Geologic Investigations No. 12 Revised
North Dakota Geological Survey
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GEOLOGY OF THE FARGO NORTH QUADRANGLE

2005

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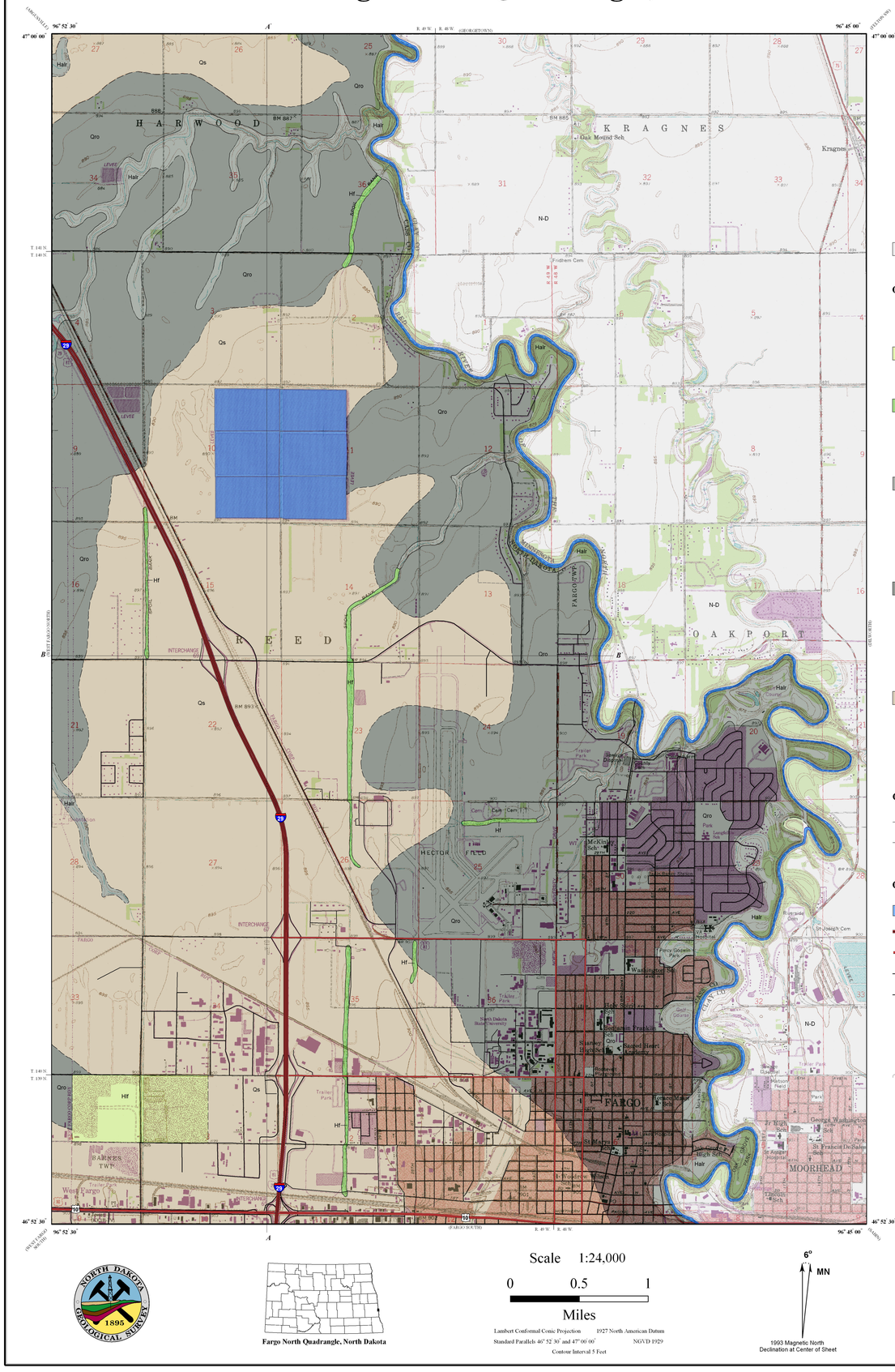
North Dakota Geological Survey
Edward C. Murphy, Acting State Geologist

Surface Geology
Fargo North Quadrangle, North Dakota

Fred J. Anderson
2005



EXPLANATION

N-D No Data

QUATERNARY SYSTEM

HOLOCENE

Hlf **Landfill Materials**
Area of the City of Fargo municipal solid waste landfill.

