NORTH DAKOTA GEOLOGICAL SURVEY
WILSON M. LAIRD, State Geologist

MISCELLANEOUS SERIES 31

Popular Geology of Eddy & Foster Counties North Dakota

by
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GRAND FORKS, NORTH DAKOTA

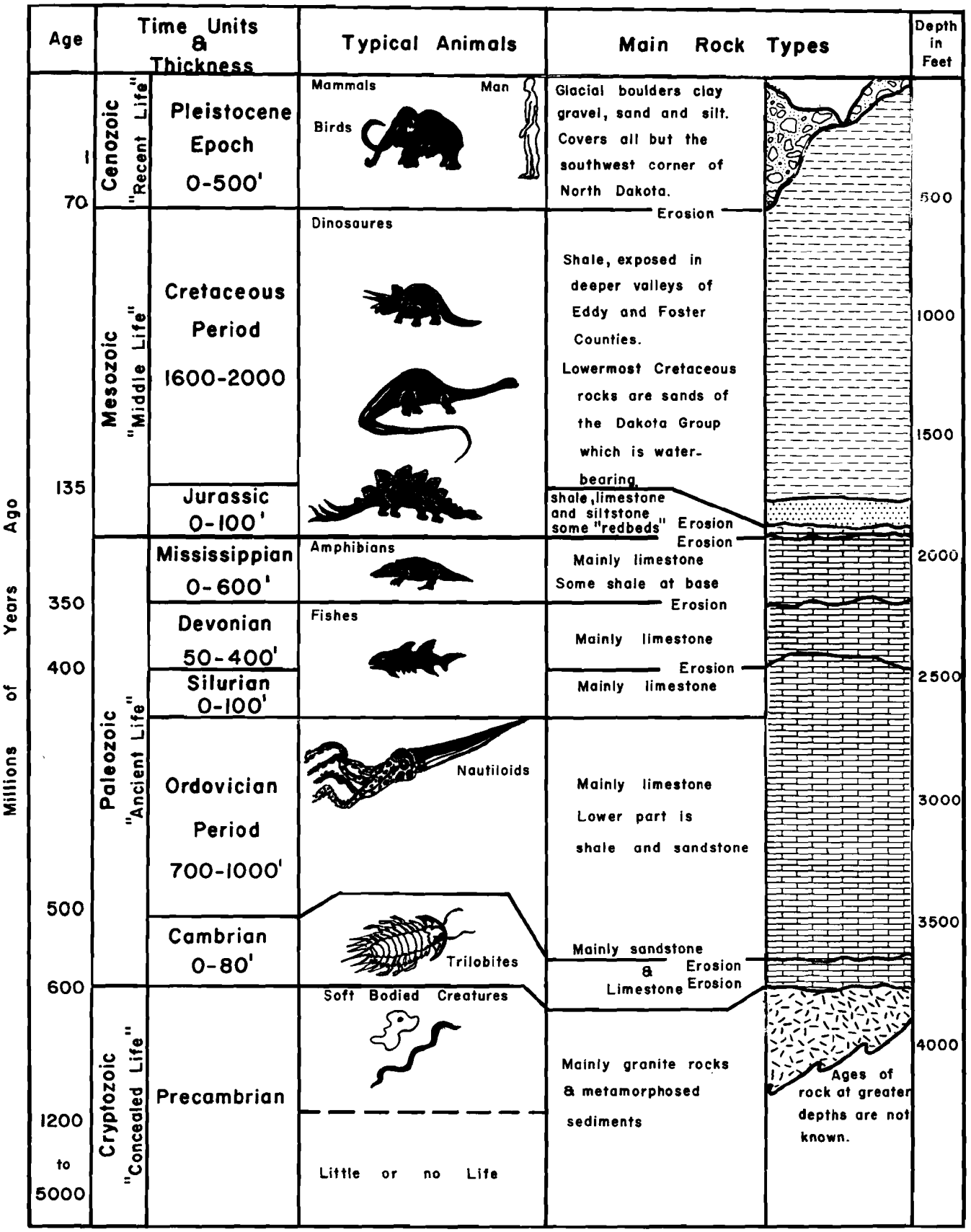
1967

A Word About the North Dakota Geological Survey

The occurrence and distribution of rock and mineral deposits in North Dakota are studied by the State Geological Survey, which is aided in its work by faculty and students of the geology department at the University of North Dakota. The Survey seeks new information about the state's natural resources and it administers the oil and gas conservation laws of the state for the State Industrial Commission. Recent research has been in the areas of ground water, oil, gas, lignite, sodium sulphate, potash, salt, limestone, clay, sand, and gravel. In many of its activities the Survey cooperates with the State Water Commission, the State Industrial Commission, the Economic Development Commission, and the United States Geological Survey, as well as with private industry. The results of the Survey's field and laboratory findings are published and made available at nominal prices on request.

Geology and related sciences are being used more and more to aid in intelligent and efficient discovery and utilization of mineral wealth. Our national life and welfare are highly dependent upon the further discovery and proper use of the earth's natural resources. North Dakota is recognized by scientists, industrialists, and educators as being a leader in conservation and in the promotion of research and industrial development.

Since the main ideas of geology are easy to understand and greatly enhance one's enjoyment and appreciation of the world we live in, the State Geological Survey is increasing its output of popular and educational booklets such as this one designed for the use of teachers, students and other interested people. The Survey also distributes a labeled collection of rocks and minerals for class use in North Dakota schools. Members of the Survey staff give illustrated lectures to organized groups about the geology and mineral resources of the state. For more information on any of these services, write to the Survey offices in Grand Forks.


Age
Time & Thickness Units
Typical Animals
Main Rock Types
Depth in Feet
Millions of Years Ago
1
70
135
350
400
500
600
1200 to 5000
Cenozoic "Recent Life"
Pleistocene Epoch 0-500'
Mammals
Man
Birds
Glacial boulders clay gravel, sand and silt. Covers all but the southwest corner of North Dakota.
Erosion
Mesozoic "Middle Life"
Cretaceous Period 1600-2000
Dinosaures
Shale, exposed in deeper valleys of Eddy and Foster Counties.
Lowermost Cretaceous rocks are sands of the Dakota Group which is water-bearing.
Jurassic 0-100'
shale, limestone and siltstone some "redbeds"
Erosion
Erosion
Paleozoic "Ancient Life"
Mississippian 0-600'
Amphibians
Mainly limestone
Some shale at base
Erosion
Devonian 50-400'
Fishes
Mainly limestone
Erosion
Silurian 0-100'
Mainly limestone
Ordovician Period 700-1000'
Nautiloids
Mainly limestone
Lower part is shale and sandstone
Cambrian 0-80'
Trilobites
Mainly sandstone & Limestone
Erosion
Erosion
Cryptozoic "Concealed Life"
Precambrian
Soft Bodied Creatures
Mainly granite rocks & metamorphosed sediments
Ages of rock at greater depths are not known.
Little or no Life
500
1000
1500
2000
2500
3000
3500
4000

GEOLOGY OF EDDY AND FOSTER COUNTIES

This booklet is intended for high school teachers and students, farmers, and others who may be interested in the geology of the area in which they live and work. It is based on one of a series of North Dakota Geological Survey bulletins that deals with the geology and ground water resources of the various counties of the state.

