

The Quaternary Period comprises the "Great Ice Age" or Pleistocene Epoch, which began about 2 million years ago and ended only about 10 thousand years ago. It also includes the Holocene or Recent Epoch, which spans the last 10 thousand years. By comparison with bedrock formations in Minnesota, which range from about 100 million to more than 3,500 million years in age, Quaternary formations represent only a very small part of the state's geologic history. However, glacial drift spread by Pleistocene ice sheets covers most of Minnesota and ranges to hundreds of feet in thickness, so that Quaternary geology is the major influence on topography, soils, water, and land uses—in short, the environment of Minnesota.

Quaternary geologic units are unconsolidated sedimentary materials deposited by water, wind and plant growth, and by glacial ice and meltwaters. This map portrays the distribution of Quaternary formations. Outcrops of bedrock, which are common only in the northeast and along larger river valleys in the south, are not shown on this map.

HOLOCENE DEPOSITS

hp PEAT—Accumulations of partially decayed vegetation, especially mosses, reeds and sedges, in wet, poorly-drained areas. Peat is valuable as an organic soil conditioner and chemical feedstock and as a potential energy resource. It is a very poor base for roads and other construction.

ha ALLUVIUM—Sand and gravel, locally interbedded with silt, clay and organic material, deposited on present floodplains. Sand and gravel deposits, copious shallow ground water and flat terrain make alluvial plains attractive for urban and industrial development, but they are flood-prone, and sensitive to pollution. They are valuable for agriculture and wildlife.

PLEISTOCENE DEPOSITS

There were four major ice advances in North America during the Pleistocene Epoch: the Nebraskan, Kansan, Illinoian and Wisconsinan Glaciations. Each lasted tens of thousands of years and was followed by a warmer period when the ice melted. Each deposited sediments, called drift, over vast areas. Drift deposited during the last stage of the Wisconsinan Glaciation covers most of Minnesota and conceals evidence of older ice advances except in the southeast and southwest corners of the state.

Redistributed Drift

Some drift deposited by glaciers was quickly eroded, transported and redeposited by water and wind in lakes, on floodplains and on land beyond the margin of the ice.

pl GLACIAL LAKE DEPOSITS—Clay, silt and sand with local gravel bars and beaches deposited on the beds and margins of extensive lakes that existed when outlets for meltwater were blocked by ice or by glacial deposits which have now eroded away. Major glacial lakes were: Lake Agassiz in northwestern and north-central Minnesota, Lakes Upham and Aitkin northwest of Duluth, and Lake Minnesota south of Mankato. Due to the prevalence of fine silt and clay, glacial lake deposits present drainage and construction problems and tend to be poor ground-water sources. They form extensive areas of flat farmland, notably the Red River Valley.

pt TERRACE DEPOSITS—Stratified sand and gravel with some interbedded silt and clay occurring along stream valleys above the level of present floodplains. During glacial melting, stream-flow was larger than at present, and floodplains were built up by glacial sediments. Recent streams have cut into older floodplains leaving remnants as terraces. Terrace tops are commonly flat and well drained. They are attractive for residential and industrial development, but they also contain valuable sand and gravel resources.

pe LOESS—Eolian silt and fine sand blown from unvegetated drift exposed along major glacial streams. Loess is shown on the map for areas where it is commonly more than 2 meters (6.5 feet) thick. Excellent agricultural soils are formed in loess.

po OUTWASH—Sand, silt and gravel carried from glaciers by meltwater and spread over wide areas. The deposits are typically sorted into discontinuous and interfingering beds of silt, sand and gravel called stratified drift. Outwash plains have flat topography, sandy soils, and many gravel deposits. Shallow ground water is commonly abundant for irrigation.

Late Wisconsinan Drift Deposited Directly From Glaciers

The ice of each glaciation accumulated in northern Canada and moved southward in a complex series of tongue-like extrusions or lobes. Near the center of ice accumulation, the moving ice scoured the land surface down to hard bedrock and picked up a load of rock fragments and soil. Farther from the center the ice deposited this drift from its base. Areas of ice-scoured, exposed bedrock occur mainly in northeastern Minnesota; deposition predominated throughout the rest of the state. Drift deposited directly from ice is called till. In general, till is an unsorted mixture of all sizes of rock from boulders to clay and "rock flour." It tends to be stiff, stony and impervious. Till of different lobes differs in composition depending on the geology "upstream" along the path of the advancing ice.

