UNIVERSITY OF MINNESOTA

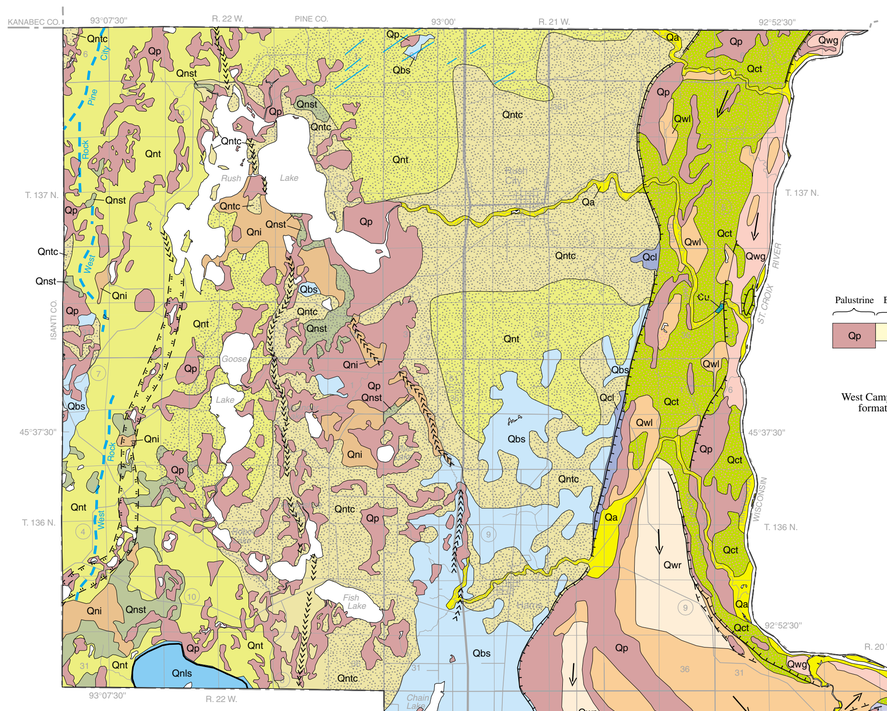
MINNESOTA GEOLOGICAL SURVEY
D.L. Southwick, Director

SUPPORTED IN PART BY THE MINNESOTA MINERALS DIVERSIFICATION PROGRAM AS ADMINISTERED BY THE MINERALS COORDINATING COMMITTEE FOR THE MINNESOTA LEGISLATURE, AND BY THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF LANDS AND MINERALS

Miscellaneous Map Series
MAP M-116
Plate 1— Surficial Geology

SURFICIAL GEOLOGY

Compiled by
Gary N. Meyer and Barbara A. Lusardi
2001

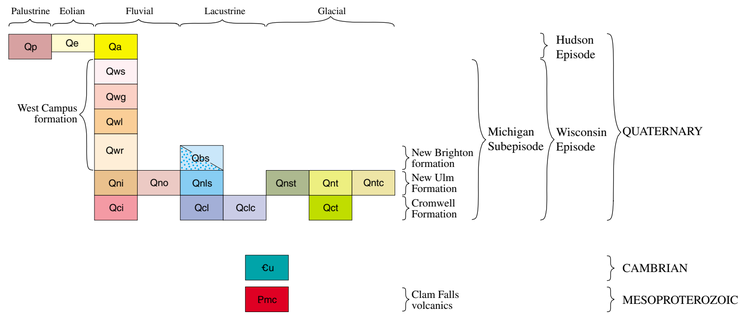


Digital base modified from 1990 Census TIGER/Line Files of U.S. Bureau of the Census (source scale 1:100,000); county border files modified from Minnesota Department of Transportation files; digital base annotation by Minnesota Geological Survey.

Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

LOCATION DIAGRAM

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

QUATERNARY

Qe **Eolian sand**—Very fine to medium-grained sand, more than 3 feet (1 m) thick; windblown; forms low-lying dunes.