Hf **Fill**
Cut/Fill materials consisting dominantly of silts, clays, and sands from adjacent nearsurface formations placed by artificial means.

OAHE FORMATION

Halr **Red River Alluvium**
Channel alluvium reworked and deposited by the Red River during recent flow and flooding events. Consists of brown to gray bedded sands, silts, gravels, and clays. Constrained to areas within the Red River floodplain and along adjacent tributary drainages. Prone to slope failure and cutbank erosion.

PLEISTOCENE

Qro **River Sediment (Overbank)**
Clay, silt, sand, and disseminated organic debris, obscurely bedded; dark colored; in many places associated with sand and gravel of older river channel sediment; commonly more than a meter (3 feet) thick. Deposited on ancient rivers on the Lake Agassiz Plain.

COLEHARBOR GROUP

Qs **SHERACK FORMATION**
Glaciolacustrine, yellow gray, thinly laminated silt, clay, and silty clay. Generally the most ubiquitious surface lithostratigraphic unit within the quadrangle. Deposited as offshore sediments of Glacial Lake Agassiz. Commonly more than 25 feet thick.

Geologic Symbols

Known contact between two geologic units

Approximate contact between two geologic units

Other Features

Water

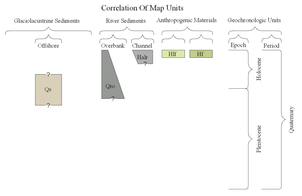
Interstate Highway

US Highway

Paved Road

Unpaved Road

Correlation Of Map Units



Scale 1:24,000

0 0.5 1

Miles

Lambert Conformal Conic Projection 1927 North American Datum
Standard Parallels 46° 52' 30" and 47° 00' 00" NGVD 1929
Contour Interval 5 Feet

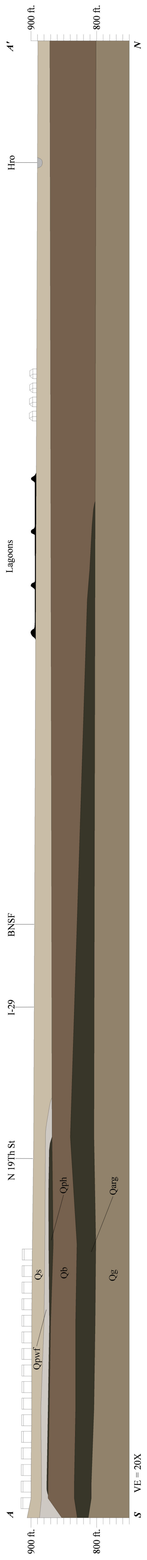
Fargo North Quadrangle, North Dakota

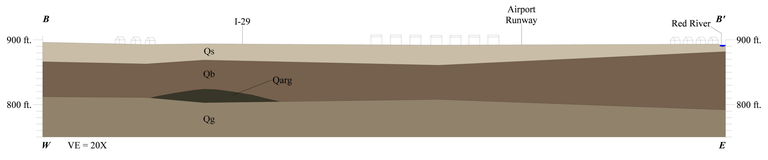
6° MN

1993 Magnetic North
Declination at Center of Sheet

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program.

Cartographic Compilation: Elroy L. Kademas





Geologic Units Depicted in Cross-Section

Qs **SHERACK FORMATION** - Glaciolacustrine, yellow gray, thinly laminated silt, clay, and silty clay. Generally the most ubiquitious surface lithostratigraphic unit within the quadrangle. Deposited as offshore sediments of Glacial Lake Agassiz. Commonly more than 25 feet thick.

