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By
WILSON M. LAIRD
State Geologist

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THE GEOLOGY OF THE TURTLE RIVER STATE PARK

BY WILSON M. LAIRD
State Geologist,
Associate Professor of Geology, University of North Dakota

INTRODUCTION

Abstract

The study of the Turtle River State Park shows that the area is underlain entirely by glacial deposits called drift or till. On this till was deposited beach gravels during the Campbell and McCauleyville stages of Glacial Lake Agassiz. The Campbell beach appears to be twofold in the Park but the McCauleyville is a single beach. Extensive terrace deposits, which appear to correlate with a later Lake Agassiz beach, (the Ojata beach) are found along the stream. Maps are presented showing geology of the area and changes of the stream's course during the time since the formation of the stream. Necessary geologic principles are also discussed.

Location

The Turtle River State Park comprises the southwest, southeast, and northeast quarters of Section 36, Township 152 north, Range 54 west, in Grand Forks County, North Dakota. The Park is one mile north of Arvilla and is reached by Route 2 which passes just south of the entrance to the Park. The Park is 22 miles west of Grand Forks, the county seat of Grand Forks County.

Method of Study

The Turtle River State Park had already been mapped topographically when the Park was under construction so no effort to duplicate this work was made during this study. However, the plane table and alidade were used to get accurate elevations on the terrace remnants along the stream in, as well as adjacent to, the Park. In order to ascertain whether the terraces were depositional or erosional, holes bored with a 4 inch diameter post hole auger were put down at selected localities.

Purpose of Investigation

The study of the Park was undertaiken at the request of Supt. Russell Reid to provide a popular yet scientific account of the geologic features of the Park. By means of a written text as well as maps, diagrams, and pictures it is hoped that visitors to the Park will be better able to enjoy their visit. Scenery when viewed with some understanding of how it was formed should be doubly interesting even to the casual observer. It is with this idea in mind that this report is written.

GEOLOGIC PRINCIPLES

Introduction

"The present is the key to the past" is a statement of an idea advanced by the Scotch geologist Hutton. What Hutton meant was, that we can look about us and see geologic processes such as erosion by running water, weathering, formation of soil, and erosion by waves going on now. Some years later Charles Lyell, the famous English geologist, maintained that such processes went on at approximately the same rate in past geologic ages as they do now and that the present rocks are the records of such actions. Thus we can look at ripple marks in sandstone and say the ocean once stood where he stand and waves played over its surface in the same fashion as they do now at the seashore. Or to bring our illustration nearer home we can stand on any of the beaches of this area near the Park and see the evidences of a large lake which existed in this area during the time of the glaciers. This lake is called Glacial Lake Agassiz in honor of the great Swiss glacial geologist.

Present day geologists do not agree exactly with Lyell that geologic processes went on at the same rate in the geologic past as they do now. After all, we lack really concrete evidence as to how rapidly streams erode their valleys or how fast sand piles up to make a sand dune. How then, do we know it went on as fast in the past or slower than such processes do now? There is reason to believe that during part of geologic time when plant life was scantier than now that erosion was faster than at the present time. Therefore, geologists agree with Hutton's main idea that geologic processes went on in much the same way that they do now but they do not see eye to eye with Lyell on the rate at which they operated.

The Formation of Rocks

Because the earth is made up of various types of rocks, it may be well to mention how some of the main types of rocks are formed. Geologists call the study of the origin of rocks *petrology.*

There are three main types of rocks: Igneous, Sedimentary, and Metamorphic. Igneous rocks are those rocks which have solidified

from molten material. Such rocks as granite and basalt are examples of igneous rocks. These rocks commonly contain a large percentage of quartz (silicon dioxide) and feldspar (potassium or sodium or calcium aluminum silicate) as well as a small percentage of ferro-magnesian minerals (complex silicates of iron, calcium, sodium, aluminum, and magnesium).

Sedimentary rocks are rocks which have been deposited through the action of water, ice, or wind. Limestone, sandstone, conglomerate and shale are examples of this type of rock. The sedimentary rocks are formed largely of the products of weathering of the igneous rocks. The minerals making up the sedimentary rocks are usually quite different from those of the igneous rocks but many of the same chemical elements are present in both types.

Metamorphic rocks are rocks which have undergone some changes due to pressure, heat or chemically active gases or fluids. Metamorphic rocks originally may have been either igneous or sedimentary rocks or even other metamorphic rocks. However, due to great pressures or heat or as a result of chemical action they have been changed. Most metamorphic rocks are banded or foliated, and often contain large amounts of mica which in part accounts for their foliated or plate-like appearance. Such rocks as gneiss, schist, slate and marble are examples of metamorphic rocks. Metamorphic rocks commonly contain many of the same minerals as igneous rocks only in different amounts. The amount of change or metamorphism a rock has undergone makes a great difference in its final appearance. The same rock at different stages of metamorphism may look very unlike.

Representatives of all three of these main rock types are found in the glacial drift in the Park. These rocks are not in place where they were formed but have been brought from their original place of formation to their present location by glacial action. The locale of these rocks in the glacial drift was many miles to the northward in Manitoba in Canada. Many of the limestone pebbles in the drift came from the area just to the west of Winnipeg where limestone quarries are operating today. In these quarries the surface of the limestone can be seen to be smoothed off and polished by the same glacier which later deposited the rock in North Dakota.

The Formation of Landscape

The scenery which we see about us is the result of a number of geologic processes. Everyone who has observed any particular locality over a period of years is bound to notice slight changes in the course of streams, the shape of some hillsides, or the position of such features as sand dunes. As far as the present report is concerned, only the work of running water, waves, glaciers, and wind will be considered as it is the work of these processes which was most influential in the production of the landscape in and near Turtle River State Park.

