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GEOLOGY OF THE GRAND FORKS QUADRANGLE

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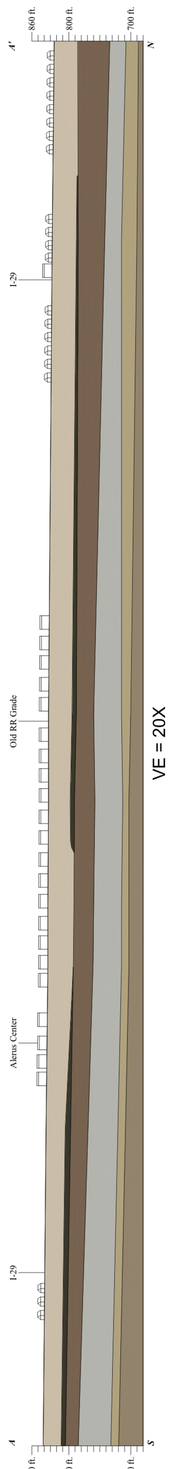

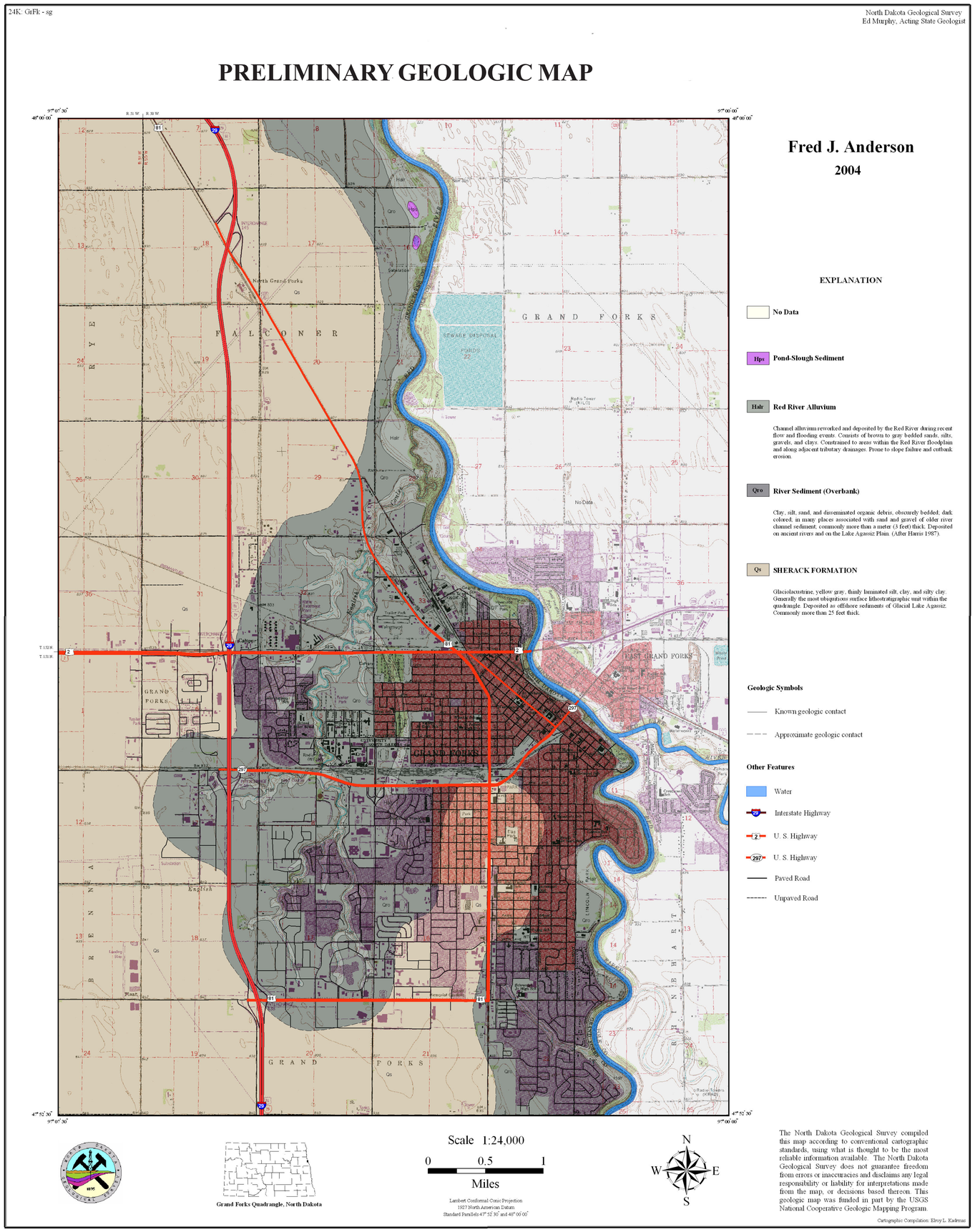

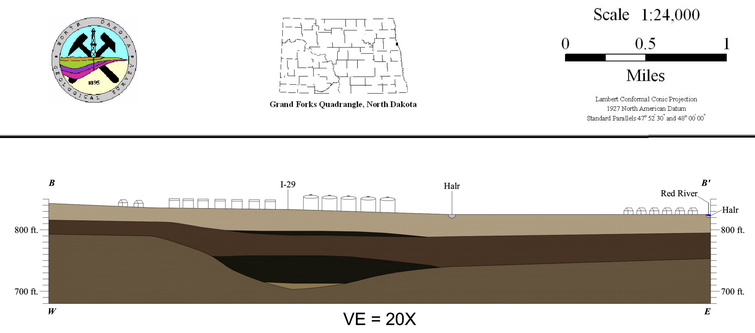

FLOODING

View to the west of the Sorlie Bridge in Grand Forks from the East Grand Forks side of the Red River. Seasonal flooding of the Red River in 2001 creates dangerous high water levels throughout the city of Grand Forks. With these seasonal overbank events the Red River delivers a significant amount of fine grained sediments (muds) to the areas reached by the high water levels. This presents a nuisance in some locations. Repeated high water level serve to weaken the bearing capacity of near-surface geologic materials (Photo by Bluemle).

