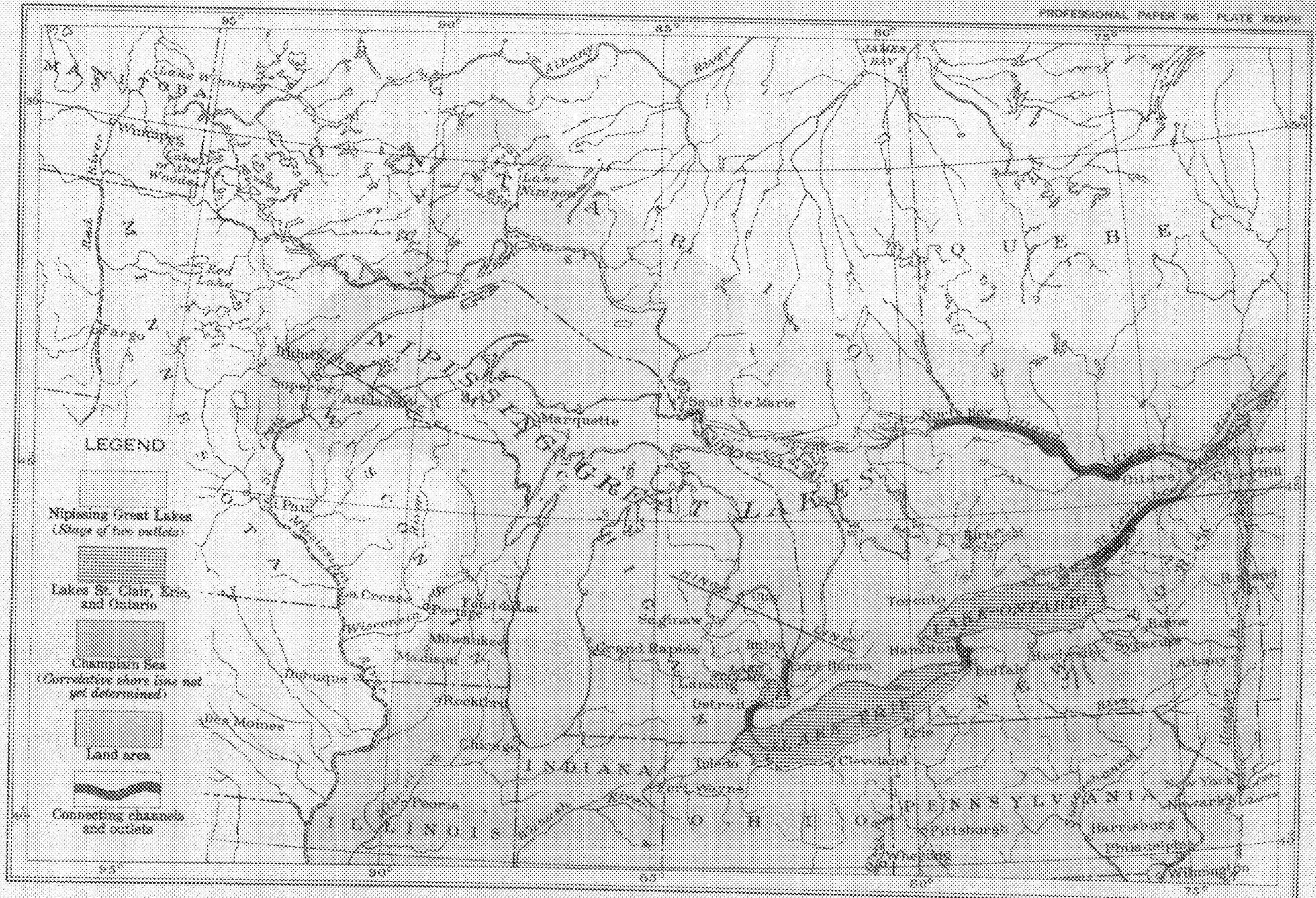

Figure 82.- MAP OF NIPISSING GREAT LAKES AND CORRELATIVES

By Frank B. Taylor and Frank Leverett

100 0 100 200 300 Miles

1917

place and transpose them to another if the retreat of the ice had not been accompanied by a gradual rise to the northeast and a consequent warping of the old strand lines.

In Peninsula Park Goldthwait has worked out the series of strand lines shown in figure 76. Figure 77 shows a cave eroded by the waters of Glacial Lake Algonquin.

With the present level of the lake the headlands are being worn back and beaches and bars are being formed in the bays just as in the preceding stages.

Geology

The Byron and Coral beds of the Niagara formation crop out in the park. The characteristics of these beds are shown in the following section:

Section exposed along Eagle Terrace Trail in sec. 14, T. 31, R. 27 E.[6]

Formation	Thickness Feet (approximate)	Elevation above lake
Coral		
Medium grained, gray dolomite with silicified fossils in layers 4 - 12 inches.	5	195
Unexposed slope above bench	10	
Dolomite, medium grained, some beds fine grained, gray, weathers light gray, many silicified fossils, layers 2 inches - 2 feet, not all well exposed; top makes bench	21	180.5
Dolomite, fine grained, dense, dark gray; irregular wavy beds 1 - 2 inches	5.5	
Dolomite, medium grained, gray, weathers light gray, wavy bedding, white chert nodules, many silicified fossils, layers 2 inches - 2 feet	12.5	

6 Thwaites, F. T., and Lentz, R. C., op. cit., Field notes.

Formation	Thickness Feet (approximate)	Elevation above lake
Dolomite, coarse grained, gray, weathers gray and "sandy". Laminated, beds 4 inches - 2 feet. Formerly used for dimension stone	12	
Dolomite, medium grained, gray, weathers dark gray and sandy, layers 2 inches - 4 feet	4	
Dolomite, very fine grained, wavy lamination, readily mistaken for "blue". Color gray, weathers white. Layers 4 - 6 inches. Coarser grained than "blue" and less chert-like	2	
Dolomite, coarse grained, gray, weathers dark gray, layers 2 - 12 inches. Many cavities in some layers	34	
Byron		
"Blue bed", dolomite, very dense, gray, chert-like, brittle conchoidal fracture, laminated beds 2 - 6 inches	12	87.5
Dolomite, fine to very fine, medium to coarse above, gray, layers 2 - 8 inches, planes somewhat irregular, few small cavities	19	75.5

Just west of the center of sec. 15, T. 31, R. 27 E. a steep hill on the park road shows an excellent exposure of the Byron-Coral contact[7].