Geology is the science that is concerned with the history of the earth, its composition, and its structure. Each of us should be interested in geology because it so strongly affects the way we live, both directly and indirectly. Besides, if we are typically curious individuals, we probably want to know as much as we possibly can about our surroundings. Ability to interpret the landscape requires knowledge of the forces that produced it. One may admire the beauty of a waterfall or marvel at its grandeur, but to appreciate it fully, one must know how it was formed. Of course, in a small booklet such as this one, it is impossible to go into any great detail but we can discuss some important concepts and go on from there to a fairly detailed look at our two counties. The reader interested in a more detailed treatment of the geology of Eddy and Foster Counties can purchase North Dakota Geological Survey Bulletin 44, Part 1, for $1.25 from the Survey offices in Grand Forks or from the North Dakota State Water Commission in Bismarck. For the reader interested in learning more about geology in general, a listing of suggested reading is included at the end of this booklet.

General Geology

The earth can be divided into three zones: core, mantle, and crust (fig. 1). The core is the innermost zone of the earth. It is mainly iron with some nickel and cobalt. The inner core is probably solid, and the outer core may consist of the same elements in a molten form. The core is the most dense of the three zones. The mantle, which surrounds the core, is a solid zone of materials rich in iron and magnesium.

The crust, the top part of which includes the ground we walk on, is the hard, outer surface layer of the earth. Although the crust is about 6 to 30 miles deep, it is only a thin skin on a world that is almost 8000 miles in diameter. The components of the crust include such rocks and minerals as limestone, sandstone, shale, coal, iron, nickel, basalt, granite and many others. These crustal rocks are not as dense and do not have as high an iron content as does the rock of the mantle and core.

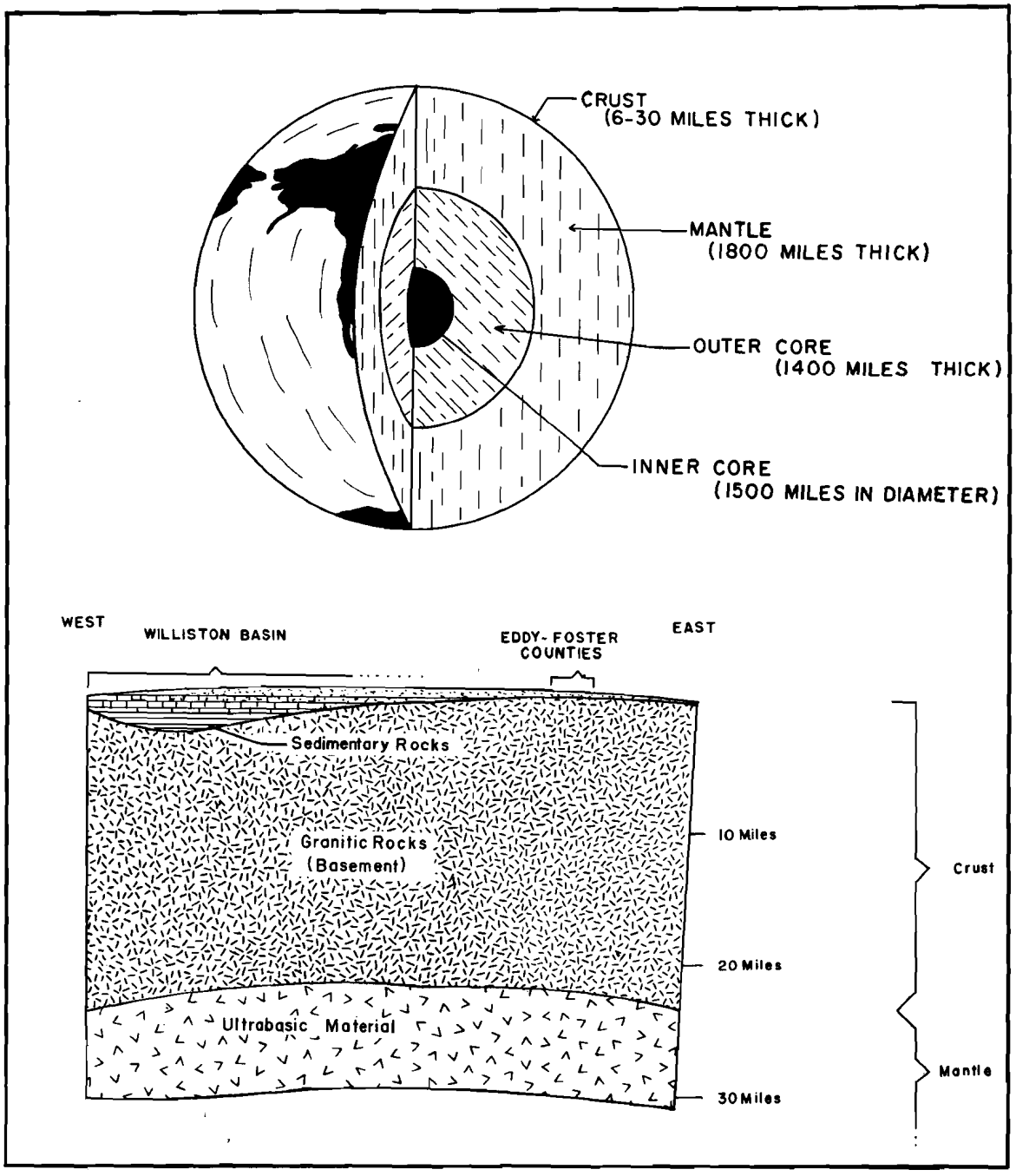


Figure 1. The upper portion of this figure shows the earth with a segment removed to show the internal zones. The lower portion shows an east-west cross-section through the earth's crust in the North Dakota area. It shows the Williston basin, the area of thick sedimentary rocks and the underlying granitic rocks.

In Eddy and Foster Counties all the rock types we will be concerned with belong to the earth's crust. It is convenient to group these rock types in three categories: 1) the granitic rocks; 2) the sedimentary rocks excepting the glacial drift; and 3) the glacial drift.

The granitic rocks of the crust are the oldest and deepest of the three rock types with which we are concerned. They are generally from 2500 to 4000 feet deep in Eddy and Foster Counties but in the western part of the state they are deeper than 15,000 feet. The granite formed more than 600 million years ago when magma (molten rock) cooled and solidified.

The sedimentary rocks that lie on top of the granite consist of layers of sediments (minute particles of rocks and minerals) that were deposited in shallow seas. These seas covered North Dakota during much of the past 600 million years (fig. 2). The sedimentary rocks are mainly limestone, shale and sandstone. They were formed when sediment was eroded from nearby land by rivers and carried to the seas just as much of our rich North Dakota topsoil is carried by streams and rivers to the Gulf of Mexico today. In Eddy and Foster Counties there are 2500 to 4000 feet of sedimentary rocks but in western North Dakota in the Williston basin, the sedimentary rocks are more than 15,000 feet thick in places.

