UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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MISCELLANEOUS MAP SERIES
MAP M-97
Anoka Quadrangle

SURFICIAL GEOLOGY OF THE ANOKA 30 x 60 MINUTE QUADRANGLE, MINNESOTA

Compiled by

Gary N. Meyer and Carrie J. Patterson

1999

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

Universal Transverse Mercator Projection, grid zone 15
1927 North American Datum

Contours derived using USGS 90-meter grid cell digital elevation data.

SCALE 1:100 000

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 6 7 8 KILOMETERS

CONTOUR INTERVAL 15 METERS

2°36' TRUE NORTH / MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1999.

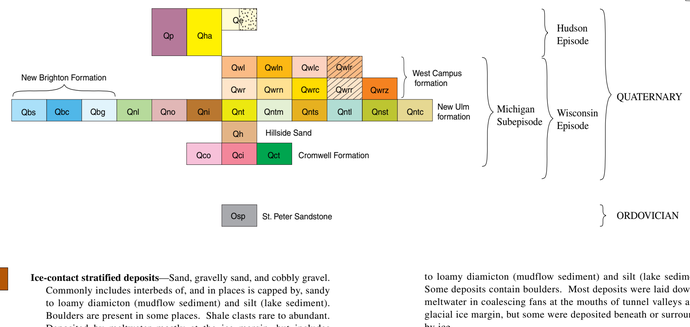
Digital cartography by
Joyce Meints and Philip Heywood

INDEX TO 1:100,000 COMPILATION MAPS
1. Anoka (M-97)
2. Stillwater (M-95)
3. Hastings (M-96)

TABLE 1. GENERAL CHARACTERISTICS OF MAPPED GLACIAL DEPOSITS.

Provenance	Riding Mountain (northwest)	Superior (northeast)
Till texture	loamy	sandy
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 and sandstone	rare to uncommon	common
gray shale	uncommon to abundant	absent

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

This map is a compilation of maps completed from 1989 to 1993 by several authors who mapped at different scales and had diverse emphases. Unlike the maps from which it is derived, most of the deposits on this map have been placed in lithostratigraphic units that have been modified from units previously defined by Stone (1966), Matsch (1962 and 1972), and Wright and others (1970). The Correlation of Map Units incorporates a new scheme developed by Johnson and others (1997) for the division of the late Quaternary into episodes, emphasizing the diachronic nature of the map units. The Michigan Subepisode of the Wisconsin Episode replaces the late Wisconsinan glaciation of earlier publications, and the Hudson Episode is a new name for the current interglaciation or postglacial time—the time since Michigan deglaciation in various regions.

QUATERNARY

Qe — **Eolian sand**—Very fine to medium-grained sand; more than three feet (1 m) thick; windblown. Generally forms low-lying dunes, except in stipple area where dune relief exceeds 30 feet (9 m).

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 alluvium along smaller streams, small bodies of open water, and narrow beach deposits. In developed areas, many of these deposits have been buried under artificial fill; organic sediment commonly has been removed prior to burial.

Qha — **Floodplain alluvium**—Mississippi River alluvium consists of generally less than six feet (2 m) of silt loam to loamy sand overlying sand, gravelly sand, or cobbly gravel; scattered wood and shell fragments. Alluvium of smaller streams is finer grained and is typically topped and interbedded with thin organic-rich layers. Some depressions on floodplains have been filled with thick silty to clayey sediment. Contacts with other map units are commonly scarps.

West Campus formation—Sand and gravelly sand of mixed Riding Mountain and Superior provenance (Table 1). Coarsens to cobbly gravel in places. Laid down during early, higher stages of the Mississippi River, and preserved as terraces above the modern floodplain. The West Campus formation is mapped at two terrace levels upstream of the confluence with the Minnesota River at Fort Snelling. The original West Campus Sand of Stone (1966) is modified here to include a silt and clay facies.

Qwl — **Langdon terrace** (Matsch, 1962)—Surface 10 to 40 feet (3 to 12 m) above modern floodplain, ranging in elevation from about 830 feet (253 m) at the south edge of the map to about 950 feet (290 m) at the northwest edge. Most contacts with other map units (except peat) are scarps. Boulder lags are common at the contact with the underlying material.

Qwln — ***Sand overlying till of the New Ulm formation***—Sand less than 10 feet (3 m) thick over till of the New Ulm formation.

Qwlc — ***Sand overlying till of the Cromwell Formation***—Sand less than 10 feet (3 m) thick over till of the Cromwell Formation.

