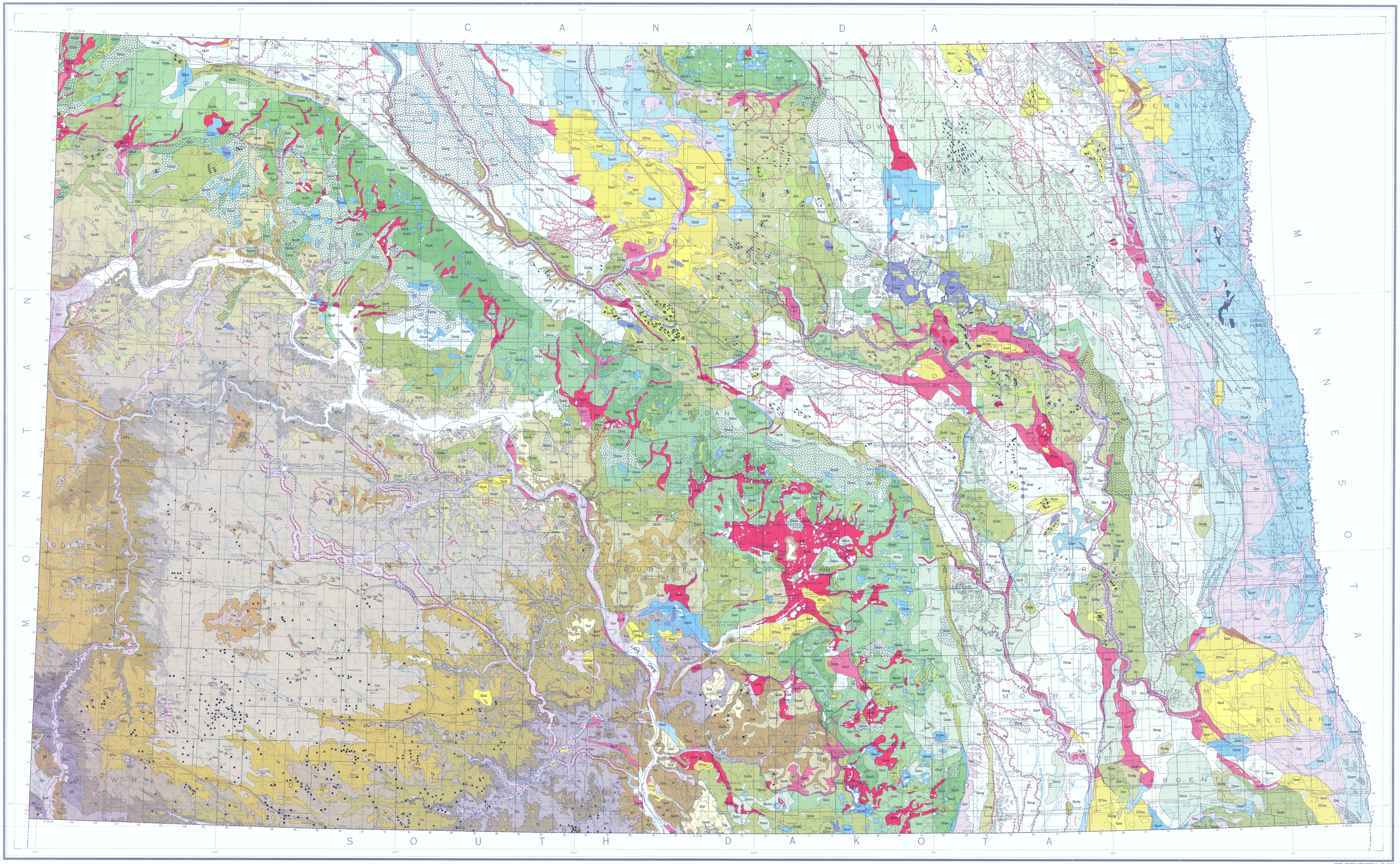
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC MAP OF NORTH DAKOTA



