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Stratigraphy of Paleocene and Pleistocene Sediments Exposed Along Lake Sakakawea in Eastern Dunn and Western and Central Mercer Counties, North Dakota

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STRATIGRAPHY OF PALEOCENE AND PLEISTOCENE SEDIMENTS EXPOSED ALONG LAKE SAKAKAWEA IN EASTERN DUNN AND WESTERN AND CENTRAL MERCER COUNTIES, NORTH DAKOTA.

by

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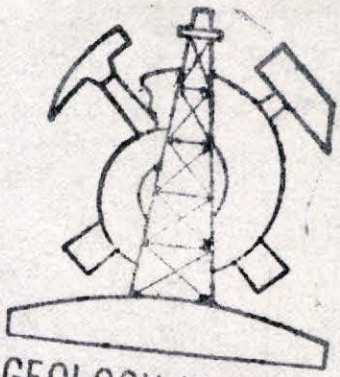

This Thesis submitted by Joel A. Degenstein in partial fulfillment of the requirements for the Degree of Bachelor of Science in Geology from the University of North Dakota is hereby approved by the Faculty Advisor under whom the work has been done.

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BERKSHIRE
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ABSTRACT

The bluffs of Lake Sakakawea, west-central North Dakota, provide excellent exposures of the Paleocene Sentinel Butte Formation and Pleistocene glacial deposits of the Coleharbor Group. The dominant sediment type in the Sentinel Butte Formation is thinly-bedded silt. Fine sand, clay, and lignite occur in lesser abundance. Lignite, clay, and peat are most commonly bounded by thinly-bedded silt. No lignite beds greater than five feet are present in the study area. The complete section of the Sentinel Butte Formation was not present in bluff exposures of the study area. The maximum exposed thickness of the Sentinel Butte Formation was 110 feet. Extreme lateral variability of lithology made detailed correlations exceedingly difficult, even across small distances such as from one bluff to the next. Glacial deposits of the Coleharbor Group are more common in bluff exposures in the eastern part of the study area and become less common and extensive towards the western edge of the study area. At least two separate units of pebble loam are present in the eastern part of the study area. Gravel and bedded silt crop out in the eastern part of the study area. Thicknesses of glacial drift in bluff exposures range from 0 to 30 feet. The glacial deposits seem to be restricted to former topographic low areas. Erosion by waves and ground water sapping is substantial, resulting in considerable land loss. This erosion is greater along the south shore of the lake.

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INTRODUCTION

The purpose of this study was to map the Sentinel Butte Formation and Pleistocene glacial deposits that are exposed in bluffs along the shores of Lake Sakakawea in west central North Dakota. The idea for the project first came from discussions with Dr. Lee Clayton about a reconnaissance study he had done on the shoreline bluffs in 1973.

The best exposure of Paleocene rocks and glacial deposits in the state occur in bluffs that surround Lake Sakakawea. The bluffs north and west of Riverdale, North Dakota, were studied by Sackreiter and Ulmer in 1973 (Ulmer and Sackreiter, 1973). Prior to the present project, no extensive study had been made of the bluffs along the other parts of Lake Sakakawea.

The project consisted of cross-sections of the bluffs that are exposed along the south shore of Lake Sakakawea and a determination of the correlation of the units along the length of the study area.

LOCATION OF STUDY AREA

The project was divided into two study areas. One is designated as "eastern study area" and is located in central Mercer County along Lake Sakakawea (figure 1.). The other is designated as "western study area" and is located in eastern Dunn and western Mercer Counties. Refer to Plate 1 for specific locations of the described sections.