Work of Running Water

Considering the world as a whole, probably the most potent factor in the production of landscape is running water. Even in arid and semi-arid regions the main erosive agent is running water. In considering the effects of running water on a region let us start with an area recently arisen above sea level or lake level (for example, the very area in which we are interested). This land has initial irregularities on it due to beaches, or irregularities due to wave and current action. When the rain falling on it first begins to run off, it is more or less unconcentrated and is mainly in the form of sheetwash.

Soon, however, the initial irregularities concentrate the runoff and we have the beginnings of streams. At first when they are shallow, the streams will flow only after heavy or prolonged rainfalls. Such streams are called *intermittant streams.* In this stage of regional development the areas between the streams of the area are broad, usually relatively flat and often poorly drained. Such a region is said to be in the stage of topographic youth. The Red River Valley is an example of such an area.

As time goes on, the streams cut their valleys deeper and deeper until they reach the underground water table. The water table is simply the level at which all the pore spaces between the particles of the soil or rock are saturated with water. When the underground water begins to feed the stream it flows all year round and the stream is called a *permanent stream.* As the main streams of the area are downcutting, their tributaries are also growing until all of the area his been cut up by the tributaries so that none of the original broad interstream divides remain. When this stage in regional development is reached the area is said to be in topographic maturity. The badland area in the immediate vicinity of the Little Missouri River in western North Dakota is an example of topographic maturity.

From the stage of maturity onward, the visible changes in the topography of an area become increasingly less noticeable. The

streams meander back and forth cutting the valley walls here and depositing the material there. See figures 1 and 2 for diagrams.

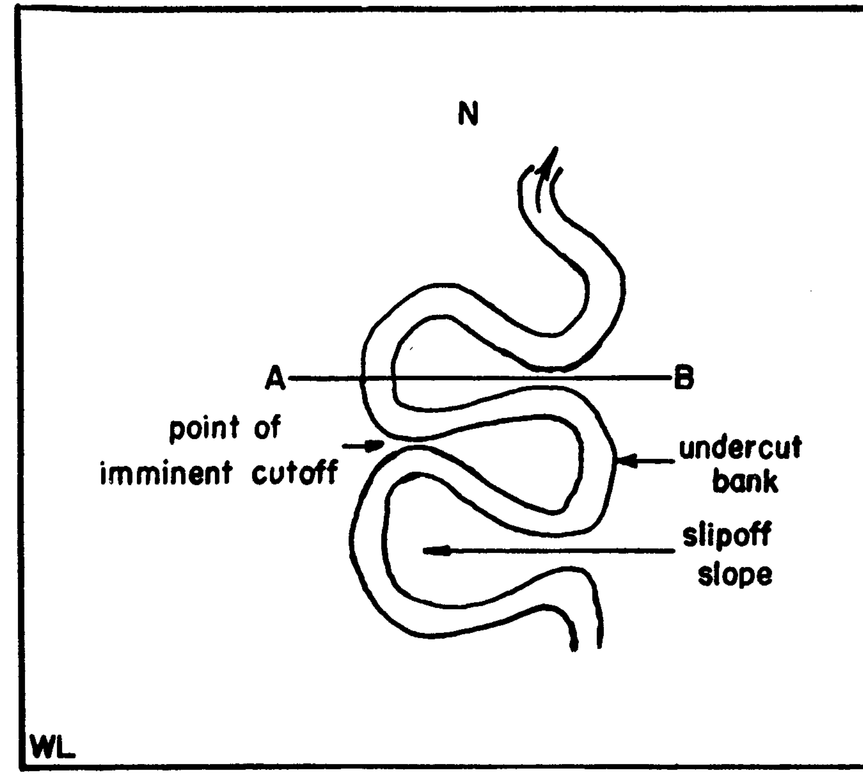

FIGURE 1. Diagram of a stream flowing north. Note that the stream is doing its cutting dominantly on the outside of the meander curves. As the bank is undercut, the stream meander moves in that direction. Thus it progressively tends to widen its valley. The inside of the meander curve is the slip off slope and because the current of the stream is slower here some of the material the stream is carrying is deposited on the slip off slope.

The divides are slowly lowered by sheetwash and by such earth movements as landslides. The end result of erosion in the area is a near-level surface of erosion which is called a *peneplain.* Such an erosion surface no doubt once existed over much of North Dakota but only remnants of it have been spared by later and more recent eroson. The main reason why extensive peneplain surfaces are not usually developed is that the earth's crust is so unstable that frequent uplifts interrupt the cycle of erosion causing a new erosion cycle to be inaugurated.

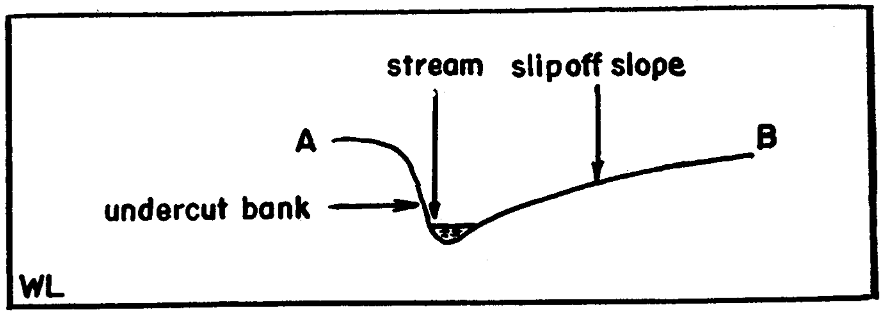

FIGURE 2. Diagrammatic section along A-B of Figure 1. Note that the stream is undercutting on the left side of the diagram and as it undercuts, it moves to the left exposing more stream bottom on the right side. This newly exposed stream bottom is added to the slip off slope.