	Thickness Feet
Unexposed. Bench at top marks top of Eagle Bluff	5
Coral beds	
Coarse gray dolomite irregular layers 2 - 6 inches. Weathers sandy and with holes	about 14
Byron	
"Blue bed", very dense blue dolomite, weathers white, laminar layers 3 - 12 inches	about 11
Heavy or "marble beds", medium-coarse, gray dolomite in layers 6 - 12 inches	about 8
Alternating dense and fine grained bluish-gray laminar dolomite	about 15

Another excellent exposure of this contact is on the old dugway east

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7 Thwaites, F. T., and Lentz, R. C., op cit., Field notes.

of the cemetery in the NW. NW. 28, T. 31, R. 27 E.[8]

Formation	Thickness Feet
Coral	
Medium grained, gray, somewhat laminated, contains cavities, layers 3 - 6 inches	5.5
Byron	
"Blue bed"	about 7
"Heavy" beds	about 10
Flags	slight

A road cut on T. H. 17 just inside the park (SE. SW. 23, T. 31, R. 27 E.) shows the "blue bed" of the Byron overlain by beach gravels. The top is about 60.5 feet above the lake and probably corresponds with the highest beach shown on figure 76, page 139.[9]

A small quarry just north of T. H. 17 in the NE. NE. 32, T. 31, R. 27 E. shows about 8 feet of Byron fine, bluish gray, laminated dolomite[10]. "The peculiar thing is that the amount of disintegration by waters is excessive so that certain beds are much broken down and look like shale. This alteration is variable, both vertically and horizontally."

On page 143 it was stated that the regional dip was east-southeast, but not all the beds in the park dip in this general direction, for they seem to be arched into an anticline or dome[11]. In the SW. SW. 23, T. 31, R. 27 E., for example, an outcrop of coral beds dips strongly downhill to the northeast.

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8 Thwaites, F. T., and Lentz, R. C., op cit., Field notes.

9 Idem, Field notes.

10 Idem, Field notes.

11 Idem, Report. (Unpublished)

It is of considerable interest to speculate on whether this anticline is due to inequalities in the deposition of the upper formations and therefore extends to slight depth or whether it is due to settling around a pre-Cambrian knob of quartzite like the one which was struck in drilling a well at Fond du Lac.[12]

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12 In the Galloway-West well, Fond du Lac, Wisconsin quartzite was struck at a depth of but 430 feet.

CHAPTER XI

BELMONT STATE PARK

Geographic Location

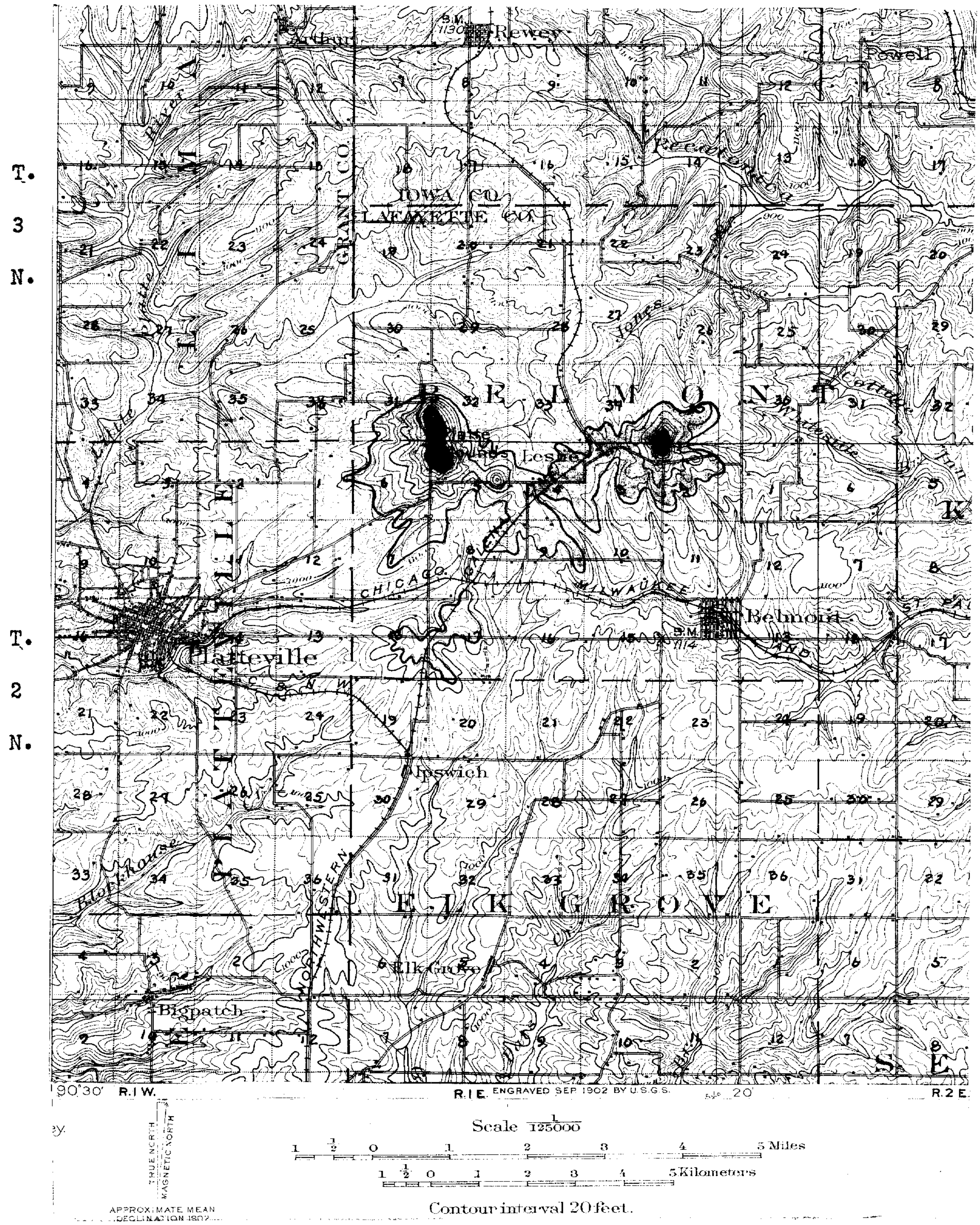
Old Belmont (Pl. IX), the site of the first capitol of the state, is located in the northwest corner of Lafayette County. It is located on T. H. 23 between Mineral Point and Platteville. The park, itself, consists of but two acres in the NW. 1/4, sec. 3, T. 3, R. 1 W., but the mounds of the vicinity are of considerable beauty and interest.

