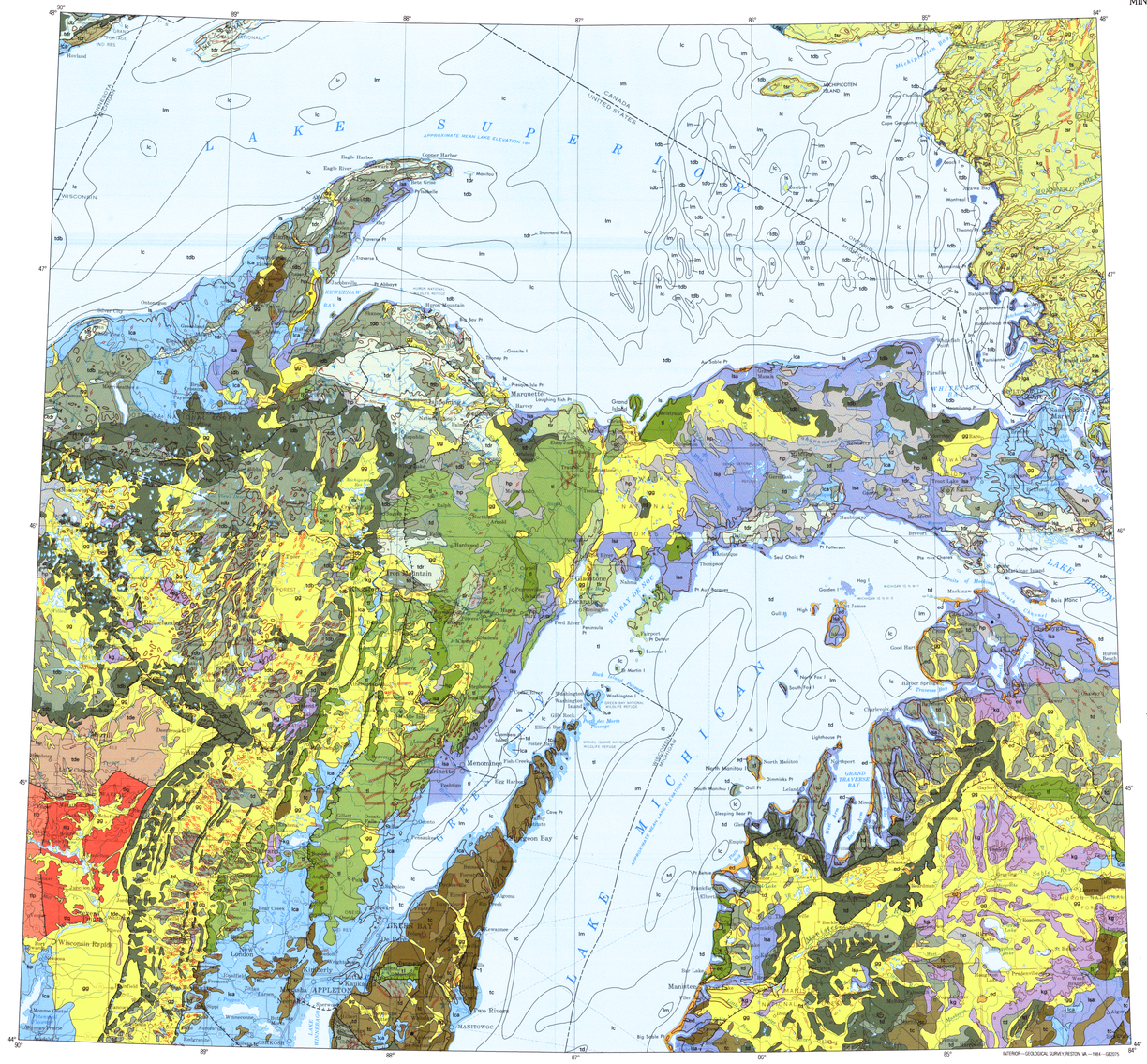
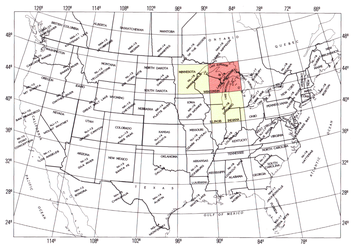
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DEPARTMENT OF GEOLOGICAL SCIENCES, UNIVERSITY OF MICHIGAN
DEPARTMENT OF GEOLOGY AND GEOPHYSICS, UNIVERSITY OF WISCONSIN
ONTARIO DEPARTMENT OF NATURAL RESOURCES AND THE
MINNESOTA GEOLOGICAL SURVEY

