UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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SURFICIAL GEOLOGY

By

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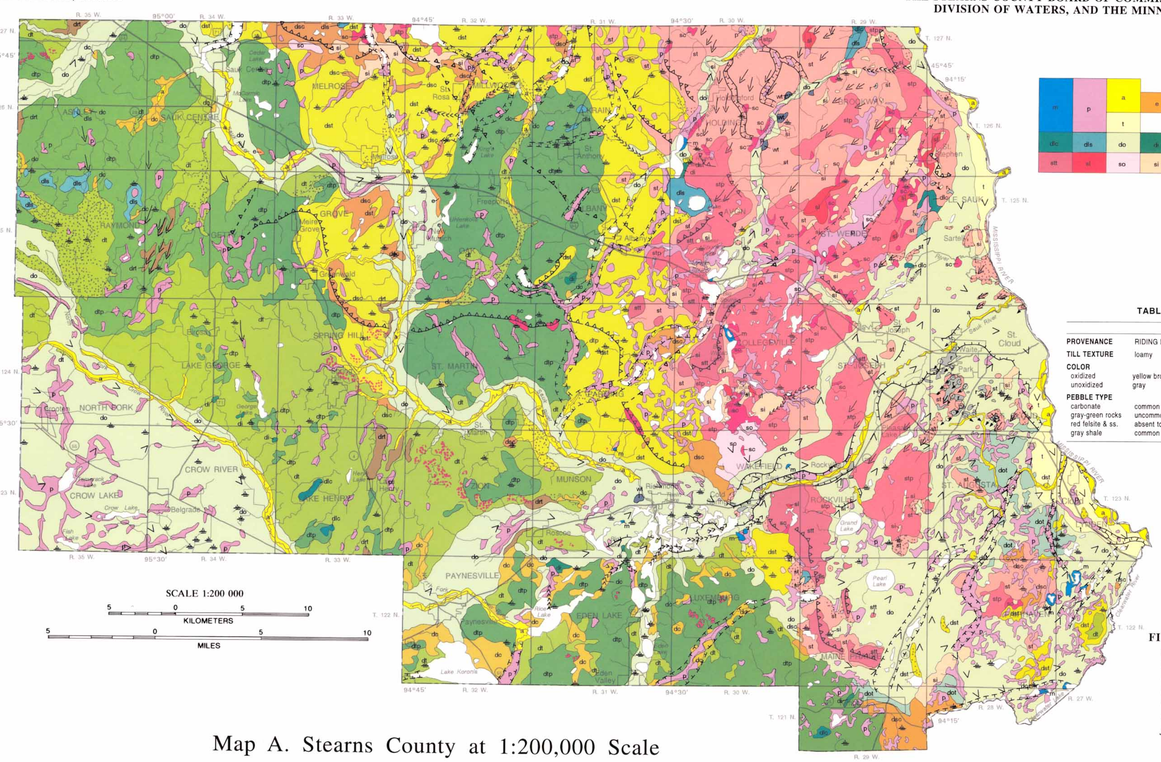
1995



Map A. Stearns County at 1:200,000 Scale

CORRELATION OF MAP UNITS

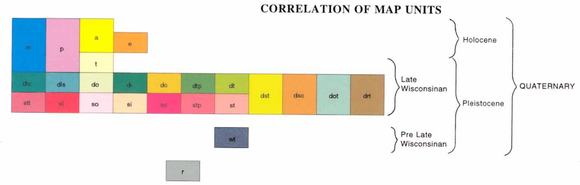


TABLE 1. *Physical attributes of glacial deposits in Stearns County.*

	NORTHWEST		NORTHEAST	
PROVENANCE	RIDING MOUNTAIN	WINNIPEG	RAINY (WADENA)	SUPERIOR
TILL TEXTURE	loamy	loamy to clayey	sandy	sandy
COLOR				
oxidized	yellow brown to olive brown	yellow brown to olive brown	yellow to yellow brown	brown to red brown
unoxidized	gray	gray, dark gray, green gray	gray	gray to red gray
PEBBLE TYPE				
carbonate	common	uncommon to abundant	uncommon to common	rare to common
gray-green rocks	uncommon to common	uncommon to common	uncommon to common	common to abundant
red felsite & ss.	absent to uncommon	absent to uncommon	rare to uncommon	uncommon to common
gray shale	common	absent to uncommon	absent to rare	absent

