UNIVERSITY OF MINNESOTA

MINNESOTA GEOLOGICAL SURVEY
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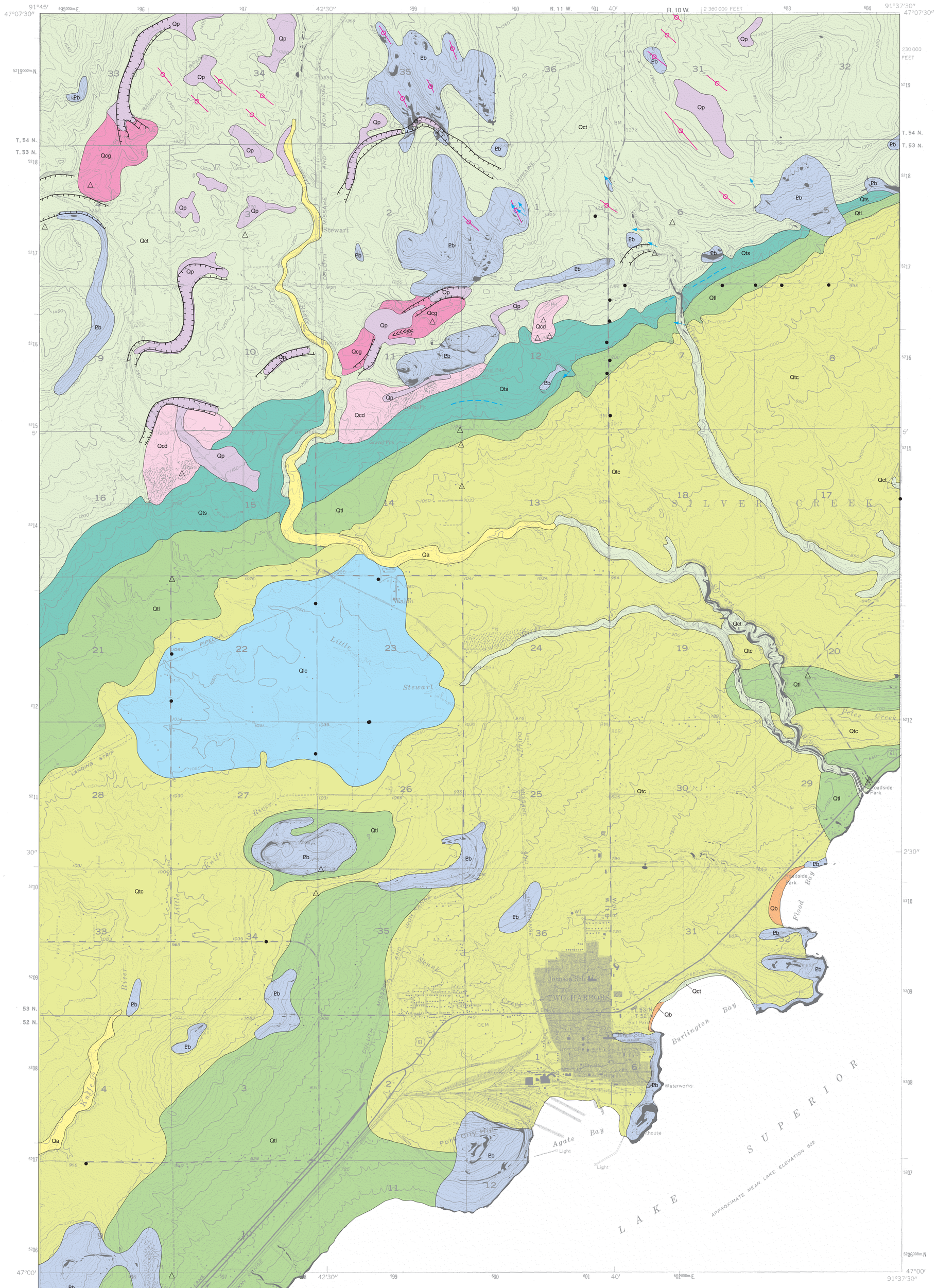
MISCELLANEOUS MAP SERIES
MAP M-138
Surficial Geology, Two Harbors Quadrangle



Base from U.S. Geological Survey Two Harbors 1:24,000 quadrangle, 1957, revised 1969.