Till deposited from the base of an ice lobe forms a smooth to undulating blanket called a ground moraine. Such till is stiff and compact; it yields little ground water.

Till deposited at ice margins or from stagnating masses of melting ice forms irregular pitted to hilly topography with many ponds and lakes. These landforms are called end moraines, recessional moraines and stagnation moraines. These deposits may contain pockets of sand, gravel and boulders with some local ground water.

pms **pmh** DES MOINES LOBE TILL—Smooth to undulating moraine (pms) and pitted to hilly moraine (pmh). The Des Moines lobe is the most recent glacial lobe. It advanced through the Red River Valley into Iowa. Sublobes extended eastward into the St. Louis River basin and northeastward across Minneapolis and St. Paul, incorporating drift from earlier lobes. Des Moines lobe till is typically clay-rich. It is mainly composed of gray (olive-brown where oxidized) calcareous silt and clay, with lesser amounts of sand and gravel. Shale and limestone are diagnostic.

pss **psh** SUPERIOR LOBE TILL—Smooth to undulating moraine (pss) and pitted to hilly moraine (psh). Ice of the Superior lobe moved out of the Lake Superior basin in several pulses, spreading westward across the Mille Lacs area and southward across the Minneapolis-St. Paul area. It interacted with the partly contemporaneous Rainy lobe along the Laurentian Divide. Superior lobe till is generally reddish-brown, sandy to stony, and non-calcareous; it contains abundant fragments of volcanic, granitic, gabbroic and metamorphic rocks, red sandstone and conglomerate. Where it incorporates earlier lake deposits, it is locally silty or clayey.

prs **prh** RAINY LOBE TILL—Smooth to undulating moraine (prs) and pitted to hilly moraine (prh). The Rainy lobe moved southward into Minnesota along a broad front from Lake of the Woods almost to Lake Superior, where it met ice from the Lake Superior basin along the Laurentian divide and moved southwestward. It advanced to the vicinity of Little Falls overriding drift and perhaps encountering ice remaining from the earlier Wadena lobe. Part of the Rainy lobe drift area was later overridden by the St. Louis sublobe of the Des Moines lobe. Rainy lobe till is grayish brown (moderate brown where oxidized), non-calcareous and generally sandy with abundant fragments of granitic, metamorphic and greenstone volcanic rocks.

pws **pwh** WADENA LOBE TILL—Smooth to undulating moraine (pws) and pitted to hilly moraine (pwh). The Wadena lobe was the earliest of the Late Wisconsinan glacial lobes. A large remnant of its till and outwash survives in northwest-central Minnesota in an area that was not overridden by any of the three later lobes. A large drumlin field indicates movement of ice from the north or a little east of north. Wadena lobe till is gray (yellowish brown where oxidized) and calcareous with fragments of igneous and metamorphic rocks, some limestone and little or no shale.

Pre-Late Wisconsinan Materials

At one time or another, prior to the Late Wisconsinan, all of Minnesota must have been covered by glaciers. Evidence is concealed beneath Late Wisconsinan drift except in the southwestern and southeastern corners of the state where there are deposits of weathered and stream-dissected drift that are older than Late Wisconsinan and could be Illinoian or Kansan in age.

ph OLD RED DRIFT—Moderate to dusky-brown till and outwash found mainly in Dakota and southern Washington Counties. Fragments of gabbro, felsite and red sandstone are notable. Some exposures show a distinct weathered profile overlain by younger drift.

pd EASTERN OLD GRAY DRIFT—Moderate yellowish-brown weathered silty till and outwash. It contains fragments of igneous and metamorphic rocks, limestone and sandstone, but lacks shale. It appears to underlie Old Red Drift in southern Dakota County.

pg WESTERN OLD GRAY DRIFT—Dark-gray, strongly weathered, clayey, stream-dissected till and outwash with fragments of quartzite, granite and limestone.

pp RESIDIUM—Soils of uncertain age and origin, including some old weathered drift and loess, on weathered pre-Quaternary rocks.

GEOLOGIC MAP OF MINNESOTA
QUATERNARY GEOLOGY

by
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SCALE 1:3,168,000
1 inch = 50 miles
0 50 100 Miles
0 50 100 Kilometers