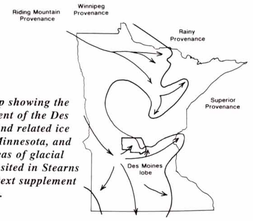
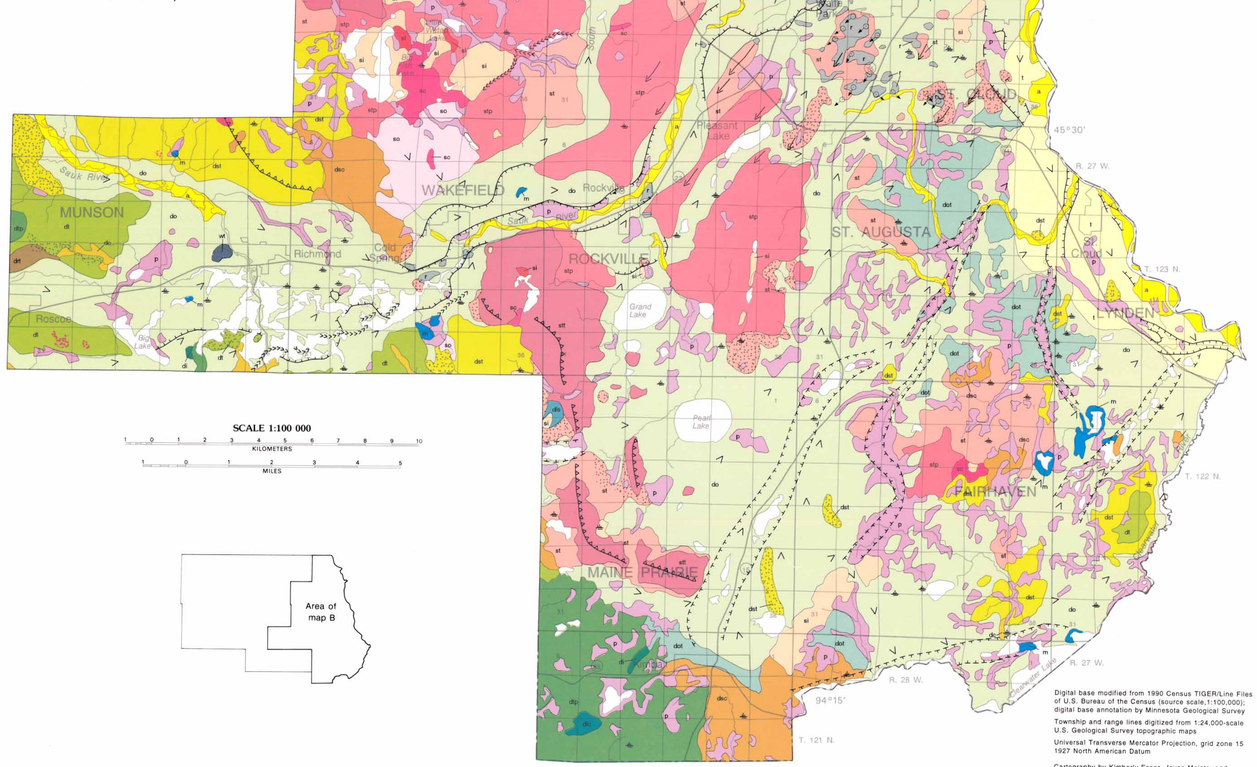
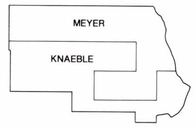


FIGURE 1. *Map showing the maximum extent of the Des Moines lobe and related ice advances in Minnesota, and the source areas of glacial sediment deposited in Stearns County. See text supplement for discussion.*