Although North Dakota was at the bottom of the sea during much of the geologic past, there were several times it was above sea level. In fact, during the entire past 60 million years, North Dakota has been above sea level.

The third of the three rock types is the glacial drift. Because this glacial drift covers all of Eddy and Foster Counties, we shall go into more detail in discussing it.

The landscape over most of North Dakota developed during the ice age (Pleistocene epoch) that lasted from about one million years ago up to about 10,000 years ago. During that time, the state was covered by glaciers several times. The most recent glaciation began about 75,000 years ago and lasted until about 10,000 years ago. Only the southwest corner of the state escaped glaciation. Figure 3 shows the area of North America that was glaciated during the ice age.

Eddy and Foster Counties, North Dakota, are almost entirely covered by glacial deposits consisting of everything from sand and clay to boulders. Before the glaciers advanced over North Dakota, the area was probably hilly, much like the southwest part of the state today. The glaciers smoothed down and covered much of the old, rocky, hilly land surface and filled old valleys with loose deposits of ground-up material. In the time since the

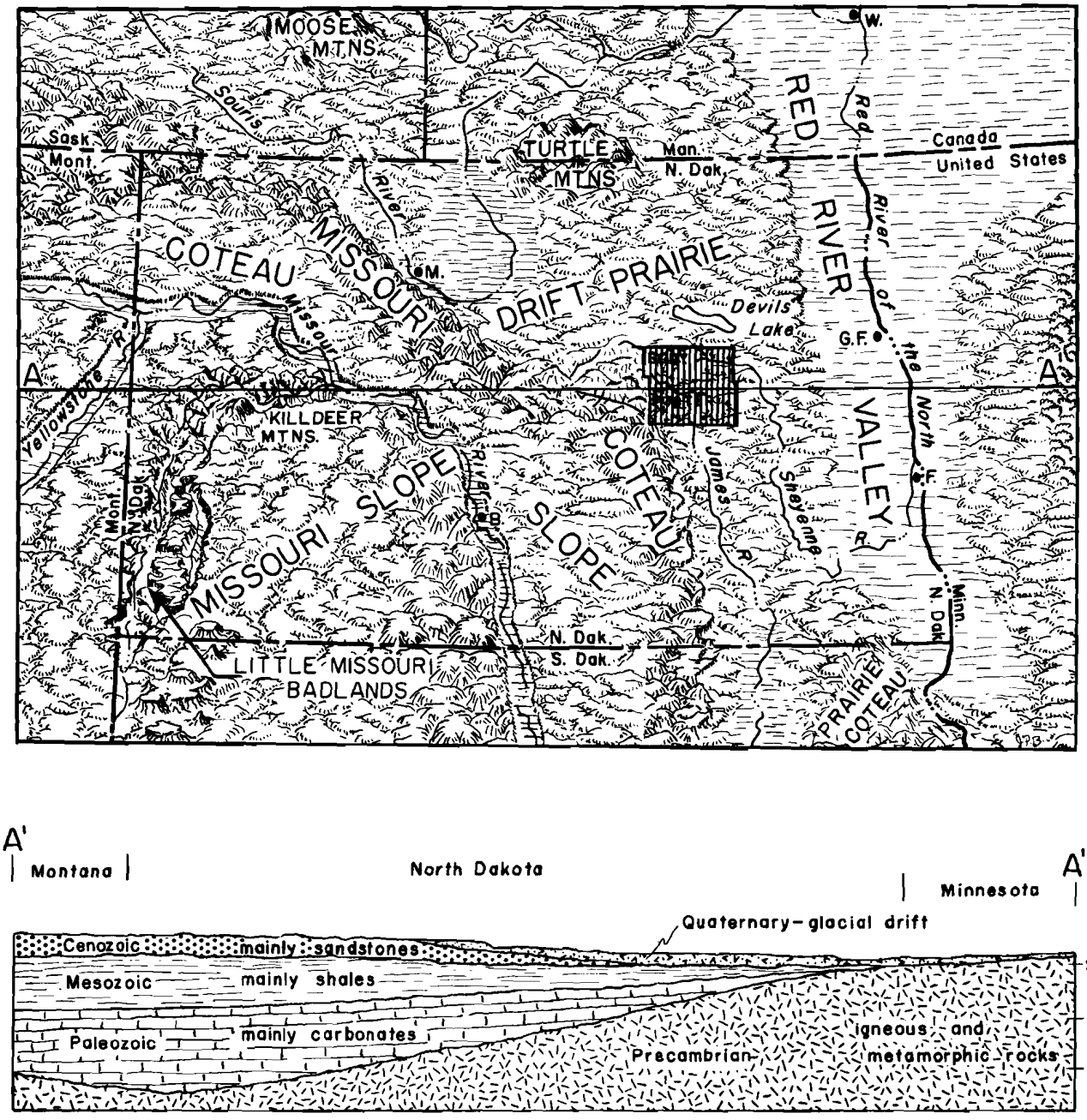


Figure 2. Physiographic map of North Dakota showing the location of Eddy and Foster Counties.