Qwlf — ***Sand overlying bedrock***—Sand less than 10 feet (3 m) thick over bedrock.

Qwr — **Richfield terrace** (Meyer and Jirsa, 1982)—Surface 40 to 70 feet (12 to 21 m) above modern floodplain, ranging in elevation from about 850 feet (259 m) at the south edge of the map to about 1000 feet (305 m) at the northwest edge. Most contacts with other map units (except peat) are scarps; however the contact with adjacent New Ulm outwash (Qno) on both sides of the river in the northwest corner of the map is gradational. Boulder lags are common at the contact with the underlying material.

Qwrn — ***Sand overlying till of the New Ulm formation***—Sand less than 10 feet (3 m) thick over till of the New Ulm formation.

Qwrc — ***Sand overlying till of the Cromwell Formation***—Sand less than 10 feet (3 m) thick over till of the Cromwell Formation.

Qwrf — ***Sand overlying bedrock***—Sand less than 10 feet (3 m) thick over bedrock.

Qwrz — **Silt and clay facies**—Generally thinly bedded, clay to sandy silt; silt predominates over clay in most places. Deposited in ice-block melt-out depressions by slack-water of the Mississippi River at the Richfield terrace level.

New Brighton formation—Mostly fine-grained sand; includes coarse-grained facies. Laid down in Glacial Lake Anoka (Meyer, 1993). The New Brighton formation is modified from Stone (1966) to include both his Turtle Lake Sand and Fridley Formation because the sediments of the three units are similar, and it has since been determined (Meyer and others, 1993; Meyer, 1993) that the sediment of these units was laid down in the same large glacial lake.

Qbs — **Sand facies**—Very fine to medium-grained sand; loamy in places; scattered lenses of silt to silty clay at depth. Gravelly sand occurs locally where adjacent to glacial or fluvial sediment. The surface has been modified in places by fluvial processes during drainage of Glacial Lake Anoka. The upper few feet (meter) of sand has commonly been reworked by wind action. Includes sediment deposited in ice-walled lakes between Zimmerman and Elk River in Sherburne County that were precursors to Glacial Lake Anoka. The fine-grained sand of Glacial Lake Anoka is commonly underlain by gravelly sand in the northern and western portions of the map area. The boundary with adjacent outwash is typically gradational.

Qbc — **Silt and clay facies**—Silt and clay; interbedded with fine-grained sand in places; locally rhythmically bedded; rare dropstones. Deposited in deeper, quiet water of Glacial Lake Anoka.

Qbg — **Sand and gravel facies**—Medium- to coarse-grained sand to fine-grained gravel. May overlie coarser fluvial sediment of the New Ulm or Cromwell formations. Deposited in deltaic or shallow-water environments in Glacial Lake Anoka.

New Ulm formation—Glacial, fluvial, and lacustrine sediment of Riding Mountain provenance (Table 1) deposited by ice and meltwater of the Des Moines lobe and the Grantsburg sublobe. The New Ulm formation is modified from the New Ulm Till of Matsch (1972) to include related bedded sediment. Due to its similar lithologic and stratigraphic position, the Twin Cities Formation of Stone (1966) is herein incorporated into the New Ulm formation. The distinct mixed till facies of Stone's (1966) Twin Cities Formation is designated as a member of the New Ulm formation.

Qnl — **Lake clay and laminated silt**—Laminated clay to silt; generally less than 10 feet (3 m) thick. Deposited in small ice-walled lakes. Includes a few deposits laid down in depressions created during the final stages of ice-block melt-out. Thin beds of silty, fine-grained sand to gravelly sand occur at boundaries and at or near the base in places. Small areas of this unit are likely present in places in the uplands of Wright County, but are not mapped.

Qno — **Outwash**—Sand, gravelly sand, and gravel. Deposited by glacial meltwater streams. Commonly includes clasts of Superior provenance eroded from older sediment. The percentage of these clasts generally increases to the north and east of the map in the vicinity of the Cromwell Formation. The upper few feet (meter), particularly in Sherburne County, have been reworked in many places by wind action. Commonly bounded by scarps where laid down in channels.

Qni — **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). Boulders are present in some places. Shale clasts rare to abundant. Deposited by meltwater mostly at the ice margin, but includes sediment laid down beneath or surrounded by ice. The large deposit in Sherburne County in particular has abundant red felsite and sandstone and dark igneous and metamorphic clasts of Superior provenance.