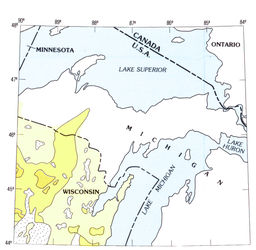
QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES
MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1420 (NL-16)





INDEX TO INTERNATIONAL MAP OF THE WORLD 1:1,000,000 TOPOGRAPHIC SERIES

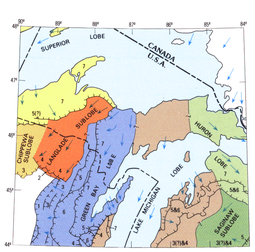
Showing location of the Quaternary Geologic Map of the Lake Superior 4° x 6° Quadrangle in red [U.S Geological Survey, Miscellaneous Investigations Series, Map I-1420 (NL-16)] and other published maps of the Quaternary Geologic Atlas of the United States in yellow.



LOESS DISTRIBUTION AND THICKNESS IN METERS

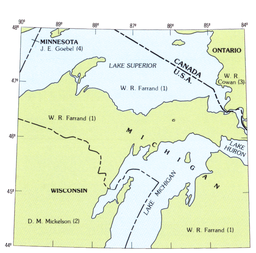
EXPLANATION

0.25 m
0.25-0.5 m
0.5-1.5 m
Sand



RELATIONSHIPS OF LATE WISCONSIN GLACIAL LOBES, SUBLOBES, AND ADVANCES WITHIN LOBES AND SUBLOBES

Numbers indicate relative ages of surface tills in respective lobes and sublobes (oldest to youngest) in this quadrangle. Hachures indicate readvance limits shown on Quaternary geologic map. Arrows indicate generalized ice flow within lobes and sublobes



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(1) DEPARTMENT OF GEOLOGICAL SCIENCES, UNIVERSITY OF MICHIGAN
(2) DEPARTMENT OF GEOLOGY AND GEOPHYSICS, UNIVERSITY OF WISCONSIN
(3) ONTARIO DEPARTMENT OF NATURAL RESOURCES
(4) MINNESOTA GEOLOGICAL SURVEY

QUATERNARY GEOLOGIC MAP OF THE LAKE SUPERIOR 4°x6° QUADRANGLE, UNITED STATES AND CANADA

State and province compilations by
William R. Farrand, David M. Mickelson, W. Richard Cowan, and Joseph E. Goebel

Edited and integrated by
Gerald M. Richmond and David S. Fullerton

1984

QUATERNARY GEOLOGIC ATLAS OF THE UNITED STATES

LIST OF MAP UNITS

HOLOCENE

- lm — LAKE CLAY AND SILT UNDER LAKES MICHIGAN, HURON AND SUPERIOR
- lc — LAKE SILT AND CLAY UNDER LAKES MICHIGAN, HURON AND SUPERIOR
- ls — LAKE SAND AND GRAVEL UNDER LAKE SUPERIOR

HOLOCENE AND LATE WISCONSIN

- al — ALLUVIUM
- hp — PEAT AND MUCK
- ed — DUNE SAND
- lds — DELTA SAND
- lga — LAKE GRAVEL

