1966

Glacial Geology One Half of the Garrison North Dakota Quadrangle

Dale R. Monsebroten

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GLACIAL GEOLOGY OF THE NORTHERN ONE HALF OF THE
GARRISON NORTH DAKOTA QUADRANGLE

Dale R. Monsebroten
August 11, 1966
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CHAPTER I

INTRODUCTION

Scope and Purpose of Study

The purpose of this study was twofold. The first was to introduce the author to fundamental techniques and procedures of field geology. The second was to present the glacial geology of a selected area. The area of study included 88 square miles of the Garrison North Dakota Quadrangle in McLean County, North Dakota, (see Figure No. 1). The area was selected on the basis of time availability and topographic variation.

Methodology

The field work was conducted in accordance with the Glacial Geology Field Manual (Clayton and Bonneville, 1961) and the Standard Field Terminology and Checklist -- Preliminary Version (Clayton, 1966). The field work was done under the supervision of Mr. Jack Kume of the North Dakota Geological Survey.

The lithologic descriptions were obtained from road cuts and shallow holes dug with shovel and hand auger. A minimum of eight such samples were taken and recorded around each section. The section was penetrated by foot when further samples were required to better describe a lithologic boundary or a glacial landform. The field equipment included:

(1) Garrison North Dakota Quadrangle; 1" = 1 mi.; C. I. = 20 feet; edited 1922 reprinted 1950.
(2) McLean County Road Map; 1" = 1 mi.; 1958.
(3) McLean County Soil Map; U. S. Dept. of Ag. Soil Conservation Service; 1956.
(4) Air photo stereoscopic coverage; 2" = 1 mi.; 1948.
(5) Hand auger.
(6) Pick and shovel.
(7) Hand level.
(8) Brunton compass.
(9) Dilute HCl.
(10) Pencils and notebooks with clipboard.
(11) Rock Color Chart (Goddard and others, 1948).
(12) Cloth sample containers.
(13) Hand lens.
FIGURE No. 1

LOCATION OF THE GARRISON NORTH DAKOTA QUADRANGLE
CHAPTER II

PHYSIOGRAPHIC UNITS AND LANDFORMS

The area of study, according to Fenneman's physiographic classification of the United States (1931, page 72), lies on the Glaciated Missouri Plateau Section of the Great Plains Province. The Glaciated Missouri Plateau was subdivided by Lemke and Colton (1958) into four units, two of these units are designated in the area of study. They include the Missouri Coteau and the Coteau Slope.

Missouri Coteau

The Missouri Coteau unit occupies approximately the northeastern one half of the selected area. This portion is characterized by a large dead-ice moraine formed by the stagnation of continental glaciers halted at the Missouri Plateau. It is an area of high relief, non-integrated drainage, and numerous ice-disintegration features. The area is overlain with thick accumulations of glacial drift. Examples of ice-disintegration features include kames, disintegration ridges, and kettles many of which contain lakes and sloughs.

Glacial Landforms

Dead-ice moraine.- The dead-ice moraine is composed of large accumulations of glacial drift, mostly till, and exhibits knob and kettle topography. The local relief reaches a maximum of 100 feet in many places. The drainage is non-integrated with numerous small lakes and sloughs. The most predominant ice stagnation feature found on the moraine is the disintegration ridge.
Kettles.- Kettles are scattered throughout the Coteau unit. They occur in circular to very irregular shapes. Many of the kettles contain water forming lakes and sloughs.

Kame.- Only one kame was found in the area of study, it lies in the SW¼ of sec. 14, T. 149 N., R. 84 W. The kame exists as a very prominent hill near the edge of the previously described ice-walled lake plain. It is composed entirely of sand and gravel and attains a maximum relief of 50 feet.

**Coteau Slope**

The Coteau Slope unit occupies the southwestern one half of the area of study. It is characterized by a thin layer of ground moraine spread over the area with scattered exposures of bedrock. The topography is gently rolling with low to moderate relief. The drainage is integrated flowing west and south into the Missouri River.