Physiographic Location

The park is located in the Western Upland of Wisconsin, figure 83. The Niagara escarpment is located to the south in Illinois, but the mounds of the vicinity are outliers. In the glaciated region of eastern Wisconsin such outliers have been removed, but in the Driftless Area they still remain and add much to the scenic attractions, figure 84. The higher mounds are capped by the Niagara dolomite; the lower mounds have lost this resistant capping stratum and as a result erosive processes are more potent upon them, figure 85.

Features of Interest

The chief interest in this park is its historical connections, for the first state capitol where the first territorial legislature met in 1836 is located here, figure 86. A bronze tablet (fig. 87) gives a brief account of the history.



BELMONT STATE PARK

■ = outcrop of Niagara dolomite
□ = outcrop of Maquoketa shale

(Mineral Point quadrangle)

T. 3 N.

T. 2 N.

BELMONT STATE PARK

▓ = outcrop of Niagara dolomite
░ = outcrop of Maquoketa shale

(Mineral Point quadrangle)

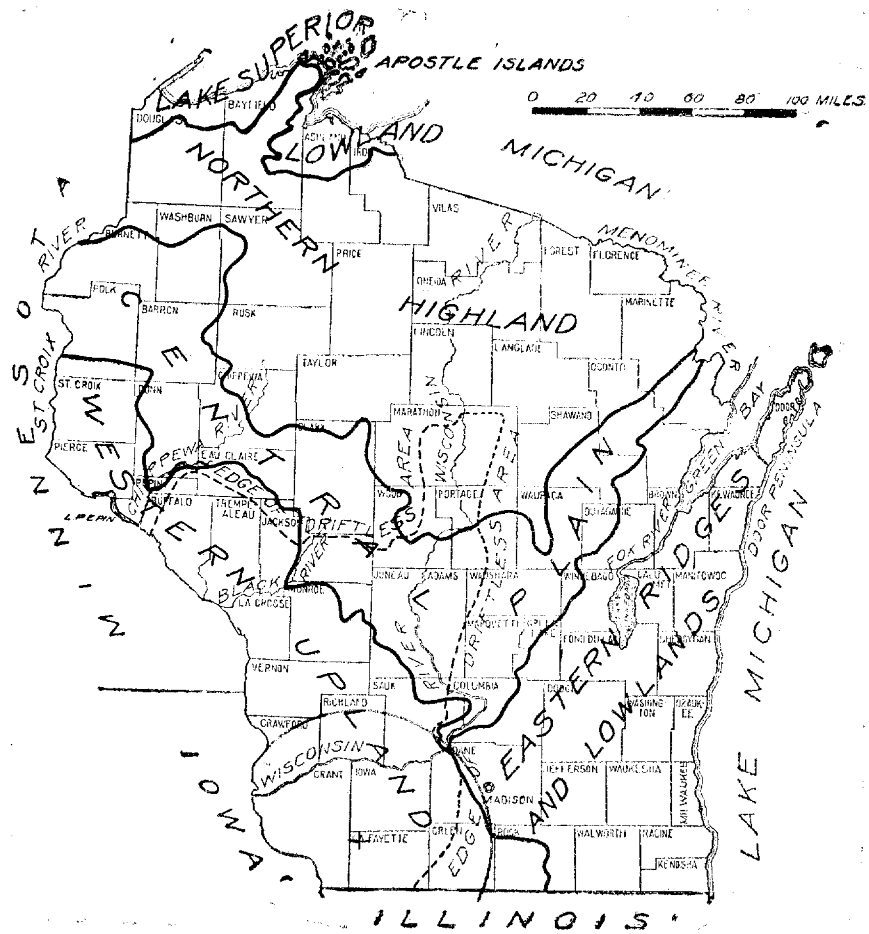


Figure 83.- Belmont State Park is located in the Western Upland. Courtesy of the Wisconsin Geological and Natural History Survey

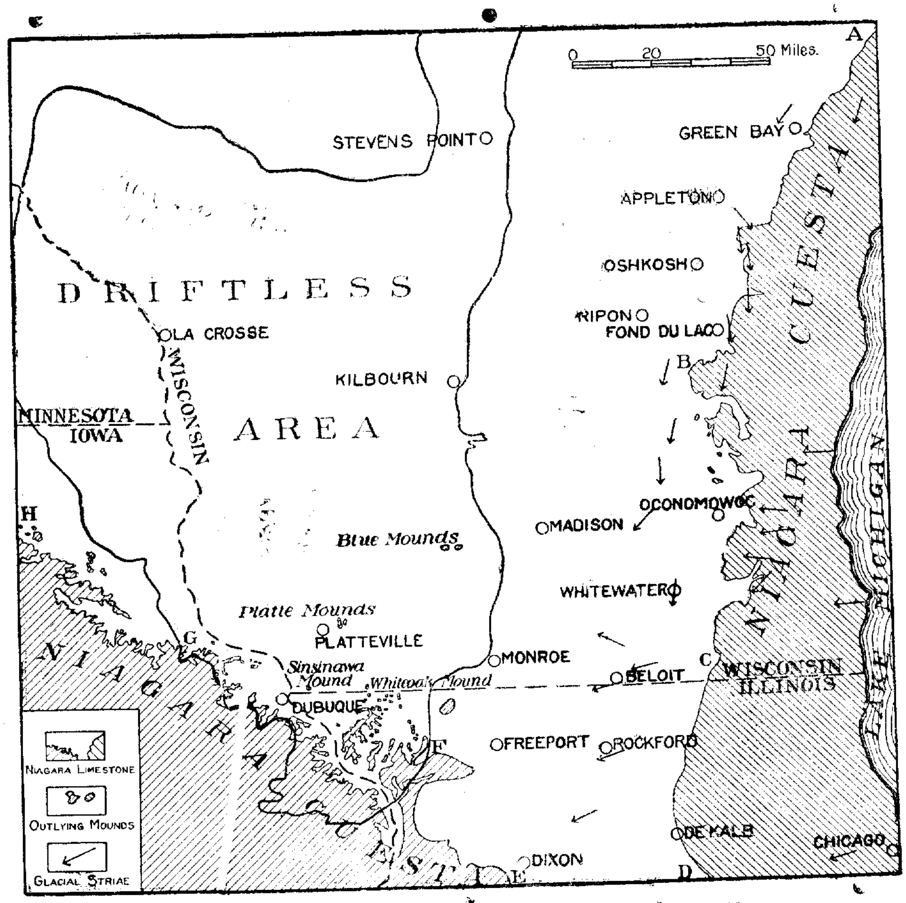


Figure 84.- The Niagara escarpment inside and outside the Driftless Area. Outliers of the Niagara cuesta in the Driftless area are abundant as at Blue Mounds, Platte Mounds, and Sinsinawa Mound, but there are practically none in the glaciated area, where the escarpment is abnormally simple. -Courtesy of the Wisconsin Geological and Natural History Survey.