Qp **Peat**—Partially decomposed plant matter deposited in marshes. Includes fine-grained organic matter laid down in ponded water, and marl (calcareous clay) at depth in places. Also includes narrow deposits of alluvium along streams, narrow beach deposits, and small bodies of open water.

Qa **Floodplain alluvium**—Chiefly sand, commonly overlain by about 5 feet (1.5 m) of sandy loam to loamy sand, with interbeds of organic-rich layers; gravelly in some places. Some depressions within the floodplain have been filled with thick silty to clayey sediment. Within the St. Croix valley, includes alluvial fan sediment that rises above the floodplain at the mouths of tributaries. Contacts with other map units are commonly scarps.

West Campus formation (Meyer, 1999; Meyer and Patterson, 1999)—Sand and gravelly sand of mixed Riding Mountain and Superior provenance (Table 1). Coarsens to cobbly gravel in places. Laid down during early, high stages of the St. Croix River, and preserved in terraces above the modern floodplain. The West Campus formation is mapped at four major terrace levels.

Qws ***St. Mary's terrace*** (Meyer, 1999)—Clasts are mostly of Superior provenance. The terrace surface is 10 to 30 feet (3 to 9 m) above floodplain level, at an elevation of about 710 feet (216 m). Alluvial sediment has accumulated in a fan on top of that surface. The terrace does not extend above the dam at Taylors Falls.

Qwg ***Grey Cloud terrace*** (Matsch, 1962)—Clasts are mostly of Superior provenance. The terrace is about 65 feet (20 m) above floodplain level below the dam at Taylors Falls, and only 10 to 20 feet (3 to 6 m) above floodplain level above the dam. The terrace ranges in elevation from about 760 feet (232 m) at Taylors Falls, to about 805 feet (245 m) at the northern county boundary.

Qwl ***Langdon terrace*** (Matsch, 1962)—Clasts are mostly of Superior provenance; rare shale. The terrace is 70 to 90 feet (21 to 27 m) above floodplain level, rising in elevation from about 835 feet (255 m) northeast of Almelund to about 865 feet (264 m) east of Rush City. The terrace consists largely of scoured till of the Cromwell Formation north of Goose Creek, where only patches of fluvial sediment are preserved.

Qwr ***Richfield terrace*** (Meyer and Jirsa, 1982)—Clasts of Riding Mountain provenance are common in most areas, mixed with clasts of Superior provenance. This terrace has two distinct surfaces. The small areas mapped just to the north and down river from Almelund formed prior to drainage of Glacial Lake Anoka (Meyer, 1998), when the St. Croix River served as the lake's outlet stream (and possibly even earlier, by the drainage of Glacial Lake Grantsburg). This upper surface rises in elevation from about 900 feet (274 m) in the area east of Duck Lake to 950 feet (290 m) north of Almelund; and is about 210 feet (64 m) above the modern floodplain below the Taylors Falls dam, and 170 to 190 feet (52 to 58 m) above the floodplain up river from the dam. The remainder of the area mapped as the Richfield terrace, at an elevation of about 880 feet (268 m), 125 feet (38 m) above the modern floodplain, formed after the drainage of Glacial Lake Anoka.

New Brighton formation (Meyer and Patterson, 1999)—Mostly fine-grained sand laid down in Glacial Lake Anoka. The maximum extent of the lake is difficult to determine as it was likely ponded against buried stagnant ice. The ice-cored landscape was lowered when this ice melted. Till of the New Ulm Formation within the shorelines of Glacial Lake Anoka has been wave-washed and covered in places with thin beds of silt, sand, or gravel. The till in some of these areas has subsequently collapsed due to melt-out of underlying ice. Some of the collapsed till areas now lower in elevation than adjacent areas of New Brighton formation were probably islands or peninsulas in Glacial Lake Anoka.

