QUATERNARY GEOLOGIC MAP OF THE MINNEAPOLIS 4° x 6° QUADRANGLE, UNITED STATES

State compilations by
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This map is a product of collaboration of State and Provincial geological surveys, universities, and the U.S. Geological Survey and is designed for both scientific and practical purposes. It was prepared in two stages. First, separate maps and map explanations of the parts of States and Provinces included in the quadrangle were prepared by the compilers. Second, the maps were combined, integrated, and locally supplemented by the editor; map unit symbols were revised to a uniform system of classification; and map unit descriptions were prepared from information received from the compilers and from additional sources. Diagrams accompanying the map were prepared by the editor.

Differences in mapping or interpretation in different areas were resolved by correspondence to the extent possible. Most simply reflect differences in available information or philosophies of mapping, and should encourage further investigation.

Surficial deposits have been mapped and described in less than forty percent of the conterminous United States. Traditionally, mapping of surficial deposits has been focused on glacial, alluvial, eolian, lacustrine, marine, and landslide deposits. Slope and upland deposits have been mapped in detail only in restricted areas. However, an enormous amount of engineering construction and many important problems of land use and land management are associated with regions that have extensive slope and upland deposits (colluvium, residuum, saprolite, and solifluction deposits, for example). These materials have many different physical characteristics. Therefore, an effort has been made to classify, map, and describe these deposits, based in large part on unpublished interpretations, published and unpublished subsoil and substratum data, and the distribution of bedrock parent materials. The classification is crude, but it represents a first step toward a more refined and useful product.

For scientific purposes, the map differentiates Quaternary surficial deposits on the basis of a combination of criteria, such as lithology or composition, texture or particle size, structure, genesis, stratigraphic relationships, and age, as shown on the correlation diagram and indicated in the map unit descriptions. Some constructional geomorphic features, such as end moraines, are distinguished as map units. Erosional landforms, such as stream terraces, are not distinguished as map units, and differentiation of sequences of alluvial deposits of different ages in most regions is not possible at the scale of 1:1,000,000. Most landslide deposits are too small to be shown at this scale, but areas in which landslides are present are distinguished as a map unit in the southwestern part of the quadrangle.

For practical purposes, the map is a surficial materials map. Materials are distinguished on the basis of lithology or composition, texture or particle size, and local specific engineering characteristics. It is not a map of soils as soils are recognized and classified in pedology or agronomy. Rather, it is a generalized map of soils as recognized in engineering geology, or of substrata or parent materials in which pedologic and agronomic soils are formed. As a materials map it serves as a base from which a wide variety of derivative maps for use in planning engineering, land use, or land management projects can be compiled.

NOTE: This map is the product of interorganizational collaboration. Following a regional meeting of State compilers with the coordinator to establish map units and related matters, Quaternary maps and map explanations of the parts of the States included in the quadrangle were prepared by each of the compilers. These were then integrated and supplemented by the editors to produce this quadrangle map and map explanation. Associated diagrams were prepared by the editors. Significant geologic problems requiring map revision 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 Herbert E. Wright, Jr., University of Minnesota, St. Paul, Charles L. Matsch, University of Minnesota-Duluth, and Van S. Williams, U.S. Geological Survey.

The map layout includes:

- An index to the location of the Quaternary geologic map of the Minneapolis 4° x 6° quadrangle and other published maps in the Quaternary Geologic Atlas of the United States
- An illustration showing the distribution of loess and its distribution and thickness, in meters, in the map area.
- An illustration showing the tentative relationships of late Wisconsin glacial lobes, sublobes, and phases in the Minneapolis quatrangle
- An illustration showing the Areas of Responsibility for compilation of the map with names and organizations of the compilers
- An Illustration showing the correlation of map units
- A chart showing relative ages of glacial phases in Des Moines, Red River, Wadena, Rainy, and Superior lobes