Map B. Eastern Stearns County at 1:100,000 Scale

LOCATION DIAGRAM



INDEX TO MAPPING

DESCRIPTION OF MAP UNITS

POSTGLACIAL DEPOSITS

e — **Eolian sand**—Windblown fine sand more than three feet thick; forms low-lying dunes. Unmapped patches of probable eolian sand, generally less than three feet thick, are present east of the Sauk River valley (east of Sauk Centre and south of Freeport).

m — **Marl**—Calcareous clay deposited in ponded water; mollusk shells are common. Generally three to twelve feet thick.

p — **Peat**—Partially decomposed plant matter deposited in marshes; mapped where mostly more than three feet thick. Includes fine-grained organic matter laid down in ponded water, and marl at depth in places. Also includes alluvium along smaller streams, and small bodies of open water. Many thick deposits too small to show in color are indicated by symbol.

a — **Alluvium**—Mississippi River alluvium consists of less than six feet of silt loam to loamy sand overlying sand, gravelly sand, or cobbly gravel. Alluvium of smaller streams is less gravelly with depth and is typically topped and interbedded with thin organic-rich layers. Contacts with other map units are commonly scarps.

MISSISSIPPI RIVER TERRACE DEPOSITS

t — **Terrace deposits**—Sand and gravelly sand; mixed clasts of northwest and northeast provenance (Fig. 1). Most contacts with other map units form scarps.

DEPOSITS ASSOCIATED WITH THE DES MOINES LOBE

(Riding Mountain provenance; Fig. 1)—Northwest source (Table 1; Des Moines lobe deposits in Stearns County are related to the New Ulm Till of Matsch, 1972).

dlc — **Lake clay and silt**—Laminated clay to silt deposited in slackwater backed up into tributary valleys of major meltwater streams; also laid down in small ice-walled lakes (where associated with units **dtp** and **dt**) on the stagnating glacial surface. Fine sand interbeds and is topped by very fine to coarse sand in places. The small area mapped northeast of St. Joseph is probably lake sediment buried and then exhumed by subsequent meltwater streams. This sediment, present in the subsurface between St. Joseph and St. Cloud, and exposed along the bluffs of the Mississippi River, was laid down in ponded water fronting the advancing Des Moines lobe, which blocked channels cut by south-flowing Superior lobe meltwater.

dls — **Lake sand and silt**—Silt to medium-grained sand; clayey lake sediment at depth in places. Deposited in slackwater of outwash streams where associated with unit **do**; otherwise, laid down in small ice-walled lakes on the stagnating glacial surface.

do — **Outwash deposits**—Sand, gravelly sand, and cobbly gravel. Deposited by meltwater issuing from the glacial ice margin. Commonly bounded by scarps where laid down in channels. Superior-provenance rock types, such as red felsite and sandstone (Table 1), increase, while shale-clast content decreases to the north and east. Superior lobe outwash is common at depth in the northern and eastern parts of the county, where the overlying deposit (unit **do**) consists primarily of reworked Superior lobe sediment.

ds — **Ice-contact stratified deposits**—Sand, gravelly sand, and cobbly gravel; commonly includes interbeds of sandy to loamy mudflow sediment. Deposited by meltwater, mostly at the ice margin, but includes sediment laid down beneath or surrounded by ice. Shale clasts are rare to abundant.

dc — **Complex of till and sand and gravel**—Glacial and fluvial sediment too intricately associated to distinguish at map scale; commonly formed through melt-out of underlying stagnant ice. Includes areas of loamy to sandy till capped by or interbedded with sand and gravel, and small areas of thick, loamy to sandy colluvium. Bouldery in places. Gravel below till in Raymond Township (sec. 6, T. 125 N., R. 35 W.) is of Rainy lobe origin.