**Glacial Landforms**

**Ground Moraine.**- The ground moraine of the Coteau Slope is undulating to rolling and low to moderate relief. It is composed chiefly of till of the stony loam variety. Its thickness varies from nonexistent to thin. A road cut exposure at the NE¼, NE½, sec. 6, T. 148 N., R. 84 W. revealed 17 feet of till overlying the bedrock. A pebble count at this exposure gave the following results: 46 per cent limestone; 30 per cent granite; 8 per cent basic igneous; 7 per cent shale; and 5 per cent chert, iron concretion, and quartz.

**Proglacial Landforms**

**Meltwater channel.**- The meltwater channels on the Coteau Slope are underlain with sand and gravel. They are cut in till and bedrock and drain south to the Missouri River. A northern extension of the
Garrison Creek was discovered flowing along the western edge of the area of study.

**Lake Plain.** A lake plain approximately one square mile in size occupies sections 27 and 34, T. 149 N., R. 84 W. It is gently undulating to nearly flat. The surface is composed of clay over sand over till in the north and sand and gravel in the south, with scattered areas of till in between.

**Outwash Plain.** Two distinct outwash plains exist west and east of the lake plain. The plains are gently undulating and composed of sand and gravel with small amounts of scattered till.
CHAPTER III

LITHOLOGY

Stony Loam

The following description of stony loam was taken from an east facing road cut at SE\textsuperscript{3/4}, SE\textsuperscript{1/4}, sec. 25, T. 149 N., R. 84 W. The grain sizes range from clay through silt to pebbles. A pebble count at this location gave the following results: 48 per cent limestone; 33 per cent granite; 8 per cent shale; 4 per cent basic igneous; 3 per cent lignite; 2 per cent clay stone; and 1 per cent sandstone and iron concretion.

The color of the stony loam is dark yellowish brown. It is nonbedded and nonlithified. Its induration is hard. It is calcareous, oxidized, and originates as glacial till deposit.

Sand and Gravel

The lithologic description of sand and gravel was recorded from a west facing railroad cut at NW\textsuperscript{1/4}, SE\textsuperscript{3/4}, sec. 24, T. 149 N., R. 84 W. The sand and gravel can be lithologically described as sandy gravel with grain sizes ranging from sand through cobble to boulder. Its constituents include limestone, granite, and basalt.

The sand and gravel is nonlithified, nonbedded, and noncemented. It is very calcareous and originates as glacial drift.

Silt and Clay

The following description of silt and clay was obtained from a
2 foot auger hole at SE$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 10, T. 149 N., R. 84 W. The particle size is clay with small amounts of silt.

The silt and clay is firm, very calcareous, and dark gray in color. It is nonlithified and nonbedded. The material originated as ice-walled lake deposit.

**Tongue River Formation**

The Tongue River Formation was exposed at an east facing road cut at the NE$\frac{1}{4}$, NE$\frac{3}{4}$, sec. 6, T. 148 N., R. 84W. The material is bedrock with grain size ranging from clay to sand. It is nonlithified and has firm induration.

The formation is prominently bedded and exhibits sharp bedding planes. The beds consist of a stony clayey shale, a silty sand, a 6 inch coal seam, and a 4 inch layer of iron concretions. The clayey shale is dark greenish gray in color and is not calcareous. The silty sand is yellow orange in color and is calcareous.
LIST OF REFERENCES


Clayton, Lee, 1966, Standard field terminology and checklist -- preliminary version: Unpublished paper, Department of Geology, University of N. Dak. (Mimeographed)


The United States Geological Survey is making a series of topographic maps to cover the United States. This work has been in progress since 1895, and the published maps cover more than 47 percent of the country, a show of outstanding persistence.

The maps are published on sheets measuring about 16 by 20 inches. The general plan adopted is the country is divided into quadrangles bounded by parallels of latitude and meridians of longitude. These quadrangles are mapped on different scales, the scale selected for each map being that which is best adapted to general use in the development of the country, and consequently, though the standard maps are of nearly uniform size, the areas that they represent are of different size. On the lower margin of each map are printed graph paper showing distances in feet, meters, miles, and kilometers. In addition, the scale of the map is shown by a brown bar, expressing a fixed ratio between linear measurements on the map and corresponding distances on the ground. For example, the scale $\frac{1}{2}$ inch means that 1 unit on the map (such as 1 inch, 1 foot, or 1 meter) represents 62,500 of the same units on the earth's surface.