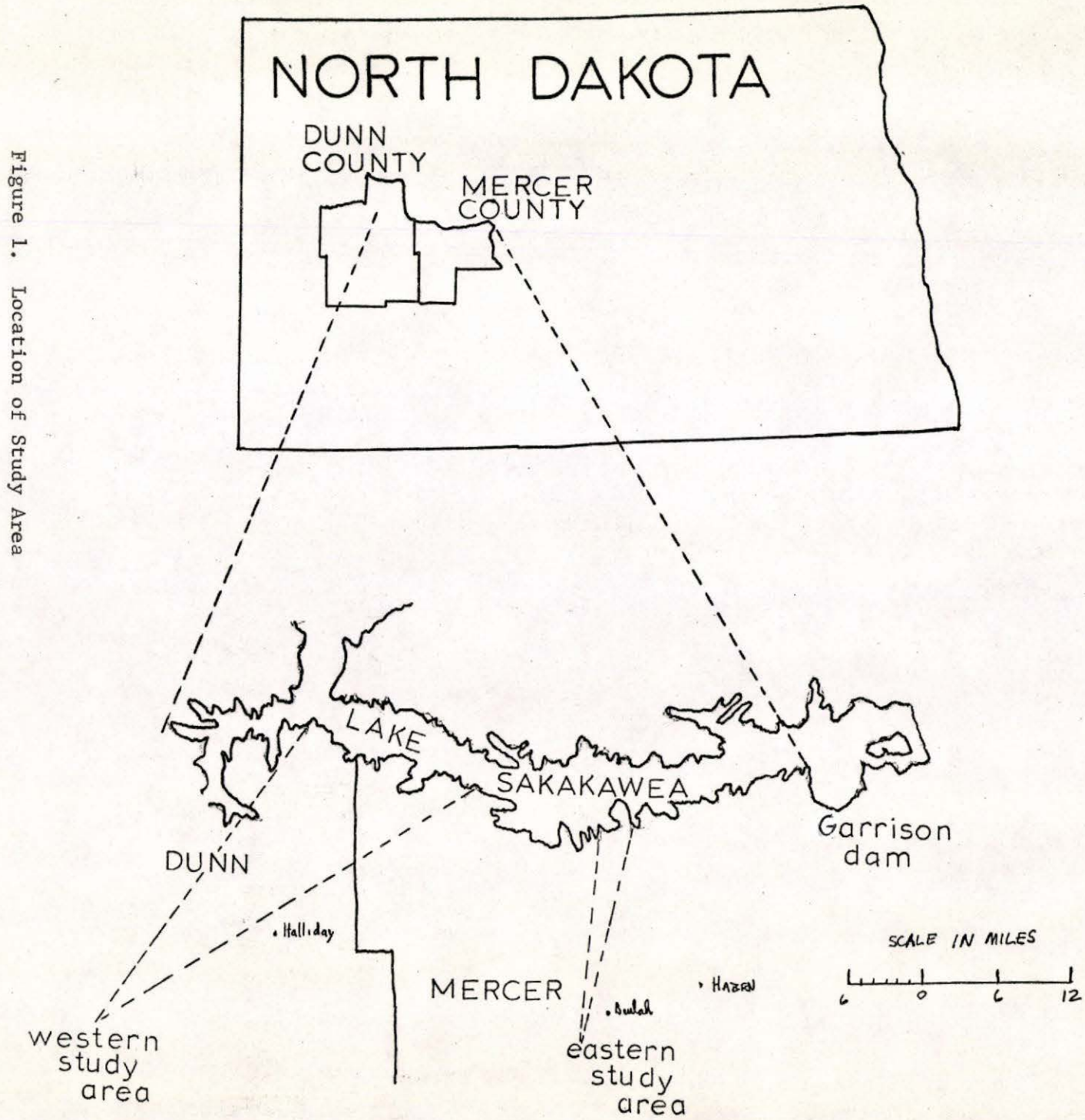

Figure 1. Location of Study Area

METHOD OF STUDY

The study was completed during May, June, and July of 1975. One of the best ways to study a maximum number of bluffs in a short period of time is by boat. I conducted my study from the water using the houseboat belonging to the Department of Geology, UND. I sketched the bluffs from the boat by sight recognition of the lithologies. I used binoculars and a height-rangefinder in estimating thicknesses and distances. To standardize my observations, I found a hill along the lake that had both an easily accessible badlands side and a lake-facing vertical bluff. I measured the badlands section on the land, noting the lithologies and unit thicknesses. I then took the boat and cruised by the vertical bluff enough times to familiarize myself with what the different lithologies looked like in a bluff exposure. I also calibrated my eye for determining thicknesses from the boat.

