

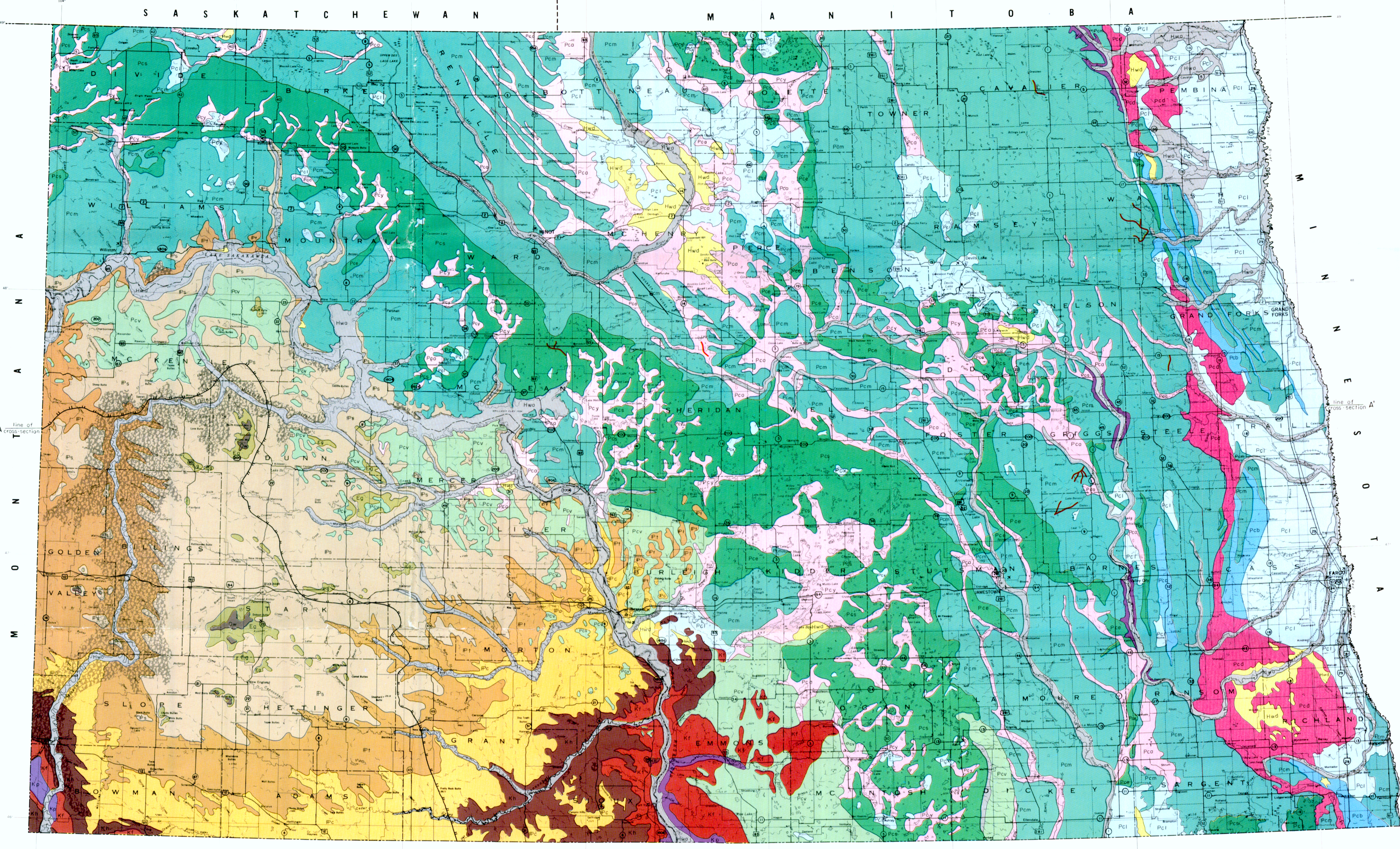
GEOLOGIC HIGHWAY MAP OF NORTH DAKOTA

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North Dakota Geological Survey
E. A. Noble, State Geologist

Educational Series 11
Miscellaneous Map 19



EXPLANATION

In some places, such as in badlands and in hilly areas covered by glacial deposits, the geologic materials indicated on the map may be seen at the surface of the ground. In many level areas however, soil completely covers the indicated geologic materials to a depth of several feet.

The composition, origin, and typical surface expression of each of the map units are included in the explanation. In all cases, the capital letter designation refers to the age of the unit. The first lower case letter identifies the formation or group and the second lower case letter (where applicable) identifies a particular type of lithology or topography that can be recognized within the formation or group.