Although some areas are surveyed and some maps are compiled and published on special scales for special purposes, the standard topographic maps and the resulting maps have for many years been of three types, distinguished as follows:

1. Surveys of areas in which there are problems of great public importance—mining, development, irrigation, reclamation, etc.—are made with sufficient detail to be used in the publication of maps on a scale of $\frac{1}{2}$ inch (1 inch = 6,250 feet) or $\frac{1}{4}$ inch (1 inch = 2,500 feet), with a contour interval of 1 to 100 feet, according to the relief of the particular area mapped.

2. Surveys of areas in which there are problems of average public importance, such as most of the basin of the Mississippi and its tributaries, are made with sufficient detail to be used in the publication of maps on a scale of $\frac{1}{8}$ inch (1 inch = nearly 2 miles) or $\frac{1}{4}$ inch (1 inch = nearly 4 miles), with a contour interval of 20 to 250 feet.

3. Surveys of areas in which the problems are of minor public importance, such as much of the mountains or desert region of Arizona, New Mexico, and the high mountain areas of the northwestern, are made with sufficient detail to be used in the publication of maps on a scale of $\frac{1}{8}$ inch (1 inch = nearly 2 miles) or $\frac{1}{4}$ inch (1 inch = nearly 4 miles), with a contour interval of 20 to 250 feet.

The scale of the map is shown by a brown bar, expressing a fixed ratio between linear measurements on the map and corresponding distances on the ground.

The sketch represents a river valley that lies between two hills. In the foreground is a stream, with a bay that is partly enclosed by a hooked sand bar. At each side of the valley is a terrace into which small streams have cut narrow gullies. The hill on the right has a rounded summit and gently sloping sides. A survey of Puerto Rico is now in progress. The scale of the published maps is $\frac{1}{2}$ inch.

A survey of the relief can be made by shading to show the effect of light thrown from the northwest across the area represented. The purpose of giving the appearance of relief is to determine the altitude. A contour line represents an imaginary line on the ground (a contour) every part of which is at the same altitude above sea level. Such a line could be drawn at any altitude, but it is only practical to contour at certain regular intervals of altitude. The contour is one of the most important interpretations of the map. A contour is a line where the lines are continued in the same direction. Contour lines are drawn at regular intervals of altitude, and the contour lines are usually drawn at 50-foot intervals. The contour lines are shown on the map by light blue lines and the gradients are shown by dark blue lines. The contour lines are used to show the shape of the land surface, and the gradient lines show the direction of the land surface.

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THE TOPOGRAPHIC MAPS OF THE UNITED STATES

The United States Geological Survey is making a standard topographic atlas of the United States. This work has been in progress since 1883, and its results consist of published maps of more than 40 per cent of the country, exclusive of outlying possessions.

This topographic atlas is published in the form of maps or atlas sheets measuring about 16 1/2 by 20 inches. Under the general plan adopted the country is divided into quadrangles bounded by parallels of latitude and meridians of longitude. These quadrangles are mapped on different scales, the scale selected for any quadrangle depending on its nature and its probable future development, and consequently though the standard atlas sheets are of nearly uniform size they represent areas of different sizes. On the lower margin of each sheet are printed graphic scales showing distances in feet, meters, and miles. In addition, the scale of the map is shown by a representative fraction expressing a fixed ratio between linear measurements on the map and corresponding distances on the ground. For example, the scale 1 inch to 1 mile means that 1 inch on the map (such as 1 inch, 1 foot, or 1 meter) represents 62,500 similar units on the earth's surface.

The standard scales used on these maps are multiples of the fraction 1:62,500. Quadrangles in thickly settled or industrially important regions are mapped on a scale of 1:62,500 or about 1 mile to 6 inches, and cover areas measuring 10° in latitude and longitude. Quadrangles in less thickly settled or industrially less important districts are mapped on a scale of 1:250,000 or about 2 miles to an inch, and cover areas measuring 20° in latitude and longitude. Reconnaisance maps of desert or sparsely inhabited regions have been made on a scale of 1:250,000 or about 4 miles to an inch, covering areas measuring 1° in latitude and longitude. Maps for special purposes are made on scales larger than 1:62,500.

