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SURFICIAL GEOLOGY

By

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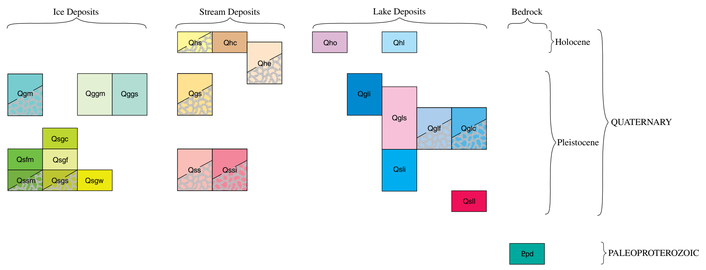
2001

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

HOLOCENE AND LATE PLEISTOCENE

Qho — **Organic deposits**—Peat and organic-rich sediment deposited in marshes and shallow lakes. Typically found in depressions interpreted to have formed through melting of buried glacial ice and along former glacial stream channels. Some deposits have been drained.

Qhl — **Lake sediment**—Clay, silt, and fine sand deposited in basins by settling from calm water.

Qhs — **Stream sediment**—Sand, gravel, and silt deposited by modern streams. May include minor organic deposits; includes areas of steep slopes created by stream incision.

Qhc — **Steep-slope and slope deposits**—Steep slopes mainly along incised streams where older glacial sediment and bedrock may be exposed but typically partially covered with debris shed from slopes.

Qhe — **Stream-eroded surface deposits**—Coarse sand and gravel stream deposits of the Kettle and St. Croix Rivers and erosional (strath) terraces exposing older glacial sediment or bedrock. Related to drainage of glacial lakes Duluth and Nemadji. Thickness of sand and gravel varies and is thickest in bar forms. In areas of thin to no sand and gravel the underlying unit exposed by erosion is commonly glacial sediment but may also be glacial-lake sediment and bedrock.

PLEISTOCENE

Deposits of the Grantsburg sublobe of the Des Moines lobe—Pine City and West Rock phases

Qgm — **Glacial sediment of end moraines**—Thick deposits of loamy, yellow brown (oxidized) and gray (unoxidized) glacial sediment; it may be complexly mixed with underlying reddish Superior-lobe sediments, which are evident near the western margin of the lobe in Pine County and near the lower contact. Collapsed areas are mainly restricted to where the Grantsburg sublobe advanced over what must have been ice-filled tunnel valleys of the Superior lobe.

Qggm — **Glacial sediment with stream- and lake-modified surface**—Loamy glacial sediment; may be covered by a thin layer of fine or sandy sediment; in places a stony surface lag may be present due to washing away of fine sediment from till matrix.

Qggs — **Glacial sediment and pond sediment accumulated in inter-morainic swales**—Commonly resedimented loamy glacial sediment intermixed with fine sand, silt, and clay from meltwater and ponded water. Found in low areas between moraines. Constitutes a thin, discontinuous but significant unit that overlies thick Grantsburg till. Not interpreted as the deposits of a continuous lake but rather short-lived small ponds and interconnecting streams.

Qgli — **Sediment of ice-walled lakes**—Minor areas of elevated lake sediment consisting of sand, silt, and clay that was deposited in calm water held in depressions on the ice surface. Found in morainic areas of the Grantsburg sublobe.

Qgs — **Stream sediment**—Sand and gravel deposited by meltwater streams of the Grantsburg sublobe along its margin. Deposited as ice wasted and after glacial Lake Grantsburg drained. Additional contributions from nonmeltwater streams of a northerly source. Collapsed in places due to deposition on or with the ice that later melted.

Lake sediment of glacial Lake Grantsburg.

Qgls — ***Sandy sediment***—Sandy deposits found in only two locations along the southeasterly and northwesterly extent of the former lake in Pine County. Interpreted as Superior-lobe sediment reworked by wave action of glacial Lake Grantsburg and redeposited near shore.

Qglf — ***Silty and sandy sediment***—Gray to yellow brown. Commonly deposited in a thin drape (less than 1.5 meters) over extant sandy Superior-lobe deposits. Deposited in shallow water. Extent may be discontinuous.

Qglc — ***Silty and clayey sediment***—Gray; in places thinly laminated with alternating clay- and silt-rich layers. Deposited in deep water. Generally greater than 1.5 meters thick.

Deposits of the Superior lobe—Automba, Beroun, Hinckley, North Hinckley, Grindstone, Sandstone, Askov, Lookout Tower, Kerrick, and Nickerson phases

Qsgc — **Clayey glacial sediment**—Locally thick morainic deposits of the Nickerson phase of the Superior lobe (Fig. 1). Red where oxidized, reddish gray where unoxidized. Hummocky surface reflects stagnation and subsequent melting of ice along margin of lobe. May be interbedded with lake clay (a proglacial lake formed behind the moraine when ice retreated slightly to north).