Qbs ***Sand facies***—Very fine- to medium-grained sand; loamy in places; widely scattered beds of silt to fine gravel at depth. Pattern indicates where stream-deposited sand, gravelly sand, and gravel of the New Ulm Formation (Qno) is buried by less than 15 feet (5 m) of fine sand of the New Brighton formation (Qbs). Gravelly sand occurs locally where adjacent to glacial or fluvial sediment. The upper few feet (1 m) of sand has commonly been reworked by wind action.

New Ulm Formation (Meyer and Patterson, 1999)—Glacial, fluvial, and lacustrine sediment of Riding Mountain provenance (Table 1) deposited by ice and meltwater of the Grantsburg sublobe of the Des Moines lobe.

Qnls ***Lake sand***—Very fine- to fine-grained sand and loamy sand; interbeds and lenses of silt and medium-grained sand. Coarse, gravelly sand occurs locally along boundaries and at or near the base. Deposited in ice-walled lakes.

Qno ***Outwash***—Sand, gravelly sand, and gravel. Deposited by meltwater issuing from the ice margin at or near its maximum extent. Includes Superior provenance clasts eroded from older sediment; shale is common.

Qni ***Ice-contact stratified deposits***—Sand, gravelly sand, and gravel. Commonly includes interbeds and lenses of, and in places is capped by, sandy to loamy diamicton (mudflow sediment) and silt (lake sediment). Shale clasts are common to abundant.

Qnt ***Loamy till***—Chiefly loam-textured, unsorted sediment (diamicton); scattered pebbles, cobbles, and boulders. Lenses of stratified sediment are uncommon in most areas. Generally more than 20 feet (6 m) thick over the Cromwell Formation. Overlain in some small, low-lying areas by 3 feet (1 m) or more of loamy to clayey, organic-bearing colluvium.

Qnst ***Sandy till***—Loam- to sandy loam-textured, unsorted sediment (diamicton), with pebbles, cobbles, and boulders; commonly capped by, or interbedded with, thin deposits of silty to gravelly stratified sediment. Includes complex deposits of thick, stratified sediment too small to distinguish on the map from adjacent till deposits. Commonly less than 20 feet (6 m) thick over Cromwell Formation deposits, except near the northwest boundary of the county where the New Ulm Formation is thicker.

Qntc ***Twin Cities member*** (Meyer and Patterson, 1999)—Complexly intermixed yellowish-brown to gray and reddish-brown to reddish-gray, loam- to sandy loam-textured, unsorted sediment (diamicton), with pebbles, cobbles, and boulders. This mixture of both Riding Mountain and Superior provenance sediment formed by the erosion and incorporation of Cromwell Formation material by the overriding ice of the Grantsburg sublobe. Small lenses of stratified sediment are common in many areas. Covered in places by as much as 20 feet (6 m) of the loamy till facies of the New Ulm Formation. Where topography is steeply rolling or gullied, Cromwell Formation deposits are locally at, or very near, the surface.

Cromwell Formation (Wright and others, 1970)—Glacial, fluvial, and lacustrine sediment of Superior provenance (Table 1) deposited by the Superior lobe and its meltwater. Cromwell Formation deposits in Chisago County are commonly reworked at the top (by the overriding Grantsburg sublobe or subsequent fluvial action) and mantled in places by generally less than 10 feet (3 m) of younger deposits.

Qcl ***Lake sand and silt***—Silt to medium-grained sand; interbeds and lenses of silty clay to gravelly sand, and scattered dropstones. Rhythmically layered in places; commonly overlies varved clay and silt. May include deltaic sediment.

Qclc ***Lake clay and silt***—Varved clay and silt laid down in Glacial Lake Lind (Johnson and others, 1999). Exposed in bottoms and walls of channels formed by the downcutting glacial St. Croix River. Includes thin beds of clayey to loamy diamicton in places. Locally capped with alluvium or colluvium.