Universal Transverse Mercator grid, zone 15
1983 North American Datum

GIS compilation and cartography by R.S. Lively
Edited by Lori Robinson

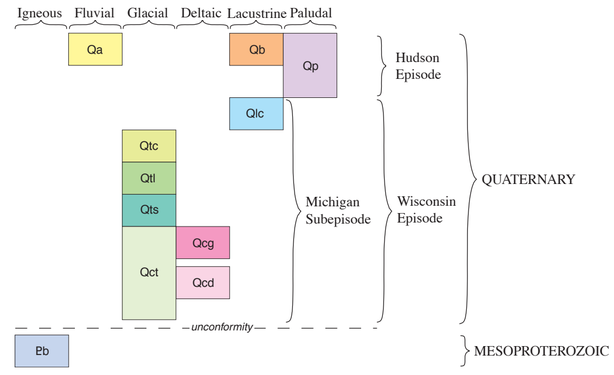
Figure 1. Texture of surficial units.

SURFICIAL GEOLOGY OF THE TWO HARBORS QUADRANGLE, LAKE COUNTY, MINNESOTA

by

Howard C. Hobbs
2003

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

QUATERNARY

HUDSON EPISODE*

Qp — **Peat**—Partly-decayed organic debris accumulated in wetlands. Usually underlain by the same material that surrounds it.

Qa — **Alluvium**—Sediment of modern streams. Channel sediment is mostly gravel, with a lesser amount of sand, over a lag of larger rocks. Little overbank sediment was observed, mostly sand and silt.

Qb — **Modern beach deposit**—Clean, rounded, sorted gravel on the shore of Lake Superior.

WISCONSIN EPISODE: MICHIGAN SUBEPISODE

Qlc — **Glaciolacustrine sediment**—Sediment deposited in a glacial lake dammed by the Superior lobe.

Glacial lake clay—Reddish-brown (2.5YR4/4 or 4/3) clay. Typically unbedded. Sand is generally less than 10 percent (Fig. 1), and coarse-grained fragments (greater than 2 millimeters in diameter) are usually less than 1 percent. Thickness is 3 to 5 feet (1 to 1.5 meters) over clay till (Qtc) on a flat lake plain; contact is obscure, and is recognized in the field by a lack of pebbles in the lacustrine sediment.

Fine-grained glacial sediment—Deposited by the Superior lobe within the Superior basin. These tills incorporate silt and clay deposited in Lake Superior during recessions between advances. Clast composition is similar to that of the Cromwell Formation (described below), except that about half of the samples from Qtc and about one third of the samples from Qtl contain one to a few fragments of Paleozoic carbonate grains in the 1 to 2 millimeter fraction. Very few samples of Qts contain any Paleozoic carbonate.

Qtc — ***Clay till***—Reddish-brown (2.5YR5/3 to 4/4) clay (Fig. 1); massive, calcareous. The upper meter is commonly leached; secondary carbonate nodules are common in the meter or two below the leached zone. The majority of samples contain between 1 and 3 percent coarse-grained fragments. In places, contains inclusions of brown (7.5YR4/3) to reddish-brown (5YR4/4) calcareous clay with few coarse-grained fragments. These inclusions are interpreted to reflect incorporation of gray Lake Agassiz clay, which was deposited in Lake Superior prior to the Marquette advance that deposited this till (Clayton, 1983). The average thickness is 10 to 13 feet (3 to 4 meters), but is absent in a large area near Lake Superior, where the underlying clayey till (Qtl) forms the surface.

Qtl — ***Clayey till***—Reddish-brown (5–2.5YR5/3 to 4/4) silty clay (Fig. 1); massive, slightly calcareous in places. About half the samples contain more than 3 percent coarse-grained fragments, but only one third contain more than 5 percent. The average thickness is about 3 meters.

Qts — ***Silty till***—Reddish-brown (mostly 5YR4/3 to 3/4) silt loam (Fig. 1); massive, noncalcareous. About half the samples contain more than 6 percent coarse-grained fragments, but very few contain more than 12 percent. The average thickness is unlikely to be more than 7 feet (2 meters). Appears to be more patchy than the tills described above.