The weather and wind were always factors I had to deal with. The bluffs I sketched were on the south side of the lake, so I was unable, because of rocky shores and waves, to ever get closer than 10 to 15 feet to the bluffs. During the summer of 1975 the water level in Lake Sakakawea was higher than it ever has been in the past. I had to contend with the constant slumping and caving bluff faces. Because of these factors, I was unable to ever get a closer view of the sediments I was drawing in cross section than about 10 to 15 feet away. This situation proved later to be a cause of frustration, in that many times I wanted to get up close and either double check my observations or else check out some interesting structure, but was unable to do so

because of waves or rocky shores.

I constructed 83 cross sections from my bluff sketches on a 50 foot roll of K and E cross-section paper. I have compiled a composite cross section from the 50 foot roll and I have included that composite section with this report.

LITHOLOGIC UNITS

Sentinel Butte Formation (Paleocene)

Sediments of this formation are dominant in the western study area.

Thinly-bedded yellow silt is the predominant sediment type within the Sentinel Butte Formation. Generally this silt has a banded appearance.

A thick pale yellow sand is the second most abundant sediment type in the Sentinel Butte Formation. This sand appears unbedded and is generally more than 3 feet thick.

Thinly-bedded gray silty clay, which is lignitic in places, occurs in beds that are generally about 5 feet thick, but in some places, it is as much as 10 feet thick.

Lignite beds are generally 2 feet thick or less, but range from 0 to as much as 4 feet thick. No lignite beds greater than 5 feet thick were present in the study area.

Facies change of the sand, silt, clay and lignite beds made precise identification of the sediment type difficult at times.

A unit that I called a tabular sand was present in only a few outcrops and was generally less than 3 feet thick.

Scoria, or baked clay, was present in a few outcrops.

Coleharbor Group (Pleistocene)

Glacially derived deposits of Pleistocene age occur in both the western and eastern study areas.

The eastern study area includes two distinct units of pebble-loam. The first unit of pebble-loam, which is most common, is generally

lignitic and forms unjointed bluff faces. I believe that this unit is equivalent to the Medicine Hill Formation of Ulmer and Sackreiter (Ulmer and Sackreiter, 1973).

The second unit of pebble-loam occurs above the first and commonly contains numerous boulders. Both units of pebble-loam are interpreted to be glacial sediment or "till".

Also present in a few outcrops are beds of thinly-bedded silt and clay, which underlie the bouldery pebble-loam. This unit occurs as contorted beds and is interpreted to be collapsed glacial lake sediment.

Coarse gravel that in some places is iron-stained is found between the bouldery pebble-loam and thinly-bedded silt and clay. It is interpreted to be glacial outwash.

In the western study area, the lignitic pebble-loam is the only "till" that crops out. The coarse gravel and thinly-bedded silt and clay occur only in a few bluff exposures in the western study area. Glacial deposits are more abundant and are the dominant sediment type in the eastern area. They become less common and extensive towards the western edge of the study areas. The thickness of glacial deposits ranges from 0 to 30 feet in the study area.

Oahe Formation (Holocene)

Silt, which in most places overlies glacial sediment, is interpreted to be windblown sediment. The silt, which occurs at the top of bluff exposures rather than as depression fillings, is a unstratified, blanket deposit. This silt is generally present in the eastern study area and in some bluff exposures is as much as 10 feet

thick. the silt is thickest downwind from a prevailing northwest wind. The source of the silt probably was the Missouri River.

Another unit, which does not fit into the lithostratigraphic divisions already covered, is a deposit of iron-stained coarse gravel that outcrops in two bluffs. This is present above a bed of pebble-loam and a bed of lignite. I have interpreted this unit to be terrace deposits of the Missouri River and its tributaries.

