UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
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COUNTY ATLAS SERIES
ATLAS C-14, PART A
Plate 3—Surficial Geology

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

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 30 METERS

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SURFICIAL GEOLOGY

By

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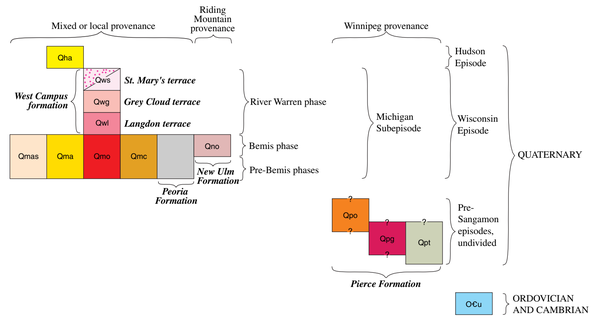
2001

CORRELATION OF MAP UNITS



INTRODUCTION

This map shows the surface distribution of different Quaternary sediments, and areas where these sediments are thin or absent. Most of the Quaternary deposits on this map are assigned to informal lithostratigraphic units that have been modified from units previously defined by Matsch (1962 and 1972), Stone (1966), Mickelson and others (1984), and Hansel and Johnson (1996). The Correlation of Map Units incorporates a scheme developed by Johnson and others (1997) for the division of the late Quaternary into episodes that emphasize the diachronic nature of the different units. The Michigan Subepisode of the Wisconsin Episode replaces the late Wisconsinan glaciation of earlier publications, and the Hudson Episode is the current interglacial or postglacial time—the time since the Michigan Subepisode deglaciation. Mapping units are introduced with a word or short phrase indicating the mode of deposition, followed by a description of the sediment. The units are distinguished from each other by texture, provenance, stratigraphic position and landscape position.

Glacial provenance refers to the bedrock area from which a glacial lobe or sector derived the bulk of its sediment, or at least a distinctive, recognizable part of it. The provenance is most easily recognized by the assemblage of stones and granules in the sediment. The outwash and terrace deposits in the Mississippi River valley include contributions from all of the glacial lobes that advanced into Minnesota and western Wisconsin; therefore they are mixed provenance. Colluvium (Qmc) is composed dominantly of local rocks; therefore it is local provenance. The fluvial and eolian units (Peoria Formation, Qha, Qma, and Qmas) are mixed provenance with a variable amount of local material. Table 1 summarizes the general characteristics of three important provenances in Wabasha County. Till (unsorted glacial sediment deposited directly by ice) is included in the table, even though till of Riding Mountain and Superior provenance is not mapped in Wabasha County. It is important to remember that all provenances are mixed to some extent, because glaciers may erode older glacial sediment of differing provenance in addition to bedrock. Similarly, outwash changes in composition downstream from the former ice margin by water eroding older material and breaking apart softer rocks.

The map was compiled from descriptions and samples taken from excavations, natural exposures, soil borings, and cuttings from water wells. The samples were supplemented by water well records, soil boring logs, and the county soil survey. Topographic maps and aerial photographs were used to interpret the landforms and help determine line placement.

MAP SYMBOLS

Geologic contact—Approximately located.

General flow direction of braided streams—Arrows point downstream in the direction that water once flowed.

Abandoned valley segment—Eroded and obscure; ticks point downslope. Valley segment no longer occupied by a through-flowing stream; bottom is higher than the current stream level. Remnant of a former stream course.

Meander scar—Dashed where older, more obscure, and generally higher above stream level; ticks point downslope; bedrock core shown where present. Symbol represents abandoned meander loop that was formed during an earlier phase of the stream.

DESCRIPTION OF MAP UNITS

QUATERNARY

Qha **Floodplain alluvium**—Chiefly fine sand and silt on floodplains; includes sand and gravel that infills modern river channels. Some depressions have been filled with thick silty to clayey sediment. Includes minor lakeshore sediment along Lake Pepin. Contacts with other map units are commonly scarps.

West Campus formation (Meyer and Patterson, 1999)—Sand and gravelly sand; coarsens to cobbly gravel in places. The sediment is largely reworked from the Mississippi valley train (Qmo) of mixed provenance, but dominated by Superior provenance (Table 1). Deposited during early, high stages of the Mississippi River and preserved in terraces above the modern floodplain. The West Campus formation is mapped at three major terrace levels in Wabasha County.

Qws ***St. Mary's terrace*** (Meyer, 1999)—Sand and gravel covered by 25–60 feet (7–18 m) of sand. The terrace is 10–20 feet (3–6 m) above the present floodplain level. In the riverfront area of downtown Wabasha, the contact of this terrace with the higher level Grey Cloud terrace is a smooth slope rather than a scarp. These terrace sediments are also present where a channel separates Grey Cloud terrace from the higher Langdon terrace at Lake City. A pattern denotes sand dunes and blowouts. The sand dunes create relief up to 50 feet (15 m) and consist of chiefly fine- to medium-textured clean sand, lacking gravel.