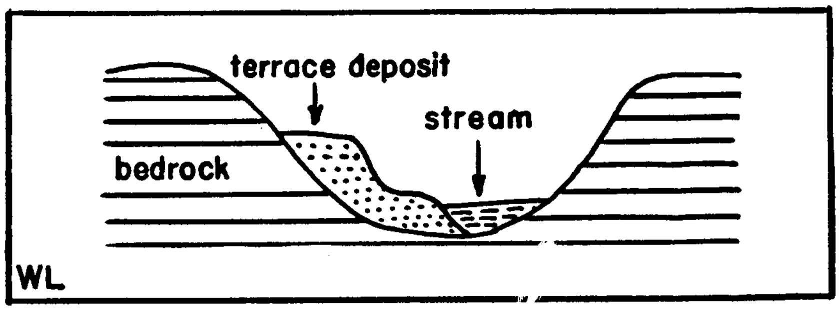

FIGURE 3. Cross sectional diagram of a stream cut in bedrock. The terrace deposits were deposited by the stream when it had either greater volume than it has now or was carrying a heavier load. Since deposition of the terrace the stream has either decreased its load or the land surface has risen allowing the stream to down cut at this point.

Work of Waves

Near the shorelines of large lakes and the oceans the most noticeable geologic process is the work of the waves. Here the waves can be seen beating against the shore eroding the shoreline, while in other places the waves and the currents produced by them can be seen to be piling material along the shore to form beaches, bars and other depositional shore features.

The shore features produced by wave erosion and deposition depend to a large extent on the slope of the bottom. If the slope of the shore is steep so that the waves break near shore such features

as wave cut cliffs, wave cut terraces, and wave built terraces may be produced. See Figure 4. A wave cut cliff on a small scale may

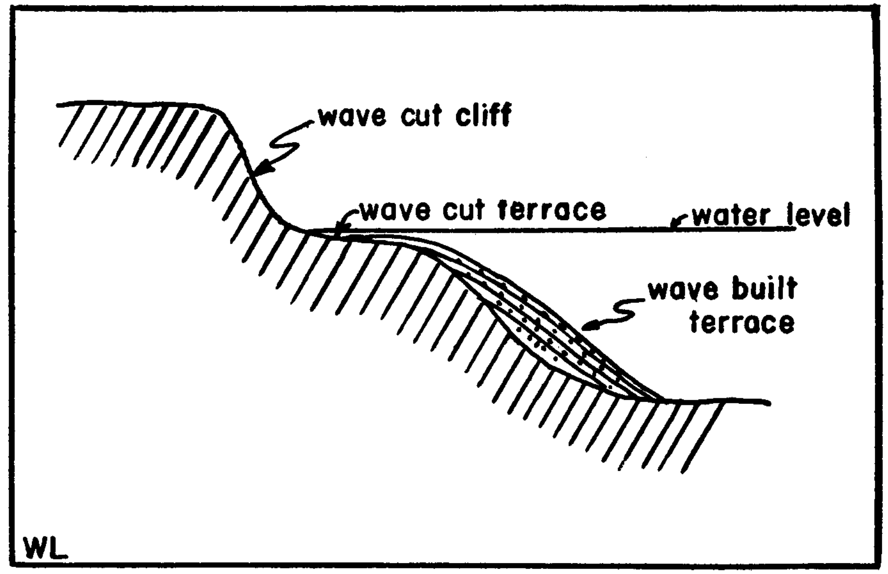

FIGURE 4. Diagram illustrating shore features produced by wave erosion and deposition on a shoreline where the waves break near shore.

be seen in the SE¼ of Sec. 17, T. 151 N., R. 53 W. about two miles south and two miles east of Arvilla. This cliff was produced when Lake Agassiz stood at the level of the beach named the Campbell beach. Such wave eroded forms are not common in the Lake Agassiz area as in most places the shore dropped off rather gently to deeper water.

Where the shore slopes gradually to deeper water the waves tend to break off shore or if they break on shore they build up a distinct beach ridge. See Figure 5.

Most of the beaches seen in the Park and in the immediate vicinity are shore features of this type.

Work of Glaciers

Like running water and waves, glaciers also erode and deposit. In this area, however, the effects of glacial erosion are not particularly noticeable. On the other hand, the depositional work of the glaciers looms large in the formation of the landscape in this particular area.

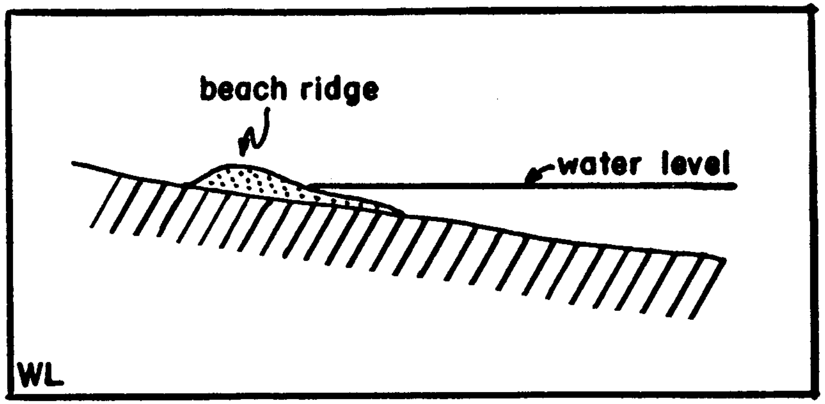

FIGURE 5. Diagram illustrating the formation of a beach ridge on a gently sloping shoreline.