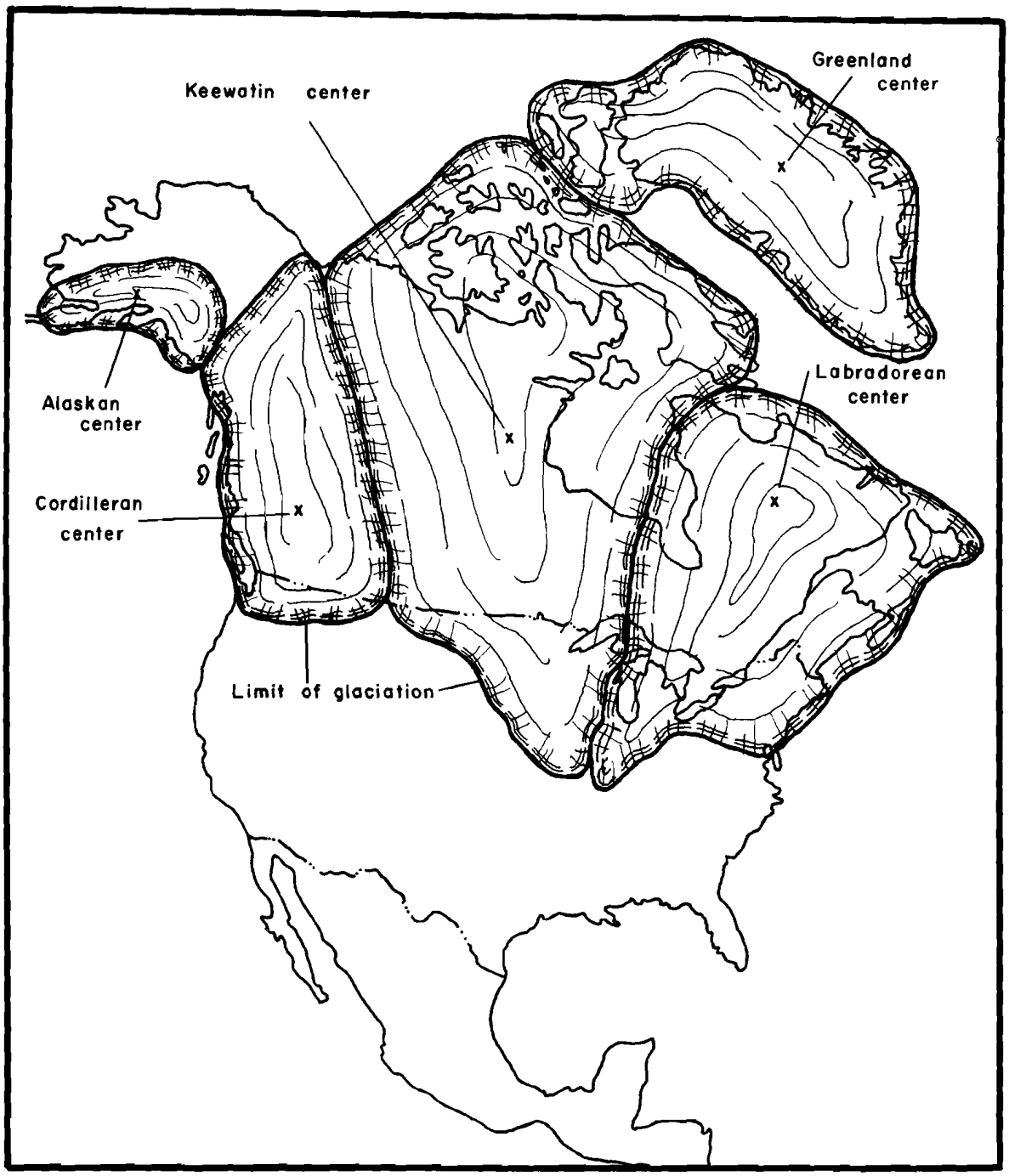


Figure 3. The above map of North America shows the limits of continental glaciation during the Ice Age. The main centers of snow accumulation from which the ice moved are shown. North Dakota was glaciated by ice that moved from the Keewatin center west of Hudson Bay.

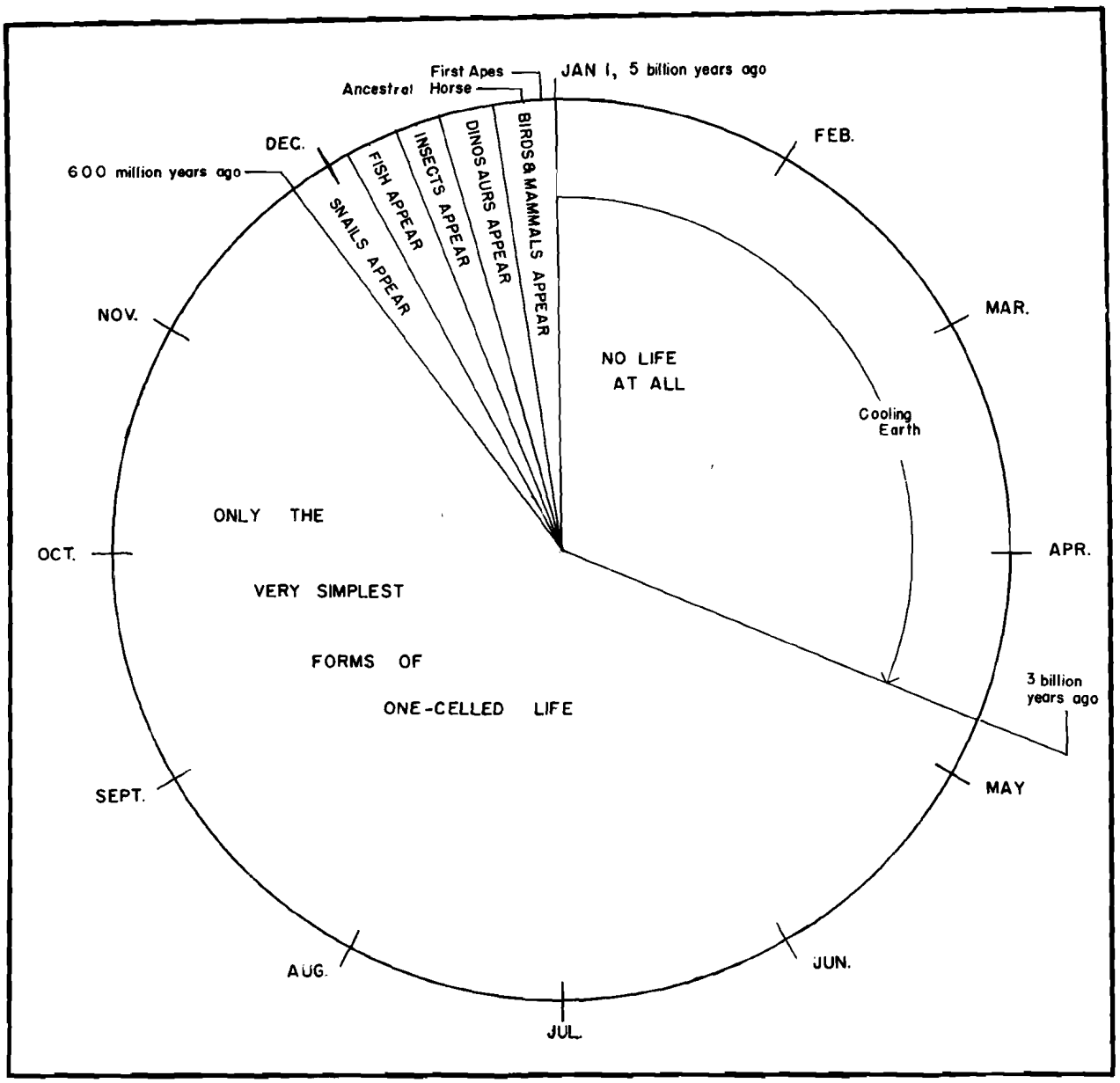


Figure 4. The above diagram represents all 5 billion years of the earth's history compressed into a single year. The earliest life forms did not appear on the earth until late in April of our imaginary year. Dinosaurs came on the scene in mid-December and lasted only six of our imaginary days. The ice age began in North Dakota at 8:40 p.m. on December 31 and ended only two minutes before midnight. Primitive man arrived on earth about 10:20 p.m. in the midst of the ice age. At 20 seconds before midnight, Christ was born and at 10 seconds America was discovered by Lief Ericson. So, as you can see, the two thousand years since Christ was born may seem like a long time to most of us but, to the geologist, they are only an instant in the total history of the earth.

glaciers left the state, weathering and bacterial decay action have modified many of these surface materials into soils. The present soils of North Dakota are fertile partly because they have minerals and trace elements (minute amounts of elements such as copper, zinc and manganese) brought in by glaciers from other areas.