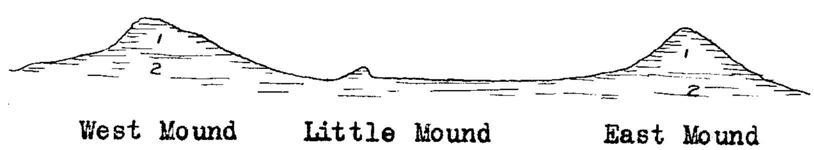


Figure 85.- Sketch of the Platte Mounds. The higher mounds are capped by the Niagara dolomite; the lower mounds have lost this resistant capping stratum. 1 = Niagara limestone; 2 = Maquoketa shale. (After Strong)

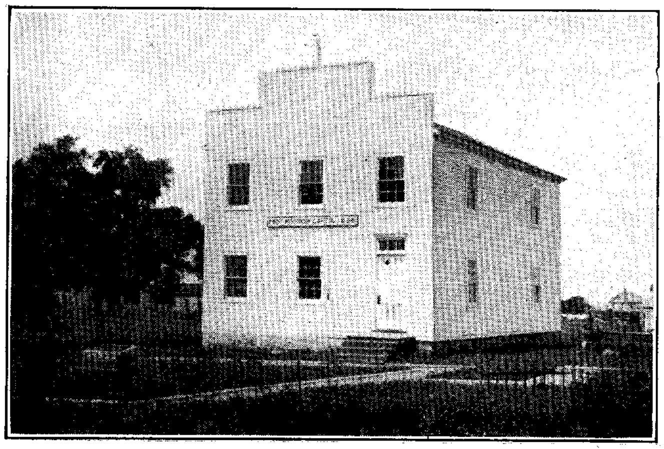


Figure 86.- The first state capitol.

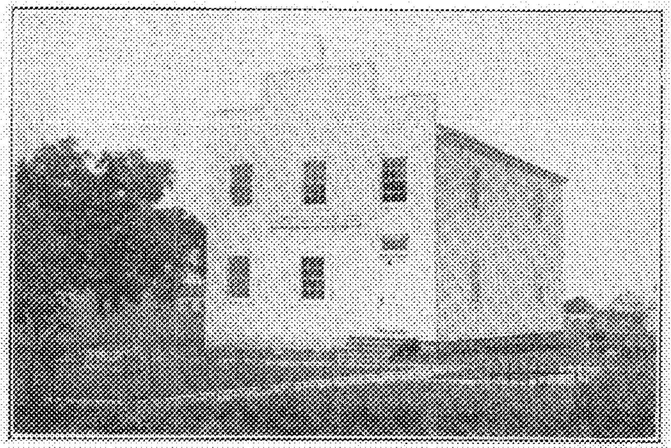


Figure 86.- The first state capitol.

Figure 87. Tablet at Belmont. - Courtesy of the Wisconsin Geological and Natural History Survey.

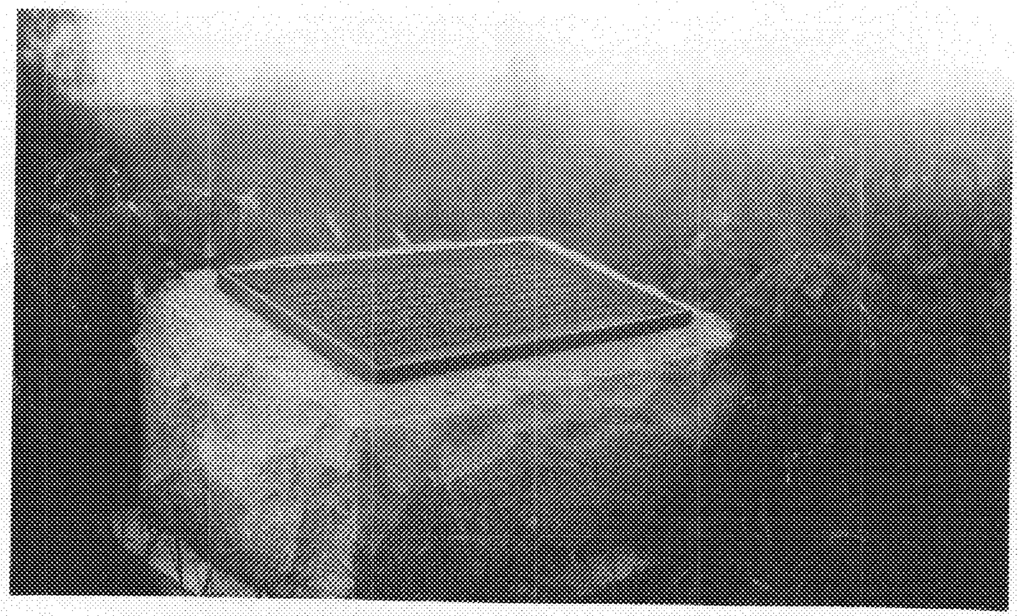


Figure 87. Tablet at Belmont. - Courtesy of the Wisconsin Geological and Natural History Survey.

Geological History

The oldest rock exposed at the surface in the immediate vicinity of the park is the Galena dolomite. In this account, therefore, the geological history begins with submergence in the Ordovician sea and the receipt of the sediments of the Galena dolomite. This was followed by the deposition of the Maquoketa shale and the Niagara dolomite, the latter of which is Silurian in age. When Wisconsin was raised above the sea, the beds were gently arched, as a result of which the beds in southwestern Wisconsin dip to the southwest. When the resistant Niagara dolomite was removed from the apex of the dome, erosive forces quickly removed the non-resistant underlying shale and even undermined the dolomite with the result that this resistant formation began to retreat down the dip in a cliff or escarpment. Such a cliff caused by the more rapid erosion of the weaker formation in gently dipping strata is known as a cuesta and is illustrated in figure 88.