There are two main types of glaciers, *mountain or alpine* glaciers, confined to valleys in the mountains so therefore need not concern us here, and *continental or ice cap* glaciers which covered large areas of North America in the recent geologic past. It is this latter type which did the greatest amount of work in this area.

In the ice cap glacier, the snow accomulates in some area due to excess snowfall over summer's melting and low temperature. As the snow continues to accumulate it gradually turns into ice. In time several thousands (sometimes a mile or more) of feet of ice may accumulate and begin to move outward from the center of accumulation.

When the ice begins to move it naturally scours the rocks over which is passes free of all soil and loose rock cover. This scoured material becomes incorporated in the base of the glacier and is carried long distances. These soil and rock fragments (some very large) help abrade other rocks over which the glacier passes. The scratches the glacier made can still be seen today on many of the hard rock exposures in Canada. Not only is the bed rock over which the glacier is passing scratched and striated but also the pebbles the glacier is carrying are striated. In the glacial till in the Park many of these striated pebbles may be found. Very often they are relatively smooth on one or two sides which may show long striations caused by the rubbing of these rocks over the bed rock.

The material which the ice carries is collectively called *glacial drift* or *till*. It is composed of fine clay, derived in part from the grinding up of rocks into a fine powder, and larger rock fragments.

The glacial till in the immediate area of the Park has a relatively small percentage of large boulders but many smaller pebbles two inches to four inches in diameter are common.

As the glacier moved southward it began to come into a warmer area. As a result the ice began to melt and to drop the rock fragments and soil it had picked up farther north. Where the front of the glacier stood while melting for some considerable period of time large piles of material were deposited. These piles of material marking the farthest advance of the ice sheet are called *terminal moraine.*

Sometimes the basal part of the ice sheet becomes overloaded with rock fragments and drops them directly from the ice underneath the glacier. Other times, large masses of ice cease to move or become stagnant and melt where they are standing letting down the material being carried by the ice. Both these types of placial deposits are spoken of as *ground moraine.* Ground moraine covers most of the area included within the Park boundaries.

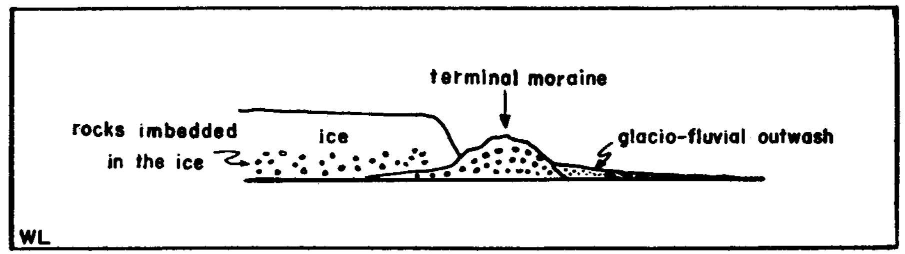

FIGURE 6. Diagram illustrating the various features associated with the end of an ice sheet.

As the ice melts, great volumes of water are naturally set free. This water picks up part of the glacial till and washes it outward from the terminal moraine. Such deposits are spoken of as *glacio-fluvial outwash* because they are the result of both glacial and running water action. Such deposits are not common in this particular locality but are well known elsewhere in the State.

Work of the Wind

The work of the wind has played a relatively minor role in the formation of the landscape in the area under consideration and in this region has been primarily a transporting agent. It can be noted that much of the top soil in this immediate vicinity is quite sandy. This sand has apparently been derived from some other source than the underlying glacial till which is usually stony clay. Much of the sand has been derived from the Lake Agassiz beaches or the sandy "delta" area in the immediate vicinity.

Sand blown by the wind making noticeable drifts are called *sand dunes*. Examples of dunes in this vicinity may be found in the NE¼ Sec. 20, T. 150 N., R. 53 W.

PREGLACIAL GEOLOGY

Very little is known of the subsurface geology of this vicinity. What is known comes from rather inaccurate information secured from a few deep wells drilled for water. We do know that rocks of three different geologic eras are represented: The Cryptozoic, the Paleozoic, and the Mesozoic.

The rocks of the Cryptozoic are all igneous and metamorphic rocks of complex origin. From what data we have, apparently pink granite is quite commonly representative of these rocks. The rocks of the Cryptozoic era outcrop over wide areas in Canada and northern Minnesota. Because of their abundance in Canada these rocks are found in great abundance in the glacial drift in this area which came from Canada.

The Paleozoic era is represented by the rocks of the early periods of the era. Inasmuch as these rocks do not outcrop directly in North Dakota all information we have concerning them is from rather indirect sources. In northeastern North Dakota these rocks appear to be predominantly limestones, sandstones, and shales of the Cambrian (?) Ordovician and Silurian periods of the Early Paleozoic era. To illustrate the nature of the rocks Figure 7 is given. This is the log or record of a well drilled some years ago in Grafton, North Dakota, and while this well is somewhat far removed from the area of the Park, it may reasonably be assumed that similar rocks are present under younger strata in this locality.

The rocks representing the Mesozoic era are better known because they have been directly observed in the State. Apparently only the rocks of the Upper Cretaceous (a period of the Mesozoic era) are found in this part of the State. The formations representing the Upper Cretaceous are as follows with the oldest formation at the bottom and the youngest formation on top.