COMPOSITE CROSS SECTION (Plate 2)

A composite cross section has been constructed from the 83 cross sections of the 50 foot roll. Lines representing the cross sections have been plotted on a grid in which all 83 could be placed side by side. In several instances, the line had to be an average representation of the cross section. Correlations have been attempted between these columns where units were equivalent, except in some cases where no obvious correlation was present between adjacent columns. As the composite cross section reveals, correlation of individual beds is limited in the Sentinel Butte Formation. In some areas, a key lignite bed or other unit can be carried through many columns, but in other cases a correlation from one column to the next is not present. It is not clear whether the Sentinel Butte Formation is dipping to the east or to the west. In some areas, for example sections 52-59, there appears to be no dip, but in others, sections 38-42, there is a general dip to the west.

It must be realized that some interesting relationships between beds that were present in the individual cross sections cannot be shown in the individual columns of the composite cross section. In one bluff there was an example of the way a glacier incorporated bedrock into its sediment load. In this case, a large block of lignite was included in an exposure of glacial pebble-loam. See section 38, Plate 2.

The lateral change in units in the Sentinel Butte is probably due to facies changes. These facies changes, along with slumping and possible differential dip of the units towards the lake, make correlations of the individual beds difficult and sometimes impossible. The

correlation within the Sentinel Butte, as this data shows, is difficult on a small scale, especially with no key marker beds. On a large scale, correlations are possible between groupings of beds, but again, without key marker beds, it is not an easy job.

Lignite and gray clay are most commonly bounded above and below by yellow silt. Lignite may or may not be associated with deposits of gray clay. In several bluffs the gray clay graded laterally into deposits of lignite. See sections 52-58, 23-30 for examples.

Glacial deposits, in some places, occupy areas that were topographically low areas in the past.

The vertical bluffs make up less and less of the total height to the uplands farther and farther west in the western study area. This must be kept in mind because it means the bluffs expose only a small fraction of the possible section in the western study area.

In the eastern study area the bluffs expose the total distance to the highlands.

The whole section of the Sentinel Butte Formation was not exposed in the study area. The bluffs in the western study area probably fall within the middle part of the Sentinel Butte Formation. Exact position in unknown because of the lack of any key stratigraphic markers.

The legend in Plate 2 relates lithogenetic, lithochronologic, and lithostratigraphic terms to the lithologic units.

EROSION RATES

Erosion rates along the south shore of Lake Sakakawea are substantial. Wave erosion and groundwater sapping account for a considerable amount of land being lost each year. High lake levels and heavy rainfall tend to increase the erosion rates. Caving of bluffs and large-scale slumping along the lake shore are common and tend to keep bluff faces vertical in areas of high relief. Numerous island spires which were once large hills were present in the lake during the summer of 1975 only to be gone in a month's time.

DEPOSITIONAL ENVIRONMENTS

The sediments of the Sentinel Butte Formation are believed to have been deposited in a fluvial environment (Royse, 1972).

The environments of deposition of the Sentinel Butte and the underlying Tongue River Formations are similar. The following interpretations are taken from a paper on the Tongue River Formation and its depositional environments (Jacob, 1972).

The yellow silt is interpreted to be natural levee and crevasse splay deposits. Several tree stumps in growth position were found in this unit.

The gray clay is interpreted to be a floodplain deposit.

The pale yellow sand was most probably deposited in stream or river channels. The tabular sands might have been point bar deposits.

Lignite represents marsh or swamp deposits on a floodplain.

The dominance of the silt unit in these bluffs suggests an unstable fluvial system in which the river or stream channel is not confined to a certain position but whose position fluctuates sporadically. This condition in which a swamp or marsh does not become well established explains why lignite deposits are not well developed (Royse, 1972).

DISCUSSION

Studies such as the present one could be carried out in other parts of Lake Sakakawea, especially in northern Dunn and southern Mountrail Counties. A workable solution to the problem of not being able to sample bluff exposures and to get closer to the bluffs would be a very useful tool to add to the sketching technique of mapping bluffs.

ACKNOWLEDGEMENTS

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