DESCRIPTION OF MAP SYMBOLS ON PRINTED MAP

CONTACT

MELTWATER CHANNEL

ESKER

DRUMLIN

WIND DIRECTION INDICATED BY DUNE ORIENTATIONS

DIRECTION OF ICE MOVEMENT INDICATED BY STRIATIONS AND GROOVED BEDROCK

LIMIT OF GLACIAL ADVANCE—Ticks on side of advance

Mapped limit of end moraine or outer limit of till

Inferred limit

Buried Limit

Interlobate limit

MAN MADE LAND—Mine dumps, tailings, and open pit mines. Some include glaciated rock outcrops

DESCRIPTION OF MAP UNITS

HOLOCENE

lm LAKE CLAY UNDER LAKE SUPERIOR—Brownish-gray to gray, chiefly noncalcareous, soft to weakly compact, clay and silty clay. A deep-water facies of the lake deposits. Thickness less than 4 m

lc LAKE SILT AND CLAY UNDER LAKE SUPERIOR—Gray to brownish-gray, massive to laminated, silty clay and silty clay loam. Laminated facies usually calcareous. More compact than lake clay (**lm**). A deep-water facies of the lake deposits. Thickness generally 1-5 m; locally 10-15 m in deep water

ls LAKE SAND AND GRAVEL UNDER LAKE SUPERIOR—Brown to gray, chiefly noncalcareous, moderately to poorly sorted, fine to coarse sand with minor gravel. Beach, offshore bar, and nearshore facies of the lake deposits. Thickness generally 1-5 m, rarely as much as 10 m

HOLOCENE AND LATE WISCONSIN

al ALLUVIUM—Yellowish-brown or brown to gray silt and sand with some gravel. Moderately to well sorted; stratified. Textures variable laterally and vertically; locally interbedded with clay; in places rich in organic matter. Upper part of deposit commonly silty; lower part commonly sand and gravel. Clasts predominantly of unweathered crystalline igneous and metamorphic rocks in glaciated areas; predominantly of chert in extreme southwest Wisconsin. Deposits commonly overlie outwash sand and gravel (**gg**, **gs**) or bedrock. Thickness generally 1 to more than 4 m

hp PEAT—Dominantly undecomposed reedsedge peat or sphagnum peat which overlies partially or well-decomposed reedsedge peat, sphagnum peat, or woody peat. Occurs in topographic lows, basins, or drainageways with surface outlets that control the water table. Also overlies deposits of large glacial lakes (**lca, lsa**). Commonly forms a blanket on level to gently undulating uplands. Thickness generally 2-3 m; locally greater than 5 m

ca COLLUVIUM AND SHEETWASH ALLUVIUM[1]

Colluvium—Brown or reddish-brown, noncalcareous to weakly calcareous, nonsorted, nonstratified to faintly stratified sandy, silty clay. Commonly includes admixed colluvially retransported loess; contains angular to subangular clasts of sandstone, limestone, dolomite, and chert. Deposit is chiefly on valley sides and encloses scattered outcrops of sandstone, limestone, and dolomite. North of lat 44°30', the material locally includes some colluvially retransported glacial deposits

Sheetwash alluvium—Brown to reddish-brown, noncalcareous to weakly calcareous, poorly sorted to well-sorted sand, silt, and clay; includes admixed reworked loess; contains local layers of subangular to subround boulders to pebbles of sandstone, limestone, dolomite, and chert. Deposit chiefly on lower slopes of valleys and on valley floors

The colluvium and sheetwash alluvium cannot be distinguished separately at the scale of this map. Generally both are 1-3 m thick. Both deposits commonly are covered by Wisconsin loess or windblown sand. Distribution of loess cover more than 2 m thick shown by pattern