Pierre shale
Niobrara shale
Benton shales
Dakota sandstones

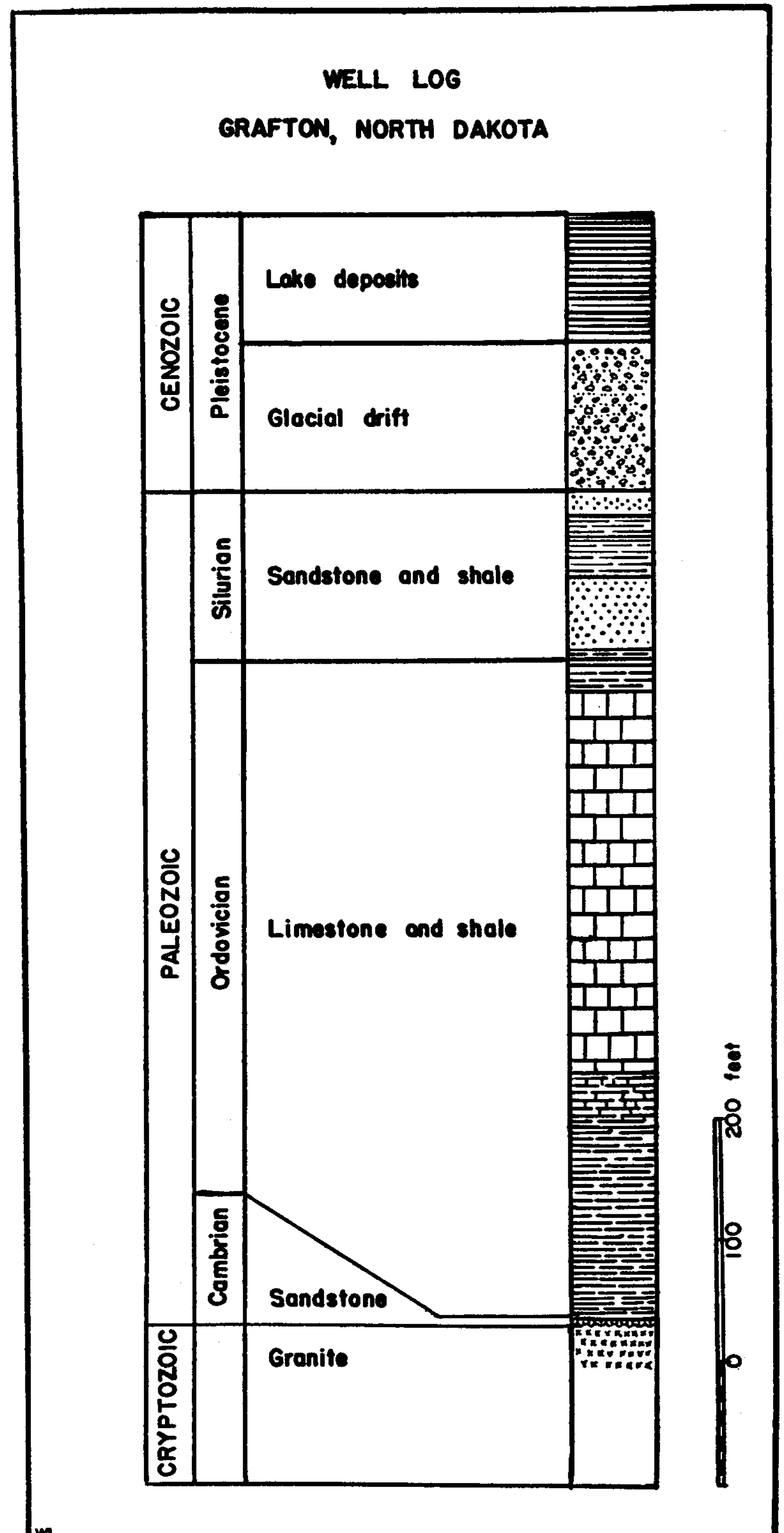

FIGURE 7. Well record of the Grafton, North Dakota, city well. Correlation taken from North Dakota Geological Survey Bulletin No. 12.

FIGURE 8. View showing bank of glacial till.

FIGURE 9. View from overlook toward the southwest showing the valley of the Turtle River.

FIGURE 10. View of terrace levels in Turtle River State Park.

FIGURE 11. View of the old meander scar on which is situated the playfields and the overnight cabins. The last path of the stream is designated by the symbol *a*.