Base from U.S. Geological Survey, 1927
1:500,000

SCALE 1:500 000

10 0 10 20 30 40 50 MILES
10 0 10 20 30 40 50 60 70 KILOMETERS

CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

GEOLOGIC MAP OF NORTH DAKOTA

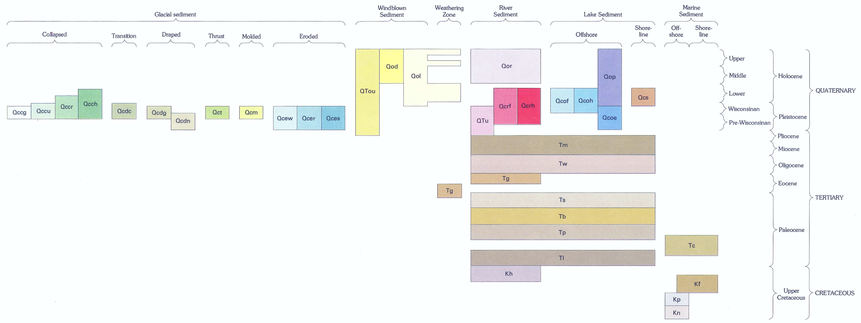
By Lee Clayton

With assistance from S. R. Moran, J. P. Bluemle, and C. G. Carlson

NORTH DAKOTA GEOLOGICAL SURVEY

1980

CORRELATION OF MAP UNITS



The stratigraphic names used in this map are those accepted by the North Dakota Geological Survey and differ in part from those accepted and used by the U.S. Geological Survey. Badland topography shown by gray overprint.

OAHE FORMATION (HOLOCENE AND PLEISTOCENE)—Clay, sand, silt, and gravel with dispersed organic material

Qor **RIVER SEDIMENT (HOLOCENE)**—Dark, obscurely bedded clay and silt (overbank sediment); generally overlying cross-bedded sand (channel sediment); as thick as 10 meters (30 feet); on flood plains of modern streams

Qod **WINDBLOWN SAND (HOLOCENE)**—Well-sorted, medium sand with obscure bedding; poorly developed paleosols common; as thick as 10 meters (30 feet); knobby topography consisting of inactive transverse or longitudinal dunes nearly obliterated by more recent blowouts

Qop **POND SEDIMENT (HOLOCENE AND WISCONSINAN)**—Dark obscurely bedded clay and silt; typically a few meters thick; in modern ephemeral ponds

Qol **WINDBLOWN SILT (HOLOCENE AND WISCONSINAN)**—Obscurely bedded silt with paleosols; as thick as 6 meters (20 feet) where mapped. As much as 2 meters (7 feet) of windblown silt is present, but not mapped, on many level uplands southwest of the Missouri River, and less than 1 meter (3 feet) occurs at the surface throughout much of the State

QTou **SAND OF THE OAHE AND OLDER FORMATIONS, UNDIVIDED (HOLOCENE TO PLIOCENE)**—Windblown sand of the Oahe Formation, as thick as 3 meters (10 feet), and sand of older formations with an undulating wind-scoured surface

COLEHARBOR FORMATION (HOLOCENE AND PLEISTOCENE)—Sandy, silty clay with pebbles of limestone, dolomite, granite, gneiss, and basalt; stratigraphic, bedded clay, silt, sand, and gravel; as thick as 200 meters (600 feet)

Qos **SHORELINE SEDIMENT (HOLOCENE AND WISCONSINAN)**—Well-sorted sand and gravel of beach-ridge complexes (individual ridges shown by line symbols); as thick as 5 meters (15 feet)

OFFSHORE SEDIMENT (HOLOCENE TO PRE-WISCONSINAN)—Laminated silt and clay of glacier-dammed lakes; as thick as 60 meters (200 feet)

Qocf PROGLACIAL LAKE SEDIMENT—Flat-bedded sediment of low-lying plains

Qoch ICE-WALLED-LAKE SEDIMENT OR COLLAPSED SUPRAGLACIAL-LAKE SEDIMENT—Flat-bedded sediment elevated above surrounding area or folded sediment with hummocky topography

Qoce ERODED LAKE SEDIMENT—Flat-bedded sediment along valley sides exposed as a result of postdepositional erosion

RIVER SEDIMENT (HOLOCENE TO PRE-WISCONSINAN)—Moderately well sorted cross-bedded sand and plane-bedded gravel, including sediment of melt-water and other rivers; as thick as 30 meters (100 feet)

Qorf UNCOLLAPSED RIVER SEDIMENT—Flat-bedded sediment of gently sloping plains and terraces, commonly with braided-channel scars

Qorh COLLAPSED RIVER SEDIMENT—Faulted and contorted supraglacial sediment with hummocky topography

GLACIAL SEDIMENT (HOLOCENE TO PRE-WISCONSINAN)—Unbedded, unsorted mixture of clay, silt, sand, and pebbles, and a few cobbles and boulders; as thick as 30 meters (100 feet)

COLLAPSED GLACIAL SEDIMENT—Supraglacial sediment with hummocky topography; local relief (in meters) and maximum slope angles (in degrees) are approximately equal to the thickness of supraglacial sediment (in meters)