LATE WISCONSIN

lca LAKE SILT AND CLAY—Brown or reddish brown to gray, dark gray, or dark bluish gray; calcareous, well bedded; commonly laminated or varved. Clay minerals are chiefly illite and smectite in Minnesota; proportion of smectite decreases eastward. The deposits occur chiefly in flat, low-lying areas formerly occupied by large glacial lakes; they are commonly covered by swamp deposits or areas of peat too small to be mapped, and underlie many of the mapped peat deposits (**hp**). Thickness generally 2-20 m

lsa LAKE SAND—Pale-yellowish-brown to brown, fine to medium sand containing local lenses of pebbly or gravelly sand or silt and clay. Sand is composed chiefly of quartz and feldspar grains. Deposits represent beach, near-shore, and offshore sediment. Locally, they include delta sand, deposited where a stream entered a former lake. In places they are covered by less than 1 m of unmapped windblown sand. Lake sand thickness 1 to more than 3 m

lga LAKE SANDY GRAVEL—Pebble and cobble gravel, composed chiefly of subrounded to rounded, well-sorted clasts of a variety of resistant igneous and metamorphic rock types in a brown to gray

matrix of medium to coarse sand. Deposits represent the sediments of beaches, offshore bars, and spits of glacial lakes. Thickness 1 to more than 4 m

gg OUTWASH SAND AND GRAVEL—Pale-brown to gray, medium to coarse sand interbedded with or including lenses of pebble and cobble gravel. Well sorted; poorly to well stratified; may contain scattered boulders, especially at base and surface of deposit. Lithology of clasts varies with that of bedrock and till in same region. In eastern part of map, clasts are chiefly of resistant metamorphic and igneous rock types. Deposits underlie terraces, whose surfaces may be smooth, pitted, or extensively collapsed. In places they are covered by less than 2 m of unmapped loess. In Wisconsin, unit locally includes some sand and gravel of late Wisconsin age and alluvium of Holocene age. Thickness 2-100 m

gs OUTWASH SAND—Pale-brown to gray, coarse to fine sand with local beds and lenses of pebble to cobble gravel. Well sorted; generally well stratified. Sand is composed chiefly of quartz and feldspar grains. Larger clasts are chiefly resistant rock types; lithology varies with that of bedrock and till in same region. Map unit includes some large delta deposits in Minnesota. Deposits occur as channel fills and beneath terraces and outwash plains; surfaces may be smooth, pitted, or collapsed. Locally covered by less than 2 m of unmapped loess. In Wisconsin, unit locally includes some sand or gravelly sand of pre-late Wisconsin age, and alluvium of Holocene age. Thickness 1 to more than 100 m

ks ICE-CONTACT SAND—Yellowish-brown or reddish-brown to gray, fine to coarse sand with minor silt. Poorly sorted; poorly to well stratified; commonly exhibits penecontemporaneous faults, folds, and slump and collapse structures. Locally includes some till. Deposits occur in small kame ridges or mounds and in eskers or ice-fracture fillings. In places, they are covered by less than 2 m of unmapped loess. Unit is mapped only in Wisconsin. Thickness of mapped deposits commonly 5-10 m, locally as great as 30 m

kg ICE-CONTACT SAND AND GRAVEL—Yellowish-brown or reddish-brown to gray, fine to coarse sand and gravel with minor silt. Poorly sorted; poorly to well stratified; commonly exhibits penecontemporaneous faults, folds, and slump and collapse structures. Locally includes some till. Textures variable laterally and vertically. Clasts are rounded to subangular, and range from granules to boulders; clasts chiefly crystalline rocks in Minnesota and of a wide variety of resistant rock types in Wisconsin. Deposits occur in small kame ridges or mounds and in eskers and ice-fracture fillings. In places, deposits are covered by less than 2 m of unmapped loess. Unit is mapped only in Wisconsin. Thickness of mapped deposits commonly 5-10 m, locally as great as 30 m

tce CLAYEY TILL—Reddish-brown and brown clay loam and silty clay loam, locally with interbedded silt or clay. Calcareous to noncalcareous; nonsorted to poorly sorted. Rounded to subangular pebbles, cobbles, and boulders of granite, gabbro, mafic volcanic rock, schist, slate, red sandstone, and conglomerate are abundant. Matrix is dominantly illite, kaolinite, and smectite. Loess cover very thin and patchy or absent