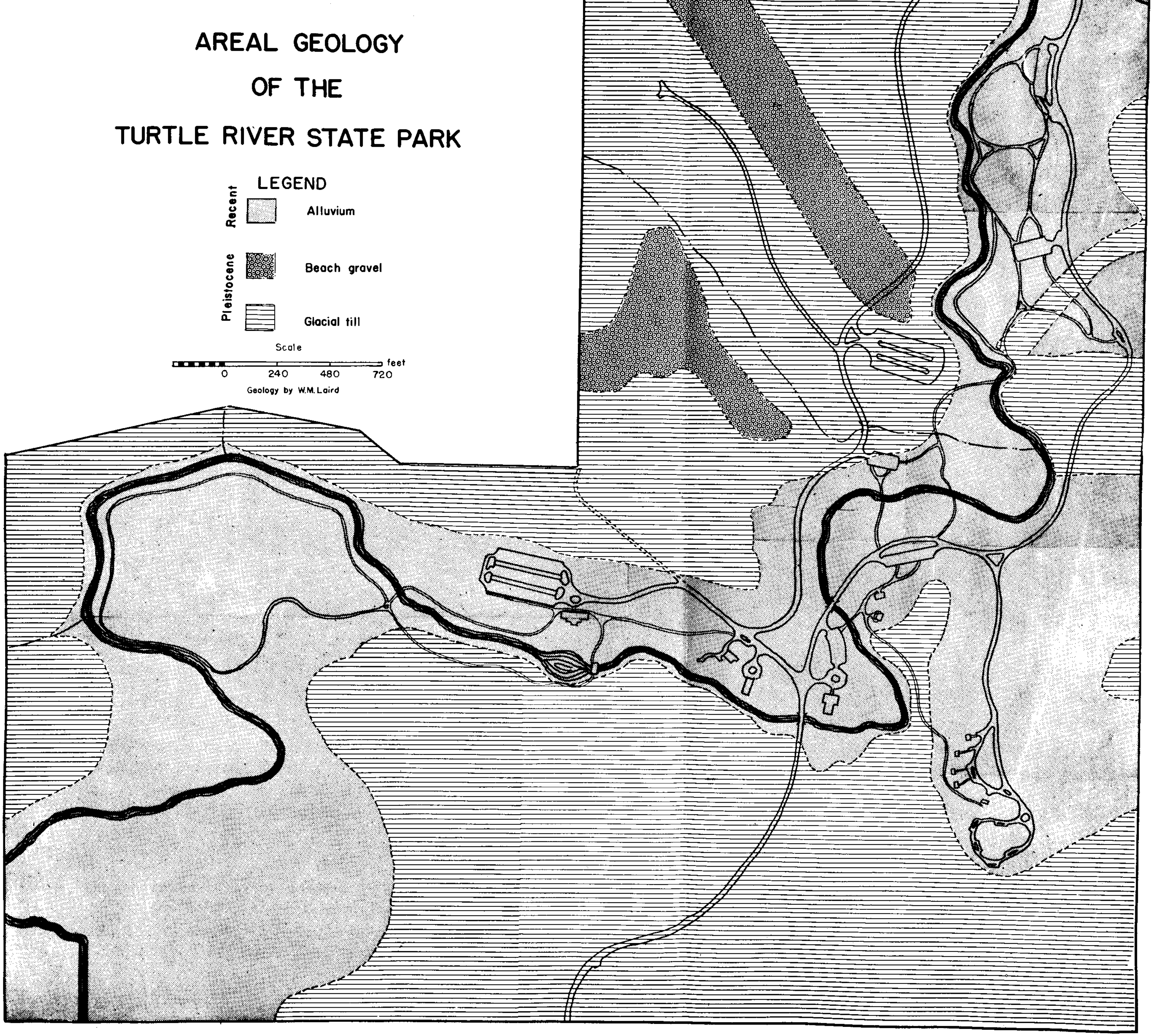
AREAL GEOLOGY
OF THE
TURTLE RIVER STATE PARK
LEGEND
Recent
Alluvium
Pleistocene
Beach gravel
Glacial till
Scale
0
240
480
720
feet
Geology by W.M.Laird

PLATE 1

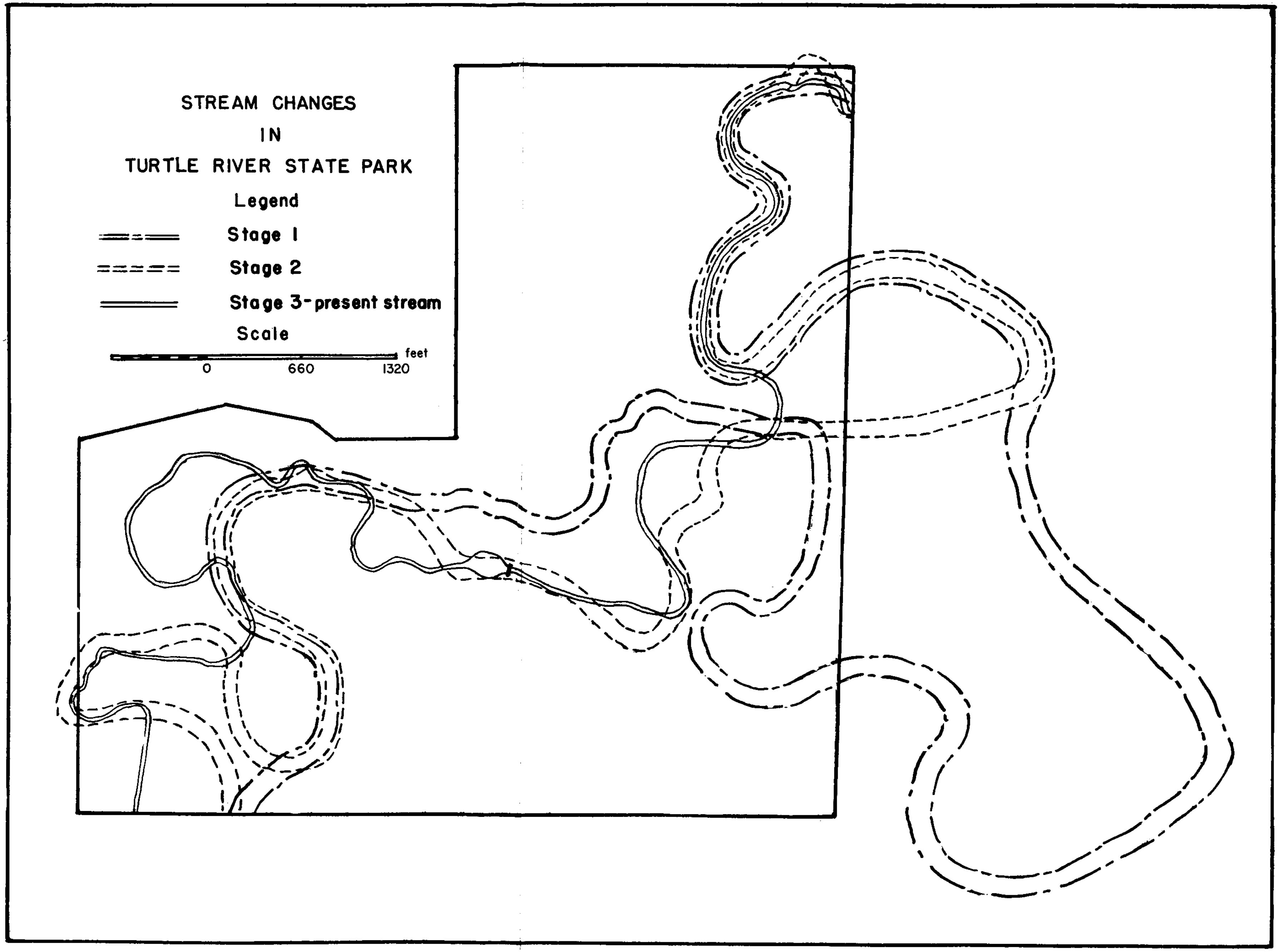
STREAM CHANGES
IN
TURTLE RIVER STATE PARK
Legend
Stage 1
Stage 2
Stage 3-present stream
Scale
feet
0
660
1320