The Ice Age in Eddy and Foster Counties

The Ice Age, or Pleistocene epoch, ended about 10,000 years ago, which is only a short time to geologists (fig. 4). During the Pleistocene epoch, a great ice sheet, like that in Greenland today, formed in Canada west of Hudson Bay. Thousands of feet of snow that accumulated there was, by its own weight, compressed into ice. Finally, the pressure resulting from the weight of so much overlying ice caused the edge to move slowly southward into North Dakota. The tremendous mass of ice flowed first through the valleys, filling and overflowing them. Then it spread over the uplands, bypassing the higher hills for a time but overriding even these when it became thick enough. Rock and surface materials of all kinds were picked up by the ice and ground into smaller fragments such as gravel, sand, silt and clay. This material, moving along with the slowly flowing ice, was later deposited far to the south when the edge of the glacier finally melted back. The material that melted out of the glacier formed the rolling landscape now typical of Eddy and Foster Counties. In places, water flowing from the melting ice washed away the silts and clays, leaving flat gravel and sand plains such as Tiffany Flats in central Eddy County. In other places there was little washing, and hills composed of a mixture of everything from clay to boulders remained.

If a person could go back in time about 12,000 years, he would probably find it hard to recognize Eddy and Foster Counties! The great ice sheet covered much of the northern part of the state and its edge probably crossed parts of Eddy and Foster Counties. The huge sheet of dirty ice stretched away to the northern horizon as far as the eye could see. Near its edge it was only a few hundred feet thick but farther north it was several thousand feet thick. Small streams of dirty, sediment-laden water flowed from the melting ice and collected in ponds and larger and larger streams until it flowed as huge rivers cutting the valleys now occupied by the James and Sheyenne Rivers. Some of these rivers were as large as the Missouri River is today.

When the ice melted away, the newly exposed land surface was rough, uneven, and poorly drained. There were many ponds. Some chunks of ice that had not yet had time to melt were buried by débris and when they finally did melt, the overlying materials slumped into the resulting holes. Today one can see these potholes in many places throughout the two counties.

Cold, damp winds blew off the melting ice during the short summer season and rainfall was abundant. The winters were probably no colder than our present-day North Dakota winters but there was much more snow. In general, the climate was probably much like the climate today in parts of northern Manitoba.

A few miles to the south where the ice had been a few years earlier, dense forests of spruce and tamarack grew. Elephant-like wooly mammoths and mastodons roamed the area along with herds of giant bison, elk, and caribou. Primitive pre-Indian man probably inhabited the area also, eking out a meager existence in the unfriendly surroundings.

Thus the last great geologic episode in Eddy and Foster Counties ended, leaving the rolling hills and plains to be covered by tall prairie grasses as the climate became milder and drier. The mammoths and mastodons died off and herds of buffalo took their place. Indian hunters who moved into the area went undisturbed, except by other Indians, until about 10,000 years later when Europeans finally arrived.

Descriptions of Some of the Features Left by the Glaciers

Four low ranges of knobby hills that formed when materials collected at the edge of the melting glacier can be seen in Eddy and Foster Counties. These ranges of hills are called end moraines because they formed at the edge or "end" of the glacier ice. They are shown as dark green areas on plate 1 (in the pocket at the end of this booklet). The end moraines are underlain mainly by sandy, gravelly and bouldery clay and commonly they have poor drainage, steep slopes and bouldery surfaces. In some places are small ridges which may have been formed when a short advance of the ice bulldozed the material into shape. Because the end moraines are rough, they commonly make poor farmland, although they are well suited for grazing.

Areas in the two counties that are relatively flat to gently rolling are shown in light green on plate 1. These areas, called ground moraine, are underlain by sandy and gravelly clay. Ground moraine is less bouldery than end moraine. Most ground moraine material is deposited continuously at the base of the moving ice and consists of the materials the ice ground up as it moved forward. The upper few feet of the ground moraine material was deposited as the glacier melted downward. This material is loose and sandy because it was washed while it was being deposited. Because the ice margin did not remain long in any one place on the areas shown as ground moraine, no extensive hilly areas were formed. Most of the best farmland in Foster County is ground moraine.

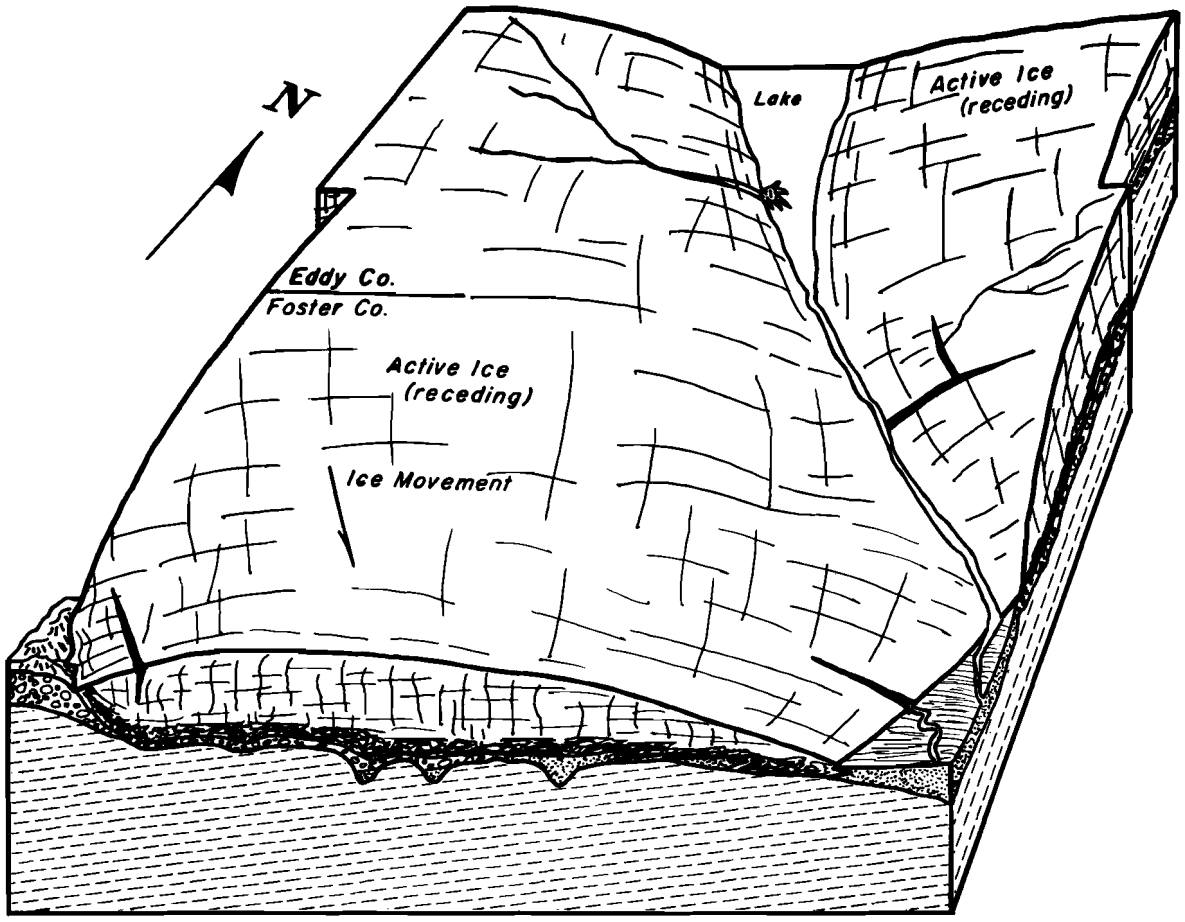


Figure 5. This diagram, along with the four that follow, shows the development of the glacial landscape in Eddy and Foster Counties. The diagrams are constructed so that the upper or northern half represents Eddy County and the lower half represents Foster County. The diagrams end at the county lines so the reader can see the area in cross-section and get a better idea of what was happening. In this illustration, the glacier still covers all but the extreme southeast and southwest corners of Foster County. The ice is moving generally southeastward (arrows) but it is melting back faster than it is advancing. The glacier picks up rocks, sand, and clay as it moves along and the base of the moving glacier in places actually consists of more debris than ice. Water flowing from the ice deposits sand and gravel plains such as the one shown in southeast Foster County. The surface of the glacier near the edge of the ice is dirty with deep cracks and crevasses. Lakes stand in the lower areas on the ice and streams flow through the cracks toward the ice margin.