The Niagara cuesta has retreated to the south past the site of the park, but some parts of the formation were particularly resistant[1] and have remained as outliers of the main escarpment. The mounds in the vicinity of the park are known as the Platte Mounds. This resistant cap

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1 In 1839 Owen made the following statement concerning these mounds: "These isolated and towering mounds, so conspicuous a feature in the landscape of Wisconsin, are evidence of the denuding action to which, under the crumbling hand of time, the surface of our globe is continually subjected, and which the more durable siliceous masses of these hills of flint have been enabled partially to resist." Martin, Lawrence, Physical Geography of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 36, p. 61, 1916. See also Leith, C. K., Silicification of erosion surfaces: Economic Geology vol. XX, p. 518, 1925.

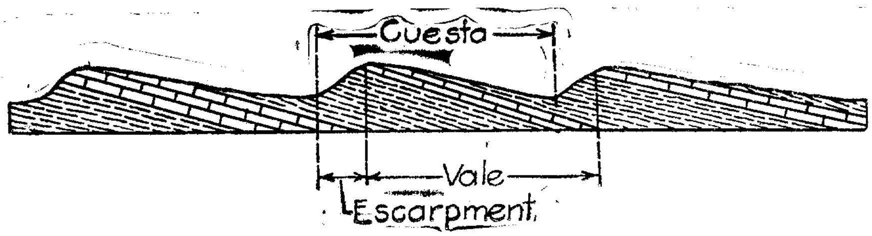

Figure 88.- A series of cuestas and escarpments. (Veatch) - Courtesy of the Wisconsin Geological and Natural History Survey.

still remains upon the higher mounds to the east and west of the park but has been removed from the lower mound west of the park. The latter is, therefore, capped by the Maquoketa shale which extends in a continuous outcrop from the western mounds to the eastern mound. This broad outcrop of the shale suggests that at one time there was one large outlier of the Niagara cuesta instead of the several mounds of this vicinity. The present situation is then just one of the steps in the removal of this outlier.

Geology

The park is underlain by the Maquoketa shale; the higher mounds of the vicinity are capped with Niagara dolomite. The general characteristics of these formations in this vicinity are shown in the following section[2]:

System	Formation Name	Thickness in Feet	Character of Rocks	Character of Topography and Soils
Silurian	Niagara limestone	150+	Light-buff to gray dolomite. Basal beds massive and rough weathering, succeeded by thinner beds, above which are layers containing more or less chert. Fossiliferous. Top of formation eroded.	Forms plateau with escarpment southwest of Mississippi River and caps the mounds scattered over the quadrangles. Dark-red clay soil containing residual chert.
Ordovician	Maquoketa shale	160 - 225	Gray argillaceous and calcareous shale, locally fossiliferous and magnesian at top. Plastic blue and green	

2 Grant, U. S., and Burchard, E. F., Description of the Lancaster and Mineral Point quadrangles: U. S. Geol. Survey Folio 145, p. 14, 1907.

System	Formation Name	Thickness in Feet	Character of Rocks	Character of Topography and Soils
Ordovician	Maquoketa shale		shale and clay with indurated fossiliferous bands near the top. Drab and blue, thin, fissile shale and fossiliferous, thin, argillaceous limestone. Fine conglomerate locally near base.	Low, rounded swells and long, gentle slopes. Thick fertile soil.

CHAPTER XII

CUSHING MEMORIAL PARK

Geographic Location

Cushing Memorial Park, Plate X, is located in Waukesha County about one-half mile west of Delafield and a short distance east of Upper Lake Nemahbin[1]. Access to the park is gained over T. H. 30 or the Milwaukee Electric Railway and Light Company interurban cars.

Physiographic Location

The park is located in the province known as the Eastern Ridges and Lowlands (fig. 89) and at the base of the third or Niagara escarpment (fig. 90).

Features of Interest

The park is the site of the old Cushing homestead and is of interest as the home of three brothers who were noted for their bravery[2]. Within the park a monument has been erected in their honor.

Geological History

The oldest rock which immediately underlies the park is the Galena-Black River dolomite. The present discussion of the geological

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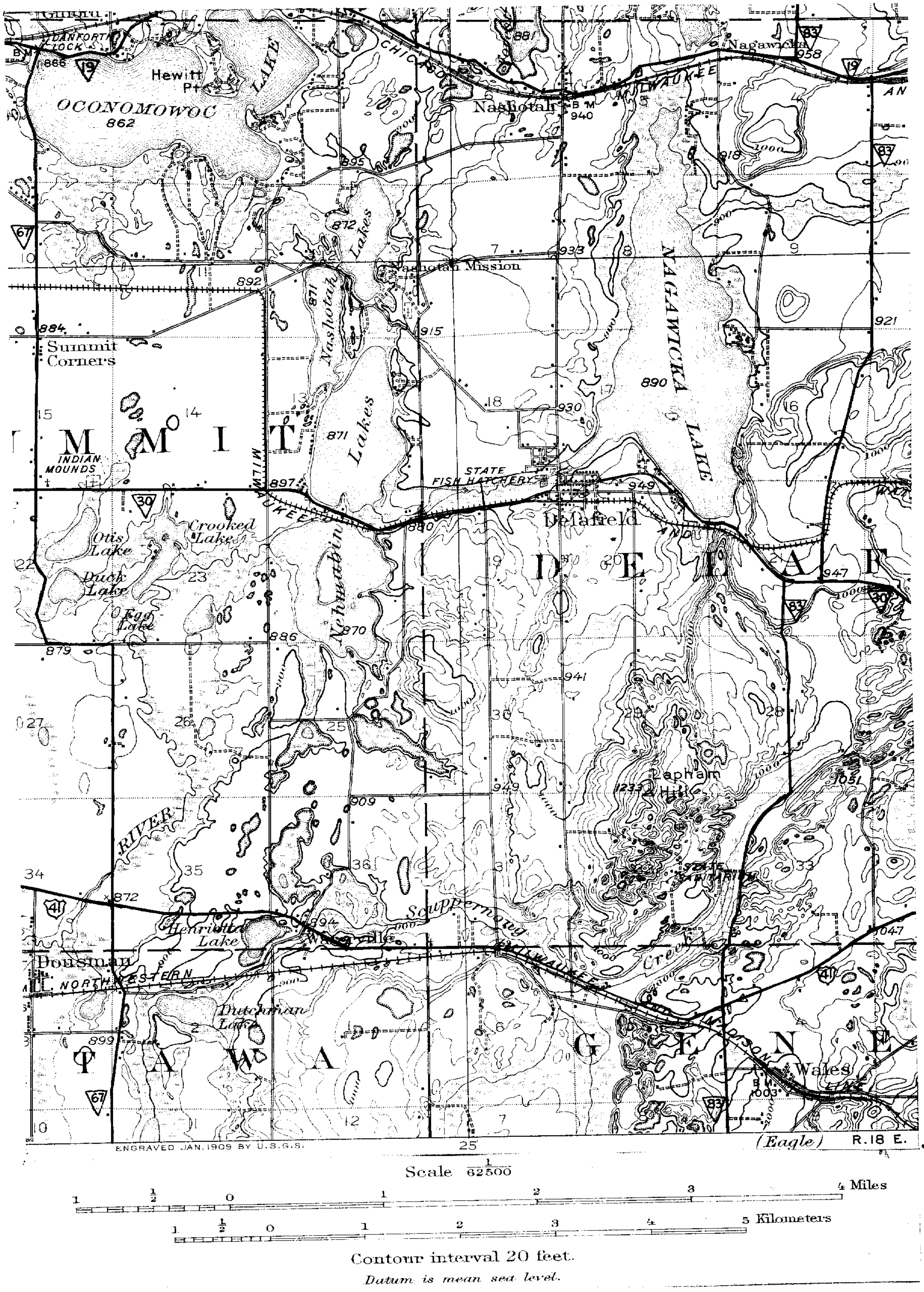
1 The shores of this lake are described by N. M. Fenneman in The Lakes of southeastern Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 8, p. 104, 1902.