dtp — **Pitted supraglacial till**—Chiefly loam-textured, unsorted sediment, with scattered pebbles, cobbles, and boulders; thin beds of silty clay to gravelly sand are common in places. The land surface is characterized on topographic maps by closed depressions, which imply that the unit is generally more than ten feet thick over more dense and massive subglacial till. Generally more than twenty feet thick over northeast-provenance sediment. Commonly overlain by three feet or more of loamy to clayey, organic-bearing colluvium in low-lying areas, and by thin stratified sediment in the vicinity of units **dls** and **dc**.

dt — **Till**—Chiefly loam-textured, unsorted sediment with scattered pebbles, cobbles, and boulders; few lenses of stratified sediment. Surface modified by slopewash processes in more steeply sloping areas. Generally less than ten feet of supraglacial till at top; generally more than twenty feet thick over northeast-provenance sediment. Less than twenty feet thick over Winnipeg-provenance sediment in a few places in the Richmond area.

dst — **Till over Superior lobe deposits**—Chiefly loam-textured to sandy loam textured till less than twenty feet thick over Superior lobe sandy till, sand, or gravel. Toward the base of the till, and near boundaries with Superior lobe deposits, complex zones of mixed sediment of both lobes are commonly present. Small areas of Superior lobe sandy till at or near the surface are common in the northern and eastern parts of the mapped area. Superior lobe and older sediments are exposed in places along steep sides of meltwater channels.

dot — **Outwash over Superior lobe deposits**—Sand, gravelly sand, and cobbly gravel less than twenty feet thick over Superior lobe till, sand, or gravel. Includes areas where Superior lobe deposits are at or near the surface. Patches of Des Moines lobe till are present in places between the outwash and Superior lobe deposits.

dsc — **Complex of till and Superior lobe ice-contact or outwash deposits**—Chiefly loam-textured to sandy loam textured till less than twenty feet thick over Superior lobe sand and gravel and minor sandy flow till, with many patches of Superior lobe sand and gravel at or near the surface.

drt — **Till over Rainy lobe deposits**—Chiefly loam-textured to sandy loam textured till less than twenty feet thick over dense, Rainy lobe (Wadena) sandy till, and, in a few places, Rainy lobe sand and gravel. Mapped along stream-cut slopes and over buried Rainy lobe drumlins. Rainy lobe and older sediments are exposed in places along steep sides of meltwater channels.

DEPOSITS ASSOCIATED WITH THE SUPERIOR LOBE

(Superior provenance; Fig. 1)—Northeast source (Table 1; Superior lobe deposits in Stearns County are part of the Cromwell Formation of Wright, 1970. Deposits mapped within the margin of the Des Moines lobe ice advance are commonly overlain by thin Des Moines lobe deposits and [or] reworked in the upper part.)

sl — **Lake sand**—Silty, very fine sand to medium-grained sand, with interbeds and lenses of silt to gravelly sand, including sandy mudflow sediment. Coarse sand and gravel occurs locally along boundaries. Includes deposits laid down in small ice-walled-lake plains, but mostly consists of sediment deposited in depressions created during the final stages of ice-block melt-out.

so — **Outwash deposits**—Sand, gravelly sand, and cobbly gravel. Laid down by meltwater issuing from the glacial ice margin.

si — **Ice-contact stratified deposits**—Sand, gravelly sand, and cobbly gravel; commonly includes interbeds of, and in places is capped by, sandy to loamy mudflow sediment and silty lake sediment. Some deposits contain boulders. Most deposits were laid down by meltwater in coalescing fans at the glacial ice margin, but some were deposited beneath or surrounded by ice. Flat-lying deposits were laid down as deltas within ice-walled-lake plains.

stc — **Complex of till and sand and gravel**—Glacial and fluvial sediment too intimately associated to distinguish at map scale; commonly formed from melt-out of underlying stagnant ice. Includes areas of sandy till capped by or thinly interbedded with sand and gravel, and areas of thin sandy till over thick sand and gravel. Gradational contacts with units **stp** and **si** and **st**.