Qb **BRENNA FORMATION** - Glaciolacustrine, brown to very dark-gray, slightly laminated to unbedded, clay, and silty clay, soft white and pink calcareous nodules abundant locally, slickensides common, soft to very-stiff. Deposited as offshore sediments of Glacial Lake Agassiz. Commonly more than 60 feet thick.

Qpwf **POPLAR RIVER FORMATION, West Fargo Member** - Sand, silt, some gravel; yellow brown to light-gray, laminated, crossbedded, contains shell and wood fragments, peat and dispersed organics. Deposited as fluvial channel and center-channel overbank sediment of Late Wisconsinan Age.

Qph **POPLAR RIVER FORMATION, Harwood Member** - Clay and silty clay; dark grayish brown-dark gray; mottled; mealy structure common; very stiff. Deposited as fluvial overbank sediment.

Qarg **ARGUSVILLE FORMATION, Offshore Lacustrine Sediment** - Silty clay, clay, sand; gray-dark-gray; massive, clay stringers, silt and pebble loam inclusions; gritty appearance; stiff to very-stiff. Deposited as offshore lacustrine sediment of Late Wisconsinan Age.

Qg **GLACIAL SEDIMENT** - Gray to dark-gray silty pebble loam. Sediment deposited by glacial ice of Late Wisconsinan age?

FLOODING

View to the north along North Elm Street in Fargo. High water levels in the Red River encroaching upon and in many cases shutting down convenient local transportation routes. Seasonal flooding along the banks of the Red River provides for an increase in overall cutbank meander instability and erosion through repeated seasonal saturation. Repeated fluctuation of high and low water levels along the entire river results in the repeated cycle of wetting and drying which further produces structurally weak bank materials.

SHERACK FORMATION

Outcrop of Sherack Formation laminated silty clays along a tributary drainage of the Red River of the North just north of the City of Fargo. The well developed laminae of silts and clays deposited in the offshore depositional environment of Glacial Lake Agassiz and subvertical fracturing developed within this unit are visible. The Sherack Formation is typically the first geologic unit encountered beneath the soil profile throughout the area. Note the rock hammer for scale.

CUTBANK EROSION

View to the southwest of failed bank along a cutbank meander of the Red River located north of the City of Fargo, North Dakota. Note the presence of a well defined failure scarp and coherent vegetated slump mass with subvertically orientated trees. The upper Sherack Formation sediments are visible along the cutbank.

BRENNA FORMATION

Brenna Formation slickensided clay uncovered at the City of Fargo, North Dakota landfill during excavations for new waste cell construction. The Brenna Formation consists of smectitic clays that were deposited in the offshore depositional environment of Glacial Lake Agassiz. The Brenna Formation is structurally weak and presents considerable engineering challenges in the near surface throughout the Red River Valley. The Brenna Formation is conformably overlain by the Sherack Formation and is present throughout the subsurface in the area. Note the camera lens cap for scale. (Image by Dr. Don Schwert, NDSU).

UNSTABLE SOILS

Historic photographic view of the failure of the Fargo Grain Elevator in 1955. Construction of the grain elevator on the Lake Agassiz floodplain presented an unknown engineering challenge. Subsoil conditions were unfavorable for the supporting of considerable structural loads such as those created by the elevator. The plastic nature of the underlying clays, deposited as offshore glacial lake sediments on floor of Glacial Lake Agassiz approximately 9000 years before, will not accommodate significant structural loads. Footings were completed within these highly unstable clays, which when the elevator was in use and subject to increased loading over time, resulted in the ultimate failure of the subsoils and subsequent failure of the structure (Photo from the Institute for Regional Studies, NDSU).

BANK FAILURE

View to the southeast along the western edge of the Red River floodplain in north Fargo. Cutbank erosion and slope instability has resulted in the failure of slope materials in this area in close proximity to new residential developments. Note the presence of a well defined failure scarp and orientation of tree growth within the main slumped block. Smaller less developed tensional features can be seen adjacent to the main scarp showing separation within upper soil materials. Behind this (moving from east to west) less developed long linear tensional features can be observed. Over time the entire bank up to the berm line will fail and slump towards the river.