2 For a brief history of the family see State Parks of Wisconsin: State Conservation Commission, p. 23, April, 1926.

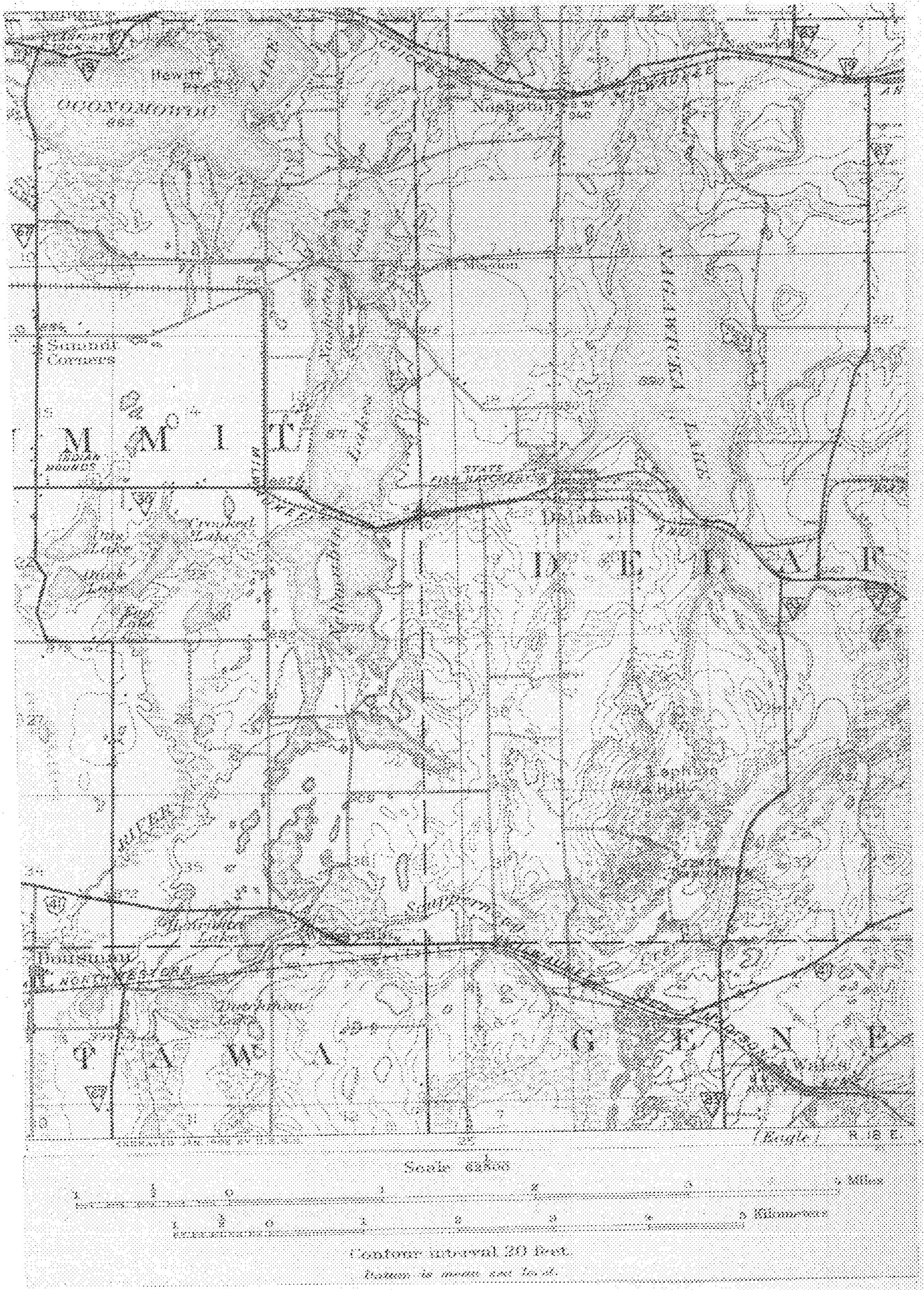
T. 7 N.