LATE WISCONSIN

- lca — LAKE SILT AND CLAY
- lsa — LAKE SAND
- gg — OUTWASH SAND AND GRAVEL
- kg — ICE-CONTACT SAND AND GRAVEL
- CLAYEY TILL
  - tc — Ground moraine
  - tc — Ground moraine under Lake Michigan
  - tc — End moraine
  - tcr — Attenuated drift
- LOAMY TILL
  - tl — Ground moraine
  - tl — Ground moraine under Lake Michigan
  - tl — End moraine
  - tlr — Attenuated drift
- CALCAREOUS SANDY LOAMY TILL
  - td — Ground moraine
  - td — Ground moraine under Lakes Michigan and Huron
  - td — End moraine
  - tdr — Attenuated drift
- NONCALCAREOUS SANDY LOAMY TILL
  - tdb — Ground moraine
  - tdb — Ground moraine under Lake Superior
  - tdb — End moraine
  - tdr — Attenuated drift
- SANDY TILL
  - ts — Ground moraine
  - tsr — Attenuated drift

EARLY WISCONSIN

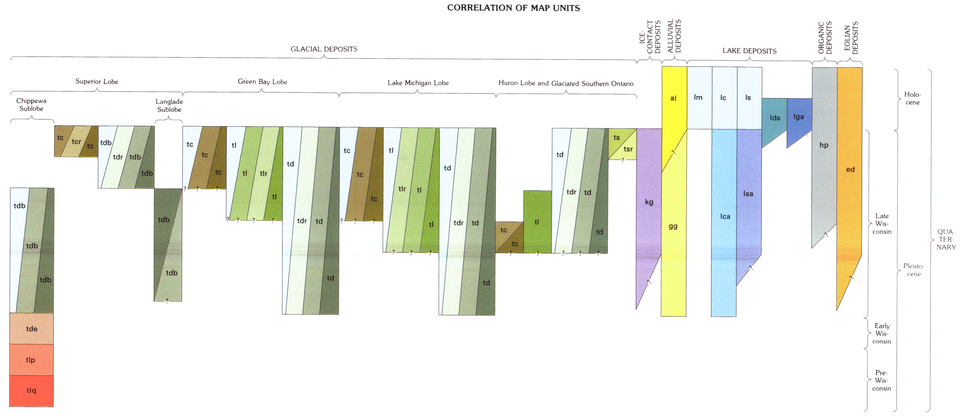
- tde — SANDY LOAMY TILL

PRE WISCONSIN

- tlp — LOAMY TILL
- tlq — LOAMY TILL

- CONTACT
- ESKER
- DRUMLIN
- DIRECTION OF ICE MOVEMENT— Indicated by striations
- OUTER LIMIT OF GLACIAL ADVANCE—Solid where marked by end moraine or outer limit of till, dashed where inferred. Ticks on side of glacial advance
- f — MAN MADE—Mine dumps and tailings (Michigan); steel mill slag (Ontario)
- LOCATION OF IMPORTANT STRATIGRAPHIC SECTION
  - •1 — Type locality of Two Creeks Forest Bed (Thwaites and Bertrand, 1957; Black, 1970); type locality of the informal Haven till of Acomb (1978).
  - •2 — Type locality of Valders Till (Thwaites and Bertrand, 1957, Black, 1970).
  - •3 — Cheboygan bryophyte bed (Farrand and others, 1969).

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

HOLOCENE

lm — LAKE CLAY AND SILT UNDER LAKES MICHIGAN, HURON, AND SUPERIOR—Brownish-gray to gray, soft to weakly compact, clay, silty clay, and clayey silt. Deep-water facies of lake deposits. Thickness less than 4 m

lc — LAKE SILT AND CLAY UNDER LAKES MICHIGAN, HURON, AND SUPERIOR—Brownish-gray to gray, massive to laminated silt and clay. More compact than unit **lm**. Deep-water facies of lake deposits. Thickness commonly 1-5 m; locally 10-15 m in deep water

ls — LAKE SAND AND GRAVEL UNDER LAKE SUPERIOR—Brown to gray, well- to poorly sorted, fine to coarse sand and minor gravel with some stratification. Beach and nearshore facies of Lake Superior deposits. Thickness generally 1-5 m; rarely 10 m