Qcog Gently undulating—1° to 2° maximum slope angles

Qccu Undulating—2° to 4° maximum slope angles

Qccr Rolling—4° to 8° maximum slope angles

Qcch Hilly—4° to 15° maximum slope angles

Qcdc COLLAPSED/DRAPED TRANSITION SEDIMENTS—Collapsed glacial sediment with hummocky topography draped over and partly obliterating the topography existing before the last glacial advance

GLACIAL SEDIMENT DRAPED OVER PRE-EXISTING TOPOGRAPHY

Qcdg Thin glacial sediment draped over and only slightly modifying the glacial topography existing before the last glacial advance

Qcdn Thin glacial sediment draped over and only slightly modifying the non-glacial topography existing before the last glacial advance

Qct GLACIAL SEDIMENT ON THRUST MASSES—Thin glacial sediment draped over Quaternary and in places Tertiary and Cretaceous sediment or rock that has been deformed into thrust slabs or folds near the glacier margin during the last glacier advance

Qcm GLACIAL SEDIMENT ON SUBGLACIALLY MOLDED SURFACES—Thin glacial sediment draped over Quaternary and in places Tertiary and Cretaceous sediment or rock that has been molded into streamlined hills, ridges and grooves beneath the glacier during the last glacial advance

Qcew WAVE-ERODED GLACIAL SEDIMENT—Glacial sediment with flat to gently undulating topography resulting from wave erosion; covered by a thin gravel lag in places

Qcer RIVER-ERODED GLACIAL SEDIMENT—Glacial sediment with flat to undulating topography resulting from stream erosion in the bottoms of large melt-water channels; overlain by a thin layer of fluvial sediment of the Coleharbor or Oahe Formations in some places

Qces SLOPEWASH-ERODED GLACIAL SEDIMENT—Glacial sediment on the sides of small Holocene valleys eroded by sheetwash and other hillslope processes

QTu **QUATERNARY AND UPPER TERTIARY SEDIMENT, UNDIVIDED**—Largely river sediment; includes upper Quaternary terrace, fan, and pediment gravel composed of subangular pebbles and cobbles of locally-derived material such as sandstone, silicified wood, and concretions and Pliocene(?) to middle(?) Quaternary clay, silt, sand, and gravel composed of rounded pebbles and cobbles of quartzite and porphyry derived from the Black Hills or Rocky Mountains; as thick as 100 meters (300 feet)

Tm **UPPER AND MIDDLE TERTIARY ROCK, UNDIVIDED**—Butte caprock consisting of fluvial or lacustrine sandstone or limestone of Oligocene, Miocene, or Pliocene age; may include the White River Group in some areas; as thick as 120 meters (400 feet)

Tw **WHITE RIVER GROUP (OLIGOCENE)**—Brule Formation: Pinkish siltstone, clay, and sand; river and lake sediment; as thick as 50 meters (150 feet). Chadron Formation: Light-colored sand with quartzite and porphyry pebbles, overlain by dark clay; river and lake sediment ; as thick as 30 meters (100 feet)

Tg **GOLDEN VALLEY FORMATION (EOCENE AND PALEOCENE)**—Upper member: Yellow-brown micaceous sandstone, sand, silt, and clay; fluvial sediment; as thick as 60 meters (200 feet). Lower member: White or yellow clay, silt, and sand; a weathering zone developed on underlying unit; as thick as 20 meters (65 feet)

Ts **SENTINEL BUTTE FORMATION (PALEOCENE)**—Gray-brown silt, sand, clay, sandstone, and lignite; river, lake, and swamp sediment; as thick as 200 meters (600 feet)

Tb **BULLION CREEK FORMATION (PALEOCENE)**—Yellow-brown silt, sand, clay, sandstone, and lignite; river, lake, and swamp sediment; as thick as 200 meters (600 feet)

Tp **SLOPE FORMATION (PALEOCENE)**—Gray-brown and yellow-brown silt, sand, clay, sandstone, and lignite; river, lake, and swamp sediment; as thick as 100 meters (300 feet)

Tc **CANNONBALL FORMATION (PALEOCENE)**—Olive-brown sand, shale, and sandstone; marine shoreline and offshore sediment; as thick as 120 meters (400 feet)

Tl **LUDLOW FORMATION (PALEOCENE)**—Gray-brown and yellow-brown silt, sand, clay, sandstone, and lignite; river, lake, and swamp sediment; as thick as 100 meters (300 feet)

Kh **HELL CREEK FORMATION (UPPER CRETACEOUS)**—Gray sand, silt, clay, and sandstone; river sediment; as thick as 150 meters (500 feet)