DRAINAGE

View to the south along drainageway north of US HWY 2 in western Grand Forks. Excavation of surficial sediments within the Grand Forks Quadrangle for the purposes of the creation of drainage way volume for increased flood capacity in and around the City of Grand Forks has been conducted at this location. Surficial soils and sediments of the Sherack Formation are present along the channel slopes. Repeated inundation of the channel results in the continued deposition of fine grained sediments that are reworked and redeposited by continued drainage. Recent water levels can be observed as evidenced by scarps (oriented horizontally running the length of the channel) developed into the channel slopes. Highest recent water level is observed by the highest disturbed area (Photo by Anderson).

WASTE MATERIALS

View to the north along English Coulee of artificial fill and exposed garbage. Contact between light gray colored sediments (artificial fill materials) and underlying soils of the original surface contact is displayed in this image. Bank failure has occurred along this section of the drainage way as unconsolidated fill materials are generally easily eroded. Fill materials and garbage are able to collapse into the drainage and make their way into the Red River flow system (Photo by Anderson).

RED RIVER BANK SEDIMENTS

View of exposure of alluvial sediments deposited within the Red River channel as terrace deposits. Cyclic nature of vertical sediment succession consisting of brown sands and gravels overlain and interbedded with overbank fines consisting of gray silts and clays. These sediments are continually reworked by fluvial action within the Red River. Unconsolidated (loose) nature of these sediments make them prone to slope failure and cutbank erosion along the channel walls (Photo by Anderson).

RIPPLE MARKS

Close view of overbank fines and current ripple marks exhibited within Red River sediments after deposition and drainage of recent high water within the Red River. Fine grained sediments (muds) are beneficial for agricultural production but in the urban setting can be problematic to deal with in sufficient quantities. Parallel waveforms are oriented perpendicular to water flow. Sedimentary structures such as these are good indicators of past (paleo) depositional environemtns and flow patterns (Photo by Anderson).

SHERACK FORMATION

Macroscopic view of surficial geologic sediments of the Sherack Formation obtained via soil probing investigations within the Grand Forks Quadrangle. Sediments consist of gray-brown (10YR6/3) thinly laminated silty-clay, moderately dense, cohesive, and heavily oxidized with 30% limonitic concretions and staining (iron rich) throughout (Photo by Anderson). Rule is graduated in centimeters on the left and inches on the right for scale (Photo by Anderson).

GEOLOGY OF THE GRAND FORKS QUADRANGLE

The geology depicted on this map represents the surficial geology of the area contained within the Grand Forks Quadrangle by lithostratigraphic unit. The surficial units present consist dominantly of offshore glaciolacustrine sediments, deposited in the offshore regions of the proglacial lake Agassiz around 12000 years ago, and alluvial channel and overbank sediments associated with the Red River. During the formation of Glacial Lake Agassiz, deposition of offshore silts, clays, and silty-clays of the Sherack Formation (**Qs**) took place around 9,000 years before present (b.p.) During successive glacial retreat the waters of Glacial Lake Agassiz retreated and resulted in the formation of the remaining drainage ways that today are exhibited as the Red River. The Red River serves to drain from the central portion of the Red River Valley and over time has incised into the offshore glacial lake sediments. Seasonal flooding, occurring dominantly in the Spring, but subject to local high precipitation events of significant magnitude and duration, delivers fluvial sediments to the overbank areas within the floodplain and tributary drainages.

The stratigraphic framework within the Grand Forks Quadrangle consists of clay matrix supported diamicton sediments of the Agrusville Formation (**Qa**) deposited in a subglacial environment by glacial ice advance around during late Wisconsinan time. These subglacial sediments are overlain by offshore lacustine sediments of the Wylie Formation (**Qw**). Overlying the glaciolacustrine sediments of the Wylie Formation are glacial till sediments of the Falconer Formation (**Qf**). Overlying the subglacial sediments of the Falconer Formation are the offshore lacustrine sediments of Glacial Lake Agassiz consisting of (from oldest to youngest) the Brenna Formation (**Qb**) the Harwood Member of the Poplar River Formation (**Qph**) and the Sherack Formation (**Qs**). Red River Valley alluvial sediments (**Halr**) consisting of reworked Sherack and Red River overbank sediments (**Qro**) mantle the offshore deposits. Other Quaternary age alluvium contained within other pre-existing drainages (**Qal**) is also depicted. Recent age engineered fill areas (Hf) are depicted and are dominantly related to drainage-way improvements associated with flood improvement projects in the Grand Forks area. Lithostratigraphic units below the Sherack Formation are present within the shallow subsurface only or within periodically inundated riverbank exposures of the Red River (Brenna Fm.) 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, inadequate bearing capacity and mass movements. Elastic deformation of clay rich soils of the Brenna Formation will occur across the majority of the map area. The Brenna Formation is the first continuous subsurface lithostratigraphic geologic unit that underlies the entire area. A review of the Depth to Brenna Formation Isopach map reveals an average depth of – feet across the quadrangle. The unit is generally thicker in the central portion of the map area and appears to form within 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, and boring log information contained in publicly available public works projects. The spatial orientation of available data is dominantly located near urbanized areas. 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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