HOLOCENE AND LATE WISCONSIN

al — ALLUVIUM—Brown or reddish-brown to gray sand, silt, and gravel. Well-to poorly sorted; generally well stratified. Textures variable laterally and vertically. Occurs in stream channels, flood plains, and low stream terraces. Map unit includes small areas of peat and muck (**hp**). In Wisconsin, alluvium is included in outwash sand and gravel (**gg**). Thickness generally 1-5 m

hp — PEAT AND MUCK—Black to dark-brown, fibrous to decomposed organic residues. Includes some areas of mineral soil rich in organic matter. Commonly overlies lake deposits (**lca, lsa**), outwash sand and gravel (**gg**), or till (**tl**, **td**, **tdb**). Occurs in low-lying, poorly drained basins. Thickness 1-3 m

ed — DUNE SAND—Pale-brown, well-sorted, crossbedded, fine to medium sand. Composed chiefly of frosted grains of quartz and some heavy minerals. Includes windblown sheet sand. Commonly occurs in massive dune ridges parallel to present shorelines, locally as parabolic dunes on glacial lake and outwash plains. Dunes commonly stabilized by vegetation, but active where vegetation disturbed, especially along lake shores. Thickness 1-30 m

lds — DELTA SAND—Yellowish-brown to brown, medium to coarse sand with some pebble gravel. Well sorted; well bedded. Occurs as topset beds of deltas in Ontario; delta sand is included in lake sand (**lsa**) elsewhere. Thickness 2-6 m

lga — LAKE GRAVEL—Brown to gray, sandy gravel and pebbly or cobbly sand. Well sorted; well bedded; commonly crossbedded. Pebbles and cobbles are rounded, chiefly of granite and gneiss. Deposits represent beach and nearshore facies of glacial-lake deposits in Ontario. Thickness 1-6 m

LATE WISCONSIN

lca — LAKE SILT AND CLAY—Silt, silty clay, and clay. In Michigan and Wisconsin, dark reddish-brown to gray; in Ontario, pink to gray. Well bedded to massive; commonly laminated or varved. Locally includes some lake sand (**lsa**), windblown sand (**ed**), or till (**tc**, **td**, **tdb**). Occurs chiefly in extensive, flat, low-lying areas formerly occupied by glacial lakes, but also in small, separate lake basins. Thickness 1-25 m

lsa — LAKE SAND—Pale-yellowish- to pale-reddish-brown, fine to medium sand. Contains local lenses of pebbly sand, gravel, or silt and clay. Moderately to poorly sorted. Sand composed chiefly of quartz and feldspar; granules and pebbles chiefly hard, fine- and coarse-grained, igneous and metamorphic rocks. Deposits represent beach and nearshore facies of glacial-lake deposits. Lake sand is overlain locally by a thin, discontinuous cover of windblown sand (**ed**) or peat and muck (**hp**). In valleys in eastern part of the Upper Peninsula of Michigan, lake sand grades upstream into outwash sand and gravel (**gg**). Thickness 1-5 m in Ontario, 1-30 m in Michigan

gg — OUTWASH SAND AND GRAVEL—Pale-yellowish-brown, pale-brown, or pale-reddish-brown to gray, fine to coarse sand alternating with beds and lenses of pebbly sand and pebble to cobble gravel. Poorly to well sorted; generally well stratified; locally crossbedded. Sand composed chiefly of quartz and feldspar grains. Pebbles and cobbles chiefly resistant rocks: in Wisconsin, primarily dolomite and limestone in Green Bay lobe and Lake Michigan lobe; granitic and hard, fine-grained metavolcanic rocks and sandstone in Superior lobe; in Ontario, chiefly granitic, hard, fine-grained metavolcanic and metamorphic rocks; in Upper Peninsula of Michigan, primarily granitic, and hard, fine-grained metamorphic rocks, and in Lower Peninsula of Michigan, chiefly dolomite and limestone. Occurs in terraces, valley trains, outwash plains, outwash fans, and deltas; surface commonly is pitted by ice-block depressions. In Wisconsin, map unit includes numerous drumlins of till around which outwash is deposited, and small striated rock outcrops. Locally, the outwash is covered by thin deposits of windblown sand (**ed**), peat and muck (**hp**), or alluvium (**al**). Thickness 1-20 m