Kf **FOX HILLS FORMATION (UPPER CRETACEOUS)**—Olive-brown sand, shale, and sandstone; marine shoreline and offshore sediment; as thick as 120 meters (400 feet)

Kp **PIERRE FORMATION (UPPER CRETACEOUS)**—Dark-gray shale; marine offshore sediment; maximum outcrop thickness is a few hundred meters

Kn **NIOBRARA AND CARLILE FORMATIONS, UNDIVIDED (UPPER CRETACEOUS)**—Niobrara Formation: light-brown to dark-gray calcareous shale; offshore marine sediment; maximum outcrop thickness is 45 meters (150 feet). Carlile Formation: dark-gray shale; marine offshore sediment; maximum outcrop thickness is 30 meters (100 feet)

Crest of beach ridge or scarp (tick-marks point lakeward)

Low ridges and shallow grooves made by floating lake ice or icebergs dragging bottom in areas of offshore sediment

Crests of transverse glacial ridges

Crest of longitudinal glacial ridges

Conspicuous ring-shaped hummocks in collapsed supraglacial sediment

Relict permafrost polygons

Large blowout depression

Ls Landslides

Spring pits, west and north of Grand Forks

Badland topography, overprints Tertiary map units as shown in boxes

Low ridge resulting from compaction of offshore sediment around enclosed fluvial sand and gravel bodies and low ridge resulting from the draping of thin glacial sediment over older ridge such as an esker or a streamlined glacial ridge

Large abandoned river channel (includes large melt-water channels), partly buried by glacial sediment

Small abandoned river channel (includes small melt-water channels), partly buried by glacial sediment

Southwestern limit of scattered glacial boulders

Ice-margin position, dashed where uncertain

Large abandoned river channel (includes large melt-water channel)

Small abandoned river channel (includes small melt-water channel)

Esker or ridge resulting from topographic inversion due to resistance of fluvial sediment to erosion

MAP COMPILATION

This map shows the surface geology of North Dakota. For the Tertiary and Cretaceous units, descriptive lithology is emphasized; each formation is indicated by a different color. In the Quaternary units, interpretive and descriptive sedimentology and geomorphology are emphasized; each type of sediment or topography is indicated by a different color.

The immediate predecessors of this map are the maps by Colton and others (1963) and Carlson (1969). Colton and others' map shows the Quaternary deposits of North Dakota at a scale of 1:500,000. Carlson's map shows the surface Tertiary and Cretaceous units, in addition to the units beneath the Quaternary deposits, at a scale of 1:1,000,000. A less detailed version of the present map, showing Quaternary, Tertiary, and Cretaceous units, has been prepared by Bluemle (1977), at a scale of 1:1,000,000.

Most of the published geologic maps consulted are listed by McIntosh and Elster (1977). In addition, extensive use was made of unpublished geologic maps of most parts of the State by Clayton, Bluemle, Carlson, and Moran. The extent of the Golden Valley Formation is in part from an unpublished map by Leo J. Hickey (1966, The paleobotany and stratigraphy of the Golden Valley Formation in western North Dakota: Princeton University dissertation, 265 p.). Soil maps of every county, published at a scale of 1:127,000 (Patterson and others, 1968), provided additional lithologic and topographic information.

All geologic contacts were refined using 1:65,000 scale airphoto stereo pairs. Photos used in the eastern half of the State were taken by the Army Map Service in 1952, and those used in the western half were taken by Aero Service Corporation in 1951, 1952, and 1953.

Clayton and Moran (1974) have described the glacial features shown on this map. A detailed discussion of all aspects of the map will appear in an explanatory text to be published by the North Dakota Geological Survey.

REFERENCES

Bluemle, J. P., 1977, Geologic highway map of North Dakota: North Dakota Geological Survey Miscellaneous Map 19, 1:1,000,000

Carlson, C. G., 1969, Bedrock geologic map of North Dakota: North Dakota Geological Survey Miscellaneous Map 10, 1:1,000,000

Clayton, Lee, and Moran, S. R., 1974, A glacial process-form model, p. 90–119, in Coates, D. R. (editor), 1974, Glacial geomorphology: Binghamton, State University of New York, 398 p.

Colton, R. B. and others, 1963, Preliminary glacial map of North Dakota: U.S. Geological Survey Miscellaneous Investigations Map I-331, 1:500,000

McIntosh, W. L., and Elster, M. F., 1977, U.S. Geological Survey Geologic map index of North Dakota.

Patterson, D. D. and others, 1968, Soil survey report, county general soil maps, North Dakota: North Dakota State University, Agricultural Experiment Station Bulletin 473, 150 p. (including 53 county soil maps, 1:127,000).

For sale by Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225

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