Qci ***Ice-contact stratified deposits***—Sand, gravelly sand, and cobbly gravel; commonly includes interbeds of, and in places is capped by, sandy to loamy diamicton (mudflow sediment) and silt (lake sediment). Some deposits contain boulders. Generally laid down along the courses (eskers) or at the mouths (kames) of subglacial streams.

Qct ***Till***—Chiefly sandy loam-textured, unsorted sediment (diamicton) with pebbles, cobbles, and boulders; silty sand to cobbly gravel lenses are commonly present.

CAMBRIAN

Cu **Cambrian rocks, undivided**—Quartzose sandstone, feldspathic to glauconitic sandstone and siltstone, and dolomitic siltstone (Jordan Sandstone, St. Lawrence and Franconia Formations, Ironton and Galesville Sandstones, and Eau Claire Formation). Discontinuously exposed; mantled by generally less than 5 feet (1.5 m) of sandy to rocky colluvium or alluvium.

MESOPROTEROZOIC

Pmc **Clam Falls volcanics** (Cannon and others, 2001)—Basalt and associated rocks; discontinuously exposed; mantled by generally less than 5 feet (1.5 m) of sandy to rocky colluvium.

MAP SYMBOLS

Geologic contact—Approximately located.

Plateau—Broad, relatively level area in a zone of hummocky topography.

General flow direction of braided streams—Arrows point downstream in the direction glacial meltwater once flowed.

Esker—Sinuous ridge of sand and gravel, interpreted to have been deposited in an ice-walled channel of a glacial meltwater stream flowing underneath the glacier. The fluvial sediment may be covered by 10 feet (3 m) or more of till. Arrows show inferred flow direction. South-flowing eskers originated beneath the Superior lobe and are now buried under New Ulm Formation.

Linear ridge—Identified from aerial photographs and interpreted to be an esker. Flow direction is undetermined.

Sides of a buried tunnel valley—Drainage channel interpreted to have formed below Superior lobe ice before partial burial by subsequent glacial events.

Ice-marginal ridge—Labelled on up-ice side. Major still-stands of the Grantsburg sublobe.

Minor morainic ridge—Identified from aerial photographs and shaded relief maps. Interpreted as a temporary ice marginal position, where the ice stood for only a short time.

Stream-cut scarp—Ticks point downslope; dashed where discontinuous or obscure. Where paired, scarps bound stream-scoured areas. Till deposits downslope of scarps are fluvially scoured and mantled in places by sand and gravel too thin and patchy to map separately.

Stream-washed till—Surface is stream-planed, and in places is mantled by sand and gravel too thin and patchy to map separately.

Wave-washed till—Surface is wave-planed, and in places is mantled by sand and silt too thin and patchy to map separately.

Alluvial fan—Fan-shaped deposit at the mouth of tributary streams of the St. Croix River; rises above the surrounding surface.

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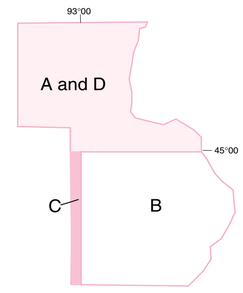

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B. Meyer, G.N., 1999, comp., Surficial geology of the Stillwater 30 x 60 minute quadrangle, Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-95, scale 1:100,000.

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GIS compilation and cartography by
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Edited by Lori Robinson

Table 1. General characteristics of mapped glacial deposits.

PROVENANCE	RIDING MOUNTAIN (NW)	SUPERIOR (NE)
TILL TEXTURE	Loamy	Sandy
TILL COLOR		
Oxidized	Yellow-brown to olive-brown	Red-brown
Unoxidized	Gray	Gray and red-gray
PEBBLE TYPE		
White to buff carbonate	Common	Rare to uncommon
Dark-gray to gray-green rocks	Uncommon to common	Common to abundant
Red felsite & sandstone	Rare to uncommon	Common
Gray shale	Uncommon to abundant	Absent

AGGREGATE RESOURCE POTENTIAL OF CHISAGO COUNTY, MINNESOTA