kg — ICE-CONTACT SAND AND GRAVEL—Pale-brown to gray, fine to coarse sand with abundant pebbles, cobbles, and occasional boulders. Poorly to well sorted; poorly to well stratified; locally crossbedded. Pebbles, cobbles, and boulders chiefly of resistant rocks; in Wisconsin, primarily dolomite and limestone in Green Bay lobe, and granitic and hard, fine-grained metavolcanic rocks and sandstone in Superior lobe; in Ontario, chiefly granitic, and hard, fine-grained metavolcanic and other metamorphic rocks; in Upper Peninsula of Michigan, primarily granitic and hard, fine-grained metamorphic rocks,and in Lower Peninsula of Michigan, chiefly limestone and dolomite. Texture varies abruptly, laterally and vertically. Commonly exhibits penecontemporaneous deformation in the form of faults, folds, and slump or collapse structures. Surface commonly pitted by ice-block depressions. Occurs in kames, kame terraces, and eskers and in broad tracts between former glacial lobes. Mapped areas include small deposits of outwash sand and gravel (**gg**) and sandy till (**td**, **ts**). Commonly overlain by as much as 2 m of unmapped loess in Wisconsin. Thickness 1 to more than 30 m

CLAYEY TILL—Clay, silty clay, clay loam, and silty clay loam. Reddish-brown to gray, calcareous, non-sorted to very poorly sorted. Locally interbedded with sand and gravel. Commonly contains pebbles, cobbles, and boulders, chiefly of limestone or dolomite in the area around Lake Michigan. Map unit includes small areas of sandy till (**td**, **tdb**) and outwash sand and gravel (**gg**). In Wisconsin, the till commonly is overlain by as much as 2 m of unmapped loess

tc — Ground moraine—Thickness of till is generally less than 20 m, locally 20-30 m

tc — Ground moraine under Lake Michigan

tc — End moraine—Linear ridge or belt of hummocky terrain. Thickness of till generally greater than that of associated ground moraine

tcr — Attenuated drift—Deposits of thin discontinuous till separated by numerous or extensive bedrock exposures. Mapped only in northwest corner of quadrangle, in Minnesota

LOAMY TILL—Brown or reddish-brown to gray, calcareous, nonsorted to poorly sorted loam, silt loam, and sandy loam. Scattered pebbles, cobbles, and boulders composed predominantly of limestone and dolomite. Map unit includes small areas of outwash sand and gravel, (**gg**) and sandy or clayey till (**td**, **tdb**, **tc**)

tl — Ground moraine—Thickness of till generally less than 20 m, locally 20-30 m

tl — Ground moraine under Lake Michigan

tl — End moraine—Narrow, linear ridge or belt of hummocky terrain. Till locally is interbedded with outwash or ice-contact sand and gravel (**gg**, **kg**). Thickness of till generally greater than that of associated ground moraine

tlr — Attenuated drift—Deposits of thin, discontinuous till separated by numerous or extensive bedrock outcrops. Mapped only in northeastern Wisconsin

CALCAREOUS SANDY LOAMY TILL—Reddish-brown or pale-brown, non-sorted to poorly sorted sandy clay loam, sandy loam, and loam. Contains abundant pebbles, cobbles, and boulders, chiefly of limestone and dolomite with some of hard, coarse- and fine-grained, igneous or metamorphic rocks. In Wisconsin, till commonly overlain by as much as 2 m of unmapped loess

td — Ground moraine—Thickness of till generally less than 20 m, locally 20-30 m

td — Ground moraine under Lakes Michigan and Huron

td — End moraine—Broad to narrow, hummocky ridges. Thickness of till generally greater than that of associated ground moraine

tdr — Attenuated drift—Thin discontinuous deposits of sandy loamy till, separated by numerous or extensive bedrock outcrops on which are scattered erratics. Lithology and carbonate content of till similar to that of adjacent ground moraine (**td** or **tdb**)

