Lithostratigraphy and hydrostratigraphy of the Alexandria moraine, Otter Tail County area, west-central Minnesota

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The Minnesota Geological Survey and Minnesota Department of Natural Resources, Division of Waters (DNR-W) are jointly producing the Otter Tail Regional Hydrogeologic Assessment (OT RHA). The Alexandria moraine trends from northwest to southeast across the study area. It is cored by Rainy lobe deposits that are buried by sediment deposited by multiple advances of the Red River ice stream. Geologic mapping has expanded our understanding of the sequence of surge-like ice advances, their depositional extent, and the hydrostratigraphy of the Alexandria moraine.

Surficial mapping, test drilling, and outcrop examination provided information necessary to interpret the near-surface lithostratigraphic setting. This information included samples derived from Rotasonic cores (3 test holes; ~600 ft of core), soil probe borings (~360 test holes), and outcrop descriptions. Computer assisted interpretation of nearly 900 textural and lithologic sample sets were used to characterize tills. Otter Tail RHA interpretations were combined with the results of the Red River Valley Regional Hydrogeologic Assessment (RRV RHA) and other regional studies to develop the near-surface lithostratigraphic model (Figs. 1 & 2).

Thirteen near-surface lithostratigraphic units were identified and placed in seven groups based on textural and lithologic attributes and stratigraphic position. Four of the groups are present on the surface of the Alexandria moraine, and three are confined to the subsurface.

Eighteen computer assisted regional cross sections were generated from water-well data and surficial geologic maps. Older layers of Rainy lobe till were correlated based on similarities in elevation and the assumption that associated sand layers represented boundaries between successive glacial advances. The presence of oxidized till was also used to delineate till boundaries. Correlations at the intersections of the cross sections were made consistent to create a three-dimensional picture of the stratigraphic setting in the eastern portion of the region.

Using a GIS platform (ARCVIEW) and working interactively with the cross-section network, sand intervals from each well log in the eastern portion of the study area were assigned a stratigraphic label. Sand thickness (or absence of sand) for each well was plotted on separate maps for the three uppermost stratigraphic units. Sand distribution maps were then drawn by hand using a fluvial depositional model (Figs. 3 & 4).

Buried sand distribution maps are useful for understanding well interference problems, water supply problems, and constructing numerical flow models. Surface and near-surface geologic maps are currently being used by the DNR-W to construct conceptual models of groundwater/lake-water interactions and a pollution sensitivity model of the water table.
**Figure 1.** Generalized lithostratigraphic map of the Otter Tail study area, Red River Valley study area (RRV RHA), and adjacent area. Cross section A-A' shown on Figure 2.

**Figure 2.** Generalized cross section through the Red River valley and Alexandria Moraine, eastern North Dakota and west-central Minnesota.
Figure 3. Buried sand and gravel deposits (over 20 feet thick) are shown with the water well records used. Channel complexes occur in the three noted elevation ranges. The Otter Tail group ice margin marks the eastern limit of the northwestern-source drift. Map shows county boundaries in the eastern half of the OT RHA study area.
Figure 4. Channel complexes of Figure 3 may have been associated with the sand plains shown. Dashed lines represent possible receding ice margins (1, 2, and 3) associated with the sand plains. Ice margins 1 and 2 match well with the drumlin pattern. Map shows county boundaries in the eastern half of the OT RHA study area.