Qsgf — **Silty and clayey glacial sediment**—Silty and clayey glacial deposits associated mainly with the Kerrick phase (Fig. 1); thin and discontinuous where associated with the Askov and Lookout Tower phases.

Qsfm — **Silty and clayey glacial sediment**—Silty and clayey glacial deposits that compose ice-marginal moraine ridges of the Kerrick and Split Rock phases (Fig. 1).

Qssm — **Sandy glacial sediment**—Red where oxidized, reddish gray where unoxidized; sandy matrix; pebbles, cobbles, and boulders common. Collapsed in places owing to deposition with or on ice that subsequently melted.

Qsgs — **Sandy glacial sediment**—Similar to unit above (Qssm) but in moraine ridges of the Automba, Beroun, Hinckley, North Hinckley, Grindstone, and Sandstone phases (Fig. 1). The moraine ridge of the Askov–Lookout Tower phase is also sandy, and contains boulders of sandstone; however, the till of this phase is fine-grained silty clay.

Qsgw — **Wave-washed glacial sediment**—Sandy red glacial sediment modified by flowing stream water of glacial Lake Grantsburg. May have a concentration of coarse clasts near the surface or be covered by a thin drape of fine sediment.

Qsii — **Sediment of ice-walled lakes**—Lake sediment in elevated positions; consists of sand, silt, and clay that was deposited in calm water within depressions on former ice surface. Present in morainic areas in all phases of the Superior lobe (Fig. 1).

Qssi — **Sorted sediment proximate to ice**—Sand and gravel sorted by meltwater in close proximity to ice. May constitute eskers, tunnel-valley fill, conical hills (kames), and ice-marginal fans. Esker symbol shown where the esker form is prominent.

Qss — **Stream sediment**—Stratified sand and gravel deposited mainly by meltwater streams from all phases of the Superior lobe. Collapsed in places owing to deposition on or with melting ice, resulting in local disruption of bedding.

Qsil — **Lake sediment of glacial Lake Lind**—Laminated lake sediment; varves of red clay and gray silt are common. Exposed by erosion in the strath terrace along the St. Croix River.

PALEOPROTEROZOIC

Epd — **Denham Formation**—Undifferentiated. See Plates 2 and 3 for further information on the bedrock geology of Pine County.

MAP SYMBOLS

Geologic contact—Approximately located; established from geomorphology and materials as interpreted from aerial photographs, examination of surficial material, and soil maps.

Sinuous narrow ridge (esker)—Linear ridge of predominantly sand and gravel. Interpreted as having been deposited in an ice-tunnel or ice-walled channel by a glacial meltwater stream. Arrowheads show inferred flow direction. The fluvial sediment may be covered by as much as three meters of till. All eskers are interpreted to be of Superior-lobe origin, although thin sediments of the Grantsburg sublobe may in places cover those in the southern half of the county.

Conical hill (kame)—Predominantly sand and gravel. Interpreted as deposit of meltwater within confines of supporting ice. When ice melted, gravel and sand assumed angle of repose. Bedding likely collapsed.

Streamlined hill or ridge (drumlin)—Typically composed of glacial sediment deposited at the base of moving Superior-lobe ice. Arrowhead on long axis shows inferred direction of ice movement. Evident in northwest corner of county.

Block of thrusted sediment—Sawteeth point in direction of thrusting agent; interpreted to be glacially thrusted ice-marginal sediment. Present in places along the Superior-lobe ice margins. Probably indicates sudden advance or surge of ice.

Fan-shaped sloping hill—Interpreted to be an alluvial fan composed of sand and gravel.

Sharp-crested ridge—Interpreted as a former ice margin.

Scarp—Ticks point downscarp. Established from aerial photographs and topographic maps. Where paired, interpreted to be a former drainageway. Not indicated where scarp coincides with stream-related unit. Former drainageways may in places control the direction of present-day surface and near-surface water flow, especially flood waters.