- Holocene**
 - Walsh Group**
 - HwS** Silt and fine sand; coarse sand in places; considerable organic detritus in places. River and stream alluvium or slopewash that has been intermittently deposited since the Pleistocene Epoch. Mainly level floodplains found along the larger streams and rivers.
 - HwD** Sand. Hilly areas of windblown dunes with 50 to 75 feet of local relief. The dunes may shift during periods of drought.
 - Coleharbor Group**
 - PcL** Flat-bedded clay, silt, and sand. Lake sediment. Level areas (PcL) are the former floors of lakes of glacial meltwater. Hilly topography (PcX) resulted when glacial lakes flooded areas of stagnant glacier ice, which later melted and collapsed resulting in an irregular surface.
 - PcB** Gravel and sand, commonly clean and well-sorted. Beach and shore sediment that was deposited along the shores of Lake Agassiz. Well-developed beach ridges occur in places, but in other places, the shore sediment is simply a sheet of sand and gravel with little relief. Similar shore sediment occurs in places along other glacial meltwater lakes in North Dakota, but it is too limited to show on a map of this scale.
 - PcD** Gravel and sand, commonly silty and poorly sorted. Outwash sediment that was deposited by water flowing from melting glaciers as well as by runoff from precipitation that occurred while the glaciers were melting. Commonly broad, flat plains (PcA) except in places where the materials were deposited on top of stagnant glacier ice, where an irregular surface (PcY) resulted when the ice melted causing the gravel and sand to slump down.
 - PcG** Gravel and sand, commonly silty and poorly sorted. Delta sediment that was deposited where rivers emptied into glacial lakes. Topography ranges from flat plains to hilly windblown dunes.
 - PcM** Unsorted mixture of clay, silt, sand, cobbles, and boulders (till). Hilly topography. Glacier sediment that accumulated at the margin of a glacier (PcE refers to "end moraine") or was deposited from stagnant glacier ice as it melted (PcS refers to "dead-ice moraine"). Deposited in sufficient amounts to mask pre-existing topography.
 - PcN** Unsorted mixture of clay, silt, sand, cobbles, and boulders (till). Nearly level to gently rolling topography commonly referred to as "ground moraine." Glacier sediment deposited directly by the glacier in sufficient amounts to mask pre-existing topographic features.
 - PcV** Unsorted mixture of clay, silt, sand, cobbles, and boulders (till); consists only of scattered boulders in places. Rolling to hilly topography. A discontinuous veneer of glacier sediment on pre-Pleistocene formations; the veneer does not greatly alter the pre-existing topography.
- Oligocene**
 - White River Group**
 - WpS** Pinkish siltstone and dark clay with some sand and freshwater limestone; silty bentonitic claystone; pebbly in places. Lake and river sediment. Commonly found on hills and buttes.
- Eocene**
 - Golden Valley Formation**
 - GvS** Bright-colored, yellowish clayey and sandy layers. Lake and river sediment. Commonly found on hills, along the sides of buttes, and over upland areas.
 - Sentinel Butte Formation**
 - SbS** Dull gray layers of silt, clay and sand with interbedded sandstone, lignite, baked clay, and limestone. Delta, lake, and river sediment. Forms rolling topography over broad areas and has been eroded to badlands near rivers.
 - Bullion Creek Formation**
 - BcS** Yellowish layers of silt, clay, and sand with interbedded sandstone, lignite, baked clay, and limestone. Delta, lake, and river sediment. Forms rolling topography over broad areas and has been eroded to badlands near rivers.
 - Ludlow and Cannonball and Slope Formations (undifferentiated)**
 - LcS** Yellowish gray to brown (Ludlow) or drab brownish gray (Slope) beds of sandstone and unthified clay, silt, sand and lignite (Ludlow and Slope) and yellowish sandstone and mudstone with some limestone (Cannonball). Ludlow and Slope: delta, lake and river sediment; Cannonball: tidal flat, estuary, shore, and offshore marine sediment. Gently rolling topography.
- Palaeocene**
 - Hell Creek Formation**
 - HcS** Dark gray maroon, bentonitic clay, shale, and gray to light-colored sand and silt; concretions and fossil dinosaur bones in places. Delta, lake and river sediment. Forms rolling topography in most places, but has been eroded to badlands near buttes and along rivers.
 - Fox Hills Formation**
 - FhS** Brown to gray shale and sandstone with loose sand in places; fossil oysters and clams common. Mainly marine coastal sediment. Forms rolling topography with smooth slopes in most places.
- Cretaceous**
 - Carlile, Niobrara, and Pierre Formations (undifferentiated)**
 - Cp** Carlile: dark gray shale (exposed only in the Pembina River valley in the northeastern corner of the state); Niobrara: calcareous, medium gray shale (exposed only in eastern North Dakota); Pierre: light gray to medium gray shale with ironstone concretions. All three formations are offshore marine sediments. Topographic expression is limited mainly to isolated exposures along river valleys.

MISCELLANEOUS SYMBOLS

- Compaction ridge.** Ridge on the Lake Agassiz plain that marks the former route of a river; usually gravel or sand.
- Drumlin.** Ridge that formed parallel to the glacier movement; usually glacier sediment, but may be other material.
- Esker.** Long, narrow, sinuous ridge of stratified glacier sediment, usually gravel, deposited by a stream that flowed on, within, or beneath the glacial ice.
- Badlands.** Areas dissected by stream erosion into an intricate system of closely spaced, narrow ridges.
- Maximum extent of glaciation.**
- Slough.**
- Surface elevation.**