stp — **Pitted supraglacial till**—Chiefly sandy loam textured, unsorted sediment, with pebbles, cobbles, and boulders; silty sand to cobbly gravel lenses are common. The land surface is characterized on topographic maps by closed depressions, which imply that the unit is generally more than ten feet thick over more dense and massive subglacial till.

st — **Till**—Chiefly sandy loam textured, unsorted sediment, with pebbles, cobbles, and boulders. Generally less than ten feet of supraglacial till over dense, subglacial till. Sand and gravel lenses are generally uncommon. Color varies from reddish brown to yellowish brown; yellowish tint is especially evident with depth, owing to incorporation of underlying older sediment. Superior lobe till in general becomes yellower westward across the county. Older sediment is at or near the surface in places along the steep sides of meltwater channels.

stt — **Thrust complex**—Superior lobe till with incorporated multiple interlayered slabs (typically deformed and dipping up-glacier) of both Superior- and Winnipeg-provenance glacial, fluvial, and lake sediment, Cretaceous clay and sand, and multicolored pre-Cretaceous saprolith. See text supplement for an explanation of thrusting processes.

DEPOSITS OF WINNIPEG PROVENANCE (Fig. 1)—Northwest source (Table 1).

wt — **Till**—Chiefly dense, loam- to clay loam textured, unsorted sediment; pebbles are common, but cobbles and boulders are generally uncommon. Shale clasts are uncommon to absent. Includes till of several different advances (units **x** and **y** on cross sections, Plate 4); northeast-source sediment may be present in places. Beds of stratified sediment are uncommon.

EARLY PROTEROZOIC AND ARCHEAN ROCKS

r — **Igneous and metamorphic rocks**—Granite or schist with diabase dikes where at or near the surface; other rock types in more deeply buried areas (see Plate 2). Includes large piles of waste rock from quarry operations.

EXPLANATION OF MAP SYMBOLS

Geologic contact—Approximately located.

Bogs—Selected organic deposits too small to show in color (unit **p**).

Loess-capped till—Des Moines lobe till capped by generally less than six feet of wind-blown silt. Present mainly across a discontinuous and narrow southeast-trending swath from the northwest corner of the county to Luxemburg Township.

Water-washed till—Surface of units **st**, **drt**, **dst**, and **dt** that has been modified by water action, and, in places, is mantled by silt, sand, or gravel.

Stream-cut scarp—Only shown where scarps cut across map units.

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

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 ten feet or more of till. Arrows show inferred flow direction. South- and west-flowing eskers are interpreted to be of Superior lobe origin; the rest are attributed to the Des Moines lobe.

Drumlin—Streamlined hill or ridge, typically of glacial till, with arrow showing inferred direction of ice movement across Stearns County. Rainy lobe drumlins in the west of the county are still evident below a thick mantle of Des Moines lobe till; in the east, Superior lobe drumlins are partially masked in places by thick supraglacial sediment.

Ice-marginal ridge of Superior or Rainy lobe ice—Teeth on up-ice side. Dashed where less pronounced.

Sides of a buried valley—Drainage channel formed by meltwater of the Rainy and (or) Superior lobes; subsequently partially buried by Des Moines lobe deposits. The valley of the Sauk River and other channels, clearly delineated by the map unit **do**, also were cut by Rainy and Superior lobe meltwater and filled with Des Moines lobe deposits. Superior lobe meltwater channels beyond the Des Moines lobe margin in eastern Stearns County were reoccupied by Des Moines lobe meltwater, except the marked channel trending southwest from St. Stephen. This channel was partially filled with ice-contact deposits laid down at the retreating margin of the Superior lobe.

Glacial striation measurement—Arrow shows direction of ice flow. Southwest-trending striations were made by Superior lobe ice, whereas southeast-trending striations were made by ice carrying Winnipeg-provenance detritus, or possibly by Rainy lobe ice flowing toward an interlobate margin with the Superior lobe.

ACKNOWLEDGMENTS

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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.

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Township and range lines digitized from 1:24,000-scale U.S. Geological Survey topographic maps

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

Cartography by Kimberly Esser, Joyce Meints, and Philip Heywood

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