PLATE 2

All of these beds except the Dakota sandstone can be observed in the Pembina Mountains in Pembina and Cavalier Counties.

The Dakota is familiar to most of the people in North Dakota because of its artesian water. It is usually found to consist of two sandstones separated by a shale. In a well at Devils Lake these three members of the Dakota are 191 feet thick.

The Benton shale is dark grey to black in color and contains considerable quantities of carbonaceous material. It is thin bedded and readily breaks into thin flakes on weathering. It is approximately 180 feet thick.

The Niobrara is a dark grey calcareous shale and contains numerous tiny fossil remains which sometimes give it a mottled appearance. Many of these fossils are microscopic in size but are readily identifiable under a lens. In the Pembina mountains, the Niobrara is 150 feet thick.

The Pierre is a dark grey shale which sometimes contains abundant fossils. These fossils include large pelecypods (clams) and cephalopods commonly. The Pierre in the Pembina mountains is 450-500 feet thick but increases in thickness westward to approximately 1,000 feet in the central part of the State.

All of these formations except the Dakota were laid down in a large arm of the sea which extended from the Arctic Ocean to the Gulf. It was probably 1000 miles wide in an east-west direction. In it lived numerous animals which crawled around on the muddy bottom, swam or floated in the clear water of the sea. Remains of one large swimming reptile (mososaur) have been found in the Pembina Mountains and more abundantly in other States, particularly Kansas.

The Dakota sandstone was apparently in part, at least, of continental or slightly salty water origin. It was probably laid down as the sea transgressed from a westward direction toward the east.

GLACIAL GEOLOGY

Some 500,000 to 1,000,000 years ago there was apparently a considerable drop in the average temperature of the earth. As a result of this and possibly combined with an excess of precipitation, there was more snow falling over parts of Canada than melted during the following summers. Gradually this snow became ice and when sufficient ice accumulated it began to move outward from the center of accumulation.

The edge of the ice cap was irregular or lobate and was not everywhere moving outward from the center at the same rate of

speed. Some of the lobes apparently moved faster than other parts of the ice sheet. The center of accumulation which affects the North Dakota area mainly was the one located west of Hudson Bay and it has been named the Keewatin Center. One lobe of this ice sheet spread southward projecting up the Red River valley. This lobe extended southward into South Dakota and spread over about half of North Dakota and over considerable parts of western Minnesota.

As the ice sheet receded from its most southerly limit, it left at its farthest extension a terminal moraine. In its retreat it also stopped at various places long enough to make other moraines similar to the terminal moraines. Inasmuch as these moraines do not mark the farthest advance of the glacier and as they were formed when the ice was receding, they are called recessional moraines. A number of these recessional moraines cross the area occupied by Lake Agassiz.

In preglacial times before the glacier advanced over this area, a stream flowing northward had excavated the valley now known as the Red River Valley. When the glacier came down from the north it filled this old valley with glacial drift and outwash so that now the bed rock is covered to a depth of approximately 200 feet. As has been noted in parts of the Red River valley this glacial material was dropped in the form of recessional moraines. However, some of it was dropped directly from the bottom of the glacier while the rest was dropped simply when the ice melted where it stood. This material is ground moraine and is the main form of the glacial drift within the boundaries of the Park. Such ground moraine is particularly well shown on the two steep banks next to the river in the eastern part of the Park.

As the ice melted, large volumes of water were released which remained as a lake in front of the glacier. As this was a large lake covering at one time an area larger than the combined area of the present Great Lakes it was subject to wave action and currents which formed distinct beaches along the shores of the lake.[1] Upham[2] in his classic report on this area records 31 distinct beaches formed at intervals as the lake fell from its highest to its lowest stages. Present day Lake Winnipeg and associated lakes are the only remaining remants of this once extensive glacial lake.

1 Glacial Lake Agassiz was formed during the later stages of the Pleistocene glaciation. A rough estimation of the time of the beginning of Lake Agassiz is about 25,000 years ago. How long the lake remained is not known definitely.

2 Upham, Warren, The Glacial Lake Agassiz: United States Geological Survey Mon. 25, p. 476, 1895.

During the early stages of Lake Agassiz it drained southward through Lake Traverse and Big Stone Lake to the Minnesota River and thence to the Mississippi. During the later history of the lake it drained through numerous outlets to the northeast until finally the present outlet of the Red River and Lake Winnipeg, the Nelson River, was uncovered allowing the water to drain from Lake Winnipeg northward.

Toward the central portion of Lake Agassiz there was deposited considerable quantities of fine silt and clay. None of this material is found within the Park proper but can be seen east and north of Ojata. The beaches of old Lake Agassiz within the boundaries of the Park consist of fine to medium-grained gravel. The bedding of the gravel can be seen to be inclined at some angle to the horizontal if viewed in the gravel pits particularly the one north of the bathhouse. This inclined bedding is due to the deposition of the material by the currents and the waves of old Lake Agassiz.