Qwg ***Grey Cloud terrace*** (Matsch, 1962)—The terrace is 40–50 feet (12–15 m) above Lake Pepin and the present floodplain level. The terrace elevation is 700–710 feet (214–216 m) in Lake City and Wabasha. Most contacts with other map units are scarps.

Qwl ***Langdon terrace*** (Matsch, 1962)—The terrace is about 70 feet (21 m) above Lake Pepin, and about 735 feet (224 m) in elevation near Lake City. South of Kellogg, the terrace ranges from 720 to 740 feet (235 to 242 m) in elevation, and lies 55 to 75 feet (18 to 25 m) above the floodplain. Most contacts with other map units are scarps.

Qmo **Mississippi valley train**—Sand, gravelly sand, and gravel. Deposited in the Mississippi River valley by glacial meltwater. Preserved in the highest terrace along the Mississippi River at an elevation of 760–780 feet (232–238 m). The only area where it is mapped at the surface is west of Lake City; however, it occupies virtually the whole Mississippi River valley, underlying the West Campus formation, the floodplain alluvium (Qha), and the sediments of Lake Pepin. Commonly extends down to bedrock, which in many places is 150–250 feet (45–75 m) below the floodplain.

Qma **Sandy alluvium and slopewash**—Sand and gravelly or loamy sand. Forms aprons at the foot of colluvium-mantled bedrock escarpments. Present as terraces above the modern floodplain at elevations grading down to the level of Michigan Subepisode outwash (Qmo and Qno). Also underlies and is thicker than modern alluvium (Qha). May include fine slackwater sediment where it merges downstream with outwash. Pebble assemblage is a mixture of local bedrock fragments derived from valley walls and material derived from glacial sediments on the uplands. Where the modern alluvium (Qha) is too thin or narrow to show on the map, the valley fill is mapped as Qma.

Qmas **Slackwater sediment**—Silty alluvium. Mapped along small tributaries of the Mississippi River, where aggradation of the Mississippi valley train caused local ponding. The mapping of Qma in relation to Qmas is greatly simplified at this map scale. Modern stream systems have cut small valleys into the Michigan alluvium (Qma and Qmas) and deposited modern alluvium (Qha) therein.

Qmc **Colluvium**—Angular, unsorted fragments of local bedrock, typically overlain by unbedded to poorly bedded silt that contains a few angular rock clasts. The rock fragments are derived from mechanical weathering of the bedrock that forms the hillslopes above. Rare glacial erratics are sometimes observed, derived from drift on the uplands. The silts are mudflow and slopewash deposits derived from loess on the uplands. Loess where the colluvium merges downslope into terrace flats is generally this reworked loess (see Figure 2). The thickness of both units typically diminishes upslope, where bedrock outcrops are common.

Peoria Formation (Hobbs, 1999)—Eolian sediment. Consists of a loess facies and an eolian sand facies. In Wabasha County, the eolian sand facies is buried by loess and unknown in detail, and therefore not mapped. Eroded and transported by wind from outwash plains and older till surfaces. Generally deposited southeast of its source area. Shown on this map only where thicker than 5 feet (1.5 m), although thin Peoria Formation extends across much of the map area.

Loess—Shown as gray overlay in Figure 2. Chiefly silt, it includes some very fine sand and clay. The clay was probably deposited as silt-sized aggregates. The overall grain size decreases from northwest to southeast across the map area. The loess is underlain by patchy eolian sand, which is clean, fine to medium grained, and lacks gravel.

New Ulm Formation (Meyer and Patterson, 1999)—Glaciofluvial sediment, mostly of Riding Mountain provenance (Table 1), deposited by meltwater associated with the last glacial advance into the region, which did not enter Wabasha County. May include outwash from more than one ice advance.

Qno ***Outwash***—Sand, gravelly sand, and gravel. Deposited along the Zumbro River by meltwater issuing from the ice margin of the Des Moines lobe at or near its maximum advance during the Michigan Subepisode (Fig. 1). Clasts of Superior provenance (Table 1) eroded from older deposits are common, and are generally more abundant in the branch of the Zumbro that enters the county from the south. Shale content ranges from rare to uncommon in Wabasha County because it is easily broken down in stream transit. This outwash is underlain in places by older outwash (Qpo), and is probably also underlain in places by sandy alluvium (Qma). Commonly capped by a mantle of loess less than 4 feet (1.3 m) thick.

Pierce Formation (Mickelson and others, 1984)—Glacial and glaciofluvial deposits of Winnipeg provenance (Table 1). In Wabasha County it represents deposits of more than one glacial advance.

Qpo ***Outwash***—Chiefly sand and gravel, well sorted. Contains a truncated paleosol in its upper part. Forms discontinuous terraces above the level of New Ulm Formation outwash (Qno). Deposited during more than one glacial advance. Distinguished from the glaciofluvial deposits (Qpg) because it occupies existing valleys.

