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MISCELLANEOUS MAP SERIES
MAP M-112
Surficial Geology, Brainerd Quadrangle

# SURFICIAL GEOLOGY OF THE BRAINERD QUADRANGLE, CROW WING COUNTY, MINNESOTA

by

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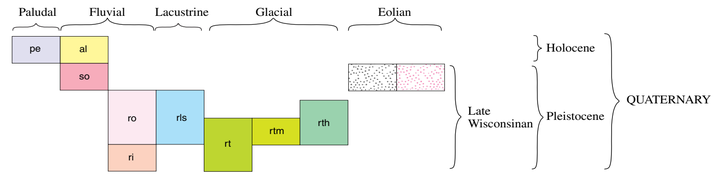
2001

## CORRELATION OF MAP UNITS




## DESCRIPTION OF MAP UNITS

This map of the Brainerd quadrangle shows the surface distribution of Quaternary sediments. It was constructed using aerial photographs from 1977 (1:80,000 scale), U.S. Soil Conservation Service soil-survey maps for Crow Wing County (Arneman and others, 1965), and field work conducted during 2000 and 2001, which included observations, descriptions, and samples from shallow auger borings (generally less than 20 feet [6 m] deep), roadcuts, outcrops, and construction exposures. Additional information from previous nearby mapping projects (Schneider, 1961; Goldstein, 1985; Mooers, 1988) was used for interpretation.

### HOLOCENE

al — **Floodplain alluvium**—Sorted gravel, sand, and silt deposited by modern rivers in channels, and as overbank and slackwater deposits. Deposits may contain organic debris disseminated in the sediments and in discrete beds.

pe — **Organic deposits**—Shallow- and ponded-water sediments consisting of peat and organic-rich materials. Typically found in depressions; some deposits have been drained, and in the town of Brainerd, filled. Many peatlands occupy swales among drumlins, others occupy depressions formed by melting stagnant ice.

### PLEISTOCENE

**Deposits of the Superior lobe**

so — ***Outwash***—Fluvial sand and gravel deposited by meltwater streams that drained the Mille Lacs moraine of the Superior lobe (Wright, 1972). Somewhat richer in Superior provenance red volcanic rocks and red sandstone than the Rainy lobe deposits of this quadrangle. The red grains range from 9 to 13 percent of the 1 to 2 millimeter size sand-grain fraction (Hobbs, 1998), and the dark grains range from 17 to 21 percent. Only present in the extreme southeastern corner of the map.

**Deposits of the Rainy lobe**—Glacial till, glaciofluvial, and lacustrine sediments of the Rainy lobe (Wright, 1972), which advanced from the northeast. Deposits are commonly deeply leached of carbonate materials, and contain less than 5 percent carbonate even where unleached. Red sandstone and volcanic rocks commonly compose 6 to 14 percent of the 1 to 2 millimeter size sand-grain fraction (Hobbs, 1998) of till and glaciofluvial sediments. The same size fraction commonly contains 14 to 26 percent dark grains, which are mostly mafic igneous and fine-grained metamorphic rocks. The rest of the grains are almost all granite fragments.

rls — ***Lacustrine deposits of Glacial Lake Brainerd*** (Mooers, 1988)—Well-sorted, fine- to medium-grained, noncalcareous sand. Locally contains interbedded, calcareous, fine-grained sand, silt, and clay layers at depths of more than 10 feet (3 m). Deposited on and around partially buried ice blocks left by the retreating Rainy lobe. These ice blocks subsequently melted following drainage of Glacial Lake Brainerd, leaving depressions in the landscape, which are lakes today. Capped by eolian sand that commonly forms dunes (see Map Symbols). Glacial Lake Brainerd formed after active ice of the Rainy lobe retreated east of the area, but before the present day Mississippi River channel opened up—stagnant or active ice probably blocked meltwater drainage to the south. As this ice melted and Glacial Lake Brainerd drained, the initial downcutting of the present Mississippi River valley began (Mooers, 1988).

ro — ***Valley train and outwash deposits***—Fluvial sand and gravel deposited by meltwater streams that drained melting Rainy lobe ice. Bedding is locally disrupted because the outwash was deposited on stagnant ice in places, which later collapsed. Interdrumlin outwash is commonly thin and discontinuous, and may be represented in places by a lag of stones on top of till. Contact with Glacial Lake Brainerd sand is obscured by eolian sand; the outwash is probably deltaic, and was drawn with the assumption that the lake level was approximately 1,220 feet (372 m) in elevation. No soil boring penetrated both outwash and lake sand.