In the Park as can be seen by reference to the map, portions of three distinct beaches can be observed. Two of these belong to the Campbell stage of Lake Agassiz and are called the Campbell beaches.[3] These beaches in the Park from their elevations appear to correspond most closely with Upham's aa beach (1010 feet above sea level) and the b beach (1000 feet above sea level). Just a short distance northeast of the Campbell beach and crossing only the northeast corner of the Park is the McCauleyville beach. This beach has an elevation of 995 feet in the Park.

After Lake Agassiz had lowered, normal stream erosion began to cut their beds into the former lake bottom. One such stream is the Turtle River. Exactly how soon after the lowering of the lake the Turtle River began to flow in its present course is not known. However, along the river at varying elevations above the stream (10 feet - 15 feet on the average) is a distinct terrace deposit of alluvial material deposited when the stream was flowing at a higher level than now. This terrace deposit in general is parallel to, or closely associated with, the present stream in the Park except for the area on the east side of the Park where the playfields and the overnight cabins are located. Here the stream swung widely, flowing in broad meandering curves.

It can be seen by referring to the geologic map that the stream and its terrace deposits definitely cut through the Campbell and

3 The various beaches of Lake Agassiz are named for towns in the Red River Valley near which they are well developed. The Campbell and McCauleyville beaches take their name from Campbell, and McCauleyville, Minnesota, respectively.

McCauleyville beaches and therefore is geologically younger than those beaches. The terrace deposit was traced downstream until it no longer could be found and it was discovered that this terrace apparently graded rather evenly into the Ojata beach. The Ojata beach is one of the Lake Agassiz beaches formed at a lower stage of the lake. Apparently, therefore, the Turtle River was established during the Ojata Stage of Lake Agassiz.

FEATURES TO BE SEEN ON DRIVING AROUND THE PARK

Upon entering the Park from the contact station to the hill leading down to the Turtle River, the road travels over a level area underlain by glacial till. Into this glacial till has been cut the valley of the Turtle River. Upon descending into the valley the road passes from the till to a lower level near the river which is reached shortly before one comes to the first bridge crossing the Turtle River.

After crossing the bridge, keep to the right passing by the Lodge. You are still travelling on the lower level which is a terrace deposit formed by the stream when it flowed at a higher level than it does at present. As this material was deposited by the stream this is spoken of as a depositional terrace. If this terrace is followed in the western part of the Park along the paths west of the bathhouse it will be noted that its surface is quite irregular. These irregularities are due largely to irregular deposition and partly to erosion by the stream when it was flowing at this level.

Passing the Lodge the second bridge across the River is reached. Immediately after crossing this bridge note the several terrace levels to the right where the picnic pavilion and the well are located. This is the same terrace level as that on which the Lodge and the custodian's houses are located.

The road leaves this terrace by climbing a slight grade and reaches the level on which are situated the overnight cabins and the playfields. This broad level area is the path of the Turtle River when it flowed at a slightly higher elevation than that represented by the terrace remnant which the road has just left. This broad area is a meander scar left when the river cut off this loop by another loop of the river to the north near the old dance hall. The last sinuous path of the stream before this meander was cut off can be seen by the depression in which is located the well for the cabins. This depression also crosses the road to the cabins just north of the cabin site.

Getting back to the main road and continuing in a northward direction, the road dips down off the level of the old meander scar to a lower level just above the present stream. This level can be seen to be quite narrow and to have a distinct valley shape trending in an east-west direction. This is also a meander scar now abandoned and is the one which cut off the large meander scar on which are located the cabins and the trailer camp. This lower meander scar was, in turn, cut off by the meandering of the present stream.

Leaving this meander, the road climbs a hill composed of glacial till, and descends again to the main terrace level just above the present stream. After passing the well on the west side of the road, you will note the lower meander scar trending in a westerly direction to the left of the road.

The road continues on the main terrace level until the third bridge crossing the river is reached. After passing over the bridge the road ascends a hill composed of glacial till. At the crest of the hill and capping it is a deposit of gravel that is a remnant of the McCauleyville beach whose top has an elevation of 995 feet above sea level. There are just a few feet of gravel here but the low mound-like ridge can be seen to trend off in a northwesterly direction.

The road is now running on a level formed of glacial till. Looking to the west a low ridge will be seen. This is an old railroad embankment built to take advantage of the gravel of the Campbell beach on which it is located. Little gravel can be seen on the road but if one walks back of the old enbankment much gravel can be seen. The elevation of the Campbell beach here is about 1000 feet above sea level.

Leaving the Campbell beach the road descends again to the main terrace level following it until the custodian's houses are reached. Turning to the right here the road still follows the upper edge of the main terrace dropping a little to the level occupied by the bathhouse. Looking to the north the main gravel pit of the Park can be seen. This gravel was deposited during a slightly higher period of the Campbell stage of glacial Lake Agassiz. This beach has an elevation of about 1010 feet above sea level.

Leaving the car at the parking lot near the bathhouse, foot paths to the western part of the Park can be seen. By following these paths more of the main terrace level as well as several cut-off meanders can be observed. This part of the Park has hardly been touched except for the construction of foot paths and retains all of the natural beauty of the Park.

SUMMARY

From the foregoing description it can be seen that the present topography of the Turtle River State Park is the result of deposition by glaciers, deposition of materials by Lake Agassiz, erosion by streams and deposition by streams. These processes can not be thought of entirely as operating distinct from each other. True, the glacier deposited material first but Lake Agassiz was closely associated with, and caused by the glacier. The lake worked on the glacial materials eroding them in some places and depositing the material in beach ridges in others. Then at a later and lower stage of the lake the Turtle River was inaugurated. This stream deposited much material as well as cut its valley through the old lake bottom. Then at an even later date the stream began to cut downward in its own deposits.