Cromwell Formation (Wright and others, 1970)—Glacial and glacial meltwater sediment of the Superior lobe. Defined as reddish-brown sandy to silty till containing fragments of red sandstone from the Superior basin, and associated sand and gravel. In this area, the clasts of the Cromwell Formation are mostly rocks of the Superior basin. Red sandstone is present, but North Shore Volcanic Group and Duluth Complex rocks are more common. The fine-grained tills described above are not included in the Cromwell Formation because they contain too little sand. On this quadrangle, the formation is divided into an unsorted glacial facies (Qct) and two stratified facies (Qcd and Qcg).

Qct — ***Till, subglacial facies***—Reddish-brown (5YR5/4 to 4/4) rocky loam to sandy loam; compact, jointed, noncalcareous. Coarse-grained fragments range from less than 1 to 45 percent, but average about 12 percent. Topography is controlled chiefly by bedrock. The average thickness is about 10 feet (3 meters).

Qcg — ***Glaciofluvial gravel***—Gravel and sand. Overall texture ranges from fine-grained sand to coarse-grained gravel, but individual beds have a narrower range, such as fine- to coarse-grained gravel. Trough cross-bedding is common; in places the bedding is flat and obscure. Unit occupies the elevation range between 1,200 to 1,260 feet in one place, and 1,290 to 1,370 feet in another. The lower area includes an esker and an adjacent area with hummocky topography where the gravel is interfingered with till of the Cromwell Formation. The upper area appears to be a fan associated with a meltwater channel. Meltwater channels are expected to contain thin glaciofluvial gravel in places, but most of them are now covered with peat (Qp). Most of the sediment was likely deposited in small ice-marginal lakes.

Qcd — ***Ice-contact delta sediment***—Sandy gravel similar to unit Qcg above, but finer-grained on average and lower in elevation (elevation ranges from 1,160 to 1,210 feet). Foreset beds were observed in places. Unit is about 33 feet (10 meters) thick. Overlain in most places by 3 to 10 feet (1 to 3 meters) of till of the Cromwell Formation (Qct), which in turn is overlain in places by thin silty till (Qts). This stratigraphic relationship suggests that the deltas formed during a recessional phase of the Superior lobe before its advance to the Highland moraine (Wright, 1972).

MESOPROTEROZOIC

Pb — **Bedrock at or near the surface**—Dominated by mafic volcanic flows and diabase. The larger areas of this unit are diabase sills that are now tilted toward Lake Superior and form prominent ridges. The surface of the rock has been smoothed by glacial erosion and is relatively unweathered. Narrow areas of this unit along streams and the Lake Superior shoreline are shown as bedrock outcrop.

*Time–event classification follows Hansel and Johnson (1996).

MAP SYMBOLS

Geologic contact—Approximately located.

Meltwater channel—Channel segments aligned parallel to presumed retreatal ice margins of the glacier that deposited the Cromwell Formation. The general pattern of meltwater flow at this time was to the southwest, where the water followed the lowest course out of the Superior basin.

Lake Superior strandline—Faint lineation visible on aerial photographs; interpreted as one of the highest stands of glacial Lake Superior. Present sporadically, just above the 1100-foot contour line.

Esker—Coarse-grained meltwater sediment deposited in a tunnel under the ice. Contains gravel and boulders.

Bedrock outcrop—Mapped by Boerboom and others (2003).

Glacial striation—Arrow shows the direction of flow.

Flutes—Streamlined landforms, composed mostly of bedrock but mantled by till; shaped by ice flowing out of the Superior basin. Named the Highland Flutes by Wright (1972, p. 531.)

Soil boring—Most borings are less than 20 feet (6 meters) in depth.

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

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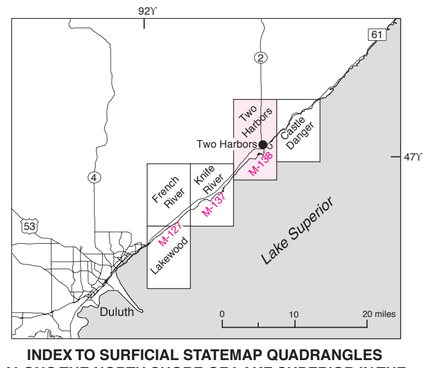

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