GEOLOGY OF THE FARGO NORTH QUADRANGLE

The geology depicted on this map represents the surficial and near-surface geology of the Fargo North Quadrangle. The geologic units present consist dominantly of offshore glaciolacustrine sediments, deposited in the offshore regions of proglacial Lake Agassiz around 12,000 years ago, and alluvial channel and overbank sediments of the Red River. Prior to the formation of Glacial Lake Agassiz the advance and retreat of glacial ice deposited a blanket of subglacial till which forms the base geologic unit of the near surface geology described here. During glacial retreat and the contemporaneous formation of Glacial Lake Agassiz, deposition of offshore silts, clays, and silty-clays of the Sherack Formation **(Qs)** was initiated around 11,000 years before present (b.p.). During successive glacial retreat the waters of Glacial Lake Agassiz retreated which resulted in the formation of many of the ancient and current drainages that contribute flow to the Red River. The Red River serves to drain the central portion of the Red River Valley and over time has incised into the offshore glacial lake sediments through a meandering pattern. Seasonal flooding, occurring dominantly in the spring, but subject to local high precipitation events of significant magnitude and duration, delivers a considerable amount of fluvial sediments to the overbank areas within the floodplain and adjacent tributary drainages.

The stratigraphic framework within this quadrangle consist dominantly of geologic units deposited as a result of glacial activity. The lowermost unit depicted here consists of subglacial sediment **(Qg)** composed of clay matrix supported diamicton sediments deposited in a subglacial environment by glacial ice advance during late Wisconsinan time. These subglacial sediments are overlain by offshore sediments of Glacial Lake Agassiz consisting of (from oldest to youngest) the Argusville Formation **(Qarg)**, Brenna Formation **(Qb)**, Poplar River Formation **(Qp)**, consisting of the West Fargo **(Qpwf)** and Harwood **(Qph)** Members, and the Sherack Formation **(Qs)**. Red River Valley overbank sediments **(Qro)** mantle the offshore deposits. **(Halr)** consisting of reworked Sherack and Red River overbank sediments **(Qro)** mantle the offshore deposits. Other Quaternary age alluvium contained within older drainages **(Qal)** is also depicted. Anthropogenic materials of recent age consisting of engineered fill **(Hf)** and landfills **(Hlf)** are depicted. Geologic units present within the quadrangle below the Sherack Formation occur within the shallow subsurface only or within periodically inundated riverbank exposures of the Red River (Sherack and Brenna Formations) and subsequently are depicted in cross-section only.

The nature of the sediments and stratigraphic relationships of the offshore lacustrine units of the Sherack and Brenna Formation exhibit considerable engineering and environmental geologic conditions consisting dominantly of problems of foundation stability and river bank erosion and stability along the Red River. Four specific types of geologic conditions have been documented with the Red River Valley and are present within the map area: elastic deformation of clayey glaciolacustrine soils, shrink-swell properties, and inadequate bearing capacity and mass movements. Plastic deformation of clay rich soils of the Brenna Formation occurs across the majority of the map area. The Brenna Formation is the first continuous subsurface lithostratigraphic geologic unit that underlies the entire Fargo area. A review of the Depth to Brenna Formation isopach map reveals an average depth of 20 feet across the quadrangle. The unit is generally thicker in the central portion of the map area and appears to fill in a "channel" formed on the underlying subglacial sediments. Depth to bedrock is generally around 200 feet below land surface and is generally deeper in the center of the quadrangle.

Lithologic information was obtained from excavations, roadcuts, hand auger and shovel borings, and near-surface drilling, well and deep hole test drilling information obtained from the North Dakota Geological Survey, North Dakota State Water Commission, North Dakota Department of Transportation, United States Geological Survey, North Dakota Department of Health, The United States Army Corps of Engineers (USACE) and boring log information contained in publicly available public works projects. The spatial orientation of available boring data is dominantly located near urbanized areas and near the banks of the Red River. Initial geologic mapping was conducted from 1953 aerial photography at a scale of 1:40,000 followed by near surface drilling and field mapping conducted during the 2004 and 2005 field seasons.

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