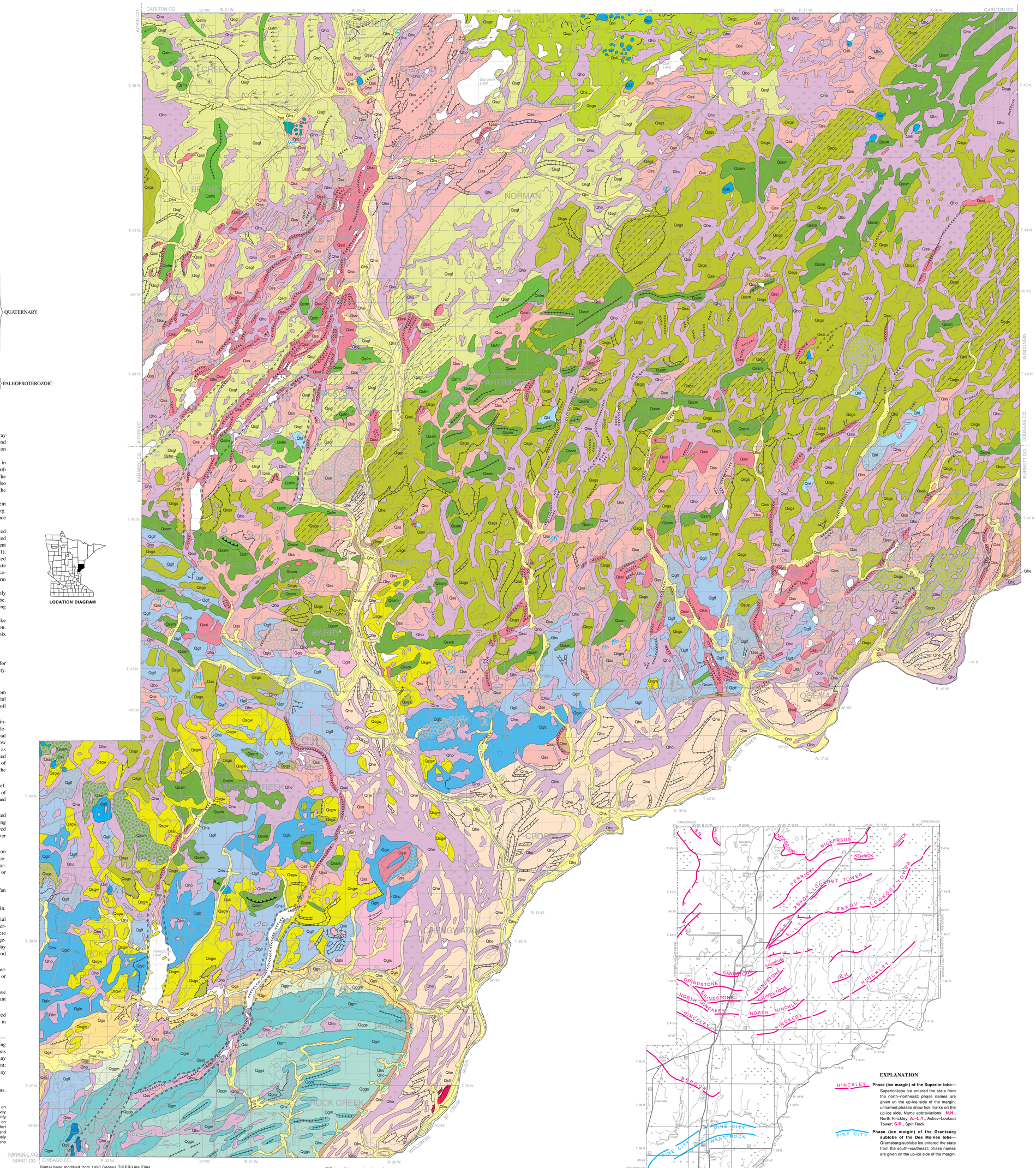
Irregular, broad trough—Ticks point downslope. Interpreted to be a collapsed subglacial drainage channel or buried valley.

Irregular, hummocky topography—Interpreted to have formed as sediments were deposited with or on stagnant ice; material collapsed when ice melted.

Irregular sandy hills—Interpreted as weakly expressed windblown dunes. Most are located in forested area in northern part of map area.

Lineations apparent in areas of thin glacial sediment—Interpreted as a reflection of bedrock structure and bedding in areas of glacial erosion or nondeposition. The lineations in areas underlain by basaltic rocks (see Plate 2) may correspond to the pattern of deposition of glacial sediment; in areas underlain by sandstone, the lineations may indicate the location and orientation of sinkholes.

Curvilinear ridges—Interpreted as clay-rich landforms. Found exclusively in the Nickerson moraine (Fig. 1).



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. Contours derived from the U.S. Geological Survey 30-meter grid cell digital elevation model data

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

GIS compilation and cartography by Joyce Meints and Philip Heywood

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 10 METERS

EXPLANATION

HINCKLEY — **Phase (ice margin) of the Superior lobe**—Superior-lobe ice entered the state from the north–northeast; phase names are given on the up-ice side of the margin; unnamed phases show tick marks on the up-ice side. Name abbreviations: **N.H.**, North Hinckley; **A.–L.T.**, Askov–Lookout Tower; **S.R.**, Split Rock.

PINE CITY — **Phase (ice margin) of the Grantsurg sublobe of the Des Moines lobe**—Grantsburg-sublobe ice entered the state from the south–southeast; phase names are given on the up-ice side of the margin.

Figure 1. Distinct phases, or ice margins, of the Grantsburg sublobe of the Des Moines lobe (blue) and of the Superior lobe (magenta). The Grantsburg sublobe entered the county from the south–southeast. The Superior lobe entered Pine County from the north–northeast. The margins represent positions where advancing or receding ice stood long enough to leave distinctive landforms at the surface. Quaternary geologists use such markers to reconstruct the glacial history of Pine County.