CUSHING MEMORIAL PARK

(Oconomowoc Quadrangle)

T.
7
N.



CUSHING MEMORIAL PARK
(Oconomowoc Quadrangle)

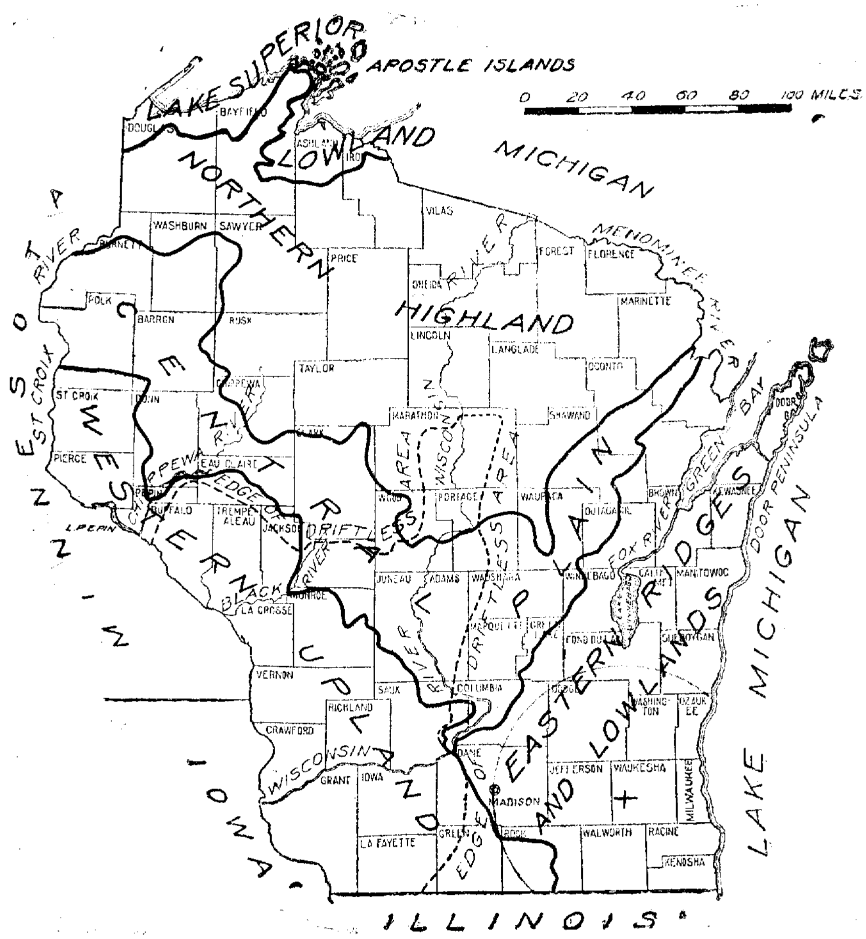


Figure 89.- Cushing Memorial Park is located in the Eastern Ridges and Lowlands. Courtesy of the Wisconsin Geological and Natural History Survey.

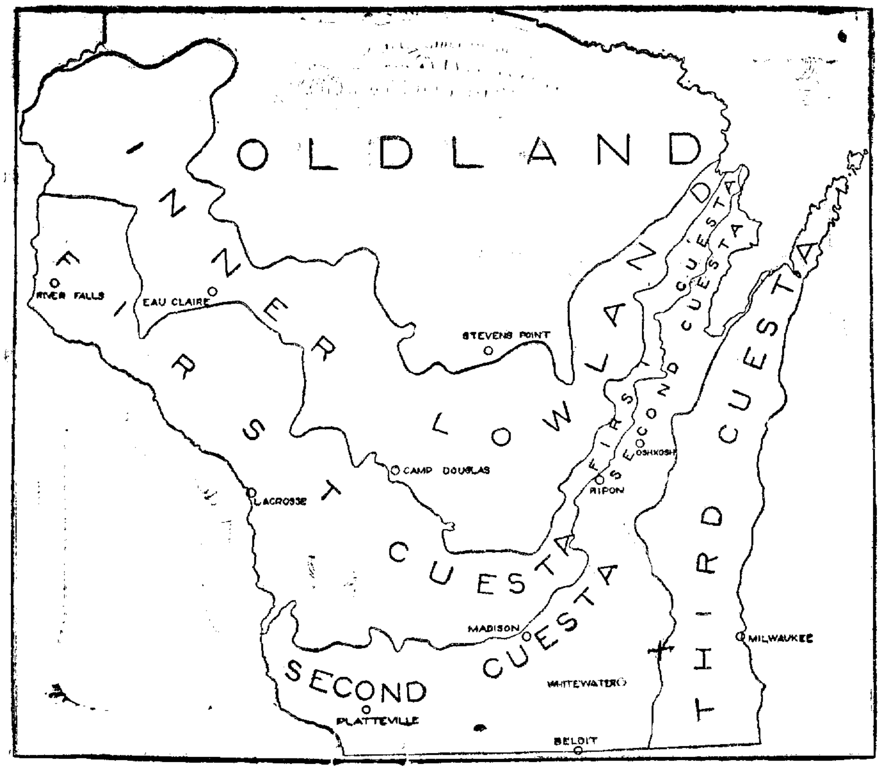


Figure 90.- Cushing Memorial Park is located at the base of the third or Niagara escarpment. Courtesy of the Wisconsin Geological and Natural History Survey.

history of this park will begin, therefore, with the region submerged beneath the Ordovician sea and receiving deposits which formed the Galena-Black River dolomite. This deposition was followed by that of the Richmond shale which also probably underlies portions of the park. The Ordovician sea was followed by the Silurian sea in which was deposited the Niagara dolomite.

When Wisconsin was raised above the sea at the close of this period of sedimentation, the sediments were gently arched so that in this region the beds dipped to the southeast. Forces of weathering and erosion were most effective on the apex of the dome and finally wore through the resistant capping of Niagara dolomite and exposed the non-resistant shale. Erosive processes worked rapidly in this material and undermined the rimming outcrop of Niagara dolomite so that a cliff was formed which retreated from the apex as erosion proceeded. Such an escarpment formed by the more rapid erosion of the weaker formation in gently dipping strata is known as a cuesta and is illustrated in figure 91.

Just prior to the coming of the continental ice sheet this Niagara cuesta had retreated past the site of the park and formed a bold and rugged cliff a short distance to the southeast. It is difficult to say just what effect each ice sheet had on this region. As the main movement of the old or Illinoian glacier was to the west in this region, it is probable that it planed off the crest of the cuesta and removed the detached columns and outliers which existed in preglacial time in this region just as they do today in the Driftless Area of southwestern Wis-

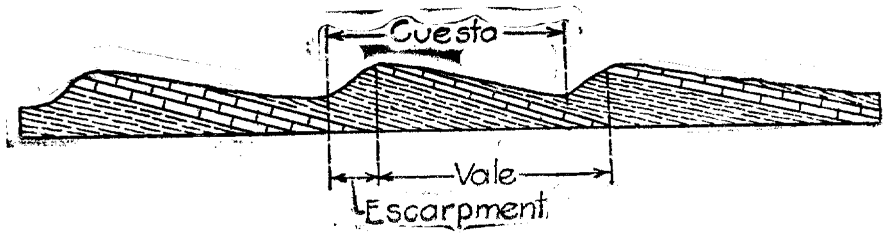


Figure 91.- A series of cuestas and escarpments. (Veatch) Courtesy of the Wisconsin Geological and Natural History Survey.