A topographic survey of Alaska has been in progress since 1899, and nearly 55 per cent of its area has now been mapped. About 10 per cent of the Territory has been covered by reconnaissance maps on a scale of 1:62,500 or about 10 miles to an inch. Most of the remaining area surveyed in Alaska has been mapped on a scale of 1:250,000 but about 5,000 square miles has been mapped on a scale of 1:250,000.

A large part of the Hawaiian Islands has been surveyed, and the resulting maps are published on a scale of 1:62,500.

The features shown on these maps may be arranged in three groups: (1) water, including sea, lakes, rivers, canals, swamps, and other bodies of water; (2) relief, including mountains, hills, valleys, and other features of the land surface; (3) culture (works of man), such as towns, cities, roads, railroads, and boundaries. The conventional signs used to represent these features are shown and explained below. Variations appear on some earlier maps, and additional features are represented on some special maps.

CONVENTIONAL SIGNS

CULTURE

Woods

Waste

Farms

Buildings

Schools

Obligations

Drainage

Bridges

Railroads

Electric railroads

School

Post office

Cemeteries

Church

State parks

National parks

River

Stream

Lake

Inlet

Bight

Port

Sound

Geological Survey 1:125,000 quadrangle

Canada 1:62,500 quadrangle

U.S. 1:62,500 quadrangle

Canada 1:250,000 quadrangle

U.S. 1:250,000 quadrangle

Topography

Relief

Water

Woods

The water features are represented in blue. The smaller streams and canals are shown in blue lines and the larger streams, the lakes, and the sea by blue water lining or blue tint. Intermitent streams—those whose beds are dry for a large part of the year—are shown by lines of blue dots and dashes. Relief is shown by contour lines in brown. A contour line represents an imaginary line on the ground (a contour) every part of which is at the same altitude above sea level. Such a line could be drawn at any altitude, but in mapping only the contours at certain regular intervals of altitude are shown. The lines of the seacoast itself are a contour; the datum or mass of altitude being mean sea level. The 20-foot contour, for example, would be the shore line if the sea should rise 20 feet. Contour lines show the shapes of the hills, mountains, and valleys, as well as their altitudes. Successive contour lines that are far apart on the map indicate a gentle slope; lines that are close together indicate a steep slope; and lines that run together indicate a cliff.

The manner in which contour lines express altitude, form, and grade is shown in the figure below.

The contour map represents a river valley that lies between two hills. In the foreground is the sea, with a bay that is partly inclosed by a hooked sand bar. On each side of the valley is a terrace into which small streams have cut narrow gullies. The hill on the right has a ramshackle man-made and gently sloping spur separated by ravines. The spur is traversed at their lower ends by a sea cliff. The hill at the left terminates abruptly at the valley in a steep scarp, from which it slopes gradually away and forms an inclined table-land that is traversed by a few shallow gullies. On the map each of these features is represented, directly beneath its position in the sketch, by contour lines. The contour interval, or the vertical distance in feet between one contour and the next, is noted at the bottom of each map. This interval differs according to the topography of the area mapped; in a flat country it may be as small as 1 foot; in a mountainous region it may be as great as 250 feet. Certain contour lines, every fourth or fifth one, are made heavier than the others and are accompanied by figures showing altitude. The heights of many points—such as road corners, summits, surfaces of lakes, and bench marks—are also given on the map in figures, which show altitudes in the nearest foot only. More exact altitudes—those of bench marks—as well as the geodetic coordinates of triangulation stations, are published in bulletins that are issued by the Geological Survey.

The lettering and works of man are shown in black. Boundaries, such as those of a State, county, city, land grant, township, or reservation, are shown by continuous or broken lines of different width and weight. Mapped roads are shown by double lines, one of which is accented. Other public roads are shown by fine double lines, private and poor roads by dashed double lines, trails by dashed single lines.

Each quadrangle is designated by the name of the principal city, town, or natural feature within it, and on the margins of the map is printed the names of adjoining quadrangles of which maps have been published. Over 5,000 quadrangles in the United States have been surveyed, and maps of them similar to the one on the other side of this sheet have been published.