tce Ground moraine—Thickness generally 1-3 m

tce Ground moraine under Lake Superior

tce End moraine—Broad, low ridges; thickness generally 2-5 m

tcf CLAYEY TILL—Olive-gray to dark-gray, clay loam and silty clay loam; reddish brown or brown in central northeastern Minnesota. Calcareous; nonsorted to poorly sorted. Contains pebbles and cobbles of shale and limestone. Loess cover very thin or absent

tcf Ground moraine—Thickness 2-20 m

tcf End moraine—Broad ridges, locally with hummocky topography; thickness as much as 50 m

tcf Stagnation moraine—Broad, irregular areas of hummocky topography without distinct moraine ridges; thickness as much as 50 m

tlf LOAMY TILL—Reddish-brown silt loam and sandy silt loam. Noncalcareous; nonsorted to poorly sorted. Subangular to subrounded pebbles, cobbles, and boulders of granite, gabbro, resistant mafic volcanic rock, schist, red sandstone, and conglomerate are abundant. Loess cover thin or absent

tlf Ground moraine—Thickness 3-5 m

tlf End moraine—Broad, low ridges; thickness generally 3-8 m

tlg LOAMY TILL—Dark-brown or olive-gray to dark-gray, silt loam and loam. Calcareous; nonsorted to poorly sorted. Contains pebbles and cobbles of shale and limestone. Thin patchy loess cover locally

tlg Ground moraine—Thickness 2-30 m

tlg End moraine—Broad ridges, locally with hummocky topography; thickness as much as 50 m

tlg Stagnation moraine—Broad, irregular areas of hummocky topography without distinct moraine ridges; thickness as much as 50 m

tlh LOAMY TILL—Yellowish-brown silt loam and loam. Calcareous; nonsorted to poorly sorted. Pebbles and cobbles of shale and limestone are common to rare. Ground moraine; mapped only near south edge of quadrangle. Locally covered by less than 2 m of unmapped loess. Thickness 5-15 m

tdb SANDY LOAMY TILL—Brown sandy loam, loamy sand, and loam. Noncalcareous; nonsorted to poorly sorted. Pebbles, cobbles, and boulders of resistant mafic volcanic rock, sedimentary rock, granite, gabbro, schist, red sandstone, and conglomerate abundant. Loess cover very thin or absent

tdb Ground moraine—Thickness 5-15 m

tdb Ground moraine under Lake Superior

tdb End moraine—Broad ridges, locally with hummocky topography; thickness 5-25 m

tdb Stagnation moraine—Broad irregular areas of till characterized by hummocky topography, but lacking distinct morainal ridges; thickness as much as 50 m

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

tdc SANDY LOAMY TILL—Yellowish-brown and brown, sandy loam and loam. Calcareous; nonsorted to poorly sorted. Clasts abundant; pebbles are predominantly limestone and sandstone; cobbles and boulders are predominantly granite, greenstone, gabbro, gneiss, and schist; little or no shale. Locally covered by less than 2 m of unmapped loess

tdc Ground moraine—Thickness 5-25 m

tdc Stagnation moraine—Broad, irregular areas of hummocky topography without distinct moraine ridges; thickness as much as 30 m

EARLY WISCONSIN

tde SANDY LOAMY TILL—Sandy loam and loam; ("Old Red Drift" of Minnesota) brown in the south-central part of quadrangle and reddish brown in the southeastern part. Noncalcareous; nonsorted to poorly sorted. Subrounded to subangular pebbles, cobbles, and boulders of gabbro, felsite, and red sandstone are abundant. In Minnesota, material is chiefly ice contact stratified drift. Deposit may represent more than one glacial advance. In Minnesota and southwestern Wisconsin, deposit commonly covered by Wisconsin loess. Distribution of loess cover more than 2 m thick shown by pattern

tde Ground moraine—Thickness generally 1-5 m

tde End moraine—Occurs as broad, low, smoothly sloping ridge segments; thickness as much as 10 m

tdf SANDY LOAMY TILL—Yellowish-brown and brown, sandy loam and loam. Calcareous; nonsorted to poorly sorted. Clasts abundant; pebbles are predominantly limestone and sandstone; cobbles and boulders are predominantly granite, greenstone, gabbro, gneiss, and schist; little or no shale. Locally covered by less than 2 m of unmapped loess