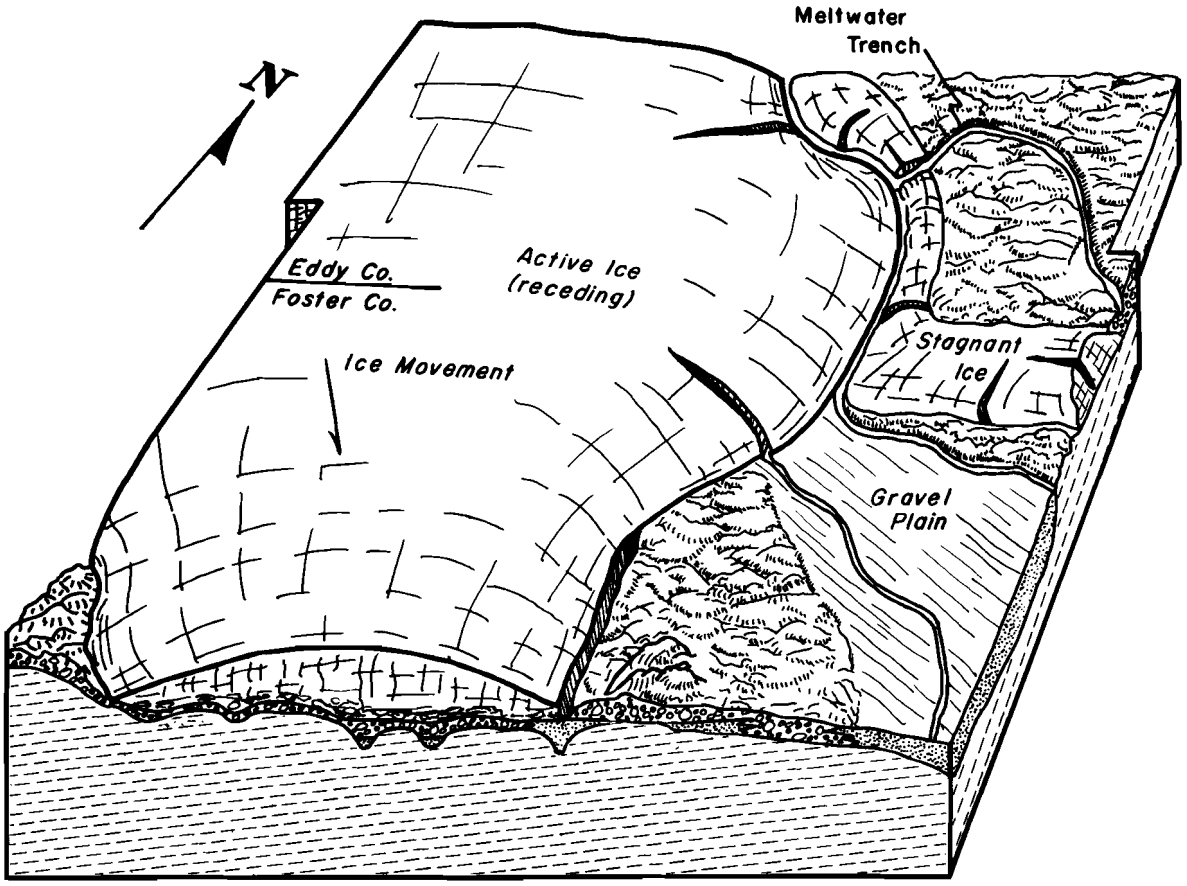


Figure 6. The ice in this diagram has wasted back so that its edge is in central Eddy and Foster Counties. It has left a large area of stagnant ice in eastern Eddy and northeastern Foster Counties. Water flowing from the melting glacier has enlarged the sand and gravel plain in eastern Foster County considerably while other meltwater flows through the meltwater valley in eastern Eddy County. Northeastern Eddy County is rolling ground moraine where the ice margin did not stay long enough to form an end moraine. The ice in Foster County is in the process of building the Grace City end moraine (see plate 1).