ri — ***Ice-contact deposits***—Stratified material consisting chiefly of sand and gravel (cobbles and boulders are common) sorted by meltwater in close proximity to ice; in places may contain thin layers of debris-flow till. Collapsed in places by the meltout of underlying ice. Forms an esker complex northwest of the Mississippi River north of Brainerd. The top of this unit may have been flattened by wave erosion from Glacial Lake Brainerd.

rt — ***Till***—Chiefly unsorted, highly compacted, pebbly, sandy loam (averaging 71 percent sand, 17 percent silt and 11 percent clay) with cobbles and boulders. Brown (7.5YR to 10YR 5/4) where oxidized, grades down to a grayer brown (7.5YR to 10YR 4/3) where less oxidized; unoxidized till was not observed. Commonly leached of carbonate to at least 15 feet (4.5 m); one till sample from a gravel pit contained 1 percent carbonate at 16 feet (5 m). Soil boring samples below 16 feet (5 m) are noncalcareous. The topography of this unit consists chiefly of drumlins and interdrumlin swales of the Brainerd drumlin field (Wright, 1972). Well developed drumlins are shown with line symbols; there is a general northeast–southwest grain to the topography even where clear drumlins do not exist. Because of its drumlined morphology and strong compaction, the till is interpreted to have been deposited subglacially.

rtm — ***Till of the Pleasant Lake recessional moraine***—Till similar in color, texture, and sand lithology to the till unit (rt) described above. Contains numerous sand lenses. Can only be distinguished from unit rt geomorphically. Locally separated from the subjacent till unit (rt) by gravel, as in a gravel pit located in the northwest part of the adjoining Fort Ripley quadrangle.

rth — ***Hummocky till***—Forms small hummocks and hollows that are visible on aerial photos. Interpreted to be thin patches of supraglacial till, similar in composition to the till unit (rt), that are draped over the drumlin topography of unit rt.

## MAP SYMBOLS

**Geologic contact**—Approximately located. Established from aerial photographs, geomorphology, soil maps, well logs, borings, and examination of surficial materials.

**Esker**—Though shown as a single feature, it may have been deposited in several close subglacial channels. Arrowheads point in the direction of inferred flow.

**Drumlin**—Streamlined hill or ridge consisting typically of glacial till, formed at the base of moving ice. Arrow shows the inferred direction of ice movement.

**Alluvial fan**—Fan-shaped accumulation of sand where a gully enters the Mississippi River valley.

**Stream flow direction**—General flow direction of streams that deposited surficial sand and gravel. Arrows point downstream.

**Broad irregular trough**—Interpreted as a buried subglacial drainage channel (tunnel valley) or a buried, pre-existing subaerial valley. Ticks point down slope.

**Eolian sand**—Fine- to medium-grained windblown sand as thick as 10 feet (3 m), that drapes units of till (rt) and moraine till (rtm); it has an irregular thickness and patchy distribution. Generally thins from west to east. Eastern boundary is drawn where the sand is less than about 2 feet (0.6 m) thick. May also be present on lacustrine deposits (rls) and outwash (ro), but is not shown because both of those units are composed of sand at the surface. Where eolian sand is mapped, ventifacts (sandblasted stones) are common on the till surface.

**Eolian sand dunes**—Fine- to medium-grained sand that forms dunes and blowouts. Mapped on sandy units (rls and ro) as well as on till (rt) because the form can be recognized on aerial photos regardless of surface material.

**Soil boring**—Power auger borings described and sampled by the Minnesota Geological Survey. Most borings are less than 20 feet (6 m) in depth.

**Material sample**—Outcrop, roadcut, and construction-site exposures examined, described and sampled during the course of field work.

**Field observation**—Outcrop, roadcut, construction-site exposures, and shallow hand probe borings examined and described during the course of field work.

**Record of water-well construction**—Location of a water well for which there is a log prepared by a well driller. A geologist (either the author or a predecessor) has interpreted the information in the log and verified the well location.

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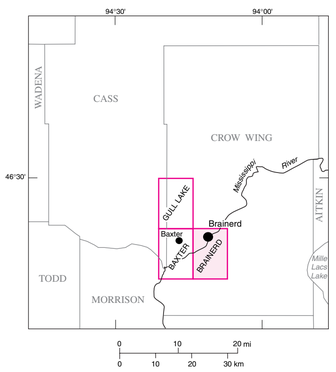


Base from U.S. Geological Survey Brainerd 1:24,000 quadrangle, 1973; revised 1994.
Universal Transverse Mercator grid, zone 15
1927 North American Datum

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APPROXIMATE MEAN DECLINATION, 2001 (TRUE NORTH, MAGNETIC NORTH 2°31′)

SCALE 1:24 000
1 1/2 0 1 MILE
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION (MINN.)

GIS compilation and cartography by Joyce Meints and Philip Heywood
Edited by Lori Robinson