The topographic map is the base on which the geology and mineral resources of a quadrangle are represented, and the maps showing these features are bound together with a descriptive text to form a folio of the Geological Atlas of the United States.

Index maps of each State showing the topographic maps and geological folios published by the United States Geological Survey may be obtained free. Copies of the topographic maps may be obtained for 10 cents each, or in lots of 50 or more, either of the same or of different quadrangles, for 5 cents each. The geological folios are sold for 25 cents or more each, the prices depending on the size of the folio. A circular describing the folios will be sent on request.

Applications for maps or folios should be accompanied by cash, draft, or money order (no postage stamps) and should be addressed to

THE DIRECTOR
United States Geological Survey
Washington, D. C.

November, 1919
THE TOPOGRAPHIC MAPS OF THE UNITED STATES

A survey of Puerto Rico is now in progress. The scale of the published maps is 1" = 2000 ft. The contours are arranged in three groups—(1) water, including seas, lakes, rivers, canals, swamps, and other bodies of water; (2) relief, including mountains, hills, valleys, and other features of the land surface; (3) culture (works of man), such as towns, cities, roads, railroads, and boundaries. The symbols used to represent these features are shown and explained below. Variations appear on some earlier maps, and additional features are represented on some new maps.

All the water features are represented in blue, the smaller streams and canals by single blue lines and the larger streams by double lines. The larger streams, lakes, and the sea are accentuated by blue water lines of blue that. Intersections of these lines whose last arc dry for a large part of the year—

The sketch represents a river valley that lies between two hills. In the foreground is the sea, with a bay that is partly enclosed by a hooked sand bar. On either side of the valley is a terrace into which several streams have cut narrow gullies. The hill on the right has a rounded summit and gently sloping spurs separated by ravines. The spurs are truncated at their lower ends by a sea cliff. The hill at the left terminates abruptly on the valley in a steep slope, from which it slopes gradually away and forms an inclined plateau that is traversed by a few shallow gullies. On the map each of these features is indicated, directly beneath its position, in the sketch, by contour lines.

The contour interval, or the vertical distance in feet between one contour and the next, is stated at the bottom of each map.

This interval differs according to the topography of the area mapped. In a flat country it may be as small as 1 ft.; in a mountainous region it may be as great as 250 ft. In order that the contours may be read more easily certain contour lines, every fourth or fifth, are made heavier than the others and are accompanied by figures showing altitude. The heights of many points—such as road intersections, summits, surfaces of lakes, and benchmarks—are also given on the map in figures, which show altitudes to the nearest foot only. More precise figures for the altitudes of benchmarks are given in the Geological Survey's bulletins on spirit leveling. The geodetic coordinate of triangulation and transit-reverse stations are also published in bulletins.

Latter and the works of man are shown in black. Boundaries, such as those of a State, county, city, town, township, or reservation, are shown by continuous or broken lines of different kinds and weights. Public roads suitable for motor travel are shown on the large-scale maps by solid blue lines; public roads and private roads by dashed double lines; trails by dashed single lines. Additional public road classification if available is shown by red overprint.

Each of the survey maps published shows the area covered by the type of map, the datum of altitude, the order of map, and the name or designation of the county, town, or region. The term "survey" indicates that the map is prepared from soundings, levels, and other surveys. Each of these maps is made by the United States Geological Survey, and a few have been published.

Geologic maps of some of the areas shown on the topographic maps have been published in the form of folios. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped, and several pages of descriptive text. The text explains the maps and describes the geologic and topographic features of the country and its mineral products. A hundred twenty-five folios have been published.

Index maps of contiguity and of Alaska and Hawaii showing the areas covered by topographic maps and geologic folios published by the United States Geological Survey may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., for 20 cents each; some special maps are sold at different prices. A discount of 40 percent is allowed on orders amounting to 20 copies or more, and a discount of 25 percent on orders amounting to 50 or more at the retail rate. Applications for maps and folios should be accompanied by cash, check, or money order and should be addressed to THE DIRECTOR, United States Geological Survey, Washington, D.C.