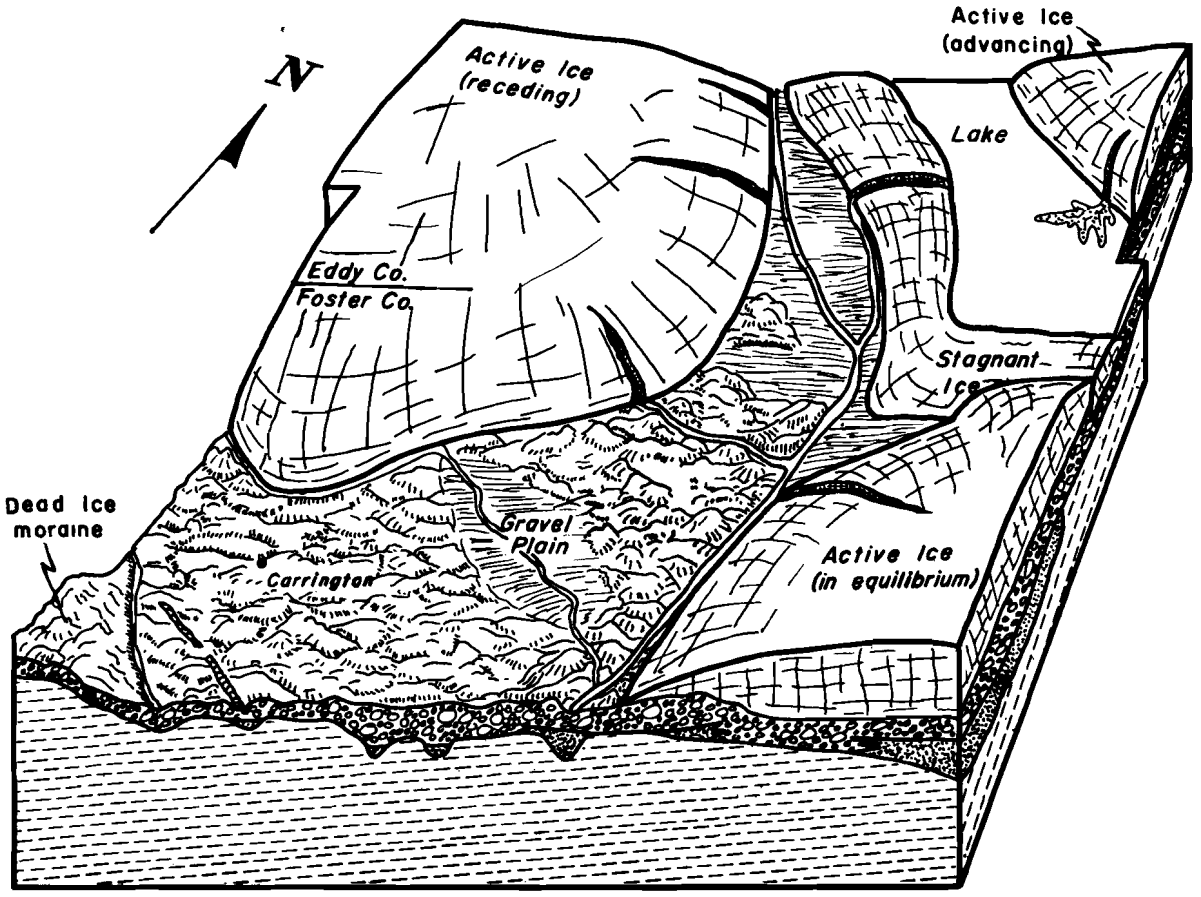


Figure 7. The ice sheet shown on the last diagram has now shrunk so that it covers only the northwest corner of the two-county area. The large band of stagnant ice in eastern Eddy County helps to form a dam for meltwater flowing from the active ice advancing into northeastern Eddy County. Silt deposits are found today in the area the resulting lake occupied. Ice has also advanced into eastern Foster County as shown on the above illustration. This ice is in equilibrium (moving westward at about the same rate it melts back) and it is building the Kensal end moraine (plate 1). The meltwater from this ice is flowing in a valley that is today represented by terraces high on the west side of the James River valley. Meltwater from the ice in the northwest part of the two-county area is depositing sand and gravel in the two areas shown.

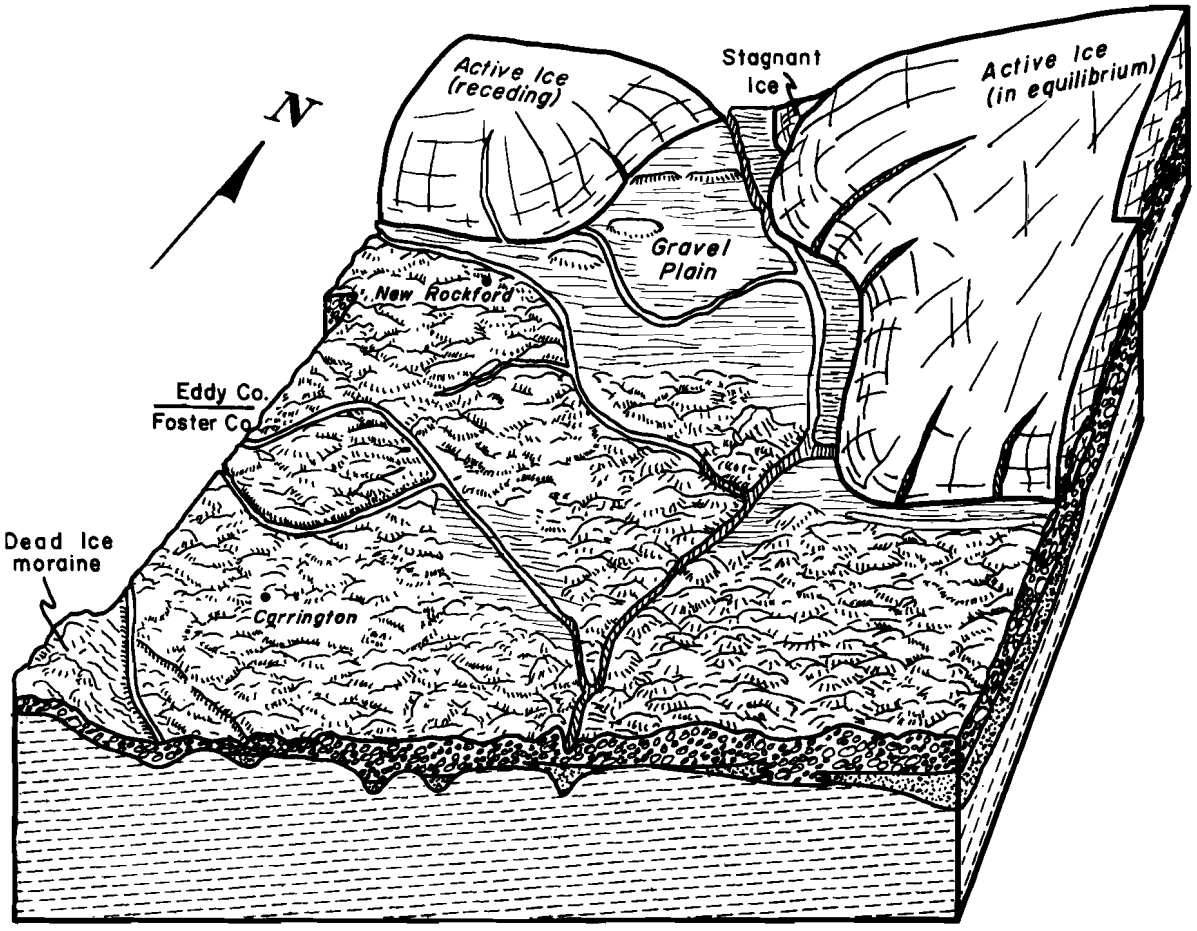


Figure 8. On this diagram, the ice that was in eastern Foster County has completely melted away. The ice front that was in northeast Eddy County has advanced to the position shown and is in equilibrium. It is building the McHenry end moraine (plate 1) on top of the band of stagnant ice. The edge of the ice sheet that crosses northwest Eddy County is also in equilibrium and building the Heimdal end moraine. Meltwater from each glacier margin is still depositing sand and gravel over much of central Eddy County. This meltwater collects in larger and larger streams and most of it is carried from the area by the large valley of the James River in central Foster County.