consin. On its retreat from the region the ground was left mantled with glacial deposits. During the later or Wisconsin stage of glaciation this region was covered by the Green Bay lobe and the main glacial movement was to the southeast, figure 92. Just to the east of the park on the crest of the Niagara escarpment, however, the glacial front of the Green Bay lobe came in contact with that of the Lake Michigan lobe. When these two lobes retreated from the region, an angle was formed between them which became ever wider. When the angle was acute, the glacial fronts were close at hand and debris from the melting ice was abundant. Outwash deposits were therefore built up to a high level and are known today as the upper terrace. With further recession of the ice front a lower level or second terrace was formed. With still further recession another terrace was formed. This process was not as simple as the above, for here and there detached ice blocks were buried beneath these terrace gravels. When these melted, pits or kettles were formed on the surface. The lake basins of this region have in general this origin. When the ice fronts had retreated a considerable distance some of the older terraces were eroded by glacial streams, figure 93. According to Thwaites[3] there are four terrace levels in this vicinity: 900, 925, 1,000 - 1,020, and 1,100. The park is located on the lower terrace and is due to the erosion of the next higher terrace by a glacial stream.

Geology

The park is on what Thwaites terms the lower outwash terrace of this vicinity, figure 93. Well records indicate that these surficial

[3] Thwaites, F. T., Personal communication.

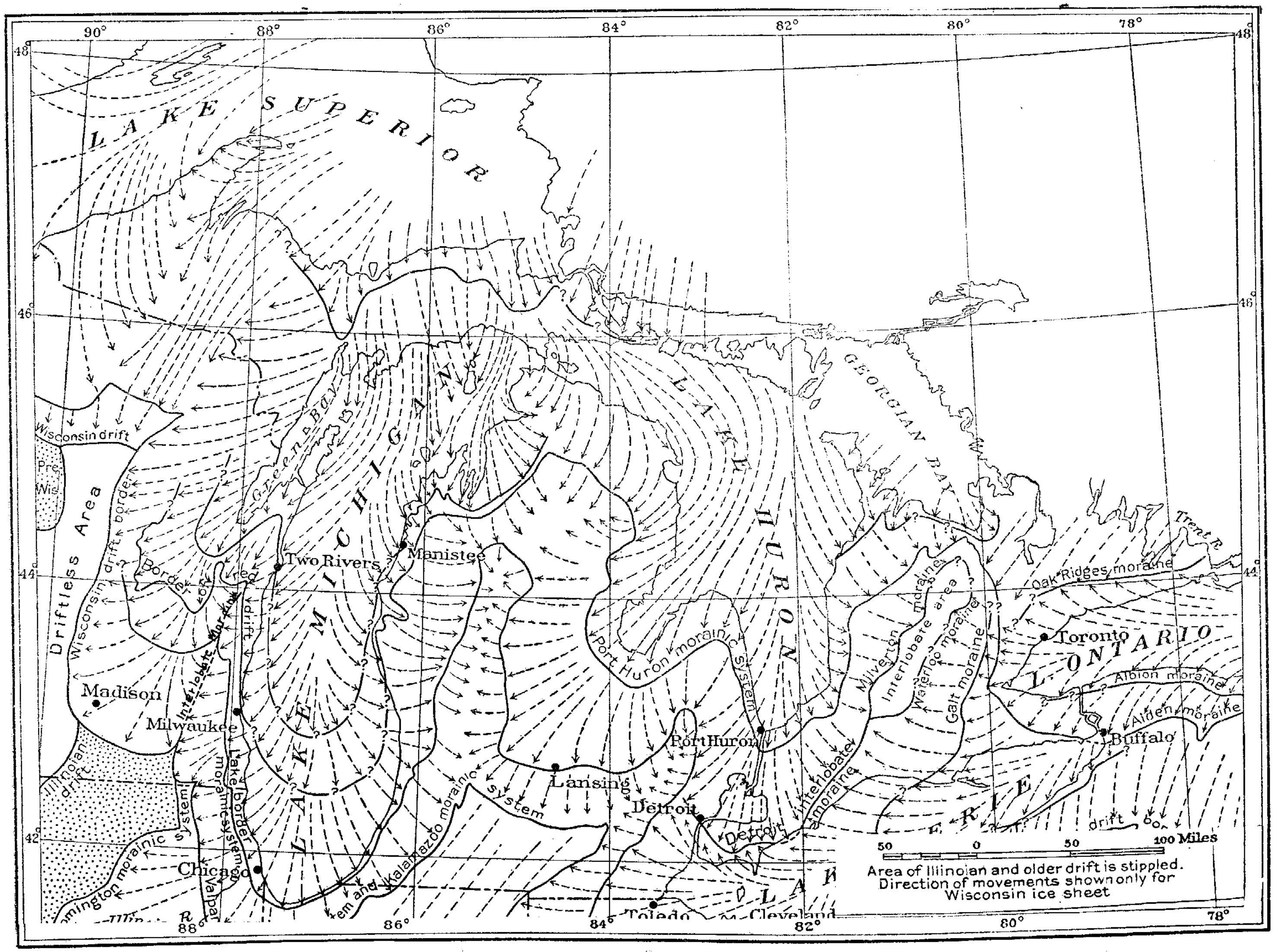


Figure 92.- Cushing Memorial Park is in the Interlobate Moraine. (After Frank Leverett, F. B. Taylor, W. C. Alden, and Samuel Weidman.)

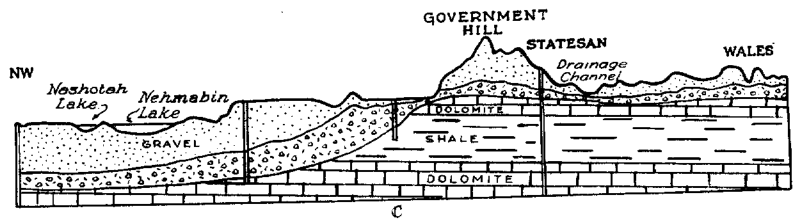


Figure 93.- Section through southwest corner of park. Shows interlobate gravels and pitted gravel terraces with eroded drainage channel. - Courtesy of F. T. Thwaites.

deposits are probably 100 feet in thickness in the park[4]. Bed rock is Galena-Black River dolomite which may be overlain by a thin layer of Richmond shale.

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4 Alden, W. C., Field map.

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