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, colluvium bearing organic material. Commonly water-washed and overlain in places by a few feet (meter) of lacustrine, fluvial, or eolian sand in the vicinity of sand deposits.

Qntm — ***Loamy till with stream-modified surface***—Till topography modified by running water; locally fluvially eroded and streamlined. Covered in some places with thin, discontinuous sand and gravel. Mapped only in Ramsey County.

Qnts — ***Loamy till beneath stream sediment***—Till beneath as much as 20 feet (6 m) of sand and gravel. Mapped only in Ramsey County.

Qntl — ***Loamy till beneath sandy lake sediment***—Till beneath as much as 20 feet (6 m) of fine-grained sand. Mapped only in Ramsey and southeastern Anoka Counties.

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. Locally patchy over thick deposits of sand and gravel. In Wright County, generally overlies thick sand and gravel of the Cromwell Formation.

Qntc — **Twin Cities member**—Complexly intermixed yellowish-brown to gray and reddish-brown to reddish-gray, loam- to sandy loam-textured unsorted sediment (diamicton); 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 Des Moines lobe and 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 loamy till of the New Ulm formation. Where topography is steeply rolling or gullied, Cromwell Formation material is locally at or very near the surface. Capped in places by thin deposits of sand in the vicinity of sand deposits.

Qh — **Hillside Sand** (Stone, 1966)—Sand and gravel; proglacial outwash of the Grantsburg sublobe with clasts of both Riding Mountain and Superior provenance, commonly overlying recessional outwash of the Superior lobe.

Cromwell Formation (Wright and others, 1970)—Glacial and fluvial sediment of Superior provenance (Table 1), deposited by the Superior lobe and its meltwater. Mapped where mantled by generally less than 10 feet (3 m) of younger deposits. Commonly reworked at the top by the overriding Des Moines lobe and Grantsburg sublobe.

Qco — **Outwash**—Sand, gravelly sand, and gravel. Laid down by meltwater in an extensive fan that issued from the receding glacial ice margin.

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. Most deposits were laid down by meltwater in coalescing fans at the mouths of tunnel valleys at the glacial ice margin, but some were deposited beneath or surrounded by ice.

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

ORDOVICIAN

Osp — **St. Peter Sandstone**—Fine- to medium-grained, quartz sandstone; generally massive to thick bedded. Exposed by extensive excavation for railroad yard expansion in the area east of the Mississippi River.

MAP SYMBOLS

Geologic contact—Approximately located.

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

Stream-cut scarp—Hachures on downslope side; only shown where scarps cut across map units. Interpreted as remnant of former drainageway.

Approximate shorelines of Glacial Lake Anoka—The maximum extent of the lake is difficult to determine, particularly along its southern and western boundaries where it was likely ponded against buried stagnant ice. The ice-cored landscape was lowered when this ice melted. Till of the New Ulm formation at the same or lower elevations in the vicinity of mapped areas of the New Brighton formation has been wave-washed and covered in places with thin beds of silt, sand, or gravel. The till in some of these areas subsequently collapsed due to melt-out of underlying ice. It is likely that some of the areas of collapsed till, which are now lower in elevation than adjacent areas of the New Brighton formation, were once islands or peninsulas in Glacial Lake Anoka.

Fridley level—About 915 feet (279 m) above mean sea level.

Hugo level— About 940 feet (287 m) above mean sea level.

Esker—Sinuous ridge of sand and gravel deposited in an ice-walled channel of a glacial meltwater stream. The fluvial sediment may be covered by 10 feet (3 m) or more of till. Arrows show inferred flow direction. South- and west-flowing eskers interpreted to be of Superior lobe origin are buried by the New Ulm formation. Other eskers were formed in Des Moines lobe or Grantsburg sublobe ice.

Deep, broad, irregular troughs—Locally contain long lakes or chains of lakes. Interpreted to reflect valleys cut by meltwater flowing beneath Superior lobe ice that were partially buried by subsequent glacial events. Drainage channels beneath the Superior lobe ice locally eroded deeply into the substrate, in places exploiting pre-existing bedrock valleys. These tunnel valleys were commonly reoccupied by meltwater streams of the Superior lobe and Grantsburg sublobe.

ANOKA CO / HENNEPIN CO — **County boundary.**

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SOURCES OF GEOLOGIC DATA USED TO COMPILE THE MAP

The map above shows the location of the Anoka quadrangle (shaded) relative to surrounding counties. Citations A through H were used to compile the geology.

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NOTE: This map (M-97) supercedes map Open File Report 97-3.

Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.