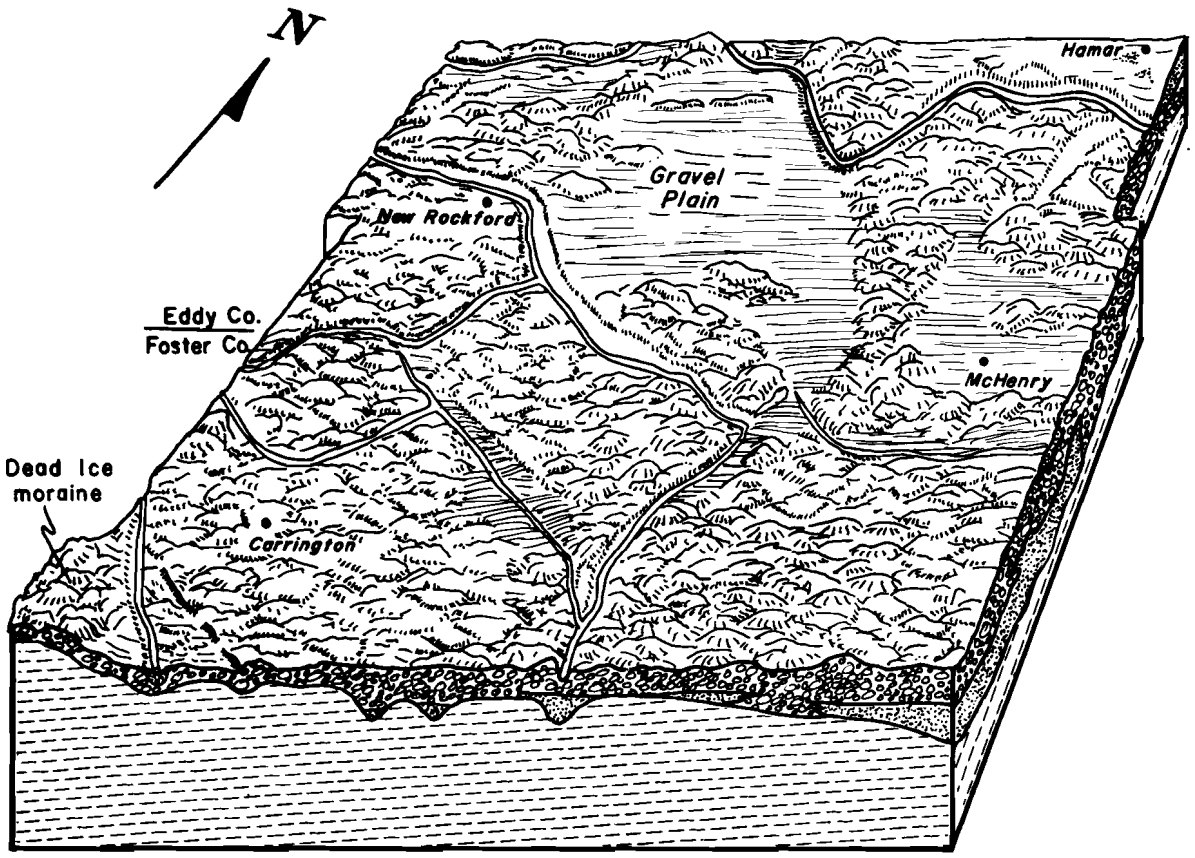


Figure 9. This diagram is the last in the series showing the development of Eddy and Foster County landforms. Here, all the landforms are shown essentially as they are today. After the glacier melted from the two-county area, there was only slight modification of the landscape. This consisted mainly of deepening of the Sheyenne and James valleys by meltwater from the north. Meltwater from the north also spread over northeastern Eddy County, depositing sand and gravel in the Hamar area.

Suggested Additional Reading Materials

Your local library may have some of the books listed below as well as many others. A good encyclopedia such as World Book or Americana also has much non-technical information about geology.

The world is round by Anthony Ravielli; Viking Press, Inc., 625 Madison Avenue, New York 22, N. Y., 1963.

Rocks, rivers and the changing earth, a first book about geology by Herman Schneider and Nina Schneider: W. R. Scott Co., New York, N. Y., 1956.

The planet earth by the Scientific American: Simon and Schuster, Inc., New York, N. Y., 1957.

The world of geology by L. D. Leet: McGraw Hill Book Co., New York, N. Y., 1961.

Earth and space science by Wolfe and others: D. C. Heath and Company, Boston, Massachusetts, 1966.

How old is the earth? by P. M. Hurley; Doubleday and Co., Inc., Garden City, N. Y., 1959.

Glaciers by Robert P. Sharp: University of Oregon Press, Eugene, Oregon, 1960.

The story of the Prairies by Daniel E. Willard: Webb Publishing Co., St. Paul, Minnesota, 1923.

North Dakota, the northern prairie state by B. L. Wills: Edward Brothers, Inc., Ann Arbor, Michigan, 1963.

The fossil book by C. L. Fenton and M. A. Fenton: Doubleday, Garden City, N. Y., 1958.

The geology of North Dakota by John Hainer: North Dakota Geological Survey Bulletin 31, Grand Forks, North Dakota, 1956.

Geology and ground water resources of Eddy and Foster Counties, North Dakota, Part 1, Geology by John P. Bluemle: North Dakota Geological Survey Bulletin 44, Grand Forks, North Dakota, 1965.

Geology and ground water resources of Eddy and Foster Counties, North Dakota, Part II, Ground water basic data by Henry Trapp, Jr.: North Dakota Geological Survey Bulletin 44, Grand Forks, North Dakota, 1966.

Geology and ground water resources of Eddy and Foster Counties, North Dakota, Part III, Hydrology by Henry Trapp, Jr.: North Dakota Geological Survey Bulletin 44, Grand Forks, North Dakota (in preparation).

R. 67 W. R. 66 W. R. 65 W. R. 64 W. R. 63 W. R. 62 W.

T. 150 N.

T. 149 N.

T. 148 N.

T. 147 N.

T. 146 N.

T. 145 N.

Sheyenne River
Sheyenne
Moraine
End
Heimdal
James River
New Rockford
STOP E-1
STOP E-2
STOP E-3
McHenry
Horseshoe Lake
STOP E-4
STOP E-5
Hamar
Sheyenne River
North Washington Lake
South Washington Lake
Lake Coe
Tiffany Flats
Johnson Lake
Moraine
Brantford
Barlow
Grace City
Juanita Lake
Mc Henry
Scotts Slough
Kelly Creek
End Moraine
Juanita
Pipestem Creek
Carrington
James River
Glenfield
Grace City End Moraine
Kensal
STOP F-4
STOP F-3
STOP F-2
Bordulac
STOP F-1
Dead Ice Moraine
Melville

GEOLOGIC MAP OF EDDY AND FOSTER COUNTIES, NORTH DAKOTA

EXPLANATION

End moraines that collected at the edge of the melting ice. These are hilly areas with many ridges. The dark green areas on the map represent areas underlain by sandy, gravelly and bouldery clay.

Ground moraine that was deposited beneath the moving ice. These are gently rolling areas. The ground moraine areas are underlain by sandy, gravelly clay that is less bouldery than end moraine.

Dead-ice moraine that was deposited when debris lying on stagnant ice slumped into place as the ice melted. Dead-ice moraine is very rough with many potholes. It is composed of bouldery and gravelly clay, much like end moraine.

Sand and gravel plains deposited by water flowing away from the melting ice. These areas are generally quite flat.

Lake sediments deposited in lakes that existed when the ice was melting. The areas are quite flat and underlain mainly by silts and clays. Some of the areas still contain water at times.

Ice-disintegration ridges and kames (see text) of sand and gravel. These were deposited in cracks and holes in the melting ice. Most of the long red areas are ridges and the round, smaller areas are kames.

River alluvium of sand, silt and clay. These are recent deposits located in the major river valleys.

The numbers on the map (E-1; F-6; etc.) refer to stops on the road logs. The dashed lines show the routes of the road logs.

N

0 1 2 3 4 5 miles
SCALE