PRE-WISCONSIN

tlp LOAMY TILL—Yellowish-brown silt loam and loam. Generally noncalcareous; nonsorted to poorly sorted; locally very sandy; contains abundant subrounded to subangular pebbles, cobbles, and boulders of granite, gneiss, schist, limestone, and sandstone; shale clasts are lacking. Map unit probably includes deposits of more than one glacial advance. Till occurs as ground moraine; thickness generally 3-30 m, maximum 10 m in Wisconsin. In places the till is absent and the map unit is comprised of colluvium, residuum, and sheetwash alluvium (**ca**, **cr**). Locally in southwestern Wisconsin, deposit is covered by Wisconsin loess. Distribution of loess cover more than 2 m thick shown by pattern

PRE-ILLINOIAN

tlk LOAMY TILL—Yellowish-brown silt loam and loam ("Eastern Old Gray Drift" in Minnesota). Generally calcareous; nonsorted to poorly sorted; locally very sandy; contains abundant subrounded to subangular pebbles, cobbles, and boulders that are chiefly of limestone, but some are of granite, greenstone, schist, and sandstone. Map unit probably includes deposits of more than one glacial advance. Till is chiefly ground moraine. Thickness generally 3-30 m. In places till is absent and map unit is comprised of colluvium, residuum, and sheetwash alluvium (**ca**, **cr**). Map unit covered by Wisconsin loess as much as 4 m thick. Distribution of loess cover more than 2 m thick shown by pattern

ggp OUTWASH SAND AND GRAVEL—Yellowish-brown, fine to coarse sand or pebbly sand, commonly interbedded with pebble or cobble gravel. Calcareous; poorly sorted to well sorted; irregularly stratified. Textures vary laterally and vertically. Rounded pebbles and cobbles are chiefly granite, greenstone, schist, limestone, and sandstone; shale clasts are lacking. Locally covered by Wisconsin loess. Distribution of loess cover 2 m or more thick shown by pattern. Thickness of sand and gravel ranges from 2-20 m

PLEISTOCENE

cr COLLUVIUM[1]—Red, reddish-brown, or brown, noncalcareous to weakly calcareous, clay, sandy clay, and clayey sand. Poorly sorted to well sorted; massive to well stratified; clast-free to chaotic boulder rubble. Includes remnants of till and erratics in western part of map unit area in Minnesota

Much of the colluvium is clayey residuum that moved downslope by solifluction and creep. Chert fragments in the clayey colluvium commonly occur in lenses, layers, or pebble bands parallel to the slope. Discontinuous and generally thin patches of fissile, blocky, or stiff structureless residual clay with scattered chert fragments underlie the colluvium and overlie dolomite and limestone bedrocks locally

Where derived chiefly from sandstone and quartzite bedrock, the colluvium is sandy clay or clayey sand, with angular to subangular boulders, cobbles, and pebbles of sandstone and quartzite. Locally block fields, block streams, and talus are composed of boulders and cobbles of chert, sandstone, quartzite, dolomite, and limestone. Colluvium occurs on nearly all upland slopes steeper than 3-5°. Thickness generally 0.5-3 m. Deposit locally covered by Wisconsin loess. Distribution of loess cover more than 2 m thick shown by pattern. Locally the colluvium and unmapped loess are covered by unmapped eolian sand as much as 5 m thick

[1]For purposes of this map, colluvium is a general term for material transported and deposited by mass-wasting processes, in this area chiefly solifluction and creep. Sheetwash alluvium is material transported and deposited by running water, chiefly by sheetflow or rill wash. Residuum is material derived in place by solution and decomposition of bedrock with no appreciable lateral transport.

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