Qpt ***Till***—Chiefly loam-textured diamicton (unsorted mixture of sand, silt and clay) with minor pebbles, cobbles and boulders; dense and firm in most places. Includes lenses of sorted sand and gravel locally. Originally gray and calcareous, the surface is now highly oxidized and deeply leached in most places.

Qpg ***Glaciofluvial deposits***—Fine sand to coarse gravel, well sorted. Strongly weathered to a depth of 10 feet (3 m) or more. Sand and gravel are coated with reddish-brown clay (paleo-B horizon) in the upper part of the deposit. Below the leached zone it contains many carbonate clasts. Stones in the paleosol typically break apart easily. It is overlain in places by till less than 5 feet (1.5 m) thick. Distribution of Qpg shows little or no relation to modern stream valleys. This unit represents the eroded remnants of stratified ice-contact deposits and outwash related to Qpt, and was deposited before the modern stream system developed.

ORDOVICIAN AND CAMBRIAN

OCu **Bedrock, undivided**—Dolostone, limestone, sandstone, and shale of Ordovician age on the uplands; the unit also includes Cambrian sandstone in a structural high in western Wabasha County. See Plate 2 of this atlas for the distribution and a detailed description of bedrock formations. Outcrops of Cambrian rocks along the valley walls of the Mississippi River and associated tributaries are included in the colluvium unit (Qmc). Shown on the map in upland areas where covered by less than 5 feet (1.5 m) of Quaternary sediment. Locally mantled by less than 10 feet (3 m) of sand and clay interpreted either as Cretaceous sedimentary rocks, or bedrock that is deeply weathered. Thus hard, unweathered bedrock may be as much as 25 feet (7.5 m) below the ground surface in places where OCu is mapped.

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Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.

Table 1. Physical characteristics of glacial deposits in Wabasha County.

PROVENANCE	RIDING MOUNTAIN	WINNIPEG	SUPERIOR
TILL TEXTURE	Mostly loamy	Loamy to clayey	Loamy to sandy
TILL COLOR			
Oxidized	Yellow to olive-brown	Yellow-brown	Reddish-brown
Unoxidized	Gray	Gray	Grayish-red
ROCK TYPES IN TILL AND OUTWASH			
Precambrian			
Black to gray-green rock	Uncommon	Uncommon	Common
Red sandstone & felsite	Absent to rare	Rare to uncommon	Uncommon to common
Paleozoic carbonate	Common	Common to abundant	Uncommon
Cretaceous			
Gray shale	Uncommon to abundant	Absent to rare	Absent
Limestone & calcareous shale	Rare to absent	Uncommon	Absent

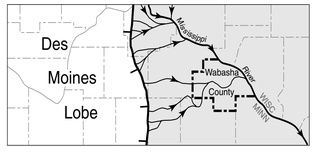

Figure 1. Meltwater flow paths from the Des Moines lobe ice margin to the Mississippi River. The water deposited New Ulm outwash in valleys along these flow paths.

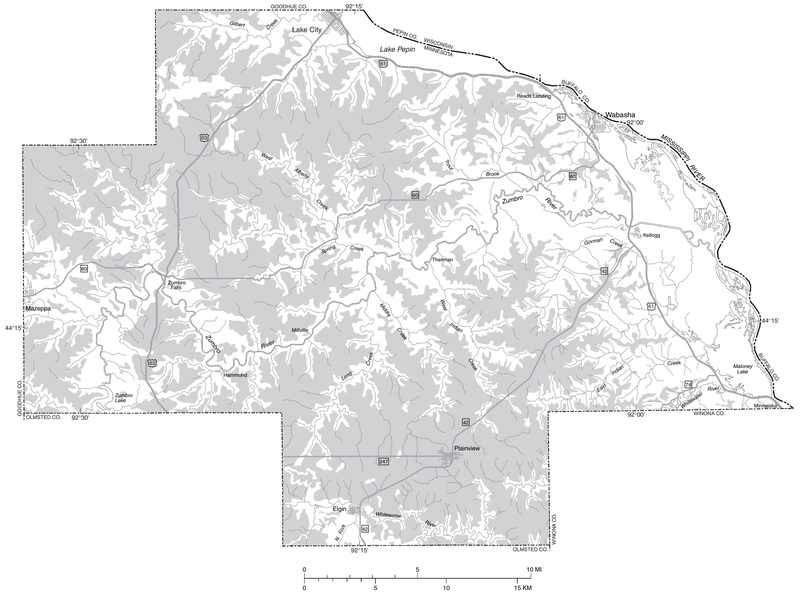

Figure 2. Distribution of loess in the Peoria Formation in Wabasha County. See Description of Map Units for further information.

GEOLOGIC ATLAS OF WABASHA COUNTY, MINNESOTA