NONCALCAREOUS SANDY LOAMY TILL—Pale loam and loamy sand. Pale- to reddish-brown, non-sorted to poorly sorted sandy clay loam, sandy loam, and loamy sand. Contains abundant pebbles, cobbles, and boulders, predominantly of granitic and hard, fine-grained metavolcanic rocks; sandstone abundant in Superior lobe. In Michigan, till locally resembles outwash or ice-contact sand and gravel, but contains lenses of non-sorted clayey or silty till

tdb — Ground moraine—Thickness of till generally less than 20 m, locally 20-30 m

tdb — Ground moraine under Lake Superior

tdb — End moraine—Broad, hummocky till ridges. Thickness generally greater than that of associated ground moraine

tdr — Attenuated drift—Thin discontinuous deposits of sandy loamy till, separated by numerous or extensive bedrock outcrops on which are scattered erratics. Lithology and carbonate content of till similar to that of adjacent ground moraine (**tdb** or **td**)

SANDY TILL—Gray (unoxidized) to yellowish-brown to reddish-brown (oxidized), locally red, noncalcareous, stony, sand and sandy silt. Non-sorted to poorly sorted; loose in upper 2 m, very compact at depth. Contains abundant pebbles and boulders of granitic or gneissic rocks, or hard, fine-grained metavolcanic, and other metamorphic rocks. Locally, in lowland areas, till is composed chiefly of red sandstone fragments. Mapped only in Ontario

ts — Ground moraine—Thickness 1-12 m

tsr — Attenuated drift—Deposits of thin, discontinuous till separated by abundant or extensive bedrock outcrops. Includes small areas of outwash sand and gravel (**gg**), ice-contact sand and gravel (**kg**), peat and muck (**hp**), and wave-washed bedrock

EARLY WISCONSIN

tde — SANDY LOAMY TILL—(Merrill Till in Wisconsin)—Dark-red to reddish-brown intensely weathered, noncalcareous, non-sorted to poorly sorted sandy loam and loam. Pebbles, cobbles, and boulders rounded to subangular; chiefly of granite, gneiss, and schist. Occurs as ground moraine. Commonly overlain by as much as 2 m of unmapped loess. Thickness 1-4 m

PRE WISCONSIN

tlp — LOAMY TILL—Reddish-brown, intensely weathered, calcareous to noncalcareous, non-sorted to poorly sorted loam and silt loam. Pebbles, cobbles, and boulders predominantly granite, gneiss, schist, and sandstone. Occurs as ground moraine. Commonly overlain by less than 2 m of unmapped loess. Till discontinuous and locally absent. Thickness generally less than 2 m

tlq — LOAMY TILL (Wauseu Till in Wisconsin)—Reddish- or dark-reddish-brown to gray, commonly intensely weathered, noncalcareous, non-sorted to poorly sorted sandy loam, loam, and silt loam. Pebbles, cobbles, and boulders predominantly of local metavolcanics, granitic rocks, and quartzite. Till forms a thin, discontinuous veneer; overlies clayey saprolite developed on granitic and metavolcanic rocks. Thickness generally less than 2 m

Note: This map is the product of interorganizational collaboration. Following a regional meeting of State and Province compilers with the coordinators to establish map units and related matters, Quaternary maps and map explanations of the parts of the States and the Provinces included in the quadrangle were prepared by each of the compilers. These were then integrated and locally supplemented by the editors to produce this quadrangle map and map explanation. Associated diagrams were prepared by the editors. Significant geologic problems requiring changes in the map or addition of information were resolved at meetings with the compilers, who reviewed the map prior to its submittal for publication. Other reviewers, to whom the editors are indebted, were Robert F. Black, University of Connecticut and Kim Manley, U.S. Geological Survey.

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Unpublished map information contributed by: R. F. Black, E. B. Evenson, F. D. Hole, A. J. Klinglehoets, G. B. Lee, M. C. McCartney, D. M. Mickelson.

DISTRIBUTION OF LOESS AND THICKNESS IN METERS (INDEX MAP)

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